Public vs. Private Goods

A polar case of an externality is a *public good*, which is a commodity that can be provided to everyone as easily as it can be provided to one person.

The case par excellence of a public good is national defense. Nothing is more vital to a society than its security. But national defense, as an economic good, differs completely from a *private good* like bread. Ten loaves of bread can be divided up in many ways among individuals, and what I eat cannot be eaten by others. But national defense, once provided, affects everyone equally. It matters not at all whether you are hawk or dove, old or young, ignorant or learned—you will receive the same amount of national security from the Army as does every other resident of the country.

Note therefore the stark contrast: The decision to provide a certain level of a public good like national defense will lead to a number of batallions, airplanes, and tanks to protect each of us. By contrast, the decision to consume a private good like bread is an individual act. You can eat four slices, or two, or none; the decision is purely your own and does not commit anyone else to a particular amount of bread consumption.

The example of national defense is a dramatic and extreme case of a public good. But when you think of a smallpox vaccine, the Hubble telescope, clean drinking water, or many similar government projects, you generally find elements of public goods involved. In summary:

Public goods are ones whose benefits are indivisibly spread among the entire community, whether or not individuals desire to consume the public good. **Private goods,** by contrast, are ones that can be divided up and provided separately to different individuals, with no external benefits or costs to others. Efficient provision of public goods often requires government action, while private goods can be efficiently allocated by private markets.



Global Public Goods

Perhaps the thorniest of all market failures are global public goods. These are externalities whose impacts are indivisibly spread across the entire globe. Important examples are actions to slow global warming (considered later in this chapter), measures to prevent ozone depletion, or discoveries to prevent a global pandemic of avian flu. Global public goods pose particular problems because there are no effective market or political mechanisms available to allocate them efficiently. Markets routinely fail because individuals do not have appropriate incentives to produce these goods, while national governments cannot capture all the benefits of their investments in global public goods.

Why do global public goods differ from other goods? If a terrible storm destroys much of America's corn crop, the price system will guide farmers and consumers to equilibrate needs and availabilities. If America's public road system needs modernization, voters will lobby the government to develop an efficient transportation system. But if problems arise concerning global public goods, such as global warming or antibiotic resistance, neither market participants nor national governments have appropriate incentives to find an efficient outcome. The marginal cost of investments to any individual or nation is much less than the global marginal benefits, and underinvestment is the certain outcome.

MARKET INEFFICIENCY WITH EXTERNALITIES

Abraham Lincoln said that government should "do for the people what needs to be done, but which they cannot, by individual effort, do at all, or do so well, for themselves." Pollution control satisfies this guideline since the market mechanism does not provide an adequate check on polluters. Firms will not voluntarily restrict emissions of noxious chemicals, nor will they always abstain from dumping toxic wastes into landfills. Pollution control is therefore generally held to be a legitimate government function.

Analysis of Inefficiency

Why do externalities like pollution lead to economic inefficiency? Take a hypothetical coal-burning electric utility. Dirty Light & Power generates an externality by spewing out tons of noxious sulfur dioxide fumes. Some of the sulfur harms the utility, requiring more frequent repainting and raising the firm's medical bills. But most of the damage is "external" to the firm, harming vegetation and buildings and causing various kinds of respiratory ailments and even premature death in people.

Eye Therapies Exhibit 2127, 295 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Dirty Light & Power must decide how much to reduce its pollution, but it also has to answer to its profit-oriented shareholders. With no pollution cleanup, its workers, plant, and profits will suffer. Cleaning up every last particle, on the other hand, will be very costly. Such a complete cleanup would cost so much that Dirty Light & Power could not hope to survive in the marketplace.

The managers therefore decide to clean up just to the point where profits are maximized. This requires that the benefits to the firm from additional abatement ("marginal private benefits") be equal to the cost of additional cleanup ("marginal cost of abatement"). Careful economic and engineering calculations might show that the firm's private interests are maximized when abatement is set at 50 tons. At that level, the marginal private benefits equal the marginal costs of $10 per ton. Put differently, when Dirty Light & Power produces electricity in a least-cost manner, weighing only private costs and benefits, it will abate only 50 tons and pollute 350 tons.

Suppose, however, that a team of environmental scientists and economists is asked to examine the overall benefits of abatement to society rather than only the benefits to Dirty Light & Power. In examining the total impacts, the auditors find that the *marginal social benefits* of pollution control—including improved health and increased property values in neighboring regions—are 10 times the marginal private benefits. The impact from each extra ton on Dirty Light & Power is $10, but the rest of society suffers an additional impact of $90 per ton of external costs. Why doesn't Dirty Light & Power include the $90 of additional social benefits in its calculations? The $90 is excluded because these benefits are external to the firm and have no effect on its profits.

We now see how pollution and other externalities lead to inefficient economic outcomes: In an unregulated environment, firms will determine their most profitable pollution levels by equating the marginal private benefit from abatement with the marginal private cost of abatement. When the pollution spillovers are significant, the private equilibrium will produce inefficiently high levels of pollution and too little cleanup activity.

Socially Efficient Pollution. Given that private decisions on pollution control are inefficient, is there a better solution? In general, economists look to determine the socially efficient level of pollution by balancing social costs and benefits. More precisely, *efficiency requires that the marginal social benefits from abatement equal the marginal social costs of abatement.*

How might an efficient level of pollution be determined? Economists recommend an approach known as *cost-benefit analysis,* in which efficient emissions are set by balancing the marginal costs of an action against the marginal benefits of that action. In the case of Dirty Light & Power, suppose that experts study the cost data for abatement and environmental damage. They determine that marginal social costs and marginal social benefits are equalized when the amount of abatement is increased from 50 tons to 250 tons. At the efficient pollution rate, they find that the marginal costs of abatement are $40 per ton, while the marginal social benefits from the last unit removed are also $40 per ton.

The resulting level of pollution is *socially efficient* because such an emissions rate maximizes the net social value of production. Only at this level of pollution would the marginal social cost of abatement equal the marginal social benefit. Here again, as in many areas, we determine the most efficient outcome by equating the marginal costs and benefits of an activity.

Cost-benefit analysis will show why extreme "no-risk" or "zero-discharge" policies are generally wasteful. Reducing pollution to zero would generally impose astronomically high cleanup costs, while the marginal benefits of reducing the last few grams of pollution may be quite modest. In some cases, it may even be impossible to continue to produce with zero emissions, so a no-risk philosophy might require closing down the computer industry or banning all vehicular traffic. Generally, economic efficiency calls for a compromise, balancing the extra value of the industry's output against the extra damage from pollution.

An unregulated market economy will generate levels of pollution (or other externalities) at which the marginal private benefit of abatement equals the marginal private cost of abatement. Efficiency requires that the marginal social benefit of abatement equals the marginal social cost of abatement. In an unregulated economy, there will be too little abatement and too much pollution.

Eye Therapies Exhibit 2127, 296 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Valuing Damages

One of the major difficulties involved in setting efficient environmental policies arises because of the need to estimate the benefits of pollution control and other policies. In cases where pollution affects only marketed goods and services, the measurement is relatively straightforward. If a warmer climate reduces wheat yields, we can measure the damage by the change in the net value of the wheat. Similarly, if a new road requires tearing down someone's house, we can calculate the market value of a replacement dwelling.

Unfortunately, many types of environmental damage are extremely difficult to value. A classic example was the proposal to ban logging across much of the Pacific Northwest in order to preserve the habitat of the spotted owl. That would cost thousands of logging jobs and raise lumber prices. How should we value the benefits in terms of the continued existence of the spotted owl? Or, to take another example, the *Exxon Valdez* oil spill in Prince William Sound, Alaska, damaged beaches and killed wildlife. How much is the life of a sea otter worth?

Economists have developed several approaches for estimating impacts, such as those on owls and otters, that do not show up directly in market prices. The most reliable techniques examine the impact of environmental damage on different activities and then put market-derived values on those activities. For example, in estimating the impact of emissions of sulfur dioxide, environmental economists first estimate the impact of higher emissions on health, and they then place a dollar value on health changes using either survey techniques or estimates that are revealed by people's actual behavior.

Some of the most difficult cases occur in situations that involve ecosystems and the survival of different species. How much should society pay to ensure that the spotted owl survives? Most people will never see a spotted owl, just as they will never see a whooping crane or actually visit Prince William Sound. They may nevertheless place a value on these natural resources. Some environmental economists use a technique called *contingent valuation*, which involves asking people how much they would be willing to pay in a hypothetical situation, say, to keep some natural resource undamaged. This technique will yield answers, but these answers have not always proved to be reliable.

Few would doubt that a healthy and clean environment has a high value, but placing reliable values on the environment, particularly on the nonmarket components, has proved a difficult business.

Graphical Analysis of Pollution

We can illustrate these points with the help of Figure 14-3. The upward-sloping market *MC* curve is the marginal cost of abatement. The downward-sloping curves are the marginal benefits of reducing pollution, with the upper, solid *MSB* line being the marginal social benefit from less pollution while the lower, dashed *MPB* line is the marginal private benefit of abatement to the polluter.



Caution on Graphing Pollution

In analyzing pollution, it is useful to think of pollution control or abatement as a "good." In the graphs, we therefore measure marginal costs and benefits on the vertical axis and the abatement or pollution removed on the horizontal axis. The trick here is to remember that because pollution removal is a good, it is measured positively on the horizontal axis. You can also think of pollution as measured negatively from the far-right point of 400. So abatement of zero is pollution of 400, while abatement of 400 means zero pollution.

The unregulated market solution comes at point *I*, where the marginal private costs and benefits are equated. At this point, only 50 tons are removed, and the marginal private costs and benefits are $10 per ton. But the unregulated market solution is inefficient. We can see this by performing an experiment that increases abatement by 10 tons; this is represented by the thin slice to the right of point *I*. For this additional removal, the marginal benefits are given by the total area of the slice under the *MSB* curve, while the marginal costs are given by the area of the slice under the *MC* curve. The net benefits are that part of the slice shown by the shaded area between the two curves.

The efficient level of pollution comes at point *E*, where marginal social benefits are equated to marginal costs of abatement. At that point, both *MSB* and *MC* are equal to $40 per ton. Also, because *MSB* and *MC* are equal, the experiment of increasing

Eye Therapies Exhibit 2127, 297 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

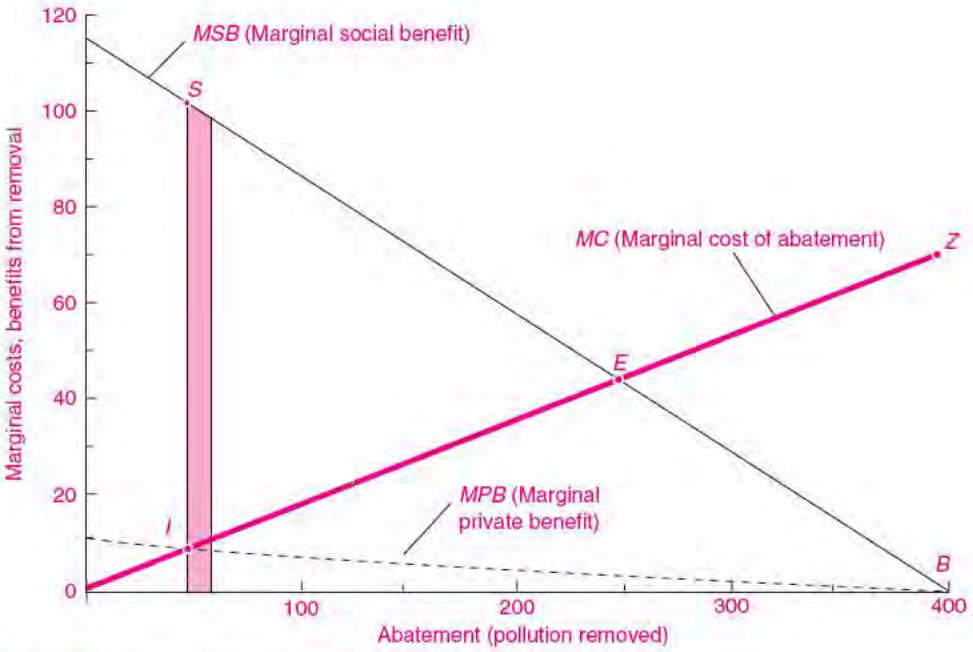


FIGURE 14-3. Inefficiency from Externalities

When marginal social benefit (*MSB*) diverges from marginal private benefit (*MPB*), markets will generate unregulated equilibrium at *I*, with too little abatement or pollution cleanup. Efficient cleanup comes at *E*, where *MSB* equals *MC*.

abatement by a tiny amount will find that there is no difference between the curves, so there is no net benefit from additional pollution control. We can also measure the net benefits of the efficient solution relative to the unregulated market by taking all the little slices of net benefit from the shaded slice to point *E*. This calculation shows that the area *ISE* represents the gains from efficient removal of pollutants.

POLICIES TO CORRECT EXTERNALITIES

What are the weapons that can be used to combat inefficiencies arising from externalities? The most visible activities are government antipollution programs that use either direct controls or financial incentives to induce firms to correct externalities. More subtle approaches use enhanced property rights to give the private sector the instruments for negotiating efficient solutions. We survey these approaches in this section.

Government Programs

Direct Controls. For almost all pollution, as well as other health and safety externalities, governments rely on direct regulatory controls; these are often called *social regulations*. For example, the 1970 Clean Air Act reduced allowable emissions of three major pollutants by 90 percent. In 1977, utilities were told to reduce sulfur emissions at new plants by 90 percent. In a series of regulations, firms were told they must phase out ozone-depleting chemicals. And so it goes with regulation.

How does the government enforce a pollution regulation? To continue our example of Dirty Light & Power, the state Department of Environmental Protection might tell Dirty Light & Power to increase its abatement to 250 tons of pollution. Under *command-and-control regulations*, the regulator would simply order the firm to comply, giving detailed instructions on what pollution-control technology to use and where to apply it. There would be little scope for novel approaches or tradeoffs within the

Eye Therapies Exhibit 2127, 298 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

firm or across firms. *If* standards are appropriately set—a very big "if"—the outcome might approach the efficient pollution level described in the previous part of this section.

While it is possible that the regulator might choose a combination of pollution-control edicts that guarantees economic efficiency, in practice that is not very likely. Indeed, much pollution control suffers from extensive inefficiencies. For example, pollution regulations are often set without comparisons of marginal costs and marginal benefits, and without such comparisons there is no way to determine the most efficient level of pollution control.

In addition, standards are inherently a very blunt tool. Efficient pollution reduction requires that the marginal cost of pollution be equalized across all sources of pollution. Command-and-control regulations generally do not allow differentiation across firms, regions, or industries. Hence, regulations are usually the same for large firms and small firms, for cities and rural areas, and for high-polluting and low-polluting industries. Even though firm A might be able to reduce a ton of pollution at a tiny fraction of the cost to firm B, both firms will be required to meet the same standard; nor will there be any incentives for the low-cost firm to reduce pollution beyond the standard even though it would be economical to do just that. Study after study has confirmed that our environmental goals have proved unnecessarily costly when we use command-and-control regulation.

Market Solution: Emissions Fees. In order to avoid some of the pitfalls of direct controls, many economists have suggested that environmental policy rely instead on market-type regulations. One approach is the use of *emissions fees*, which would require that firms pay a tax on their pollution equal to the amount of external damage it causes. If Dirty Light & Power were imposing external marginal costs of $35 per ton on the surrounding community, the appropriate emissions charge would be $35 per ton. This is in effect *internalizing* the externality by making the firm pay the social costs of its activities. In calculating its private costs, Dirty Light & Power would find that, at point *E* in Figure 14-3, an additional ton of pollution would cost $5 of internal costs to the firm plus $35 in emissions fees, for an overall marginal cost of $40 per ton of pollution. By equating the new marginal *private* benefit (private benefit plus emissions fee) with the marginal abatement cost, the firm would set its abatement at the efficient level. *If* the emissions fee were correctly calculated—another big "if"—profit-minded firms would be led as if by a mended invisible hand to the efficient point where marginal social costs and marginal social benefits of pollution are equal.

The alternative approaches are shown graphically in Figure 14-4, which is similar to Figure 14-3. With the direct-control approach, the government instructs the firm to remove 250 tons of pollutants (or to emit no more than 150 tons). This would, in effect, place the standard at the heavy vertical line. If the standard were set at the right level, the firm would undertake the socially efficient level of abatement. Hence, with efficient regulation, the firm will choose point *E*, where *MSB* equals *MC*.

We can also see how emissions fees would operate. Suppose that the government levies a fee of $35 per ton of pollution. Including the fee, the marginal private benefit of abatement would

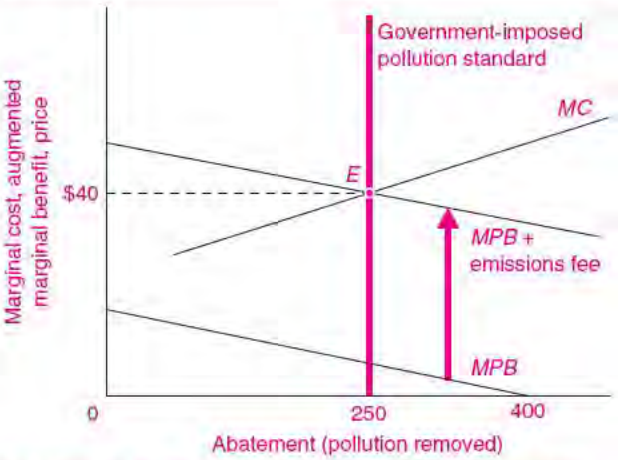


FIGURE 14-4. Pollution Standards and Emissions Fees

When government sets the pollution limitation at 150 tons, or requires removal of 250 tons, this standard will lead to efficient pollution at point *E*.

The same result can be achieved with pollution fees of $35 per ton. The $5 *MPB* plus the emissions fee gives a total marginal benefit of $40 at an abatement of 250 tons. Hence the augmented marginal benefit curve (*MPB* + emissions fee) equals *MC* at the efficient level, *E*.

Eye Therapies Exhibit 2127, 299 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

rise from $5 to $40 per ton. We show this as the augmented marginal-private-benefit schedule in Figure 14-4. Faced with the new incentives, the firm would choose efficient point E in Figure 14-4.

Market Solution: Tradeable Emissions Permits. A new approach that does not require the government to legislate taxes is the use of tradeable emissions permits. With this approach, instead of telling firms that they must pay $\$x$ per unit of pollution and then allowing firms to choose the level of pollution, the government chooses the level of pollution and allocates the appropriate number of permits. The price of permits, which represents the level of the emissions fee, is then set by supply and demand in the market for permits. Assuming that firms know their costs of production and abatement, the tradeable-permits approach has the same outcome as the emissions-fee approach.



Economic Innovations: Trading Pollution Permits

Most environmental regulations use a command-and-control approach that limits the emissions from individual sources, such as power plants or automobiles. This approach cannot cap overall emissions. More important, it virtually guarantees that the overall program is inefficient because it does not satisfy the condition that emissions from all sources must have equal marginal costs of abatement.

In 1990, the United States introduced a radical new approach to environmental control in its program on control of sulfur dioxide, which is one of the most harmful environmental pollutants. Under the 1990 Clean Air Act amendments, the government allocates a limited number of pollution permits. The total number of tons permitted for the country has been gradually reduced since 1990. The innovative aspect of the plan is that the permits are freely tradeable. Electric utilities receive pollution permits and are allowed to buy and sell them with each other just like pork bellies or wheat. Those firms which can reduce their sulfur emissions most cheaply do so and sell their permits to pollute; other firms which need additional permits for new plants or have no leeway to reduce emissions find it economical to buy permits rather than install expensive antipollution equipment or shut down.

Environmental economists believe that the enhanced incentives allow the ambitious targets to be met at a much lower cost than would be paid under traditional command-and-control regulation. Studies by economist Tom Tietenberg of Colby College in Maine have determined that the traditional approaches cost 2 to 10 times as much as would cost-effective regulations like emissions trading.

The behavior of this market has produced a big surprise. Originally, the government projected that permits in the early years would sell for around $300 per ton of sulfur dioxide. But in practice, the market price in the early years fell to below $100 per ton. One reason for the success was that the program gave strong incentives for firms to innovate, and firms found that low-sulfur coal could be used much more easily and cheaply than had earlier been anticipated. This important experiment has given powerful support to economists who argue for market-based approaches to environmental policy.

Private Approaches

It is generally thought that some form of government intervention in the market is necessary to overcome the market failures associated with pollution and other externalities. In some cases, however, strong property rights can substitute for government regulations or taxes.

One private-sector approach relies upon *liability laws* rather than upon direct government regulations. Under this approach, the legal system makes the generator of externalities legally liable for any damages caused to other persons. In effect, by imposing an appropriate liability system, the externality is internalized.

In some areas, this doctrine is well established. For example, in most states, if you are injured by a negligent driver, you can sue for damages. Or if you are injured or become ill from a defective product, the company can be sued for product liability.

While liability rules are in principle an attractive means of internalizing the nonmarket costs of production, they are quite limited in practice. They usually involve high litigation costs, which add an additional cost to the original externality. In addition, many damages cannot be litigated because of incomplete property rights (such as those involving

Eye Therapies Exhibit 2127, 300 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

clean air) or because of the large number of companies that contribute to the externality (as in the case of chemicals flowing into a stream).

A second private approach relies upon strong property rights and *negotiations among parties*. This approach was developed by the University of Chicago's Ronald Coase, who showed that voluntary negotiations among the affected parties can sometimes lead to an efficient outcome.

For example, suppose that I am a farmer using fertilizers that flow downstream and kill many of the fish in your ponds. Further, suppose that you cannot sue me for killing your fish. If your fish business is sufficiently profitable, you may try to get me to reduce my fertilizer use. In other words, if there is a net profit to be made from reorganizing our joint operations, we have a powerful incentive to get together and agree on the efficient level of fertilizer runoff. Moreover, this incentive would exist without any government antipollution program.

When property rights are well defined and transaction costs are low, particularly when there are few affected parties, strong liability laws or negotiation can sometimes operate to produce an efficient resolution in the presence of externalities.

CLIMATE CHANGE: TO SLOW OR NOT TO SLOW

Of all the environmental issues, none is so worrisome to scientists as the threat of global warming from the greenhouse effect. Climatologists and other scientists warn that the accumulation of gases like carbon dioxide (CO_2), largely produced by the combustion of fossil fuels, is likely to lead to global warming and other significant climatic changes over the next century. On the basis of climate models, scientists project that if current trends continue, the earth may warm 4° to 8° Fahrenheit over the next century. This would take the earth's climate out of the range experienced during the entire period of human civilization.

The greenhouse effect is the granddaddy of public-good problems; actions today will affect the climate for all people in all countries for centuries to come. The costs of reducing CO_2 emissions come in the near term as countries cut back their use of fossil fuels by conserving energy and using alternative energy sources (solar energy or perhaps nuclear power), plant trees, and take other measures. In the short run, that means we will have to accept more-expensive energy, lower living standards, and lower consumption levels. The benefits of emissions reductions will come many years in the future, when lower emissions reduce future climate-induced damages—with less disruption to agriculture, seacoasts, and ecosystems.

Economists have begun to study the economic impacts of climate change in order to understand how nations might undertake sensible strategies. Economic studies indicate that the market economies in advanced countries like the United States are likely to be relatively insulated from climate change in the coming decades. The major impacts are likely to be in agriculture, forests, and fisheries, along with unmanaged ecosystems such as coral reefs.

An efficient strategy for containing climate change requires weighing the marginal costs of reducing carbon-dioxide (CO_2) emissions against the marginal benefits. Figure 14-5 shows schematically the marginal costs of reductions as *MC* and the marginal social benefits as *MSB*. The vertical axis measures costs and benefits in dollars, while the horizontal axis

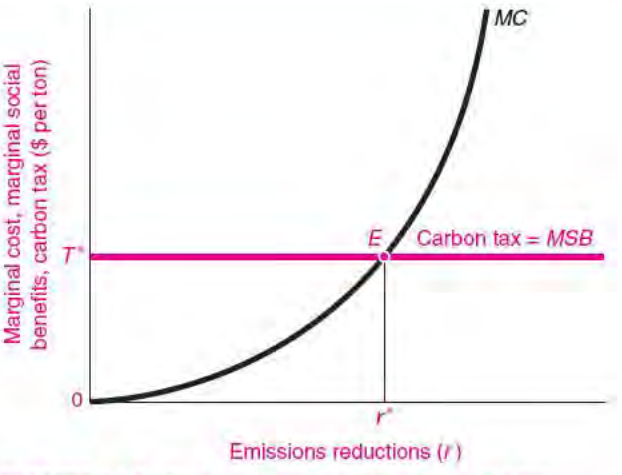


FIGURE 14-5. Carbon Taxes Can Slow Harmful Climate Change

Slowing climate change efficiently requires setting carbon taxes at T^* or limiting carbon dioxide emissions to r^*. Such measures would equate marginal costs of emissions reductions with marginal benefits of reducing damages from climate change.

Eye Therapies Exhibit 2127, 301 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

measures reduction of carbon-dioxide emissions. Point *E* in the graph represents the efficient point at which marginal abatement costs equal marginal social benefits from slowing climate change. This is the point which maximizes the net economic benefits of emissions reductions. By contrast, the pure-market solution would come with emissions reductions at 0, where *MSB* is far above the zero *MC*. An extreme environmentalist solution, which attempts to reduce emissions to zero, would come at the right-hand edge of the graph, where *MC* far exceeds *MSB*.

How can point *E*, the efficient level of CO_2 reduction, be achieved? Since CO_2 emissions come from burning carbon-containing fuels, some have suggested a "carbon tax" on the carbon content of fuels. Fuels which contain more carbon, like coal, would be taxed more heavily than low-carbon fuels such as natural gas. Economists have developed models that estimate efficient paths for carbon taxes—ones that balance the economic costs of higher taxes with the benefits of reduced damages from global warming. These models can serve as a guide to policymakers in the design of policies to combat global warming. Figure 14-5 shows that if the carbon tax is set at the appropriate level, this would induce the efficient level of emissions reductions.



Global Public Goods and the Kyoto Protocol

We discussed the problem of global public goods earlier in this chapter. Nations deal with global public goods through international agreements like treaties. These are designed to move from an inefficient noncooperative outcome to an efficient cooperative solution to the pollution game. But reaching efficient agreements often proves difficult. Measures to slow global warming provide a useful example. Although scientists have raised alarms about climate change for more than three decades, there were no major international agreements on climate change until the Framework Convention on Climate Change (FCCC) in 1992. The FCCC contained provisions in which high-income countries agreed to nonbinding commitments to limit the emissions of greenhouse gases like CO_2.

When voluntary measures were ineffective, countries negotiated the 1997 Kyoto Protocol on climate change. Under the protocol, high-income countries along with formerly socialist countries agreed to *binding commitments* to reduce by 2010 their total emissions of greenhouse gases by 5 percent (relative to 1990 levels). Each country was allocated a specific target. Based on both economic theory and the experience of the U.S. sulfur dioxide trading program (discussed above), the Kyoto Protocol included a provision for emissions trading among countries. The protocol got off to a shaky start when the Bush administration withdrew the United States from participation in 2001.

Economists have undertaken detailed analyses of the alternative approaches available to tackle the issues involved in global warming. One conclusion of such studies is that it is critical to make sure that market participants face the full costs of their actions. Currently, the climate-change externality is not "internalized" in most countries because CO_2 emissions have a zero price. Without the appropriate price signals, it is unrealistic to think that the millions of firms and billions of consumers will make decisions that reduce the use of carbon fuels. Economic studies also indicate that global participation—not just the participation of high-income countries—is critical to slowing climate change in an economical fashion. By excluding energy-intensive developing countries like China and India from reduction requirements, the cost of meeting the global emissions goal is increased greatly relative to a cost-effective global agreement.

The first round of the Kyoto Protocol went into effect in 2008, but it covers only the period through 2012. Many who are concerned about the future of the globe are looking to see whether the new Obama administration in the United States will join the effort and whether an efficient long-term solution can be designed, implemented, and enforced.

Quarrel and Pollute, or Reason and Compute?

We have seen that many environmentalists are asking gloomy questions about the future of humanity. Having surveyed the field, what should we conclude? Depending on one's perspective, it is easy to become either optimistic or pessimistic about our ability to understand and cope with the threats to our environment. On the one hand, it is true that we are moving into uncharted waters, depleting many resources while altering others in an irreversible manner, and gambling with our world in more ways than we realize. Humans seem just as quarrelsome today as they were at the dawn of recorded history, and they have

Eye Therapies Exhibit 2127, 302 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

devised weapons that are awesomely effective at avenging their grudges. At the same time, our powers of observation and analysis are also orders of magnitude more formidable.

What will prevail in this race between our tendencies to quarrel and pollute and our powers to reason and compute? Are there enough resources to allow the poor to enjoy the consumption standards of today's high-income countries, or will today's rich pull the ladder up behind them? There are no final answers to these deep questions. But economists believe that one central answer is to employ market mechanisms to provide incentives to reduce pollution and other harmful side effects of economic growth. Wise decisions along with appropriate incentives will help to ensure that *Homo sapiens* can not only survive but also thrive for a long time to come.



SUMMARY

A. The Economics of Natural Resources

1. Natural resources are nonrenewable when they cannot regenerate quickly and are therefore essentially fixed in supply. Resources are renewable when their services are replenished regularly and they can, if properly managed, yield useful services indefinitely.
2. Natural resources are appropriable when firms or consumers can capture the full benefits of their services; examples include vineyards and oil fields. Natural resources are inappropriable when their total costs or benefits do not accrue to the owners; in other words, they involve externalities.
3. The return to fixed factors like land is called pure economic rent, or rent, for short. Since the supply curve for land is vertical and completely inelastic, the rent will be price-determined rather than price-determining.
4. A factor like land that is inelastically supplied will continue to work the same amount even though its factor reward is reduced. For this reason, Henry George pointed out that rent is in the nature of a surplus rather than a reward necessary to coax out the factor's effort. This provides the basis for his single-tax proposal to tax the unearned increment of land value, which raises tax revenues without raising prices to consumers or distorting production. Modern tax theory extends George's insight by showing that inefficiencies are minimized by taxing goods that are relatively inelastic in supply or demand because such taxes lead to relatively small distortions in behavior.

B. Environmental Economics

5. Environmental problems arise because of externalities that stem from production or consumption. An externality is an activity that imposes involuntary costs or benefits on others and whose effects are not completely reflected in market prices.
6. The polar extreme of an externality is the case of public goods, like national defense, where all consumers in a group share equally in the consumption of the good and cannot be excluded. Public health, inventions, parks, and dams also possess public-good properties. These contrast with private goods, like bread, which can be divided and provided to a single individual.
7. An unregulated market economy will produce too much pollution and too little abatement. Unregulated firms decide on abatement and other public goods by comparing the marginal *private* benefits of abatement with the marginal costs. But efficiency requires that the marginal *social* benefits of abatement equal the marginal costs.
8. Economists emphasize that the efficient management of externalities requires the proper pricing of natural and environmental resources. This involves ensuring that market participants face the full social costs of their activities.
9. There are different approaches through which governments can take steps to internalize or correct the inefficiencies arising from externalities. Alternatives include decentralized or private solutions (such as negotiations or legal liability rules) and government-imposed approaches (such as pollution-emission standards or emissions taxes). Experience indicates that no single approach will fit every circumstance, but many economists believe that greater use of market-oriented approaches would improve the efficiency of regulatory systems.
10. Global public goods present the thorniest problems because they cannot easily be solved by either markets or national governments. Nations must work together to devise new tools to forge international agreements when issues such as global warming threaten our ecosystem and our standards of living.

Eye Therapies Exhibit 2127, 303 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CONCEPTS FOR REVIEW

Land and Natural Resources

renewable vs. nonrenewable resources
appropriable vs. inappropriable resources
rent, pure economic rent
inelastic supply of land
taxation of fixed factors

Environmental Economics

externalities and public goods
private vs. public goods
inefficiency of externalities
internal vs. external costs, social vs. private benefits
remedies for externalities: standards, taxes, liability, bargaining
tradeable emissions permits
global public goods

FURTHER READING AND INTERNET WEBSITES

Further Reading

Environmental economics is a rapidly growing field. You can explore advanced topics in a textbook such as Thomas H. Tietenberg, *Environmental Economics and Policy,* 7th ed. (Addison-Wesley, New York, 2006). An excellent book of readings is Robert Stavins, ed., *Economics of the Environment: Selected Readings*, 5th ed. (Norton, New York, 2005).

The quote from Wilson is from Edward O. Wilson, "Is Humanity Suicidal?" *New York Times Magazine,* May 30, 1993, p. 27. The quotation from Julian Simon is from *Scarcity or Abundance? A Debate on the Environment* (Norton, New York, 1994), available at *www.juliansimon.com/writings/Norton/NORTON01.txt.* The quotation from Ehrlich and Ehrlich is from *The New York Review of Books,* February 14, 2008.

Websites

One of the best websites on resources and the environment is maintained by the nonprofit organization Resources for the Future at *www.rff.org.* You can consult this site for information on a wide range of issues.

Energy data are available at the Energy Information Agency's comprehensive site at *www.eia.doe.gov.*

You can learn more about environmental policy at the U.S. Environmental Protection Agency's website at *www.epa.gov.* International environmental policy is found at the United Nations Environmental Program's site at *www.unep.org.* Information on the Kyoto Protocol and other programs to address climate change can be found at *www.ipcc.ch* and *www.unfccc.de.*

QUESTIONS FOR DISCUSSION

1. What is the difference between renewable and nonrenewable resources? Give examples of each.
2. What is meant by an inappropriable natural resource? Provide an example and explain why the market allocation of this resource is inefficient. What would be your preferred way to improve the market outcome?
3. Define "pure economic rent."
   a. Show that an increase in the supply of a rent-earning factor will depress its rent and lower the prices of the goods that use it.
   b. Explain the following statement from rent theory: "It is not true that the price of corn is high because the price of corn land is high. Rather, the reverse is closer to the truth: the price of corn land is high because the price of corn is high." Illustrate with a diagram.
   c. Consider the quotation in **b.** Why is this correct for the market as a whole but incorrect for the individual farmer? Explain the fallacy of composition that is at work here.
4. Assume that the supply curve for top baseball players is perfectly inelastic with respect to their salaries.
   a. Explain what completely inelastic supply means in terms of number of games played.
   b. Next assume that because of television, the demand for the services of major-league baseball

Eye Therapies Exhibit 2127, 304 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

players increases. What would happen to their salaries? What would happen to their batting averages (other things held constant)? Does this theory fit historical trends?

5. Explain why a tax on land rent is efficient. Compare a tax on the land with a tax on the houses on the land.
6. "Local public goods" are ones that mainly benefit the residents of a specific town or state—such as beaches or schools open only to town residents. Is there any reason to think that towns might act competitively to provide the correct amount of local public goods to their residents? If so, does this suggest an economic theory of "fiscal federalism" whereby local public goods should be locally supplied?
7. Decide whether each of the following externalities is serious enough to warrant collective action. If so, which of the four remedies considered in this chapter would be most efficient?
   a. Steel mills emitting sulfur oxides into the Birmingham air
   b. Smoking by people in restaurants
   c. Smoking by students without roommates in their own rooms
   d. Driving by persons under the influence of alcohol
   e. Driving by persons under age 21 under the influence of alcohol
8. Get your classmates together to do a contingent-valuation analysis on the value of the following: Prohibiting drilling in all wilderness areas in the United States; preventing the extinction of spotted owls for another 10,000 years; ensuring that there are at least 1 million spotted owls in existence for another 10,000 years; reducing the chance of dying in an automobile accident from 1 in 1000 to 1 in 2000 per year. How reliable do you think this technique is for gathering information about people's preferences?
9. Don Fullerton and Robert Stavins argue that the following are myths about how economists think about the environment (see Chapter 1 in the Stavins book in the Further Reading section). For each, explain why it is a myth and what the correct approach is:
   a. Economists believe that the market solves all environmental problems.
   b. Economists always recommend market solutions to environmental problems.
   c. Economists always use market prices to evaluate environmental issues.
   d. Economists are concerned only with efficiency and never with income distribution.
10. **Advanced problem:** Global public goods pose special problems because no single nation can capture all the benefits of its own pollution-control efforts. To see this, redraw Figure 14-5, labeling it "Emissions Reduction for the United States." Label all the curves with "US" to indicate that they refer to costs and benefits for the United States alone. Next, draw a new *MSB* curve which is 3 times higher than the MSB_{US} at every point to indicate that the benefits to the world are 3 times higher than those to the United States alone. Consider the "nationalistic" equilibrium at *E* where the United States maximizes its own net benefits from abatement. Can you see why this is inefficient from the point of view of the entire globe? (*Hint:* The reasoning is analogous to that in Figure 14-3.)

    Consider this issue from the point of view of game theory. The Nash equilibrium would occur when each country chose the nationalistic equilibrium you have just analyzed. Describe why this is analogous to the inefficient Nash equilibrium described in Chapter 10—only here the players are nations rather than firms. Now consider the cooperative game in which nations get together to find the efficient equilibrium. Describe the efficient equilibrium in terms of global *MC* and *MSB* curves. Can you see why the efficient equilibrium would require a uniform carbon tax in each country?

Eye Therapies Exhibit 2127, 305 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

Capital, Interest, and Profits

15



You can have your cake and eat it too: Lend it out at interest.

Anonymous

The United States is a "capitalist" economy. By this we mean that most of the country's capital and other assets are privately owned. In 2008, the net stock of capital in the United States was more than $150,000 per capita, of which 67 percent was owned by private corporations, 14 percent by individuals, and 19 percent by governments. Moreover, the ownership of the nation's wealth was highly concentrated in the portfolios of the richest Americans. Under capitalism, individuals and private firms do most of the saving, own most of the wealth, and get most of the profits on these investments.

This chapter is devoted to the study of capital. We begin with a discussion of the basic concepts in capital theory. These include the notion of "roundaboutness" and different measures of the rate of return on investment. Then we will turn to the crucial questions of the supply and demand for capital. This overview will give us a much deeper understanding of some of the key features of a private market economy.

A. BASIC CONCEPTS OF INTEREST AND CAPITAL

What Is Capital?

We begin with a brief summary of the important concepts of capital and finance developed in this chapter. **Capital** consists of those durable produced items that are in turn used as productive inputs for further production. Some capital might last for only a few years, while others might last for a century or more. But the essential property of capital is that it is both an input and an output.

In an earlier era, capital consisted primarily of tangible assets. Three important categories of tangible capital are structures (such as factories and homes), equipment (such as consumer durable goods like automobiles and producer durable equipment like machine tools and trucks), and inventories (such as cars in dealers' lots).

Today, intangible capital is increasingly important. Examples include software (such as computer operating systems), patents (such as the ones on microprocessors), and brand names (such as Coca-Cola). Robert Hall of Stanford calls this "e-capital" to distinguish between traditional tangible capital and increasingly important intellectual capital.

Prices and Rentals on Investments

Capital is bought and sold in capital markets. For example, Boeing sells aircraft to airlines; the airlines then use these specialized capital goods along with software, skilled labor, land, and other inputs to produce and sell air travel.

Most capital is owned by the firms that use it. Some capital, however, is rented out by its owners.

Eye Therapies Exhibit 2127, 306 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Payments for the temporary use of capital goods are called rentals. An apartment that is owned by Ms. Landlord might be rented out for a year to a student, and the monthly payment of $800 per month would constitute a rental. We distinguish *rent* on fixed factors like land from *rentals* on durable factors like capital.

Capital vs. Financial Assets

Individuals and businesses own a mix of different kinds of assets. One class is the productive input capital that we just discussed—items like computers, automobiles, and houses that are used to produce other goods and services. But we must distinguish these tangible assets from *financial assets,* which are essentially pieces of paper or electronic records. More precisely, financial assets are monetary claims by one party against another party. An important example is a mortgage, which is a claim against a homeowner for monthly payments of interest and principal; these payments will repay the original loan that helped finance the purchase of the house.

Often, as in the case of a mortgage, a tangible asset will lie behind (or serve as collateral for) a financial asset. In other cases, such as student loans, a financial asset may derive its value from a promise to pay based on the future earning power of an individual.

It is clear that tangible assets are an essential part of an economy because they increase the productivity of other factors. But what function do financial assets serve? These assets are crucial because of the mismatch between savers and investors. Students need money to pay for college, but they do not currently have the earnings or the savings necessary to pay the bills. Older people, who are working and saving for retirement, may have income in excess of their expenditures and can provide the savings. A vast financial system of banks, mutual funds, insurance companies, and pension funds—often supplemented by government loans and guarantees—serves to channel the funds of those who are saving to those who are investing. Without this financial system, it would not be possible for firms to make the huge investments needed to develop new products, for people to buy houses before they had saved the entire housing price, or for students to go to college without first saving the large sums necessary.

The Rate of Return on Investments

Suppose that you own some capital and rent it out or that you have some cash and lend it to a bank or to a small business. Or perhaps you want to take out a mortgage to buy a house. You will naturally want to know what you will pay to borrow or how much you will earn by lending. This amount is called the **rate of return on investments.** In the special case of the return on fixed-interest financial assets, these earnings are called the **interest rate.** From an economic point of view, interest rates or returns on investments are the price of borrowing or lending money. The returns will vary greatly depending upon the maturity, risk, tax status, and other attributes of the investment.

We will devote considerable space in this chapter to understanding these concepts. The following summary highlights the major ideas:

1. Capital consists of durable produced items that are in turn used as productive inputs for the production of other goods. Capital consists of both tangible and intangible assets.
2. Capital is bought and sold in capital markets. Payments for the temporary use of capital goods are called rentals.
3. We must distinguish financial assets, which are essentially pieces of paper deriving their value from ownership of other tangible or intangible assets.
4. The rate of return on investments, and the special case of the interest rate, is the price for borrowing and lending funds. We usually calculate rates of return on the funds using units of percent per year.

RATES OF RETURN AND INTEREST RATES

We now examine in greater detail the major concepts in capital and financial theory. We begin with the definition of a rate of return on investments, which is the most general concept. We then apply these definitions to financial assets.

Rate of Return on Capital

One of the most important tasks of any economy is to allocate its capital across different possible investments. Should a country devote its investment resources to heavy manufacturing like steel or to

Eye Therapies Exhibit 2127, 307 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

information technologies like the Internet? Should Intel build a $4 billion factory to produce the next generation of microprocessors? These questions involve costly investments—laying out money today to obtain a return in the future.

In deciding upon the best investment, we need a measure for the yield or return. One important measure is the **rate of return on investment,** which denotes the net dollar return per year for every dollar of invested capital.

Let's consider the example of a rental car company. Ugly Duckling Rental Company buys a used car for $20,000 and rents it out. After subtracting all expenses (revenues less expenses such as wages, office supplies, and energy costs) and assuming no change in the car's price, Ugly Duckling earns a net rental of $2400 each year. The rate of return is 12 percent per year (12% = $2400/$20,000). Note that the rate of return is a pure or unitless number per unit of time. That is, the rate of return has the dimensions of (dollars per period)/(dollars), and it is usually calculated with units of percent per year.

These concepts are useful for comparing investments. Suppose you are considering investments in rental cars, oil wells, apartments, education, and so forth. How can you decide which investment to make?

One useful approach is to compare the rates of return on the different investments. For each possibility, calculate the dollar cost of the capital good. Then estimate the net annual dollar receipts or rentals yielded by the asset. The ratio of the annual net rental to the dollar cost is the rate of return on investment, which tells you how much money you get back for every dollar invested, measured as dollars per year per dollar of investment or percent per year.

The rate of return on investment is the annual net return (rentals less expenses) per dollar of invested capital. It is a pure or unitless number—percent per year.

Of Wine, Trees, and Drills. Here are some examples of rates of return on investments:

- I buy a plot of land for $100,000 and sell it a year later for $110,000. If there are no other expenses, the rate of return on this investment is $10,000 per year/$100,000, or 10 percent per year.
- I plant a pine tree with a labor cost of $100. At the end of 25 years, the grown tree sells for $430. The rate of return on this capital project is then 330 percent per quarter-century, which, as a calculator will show you, is equivalent to a return of 6 percent per year. That is, $100 $\times$ $(1.06)^{25}$ = $430.
- I buy a $20,000 piece of oil-drilling equipment. For 10 years it earns annual rentals of $30,000, but I also incur annual expenses of $26,000 for fuel, insurance, and maintenance. The $4000 net return covers interest and repays the principal of $20,000 over 10 years. What is the rate of return here? Statistical tables show that the rate of return is 15 percent per year.

Financial Assets and Interest Rates

For the case of financial assets, we use a different set of terms when measuring the rate of return. When you buy a bond or put money in your savings account, the financial yield on this investment is called the *interest rate*. For example, if you bought a 1-year bond in 2008, you would have earned a yield of around 3 percent per year. This means that if you bought a $1000 bond on January 1, 2008, you would have $1030 on January 1, 2009.

You will usually see interest rates quoted in percent per year. This is the interest that would be paid if the sum were borrowed (or loaned) for an entire year; for shorter or longer periods, the interest payment is adjusted accordingly.

THE PRESENT VALUE OF ASSETS

Most assets will produce a stream of rentals or receipts over time. If you own an apartment building, for example, you will collect rental payments over the life of the building, much as the owner of a fruit orchard will pick fruit from the trees each year.

Suppose you become weary of tending the building and decide to sell it. To set a fair price for the building, you would need to determine the value today of the entire stream of future income. The value of that stream is called the present value of the capital asset.

The **present value** is the dollar value today of a stream of future income. It is measured by calculating how much money invested today would be needed, at the going interest rate, to generate the asset's future stream of receipts.

Eye Therapies Exhibit 2127, 308 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Let's start with a very simple example. Say that someone offers to sell you a bottle of wine that matures in exactly 1 year and can then be sold for exactly \$11. Assuming the market interest rate is 10 percent per year, what is the present value of the wine—that is, how much should you pay for the wine today? Pay exactly \$10, because \$10 invested today at the market interest rate of 10 percent will be worth \$11 in 1 year. So the present value of next year's \$11 wine is today \$10.

Present Value for Perpetuities

We discuss the first way of calculating present value by examining the case of a *perpetuity*, which is an asset like land that lasts forever and pays $\$N$ each year from now to eternity. We are seeking the present value (V) if the interest rate is i percent per year, where the present value is the amount of money invested today that would yield exactly $\$N$ each year. This is simply

$$V = \frac{\$N}{i}$$

where V = present value of the land (\$)
$\$N$ = perpetual annual receipts (\$ per year)
i = interest rate in decimal terms (e.g., 0.05, or 5/100 per year)

This says that if the interest rate is always 5 percent per year, an asset yielding a constant stream of income will sell for exactly 20 ($= 1 \div 5/100$) times its annual income. In this case, what would be the present value of a perpetuity yielding \$100 every year? At a 5 percent interest rate its present value would be \$2000 ($= \$100 \div 0.05$).

The formula for perpetuities can also be used to value stocks. Suppose that a share of Spring Water Co. is expected to pay a dividend of \$1 every year into the indefinite future and that the discount rate on stocks is 5 percent per year. Then the stock price should be $P = \$1/0.05 = \$20$ per share. (These numbers are corrected for inflation, so the numerator is "real dividends" and the denominator is a "real interest rate" or a "real discount rate," defined below).

General Formula for Present Value

Having seen the simple case of the perpetuity, we move to the general case of the present value of an asset with an income stream that varies over time. The main thing to remember about present value is that future payments are worth less than current payments and they are therefore *discounted* relative to the present. Future payments are worth less than current payments just as distant objects look smaller than nearby ones. The interest rate produces a similar shrinking of time perspective.

Let's take a fantastic example.[1] Say that someone proposes to pay \$100 million to your heirs in 100 years. How much should you pay for this today? According to the general rule for present value, to figure out the value today of $\$P$ payable t years from now, ask yourself how much must be invested today to grow into $\$P$ at the end of t years. Say the interest rate is 6 percent per annum. Applying this each year to the growing amount, a principal amount of $\$V$ grows in t years to $\$V \times (1 + 0.06)^t$. Hence, we need only invert this expression to find present value: the present value of $\$P$ payable t years from now is today $\$P/(1 + 0.06)^t$. Using this formula, we determine that the present value of \$100 million paid in 100 years is \$294,723.

In most cases, there are several terms in an asset's stream of income. In present-value calculations, each dollar must stand on its own feet. First, evaluate the present value of each part of the stream of future receipts, giving due allowance for the discounting required by its payment date. Then simply add together all these separate present values. This summation will give you the asset's present value.

The exact formula for present value (V) is the following:

$$V = \frac{N_1}{1+i} + \frac{N_2}{(1+i)^2} + \cdots + \frac{N_t}{(1+i)^t} + \cdots$$

In this equation, i is the one-period market interest rate (assumed constant). Further, N_1 is the net receipts (positive or negative) in period 1, N_2 the net receipts in period 2, N_t the net receipts in period t, and so forth. Then the stream of payments (N_1, $N_2, \ldots, N_t, \ldots$) will have the present value, V, given by the formula.

For example, assume that the interest rate is 10 percent per year and that I am to receive \$1100

[1] Question 9 at the end of this chapter asks about the real life example of the present value of the real estate of Manhattan when it was purchased by the Dutch.

Eye Therapies Exhibit 2127, 309 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

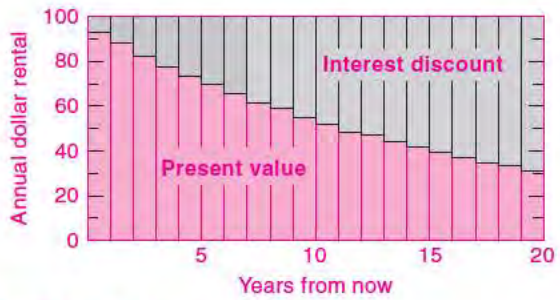


FIGURE 15-1. Present Value of an Asset

The lower, green area shows the present value of a machine giving net annual rentals of $100 for 20 years with an interest rate of 6 percent per year. The upper, blue area has been discounted away. Explain why raising the interest rate increases the blue area and therefore depresses the market price of an asset.

next year and $2662 in 3 years. The present value of this stream is

$$V = \frac{1100}{(1.10)^1} + \frac{2662}{(1.10)^3} = 3000$$

Figure 15-1 shows graphically the calculation of present value for a machine that earns steady net annual rentals of $100 over a 20-year period and has no scrap value at the end. Its present value is not $2000 but only $1157. Note how much the later dollar earnings are scaled down or discounted because of our time perspective. The total area remaining after discounting (the blue shaded area) represents the machine's total present value—the value today of the stream of all future incomes.

Acting to Maximize Present Value

The present-value formula tells us how to calculate the value of any asset once we know the future earnings. But note that an asset's future receipts usually depend on business decisions: Shall we use a truck 8 or 9 years? Overhaul it once a month or once a year? Replace it with a cheap, nondurable truck or an expensive, durable one?

There is one rule that gives correct answers to all investment decisions: Calculate the present value resulting from each possible decision. Then always act so as to maximize present value. In this way you will have more wealth to spend whenever and however you like.



Interest Rates and Asset Prices

When interest rates rise, many asset prices fall. For example, if the Federal Reserve unexpectedly tightens monetary policy and raises interest rates, you will generally read that bond and stock prices fall. We can understand the reason for this pattern using the concept of present value.

Our previous discussion showed that the present value of an asset will depend on both the stream of future returns and the interest rate. As interest rates change, so will the present value and therefore the market value of an asset. Here are some examples:

- Begin with a 1-year bond and an initial interest rate of 5 percent per year. If the bond returns $1000 one year from now, then its current present value is $1000/1.05 = $952.38. Now suppose that the interest rate rises to 10 percent per year. Then the present value of the bond would be only $1000/1.1 = $909.09. The price of the asset declined as the interest rate increased.
- Take the case of a perpetuity that yields $100 per year. At an interest rate of 5 percent per year, the perpetuity has a present value of $100/0.05 = $2000. Now if the interest rate rises to 10 percent per year, the value falls by half to only $1000.

We can now see that asset prices tend to move inversely with interest rates because their present value decreases as the interest rate increases. Note as well that the prices of longer-term assets tend to change more than do the prices of shorter-term assets. This occurs because more of the return is in the future, and the prices of long-term assets are therefore affected more by the changing interest rate.

The dependence of asset prices on interest rates is a general property of financial assets. The prices of stocks, bonds, real estate, and many other long-lived assets will decline as interest rates rise.

THE MYSTERIOUS WORLD OF INTEREST RATES

Textbooks often speak of "*the* interest rate" as if there were only one, but in fact today's complex financial system has a vast array of interest rates. If you look at *The Wall Street Journal*, you will see page after page of financial interest rates. Interest rates depend mainly on the characteristics of the loan or of the borrower. Let us review the major differences.

Eye Therapies Exhibit 2127, 310 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Loans differ in their *term* or *maturity*—the length of time until they must be paid off. The shortest loans are overnight. Short-term securities are for periods up to a year. Companies often issue bonds that have maturities of 10 to 30 years, and mortgages are up to 30 years in maturity. Longer-term securities generally command a higher interest rate than do short-term ones because lenders are willing to sacrifice quick access to their funds only if they can increase their yield.

Loans also vary in terms of *risk*. Some loans are virtually riskless, while others are highly speculative. Investors require that a premium be paid when they invest in risky ventures. The safest assets in the world are the securities of the U.S. government. These bonds are backed by the full faith, credit, and taxing powers of the government. Intermediate in risk are borrowings of creditworthy corporations, states, and localities. Risky investments, which bear a significant chance of default or nonpayment, include those of companies close to bankruptcy, cities with shrinking tax bases, or countries like Argentina with large overseas debts and unstable political systems.

The U.S. government pays what is called the "riskless" interest rate; over the last two decades this has ranged from 0 to 15 percent per year for short-term bonds. Riskier securities might pay 1, 2, or even 10 percent per year more than the riskless rate; this premium reflects the amount necessary to compensate the lender for losses in case of default.

Assets vary in their liquidity. An asset is said to be *liquid* if it can be converted into cash quickly and with little loss in value. Most marketable securities, including common stocks and corporate and government bonds, can be turned into cash quickly for close to their current value. Illiquid assets include unique assets for which no well-established market exists. For example, if you own the only Victorian mansion in a small town, you might find it difficult to sell the asset quickly or at a price near its realistic market value—your house is an illiquid asset. Because of the higher risk and the difficulty of realizing the asset values quickly, illiquid assets or loans require higher interest rates than do liquid, riskless ones.

When these three factors (along with other considerations such as tax status and administrative costs) are considered, it is not surprising that we see so many different financial assets and so many different interest rates. Figure 15-2 and Table 15-1 show the behavior of a few important interest rates over the last five decades. In the discussion that follows, when we speak of "the interest rate," we are generally referring to the interest rate on short-term government securities, such as the 90-day Treasury-bill rate. As Figure 15-2 shows, most other interest rates rise and fall in step with short-term interest rates.

Real vs. Nominal Interest Rates

Interest is paid in dollar terms, not in terms of houses or cars or goods in general. The *nominal interest rate* measures the yield in dollars per year per dollar invested. But dollars can become distorted yardsticks. The prices of houses, cars, and goods in general change from year to year—these days prices generally rise due to inflation. Put differently, the interest rate on dollars does not measure what a lender really earns in terms of goods and services. Let us say that you lend $100 today at 5 percent-per-year interest. You would get back $105 at the end of a year. But because prices changed over the year, you would not be able to obtain the same quantity of goods that you could have bought at the beginning of the year if you had $105.

Clearly, we need another concept that measures the return on investments in terms of real goods and services rather than the return in terms of dollars. This alternative concept is the *real interest rate,* which measures the quantity of goods we get tomorrow for goods forgone today. The real interest rate is obtained by correcting nominal or dollar interest rates for the rate of inflation.

The **nominal interest rate** (sometimes also called the *money interest rate*) is the interest rate on money in terms of money. When you read about interest rates in the newspaper, or examine the interest rates in Figure 15-2, you are looking at nominal interest rates; they give the dollar return per dollar of investment.

In contrast, the **real interest rate** is corrected for inflation and is calculated as the nominal interest rate minus the rate of inflation. As an example, suppose the nominal interest rate is 8 percent per year and the inflation rate is 3 percent per year; we can calculate the real interest rate as $8 - 3 = 5$ percent per year.

To take a simple example, suppose that you live in an economy where the only product is bread. Further suppose that the price of bread in the first period is $1 per loaf and that bread inflation is 3 percent per year. If you lend $100 at 8 percent-per-year interest, you will have $108 at the end of the year. However, because of inflation, next year you will get

Eye Therapies Exhibit 2127, 311 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

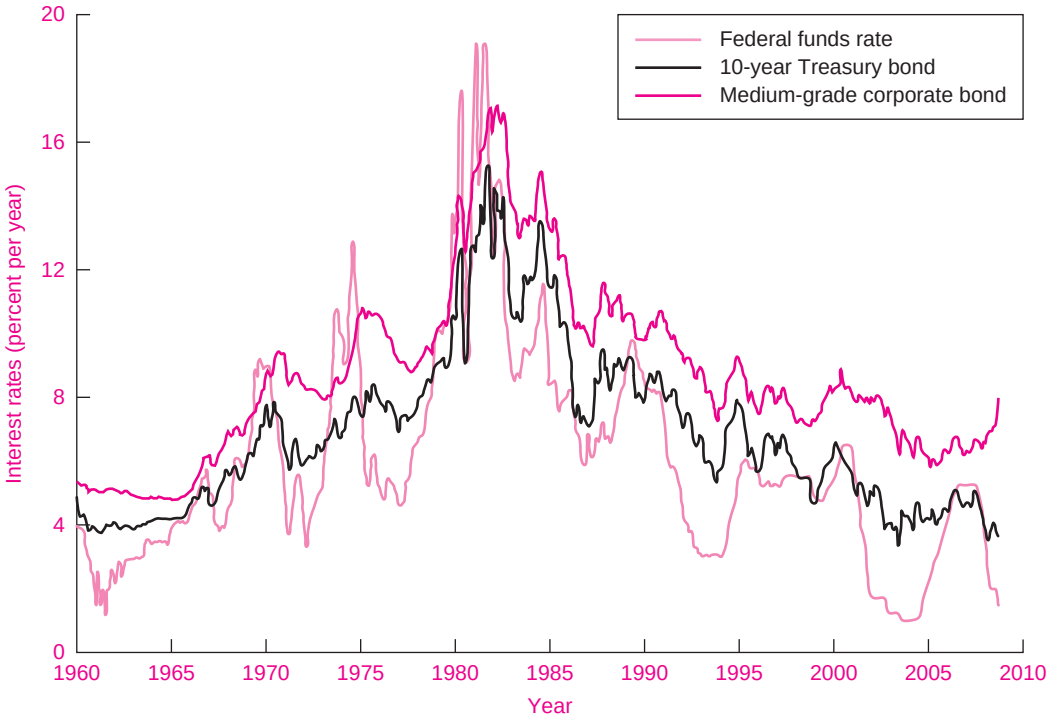


FIGURE 15-2. Most Interest Rates Move Together

This graph shows the major interest rates in the U.S. economy. The lowest rate is generally the federal funds rate, set by the Federal Reserve in its monetary policy. Longer-term and riskier interest rates are usually higher than safe and short-term rates.

Source: Federal Reserve System, available at *www.federalreserve.gov/releases/*.

Asset class	Period	Nominal rate of return (% per year)	Real rate of return (% per year)
Government securities:			
3 month	1960–2008	5.2	1.0
10 year	1960–2008	6.9	2.7
Corporate bonds:			
Safe (Aaa rated)	1960–2008	7.7	3.4
Risky (Baa rated)	1960–2008	8.7	4.4
Corporate equities	1960–2008	9.9	5.6
Consumer loans:			
Mortgages (fixed rate)	1971–2008	9.2	4.9
Credit cards	1972–2008	16.4	11.8
New-car loans	1972–2008	10.4	6.0

TABLE 15-1. Interest Rates on Major Financial Assets

Safe government securities have the lowest yields. Note that consumers pay a substantial penalty on credit-card debt (students beware!). The real interest rates are corrected for inflation. Note that Aaa bonds are the safest type of corporate security, while Baa securities have significant risks of bankruptcy.

Source: Federal Reserve Board, available at *www.federalreserve.gov/releases/*, and Department of Commerce.

Eye Therapies Exhibit 2127, 312 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

back only 105 (and not 108) loaves of bread. The real (or bread) rate of interest is $8 - 3 = 5$ percent.[2]

During inflationary periods, we must use real interest rates, not nominal or money interest rates, to calculate the yield on investments in terms of goods earned per year on goods invested. The real interest rate is approximately equal to the nominal interest rate minus the rate of inflation.

[2] The exact algebra of real interest rates is as follows: Let π be the inflation rate, i the nominal interest rate, and r the real interest rate. If you invest \$1 today, you get $\$(1 + i)$ back in 1 year. However, prices have risen, so you need $\$(1 + \pi)$ in 1 year to buy the same amount of goods that you could buy with \$1 today. Instead of buying 1 unit of goods today, you can therefore buy $(1 + r)$ units tomorrow, where $(1 + r) = (1 + i)/(1 + \pi)$. For small values of i and π, $r = i - \pi$.



The World's Safest Investment

U.S. Treasury bonds are generally considered a riskless investment. Their one shortcoming is that they pay a fixed-dollar interest rate. This means that if inflation heats up, the real interest rate could easily turn negative.

In 1997, the U.S. government fixed this problem by introducing Treasury inflation-protected securities (TIPS). TIPS have their interest and principal tied to inflation, so they pay a constant real interest rate over their lifetime.

This is how these special bonds work: Each year the principal value is adjusted by the increase in the consumer price index (CPI). Let's take a specific example: In January 2000, the Treasury issued a 4¼ percent 10-year inflation-protected bond. Between January 2000 and June 2003, the CPI increased by 12 percent. Therefore, the same

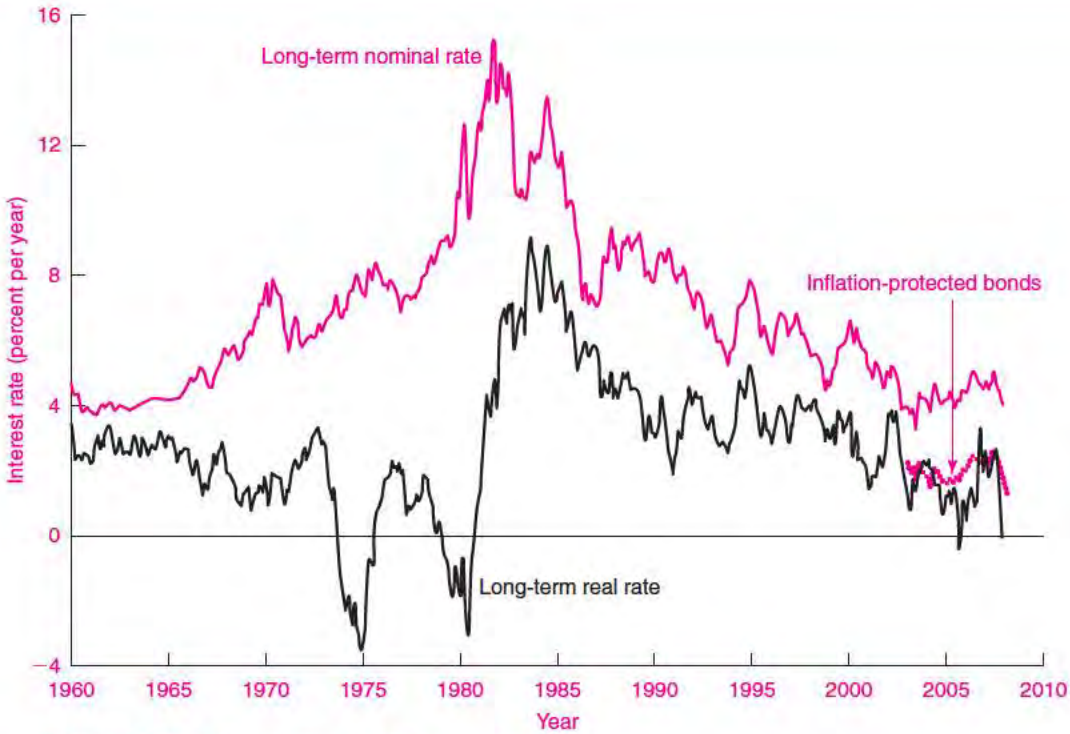


FIGURE 15-3. Nominal vs. Real Interest Rates

The long green line shows the nominal interest rate on long-term Treasury bonds. The blue line shows the "calculated" real interest rate, equal to the nominal interest rate minus the realized inflation rate over the previous year. Note that real interest rates drifted downward until 1980. After 1980, however, real interest rates moved up sharply. The short green line since 2003 shows the real interest rate on long-term inflation-indexed securities.

Source: Federal Reserve Board, Department of Labor.

Eye Therapies Exhibit 2127, 313 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

$1000 bond bought in 2000 would be valued at $1120 in June 2003. If the Treasury made an interest payment in June 2003, it would be 4¼ percent of $1120, instead of 4¼ percent of $1000 as would be the case for a standard bond. Let's further suppose that inflation averaged 3 percent per year from 2000 to 2010. This means that the principal value of the bond upon redemption would be $1343.92 [= $1000 × $(1.3)^{10}$], instead of the $1000 for a conventional bond.

As long as people expect that there will be inflation in the coming years, the interest rate on TIPS will be less than that on standard Treasury bonds. For example, in April 2008, standard 10-year Treasury bonds had a nominal yield of 3.6 percent, while 10-year TIPS had a real yield of 1.2 percent. This indicates that the average investor expected 10-year inflation to average 3.6 − 1.2 = 2.4 percent per year.

The difference between nominal and real interest rates on long-term bonds is illustrated in Figure 15-3. The upper line shows the nominal interest rate, while the long lower line shows the calculated real interest rate. In addition, the short green segment that begins in 2003 shows the real interest rate on TIPS. This figure shows that the rise in nominal interest rates from 1960 to 1980 was purely illusory, for nominal interest rates were just keeping up with inflation during those years. After 1980, however, real interest rates rose sharply and remained high for a decade. The data on TIPS show that the real interest rate declined sharply during the credit crisis of 2007–2008.

Economists have long been enthusiasts of indexed bonds. Such bonds can be bought by pensioners who wish to guarantee that their retirement incomes will not be eroded away by inflation. Similarly, parents who wish to save for their children's education can sock away some of their savings knowing that their investment will keep up with the general price level. Even monetary-policy makers find value in indexed bonds, for the difference between the interest on conventional bonds and that on TIPS gives an indication of what is happening to expected inflation. The main puzzle for many economists is why it took the government so long to introduce this important innovation.

B. THE THEORY OF CAPITAL, PROFITS, AND INTEREST

Now that we have surveyed the major concepts, we turn to an analysis of the *theory of capital and interest.* This theory explains how the supply and demand for capital determines returns such as real interest rates and profits.

BASIC CAPITAL THEORY

Roundaboutness

In Chapter 2, we noted that investment in capital goods involves indirect or *roundabout* production. Instead of catching fish with our hands, we find it ultimately more worthwhile first to build boats and make nets—and then to use the boats and nets to catch many more fish than we could by hand.

Put differently, investment in capital goods involves forgoing present consumption to increase future consumption. Consuming less today frees labor for making nets to catch many more fish tomorrow. In the most general sense, capital is productive because by forgoing consumption today we get more consumption in the future.

To see this, imagine two islands that are exactly alike. Each has the same amount of labor and natural resources. Island A uses these primary factors directly to produce consumption goods like food and clothing; it uses no produced capital goods at all. By contrast, thrifty Island B sacrifices current consumption and uses its resources and labor to produce capital goods, such as plows, shovels, and looms. After this temporary sacrifice of current consumption, B ends up with a large stock of capital goods.

Figure 15-4 shows the way that Island B forges ahead of A. For each island, measure the amount of consumption that can be enjoyed while maintaining the existing capital stock. Because of its thrift, Island B, using roundabout, capital-intensive methods of production, will enjoy more future consumption than Island A. Island B gets more than 100 units of future-consumption goods for its initial sacrifice of 100 units of present consumption.

By sacrificing current consumption and building capital goods today, societies can increase their consumption in the future.

Diminishing Returns and the Demand for Capital

What happens when a nation sacrifices more and more of its consumption for capital accumulation and production becomes more and more roundabout or indirect? We would expect the law of diminishing

Eye Therapies Exhibit 2127, 314 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

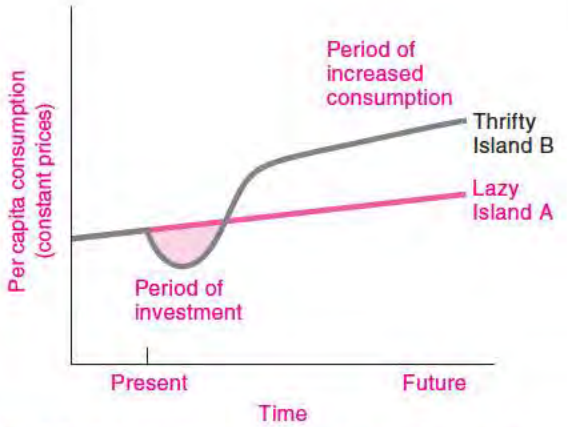


FIGURE 15-4. Investments Today Yield Consumption Tomorrow

Two islands begin with equal endowments of labor and natural resources. Lazy Island A invests nothing and shows a modest growth in per capita consumption. Thrifty Island B devotes an initial period to investment, forgoing consumption, and then enjoys the harvest of much higher consumption in the future.

returns to set in. Let's take the example of computers. The first computers were expensive and used intensively. Four decades ago, scientists would eke every last hour of time from an expensive mainframe computer that had less power than today's personal computer. By 2009, the nation's stock of computers had millions of times more computational and storage capacity. Therefore, the marginal product of computer power—the value of the last calculation or the last byte of storage—had diminished greatly as computer inputs increased relative to labor, land, and other capital. More generally, as capital accumulates, diminishing returns set in and the rate of return on the investments tends to fall.

Surprisingly, the rate of return on capital has not fallen markedly over the course of the last two centuries, even though our capital stocks have grown manyfold. Rates of return have remained high because innovation and technological change have created profitable new opportunities as rapidly as past investment has annihilated them. Even though computers are thousands of times more powerful than they were a few years ago, new applications in every corner of society from medical diagnostics to Internet commerce continue to make investments in computers profitable.



Irving Fisher: Economist as Crusader

Irving Fisher (1867–1947) was a multifaceted genius and crusader. His pioneering economic research ranged from fundamental theoretical studies on utility and capital theory to practical investigations into business cycles, index numbers, and monetary reform.

Among his fundamental contributions was the development of a complete theory of capital and interest in *The Nature of Capital and Income* (1906) and *The Theory of Interest* (1907). Fisher described the interplay between the interest rate and innumerable other elements of the economy. Yet the basic determinants of the interest rate, Fisher showed, were two fundamental pillars: impatience as reflected in "time discounting" and investment opportunity as reflected in the "marginal rate of return over cost." It was Fisher who uncovered the deep relationship between interest and capital and the economy, as described in this summary from *The Theory of Interest:*

> The truth is that the rate of interest is not a narrow phenomenon applying only to a few business contracts, but permeates all economic relations. It is the link which binds man to the future and by which he makes all his far-reaching decisions. It enters into the price of securities, land, and capital goods generally, as well as into rent, wages, and the value of all "interactions." It affects profoundly the distribution of wealth. In short, upon its accurate adjustment depend the equitable terms of all exchange and distribution.

Fisher always aimed at research that could be empirically applied. His philosophy is embodied in the Econometric Society, which he helped found, whose constitution trumpeted a science which would lead to "the advancement of economic theory in its relation to statistics and mathematics [and] the unification of the theoretical-quantitative and the empirical-quantitative approach."

In addition to research on pure economics, Fisher was a habitual crusader. He lobbied for a "compensated dollar" as a substitute for the gold standard. After he contracted tuberculosis, he became an impassioned advocate for improved health and developed 15 rules of personal hygiene. These included a strong advocacy of Prohibition and idiosyncracies such as chewing 100 times before swallowing. It is said that with no alcohol and much chewing, dinner parties at the Fishers were not the liveliest gatherings in New Haven.

Fisher's most famous forecast came in 1929 when he argued that the stock market had achieved a "permanent plateau of prosperity." He put his money behind his

Eye Therapies Exhibit 2127, 315 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

forecast, and his substantial wealth was wiped out in the Great Depression.

Even though Fisher's financial acumen has been questioned, his legacy in economics has grown steadily, and he is generally regarded as the greatest American economist of all time.

Determination of Interest and the Return on Capital

We can use the classical theory of capital to understand the determination of the rate of interest. Households *supply* funds for investment by abstaining from consumption and accumulating savings over time. At the same time, businesses *demand* capital goods to combine with labor, land, and other inputs. In the end, a firm's demand for capital is driven by its desire to make profits by producing goods.

Or, as Irving Fisher put the matter a century ago:

> The quantity of capital and the rate of return on capital are determined by the interaction between (1) people's *impatience* to consume now rather than accumulate more capital goods for future consumption (perhaps for old-age retirement or for that proverbial rainy day); and (2) *investment opportunities* that yield higher or lower returns to such accumulated capital.

To understand interest rates and the return on capital, consider an idealized case of a closed economy with perfect competition and without risk or inflation. In deciding whether to invest, a profit-maximizing firm will always compare its cost of borrowing funds with the rate of return on capital. If the rate of return is higher than the market interest rate at which the firm can borrow funds, it will undertake the investment. If the interest rate is higher than the rate of return on investment, the firm will not invest.

Where will this process end? Eventually, firms will undertake all investments whose rates of return are higher than the market interest rate. Equilibrium is then reached when the amount of investment that firms are willing to undertake at a given interest rate just equals the savings which that interest rate calls forth.

In a competitive economy without risk or inflation, the competitive rate of return on capital would be equal to the market interest rate. The market interest rate serves two functions: It rations out society's scarce supply of capital goods for the uses that have the highest rates of return, and it induces people to sacrifice current consumption in order to increase the stock of capital.

Graphical Analysis of the Return on Capital

We can illustrate capital theory by concentrating on a simple case in which all physical capital goods are alike. In addition, assume that the economy is in a steady state with no population growth or technological change.

In Figure 15-5, *DD* shows the demand curve for the stock of capital; it plots the relationship between the quantity of capital demanded and the rate of return on capital. Recall from Chapter 12 that the demand for a factor like capital is a derived demand—the demand comes from the *marginal product of capital*, which is the extra output yielded by additions to the capital stock.

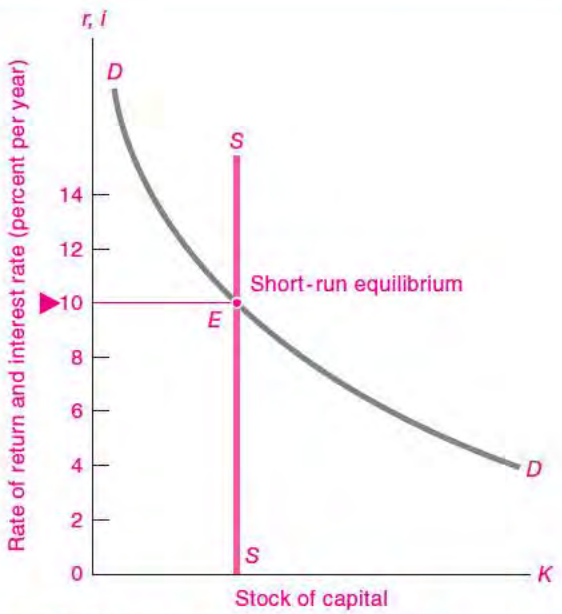


FIGURE 15-5. Short-Run Determination of Interest and Returns

In the short run, the economy has inherited a given stock of capital from the past, shown as the vertical *SS* supply-of-capital schedule. The intersection of the short-run supply curve with the demand-for-capital schedule determines the short-run return on capital, and the short-run real interest rate, at 10 percent per year.

Eye Therapies Exhibit 2127, 316 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The law of diminishing returns can be seen in the fact that the demand-for-capital curve in Figure 15-5 is downward-sloping. When capital is very scarce, the most profitable projects have a very high rate of return. Gradually, as the community exploits all the high-yield projects by accumulating capital, with total labor and land fixed, diminishing returns to capital set in. The community must then invest in lower-yield projects as it moves down the demand-for-capital curve.

Short-Run Equilibrium. We can now see how supply and demand interact. In Figure 15-5, past investments have produced a given stock of capital, shown as the vertical short-run supply curve, *SS*. Firms will demand capital goods in a manner shown by the downward-sloping demand curve, *DD*.

At the intersection of supply and demand, at point *E*, the amount of capital is just rationed out to the demanding firms. At this short-run equilibrium, firms are willing to pay 10 percent a year to borrow funds to buy capital goods. At that point, the lenders of funds are satisfied to receive exactly 10 percent a year on their supplies of capital.

Thus, in our simple, riskless world, the rate of return on capital exactly equals the market interest rate. Any higher interest rate would find firms unwilling to borrow for their investments; any lower interest rate would find firms clamoring for the too scarce capital. Only at the equilibrium interest rate of 10 percent are supply and demand equilibrated. (Recall that these are *real* interest rates because there is no inflation.)

But the equilibrium at *E* is sustained only for the short run: At this high interest rate, people desire to accumulate more wealth, that is, to continue saving and investing. This means that the capital stock increases. However, because of the law of diminishing returns, the rate of return and the interest rate move downward. As capital increases—while other things such as labor, land, and technical knowledge remain unchanged—the rate of return on the increased stock of capital goods falls to ever-lower levels.

This process is shown graphically in Figure 15-6. Note that capital formation is taking place at point *E*.

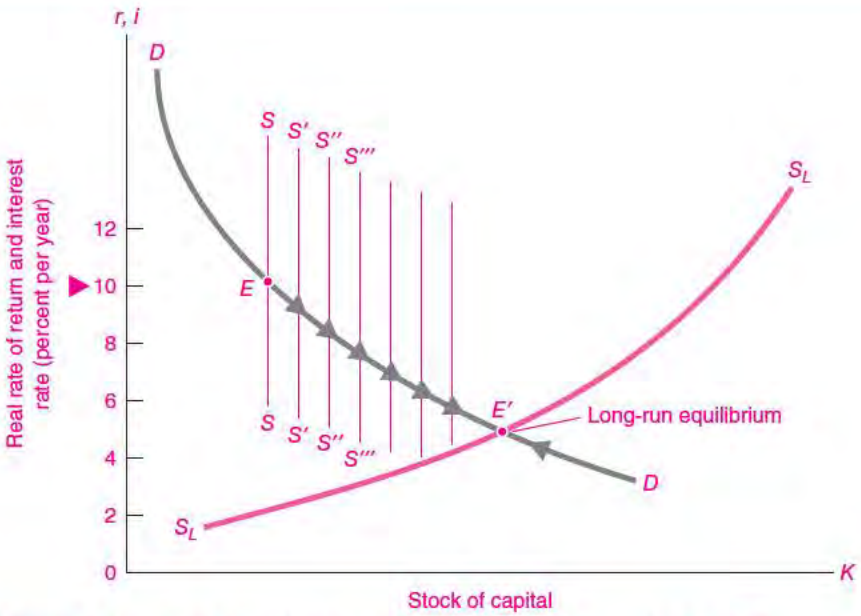


FIGURE 15-6. Long-Run Equilibration of the Supply and Demand for Capital

In the long run, society accumulates capital, so the supply curve is no longer vertical. As pictured here, the supply of capital and wealth is responsive to higher interest rates. At the original short-run equilibrium at *E* there is net investment, so the economy moves down the *DD* demand curve as shown by the blue arrows. Long-run equilibrium comes at *E′*, where net saving ceases.

Eye Therapies Exhibit 2127, 317 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

So each year, the capital stock is a little higher as net investment occurs. As time passes, the community moves slowly down the *DD* curve as shown by the blue arrows in Figure 15-6. You can actually see a series of very thin short-run supply-of-capital curves in the figure—*S*, *S′*, *S″*, *S‴*, ... These curves show how the short-run supply of capital increases with capital accumulation.

Long-Run Equilibrium. The eventual equilibrium is shown at *E′* in Figure 15-6; this is where the long-run supply of capital (shown as $S_L S_L$) intersects with the demand for capital. In long-run equilibrium, the real interest rate settles at that level where the quantity of capital that firms desire to hold just matches the value of wealth that people want to own. At the long-run equilibrium, net saving stops, net capital accumulation is zero, and the capital stock is no longer growing.

Would investment gradually decline to zero as all investment opportunities are exhausted? Some economists (such as Joseph Schumpeter) have likened the investment process to a plucked violin string: In a world of unchanging technology, the string gradually comes to rest as capital accumulation drives down returns on capital. But before the economy has settled into a steady state, an outside event or invention comes along to pluck the string and set the forces of investment in motion again.

The long-run equilibrium stock of capital comes at that real interest rate where the value of assets that people want to hold exactly matches the amount of capital that firms want for production.

PROFITS AS A RETURN TO CAPITAL

Now that we have examined the determinants of the return to capital, we turn to an analysis of profits. In addition to discussing wages, interest, and rent, economists often talk about a fourth category of income called *profits*. What are profits? How do they differ from interest and the returns on capital more generally?

Reported Profit Statistics

Before we present the economic concepts, we begin with the measures used in accounting. Accountants define profits as the difference between total revenues and total costs. To calculate profits, accountants start with total revenues and subtract all expenses (wages, salaries, rents, materials, interest, excise taxes, and the rest). The leftover residual is called profits.

It is important in analyzing profits, however, to distinguish between *accounting profits* and *economic profits*. Accounting profits (also called business income or business earnings) are the residual income measured in financial statements by accountants. Economic profits are the earnings after all costs—both money and implicit or opportunity costs—are subtracted. These concepts of profits differ because accounting profits omit some implicit returns. The opportunity costs of factors owned by firms are called *implicit returns*.

For example, most businesses own much of their capital, and there is no accounting charge for the opportunity cost or implicit return on owned capital. Accounting profits therefore include an implicit return on the capital owned by firms. In large corporations, economic profits would equal business profits minus an implicit return on the capital owned by the firm along with any other costs not fully compensated at market prices. Economic profits are generally smaller than business profits.

Determinants of Profits

What determines the rate of profit in a market economy? Profits are in fact a combination of different elements, including implicit returns on owners' capital, rewards for risk-bearing and innovational profits.

Profits as Implicit Returns. Much of reported business profits is primarily the return to the owners of the firm for the factors of production, including capital and labor provided by the owners. For example, some profits are the return on the personal work provided by the owners of the firm—such as the doctor or the lawyer who works in a small professional corporation. Another part is the rent return on the land owned by the firm. In large corporations, most profits represent the opportunity costs of invested capital.

Thus some of what is ordinarily called profit is really nothing but "implicit rentals," "implicit rent," and "implicit wages," which are the earnings on factors that the firm itself owns.

Eye Therapies Exhibit 2127, 318 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Profits as Rewards for Risk-Bearing. Profits also include a reward for the riskiness of the relevant investments. Most businesses must incur a risk of default, which occurs when a loan or investment cannot be paid, perhaps because the borrower went bankrupt. In addition, there are many insurable risks, such as those for fires or hurricanes, which can be covered through the purchase of insurance. A further concern is the uninsurable or systematic risk of investments. A company may have a high degree of sensitivity to business cycles, which means that its earnings fluctuate a great deal when aggregate output goes up or down. All of these risks must either be insured against or earn a risk premium in profits.

Profits as Reward for Innovation. A third kind of profits consists of the returns to innovation and invention. A growing economy is constantly producing new goods and services—from telephones in the nineteenth century to automobiles early in the twentieth century to computer software in the present era. These new products are the result of research, development, and marketing. We call the person who brings a new product or process to market an *innovator* or *entrepreneur.*

What do we mean by "innovators"? Innovators are people who have the vision, originality, and daring to introduce new ideas. Our economy has been revolutionized by the discoveries of great inventors like Alexander Graham Bell (telephone), Jack Kilby (integrated circuit), and Kary Mullis (polymerase chain reaction).

Every successful innovation creates a temporary pool of monopoly. We can identify innovational profits (sometimes called Schumpeterian profits) as the temporary excess return to innovators and entrepreneurs. These profit earnings are temporary and are soon competed away by rivals and imitators. But just as one source of innovational profits disappears, another is being born. An economy will generate this type of profits as long as it innovates.

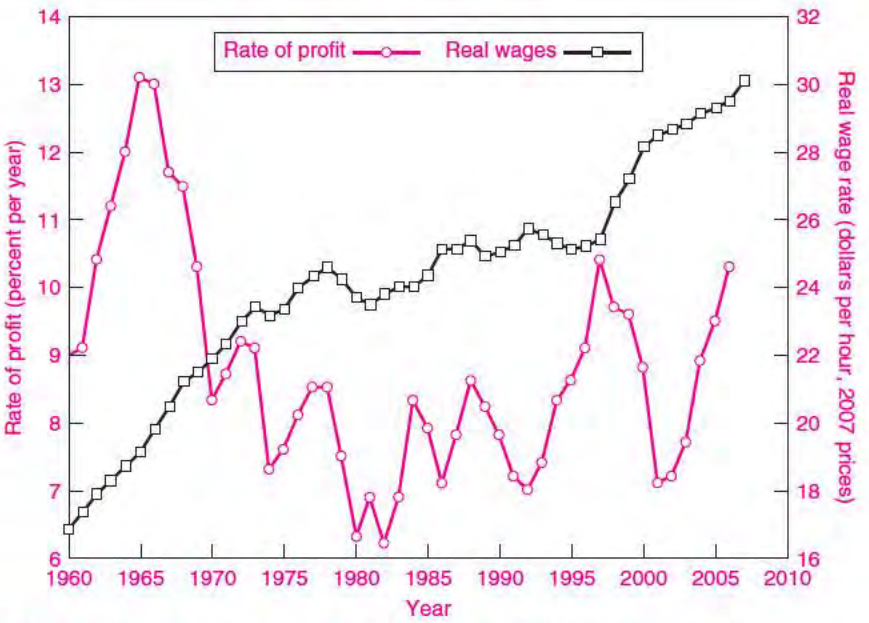


FIGURE 15-7. Trends in Wages and Rate of Profit in the United States

How have the returns to labor and capital varied in recent years? Average real wages have continued to grow. After peaking in the mid-1960s, the pretax rate of profit on American business capital fell sharply and then meandered around over the last three decades, with an average of around 8 percent per year.

Source: U.S. Departments of Commerce and Labor.

Eye Therapies Exhibit 2127, 319 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Corporate profits are the most volatile component of national income. The rights to earn corporate profits—represented by the ownership of corporate stocks or equities—must therefore provide a significant premium to attract risk-averse investors. This excess return on equities above that on risk-free investments is called the *equity premium.* Empirical studies suggest that the equity premium averaged around 5 percent per year over the twentieth century (see Table 15-1 on page 289).

Profits are a residual income item, equal to total revenues minus total costs. Profits contain elements of implicit returns (such as return on owners' capital), return for risk-bearing, and innovational profits.

Empirical Evidence on Returns to Labor and Capital

We close with a look at the actual trends in the return to labor and capital in the United States over the last four decades, as illustrated in Figure 15-7. Real wages (which are average hourly earnings corrected for movements in the consumer price index) grew steadily. The pretax rate of profit on capital declined from its peak in the mid-1960s and has averaged around 8 percent per year for the last three decades.



SUMMARY

A. Basic Concepts of Interest and Capital

1. Recall the major concepts:
   - *Capital:* durable produced items used for further production
   - *Rentals:* net annual dollar returns on capital goods
   - *Rate of return on investment:* net annual receipts on capital divided by dollar value of capital (measured as percent per year)
   - *Interest rate:* yield on financial assets, measured as percent per year
   - *Real interest rate:* yield on funds corrected for inflation, also measured as percent per year
   - *Present value:* value today of an asset's stream of future returns
2. Interest rates are the rate of return on financial assets, measured in percent per year. People willingly pay interest because borrowed funds allow them to buy goods and services to satisfy current consumption needs or make profitable investments.
3. We observe a wide variety of interest rates. These rates vary because of many factors such as the term or maturity of loans, the risk and liquidity of investments, and the tax treatment of the interest.
4. Nominal or money interest rates generally rise during inflationary periods, reflecting the fact that the purchasing power of money declines as prices rise. To calculate the interest yield in terms of real goods and services, we use the real interest rate, which equals the nominal interest rate minus the rate of inflation.
5. Assets generate streams of income in future periods. By calculating the present value of the asset, we can convert the stream of future returns into a single value today. This is done by asking what sum today will generate the total value of all future returns when invested at the market interest rate.
6. The exact present-value formula is as follows: Each dollar payable t years from now has a present value (V) of $\$1/(1 + i)^t$. So for any net-receipt stream $(N_1, N_2, \ldots, N_t)$, where N_t is the dollar value of receipts t years in the future, we have

$$V = \frac{N_1}{1+i} + \frac{N_2}{(1+i)^2} + \cdots + \frac{N_t}{(1+i)^t} + \cdots$$

B. The Theory of Capital, Profits, and Interest

7. A third factor of production is capital, a produced durable item that is used in further production. In the most general sense, investing in capital represents deferred consumption. By postponing consumption today and instead producing buildings or equipment, society increases consumption in the future. It is an economic fact that roundabout production yields a positive rate of return.
8. Interest is a device that serves two functions in the economy: As a motivating device, it provides an incentive for people to save and accumulate wealth. As a rationing device, interest allows society to select only those investment projects with the highest rates of

Eye Therapies Exhibit 2127, 320 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

return. However, as more and more capital is accumulated, and as the law of diminishing returns sets in, the rate of return on capital and the interest rate will be beaten down by competition. Falling interest rates are a signal to society to adopt more capital-intensive projects with lower rates of return.

9. Saving and investing involve waiting for future consumption rather than consuming today. Such thrift interacts with the net productivity of capital to determine interest rates, the rate of return on capital, and the capital stock. The funds or financial assets needed to purchase capital are provided by households that are willing to sacrifice consumption today in return for larger consumption tomorrow. The demand for capital comes from firms that have a variety of roundabout investment projects. In long-run equilibrium, the interest rate is thus determined by the interaction between the net productivity of capital and the willingness of households to sacrifice consumption today for consumption tomorrow.
10. Profits are revenues minus costs. Remember that economic profits differ from those measured by accountants. Economics distinguishes between three categories of profits: (*a*) An important source is profits as implicit returns. Firms generally own many of their own nonlabor factors of production—capital, natural resources, and patents. In these cases, the implicit return on owned inputs is part of the profits. (*b*) Another source of profits is uninsured or uninsurable risk, particularly that associated with the business cycle. (*c*) Finally, innovational profits will be earned by entrepreneurs who introduce new products or innovations.

CONCEPTS FOR REVIEW

capital, capital goods
tangible assets vs. financial assets
rentals, rate of return on capital, interest rate, profits
present value
interest rate, real and nominal
interest-rate premiums due to maturity, risk, illiquidity
inflation-indexed bonds
investment as abstaining from current consumption
present value
twin elements in interest determination:
returns to roundaboutness
impatience
elements of profits:
implicit returns
risk
innovation

FURTHER READING AND INTERNET WEBSITES

Further Reading

The foundations of capital theory were laid by Irving Fisher, *The Theory of Interest* (Macmillan, New York, 1930). You can pursue advanced topics in finance theory in an intermediate textbook such as Lawrence S. Ritter, William L. Silber, and Gregory F. Udell, *Principles of Money, Banking, and Financial Markets,* 11th ed. (Addison Wesley Longman, New York, 2003). The standard reference on U.S. monetary history is Milton Friedman and Anna Jacobson Schwartz, *Monetary History of the United States 1867–1960* (Princeton University Press, Princeton, N.J., 1963).

Modern capital and finance theories are very popular subjects and are often covered in the macroeconomics part of an introductory course or in special courses. A good book on the subject is Burton Malkiel, *A Random Walk down Wall Street* (Norton, New York, 2003). A recent book surveying financial history and theory and arguing that the stock market was extraordinarily overvalued in the bull market of 1981–2000 is Robert Shiller, *Irrational Exuberance,* 2nd ed. (Princeton University Press, Princeton, N.J., 2005). A recent summary of evidence on the efficient-market theory by Burton Malkiel and

Eye Therapies Exhibit 2127, 321 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Robert Shiller is found in *Journal of Economic Perspectives,* Winter 2003.

Websites

Data on financial markets are plentiful. See *finance.yahoo.com* for an entry point into stock and bond markets as well as information on individual companies. Also see *www.bloomberg.com* for up-to-date financial information.

Data on financial markets are also produced by the Federal Reserve System at *www.federalreserve.gov.*

QUESTIONS FOR DISCUSSION

1. Calculate the present value of each of the following income streams, where I_t = the income t years in the future and i is the constant interest rate in percent per year. Round to two decimal points where the numbers are not integers.
   a. $I_0 = 10, I_1 = 110, I_3 = 133.1; i = 10.$
   b. $I_0 = 17, I_1 = 21, I_2 = 33.08, I_3 = 23.15; i = 5.$
   c. $I_0 = 0, I_1 = 12, I_2 = 12, I_3 = 12, \ldots; i = 5.$
2. Contrast the following four returns on durable assets: (*a*) rent on land, (*b*) rental of a capital good, (*c*) rate of return on a capital good, and (*d*) real interest rate. Give an example of each.
3. Interest-rate problems (which may require a calculator):
   a. You invest $2000 at an interest rate of 13.5 percent per year. What is your total balance after 6 months?
   b. Interest is said to be "compounded" when you earn interest on whatever interest has already been paid; most interest rates quoted today are compounded. If you invest $10,000 for 3 years at a compound annual interest rate of 10 percent, what is the total value of the investment at the end of each year?
   c. Consider the following data: The consumer price index in 1977 was 60.6, and in 1981 it was 90.9. Interest rates on government securities in 1978 through 1981 (in percent per year) were 7.2, 10.0, 11.5, and 14.0. Calculate the average nominal and real interest rates for the 4-year period 1978–1981.
   d. Treasury bills (T-bills) are usually sold on a discounted basis; that is, a 90-day T-bill for $10,000 would sell today at a price such that collecting $10,000 at maturity would produce the market interest rate. If the market interest rate is 6.6 percent per year, what would be the price on a 90-day $10,000 T-bill?
4. Present-value questions:
   a. Consider the 1-year bond in the discussion of present value. Calculate the present value of the bond if the interest rate is 1, 5, 10, and 20 percent.
   b. What is the value of a perpetuity yielding $16 per year at interest rates of 1, 5, 10, and 20 percent per year?
   c. Compare the answers to **a** and **b.** Which asset is more sensitive to interest-rate changes? Quantify the difference.
5. Using the supply-and-demand analysis of interest, explain how each of the following would affect interest rates in capital theory:
   a. An innovation that increased the marginal product of capital at each level of capital
   b. A decrease in the desired wealth holdings of households
   c. A 50 percent tax on the return on capital (in the short run and the long run)
6. Looking back to Figures 15-5 and 15-6, review how the economy moved from the short-run equilibrium interest rate at 10 percent per year to the long-run equilibrium. Now explain what would occur in both the long run and the short run if innovations shift up the demand-for-capital curve. What would happen if the government debt became very large and a large part of people's supply of capital was siphoned off to holdings of government debt? Draw new figures for both cases.
7. Explain the rule for calculating the present discounted value of a perpetual income stream. At a 5 percent interest rate, what is the worth of a perpetuity paying $100 per year? Paying $200 per year? Paying $\$N$ per year? At 10 or 8 percent, what is the worth of a perpetuity paying $100 per year? What does doubling the interest rate do to the capitalized value of a perpetuity—say, a perpetual bond?
8. Recall the algebraic formula for a convergent geometric progression:

$$1 + K + K^2 + \cdots = \frac{1}{1 - K}$$

for any fraction K less than 1. If you set $K = 1/(1 + i)$, can you verify the present-value formula for a permanent income stream, $V = \$N/i$? Provide an alternative

Eye Therapies Exhibit 2127, 322 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

proof using common sense. What would be the value of a lottery that paid you and your heirs $5000 per year forever, assuming an interest rate of 6 percent per year?

9. The value of land in Manhattan was around $150 billion in 2008. Imagine that it is 1626 and you are the economic adviser to the Dutch when they are considering whether to buy Manhattan from the Manhasset Indians. Further, assume that the relevant interest rate for calculating the present value is 4 percent per year. Would you advise the Dutch that a purchase price of $24 is a good deal or not? How would your answer change if the interest rate were 6 percent? 8 percent? (*Hint:* For each interest rate, calculate the present value in 1626 of the land value as of 2008. Then compare that with the purchase price in 1626. For this example, simplify by assuming that the owners collect no rents on the land. As an advanced further question, assume that the rent equals 2 percent of the value of the land each year.)

10. An increase in interest rates will generally lower the prices of assets. To see this, calculate the present value of the following two assets at interest rates of 5 percent, 10 percent, and 20 percent per year:
    a. A perpetuity yielding $100 per year
    b. A Christmas tree that will sell for $50 one year from now

    Explain why the price of the long-lived asset is more sensitive to interest-rate changes than the price of the short-lived asset.

Eye Therapies Exhibit 2127, 323 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

PART FOUR

Applications of Economic Principles

CHAPTER

Government Taxation and Expenditure

16



The spirit of a people, its cultural level, its social structure, the deeds its policy may prepare, all this and more is written in its fiscal history. . . . He who knows how to listen to its messenger here discerns the thunder of world history more clearly than anywhere else.

Joseph Schumpeter

When we look at a market economy—providing all sorts of products from apples and boats to X-ray machines and zithers—it would be tempting to think that markets require little more than skilled workers and lots of capital. But history has shown that markets cannot work effectively alone. At a minimum, an efficient market economy needs police to ensure physical security, an independent judicial system to enforce contracts, regulatory mechanisms to prevent monopolistic abuses and lethal pollution, schools to educate the young, and a public health system to ward off communicable diseases. Exactly where to draw the line between government and private activities is a difficult and controversial question, and people today debate the appropriate role of government in education, health care, and income support.

As economists, we want to go beyond the partisan debates and analyze the functions of government—government's comparative advantage in the mixed economy. The present chapter examines the role of government in an advanced economy. What are the appropriate goals for economic policy in a market economy, and what instruments are available to carry them out? What principles underlie an efficient tax system? Understanding the answers to these questions is key to developing sound public policies.

A. GOVERNMENT CONTROL OF THE ECONOMY

Debates about the role of government often take place on bumper stickers, with rallying cries such as "No new taxes" or "Balance the budget." These simplistic phrases cannot capture the serious business of government economic policy. Say the populace decides that it wants to devote more resources to improving public health; or that more resources should be devoted to educating the young; or that unemployment in a deep recession should be reduced. A market economy cannot automatically solve these problems. Each of these objectives can be met if and only if the government changes its taxes, spending, or regulations. The thunder of world history is heard in fiscal policy because taxing and spending are such powerful instruments for social change.

Eye Therapies Exhibit 2127, 326 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

THE TOOLS OF GOVERNMENT POLICY

In a modern economy, no sphere of economic life is untouched by the government. We can identify three major instruments or tools that government uses to influence private economic activity:

1. *Taxes* on incomes and goods and services. These reduce private income, thereby reducing private expenditures (on automobiles or restaurant food) and providing resources for public expenditures (on missiles and school lunches). The tax system also serves to discourage certain activities by taxing them more heavily (such as smoking cigarettes) while encouraging other activities by taxing them lightly or even subsidizing them (such as health care).
2. *Expenditures* on certain goods or services (such as roads, education, or police protection), along with *transfer payments* (like social security and food stamps) that provide resources to individuals.
3. *Regulations* or controls that direct people to perform or refrain from certain economic activities. Examples include rules that limit the amount firms can pollute, or that divide up the radio spectrum, or that mandate testing the safety of new drugs.

Trends in the Size of Government

For more than a century, national income and production have been rising in all economies. At the same time, in most countries, government expenditures have been rising even faster than the overall economy. Each period of emergency—depression, war, or concern over social problems such as poverty or pollution—expanded the activity of government. After the crisis passed, government controls and spending never returned to their previous levels.

Before World War I, the combined federal, state, and local government expenditures or taxation amounted to little more than one-tenth of the entire U.S. national income. The war effort during World War II compelled government to consume about half the nation's greatly expanded total output. By 2007, expenditures of all levels of government in the United States ran around 33 percent of GDP.

Figure 16-1 shows the trend in taxes and expenditures for all levels of government in the United

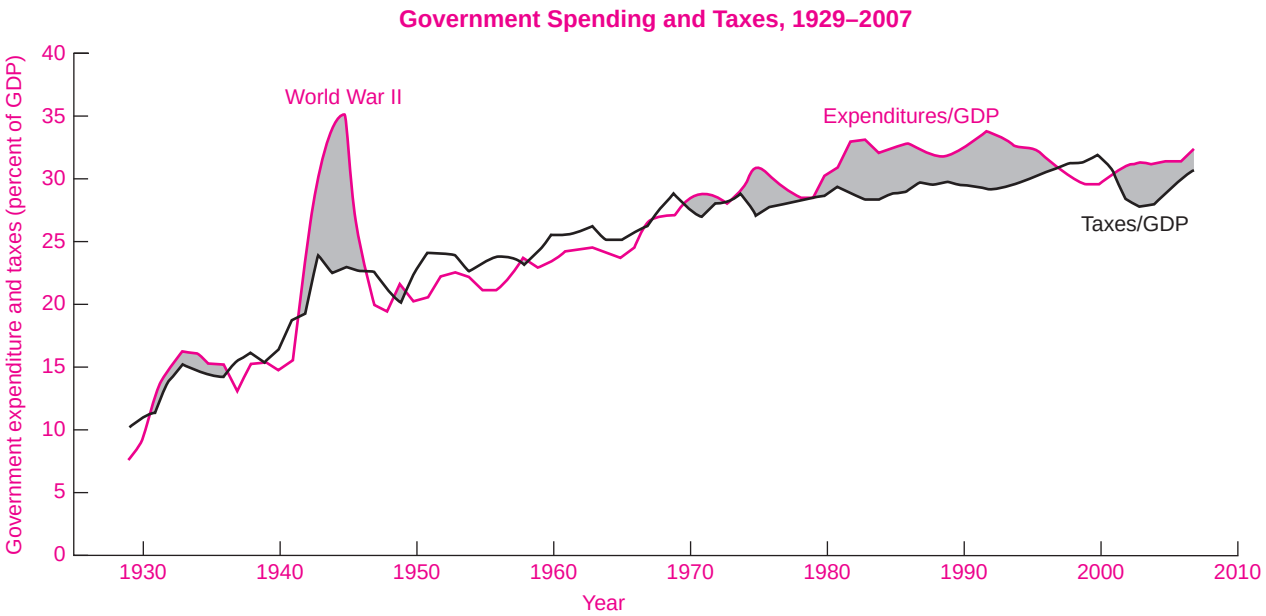


FIGURE 16-1. Government's Share of the Economy Has Grown Sharply

Government expenditures include spending on goods, services, and transfers at the federal, state, and local levels. Note how spending grew rapidly during wartime but did not return to prewar levels afterward. The difference between spending and taxes is the government deficit or surplus.

Source: U.S. Department of Commerce.

Eye Therapies Exhibit 2127, 327 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

States. The rising curves indicate that the shares of government taxes and spending have grown steadily upward over recent decades.

Government's expansion has not occurred without opposition; each new spending and tax program provoked a fierce reaction. For example, when social security was first introduced in 1935, opponents denounced it as an ominous sign of socialism. But with the passage of time, political attitudes evolve. The "socialistic" social security system is today defended by politicians of all stripes as an essential part of the "social contract" between the generations. The radical doctrines of one era become accepted gospel of the next.

Figure 16-2 shows how government spending as a percentage of GDP varies among countries. High-income countries tend to tax and spend a larger fraction of GDP than do poor countries. Can we discern a pattern among wealthy countries? Within the high-income countries, no simple law relating tax burdens and the citizenry's well-being can do justice to the true diversity of the fiscal facts of nations. For example, financing for education and health care, two of the largest components of government spending, is organized very differently across countries.

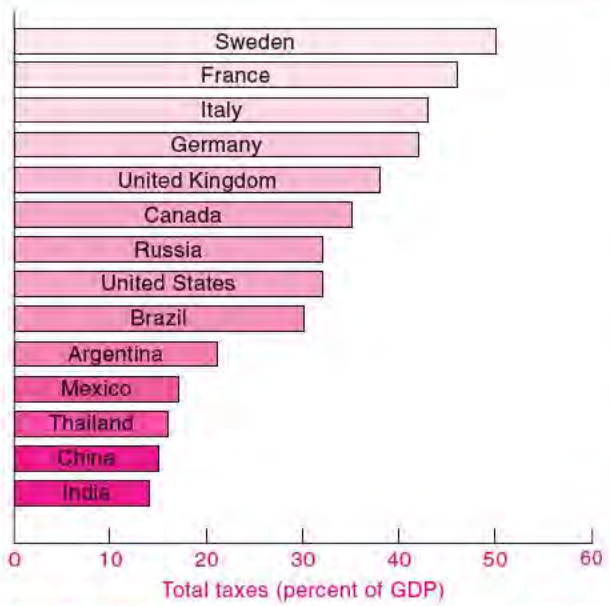


FIGURE 16-2. Government Taxation Is Highest in Rich Countries

Governments of poor countries tax and spend relatively little of national income. With affluence come greater demands for public goods and redistributional taxation to aid low-income families.

Source: United Nations for period 2000–2002, at *unpan1.un.org/intradoc/groups/public/documents/un/unpan014052.pdf*.

Figures 16-1 and 16-2 show the total expenditures of governments. Such expenditures include purchases of goods and services (like missiles and education) as well as transfer payments (like social security payments and interest on the government debt). Purchases of goods and services are called "exhaustive" because they make a direct claim upon the production of a country; transfer payments, by contrast, increase people's income and allow individuals to purchase goods and services but do not directly reduce the quantity of goods and services available for private consumption and investment.

The Growth of Government Controls and Regulation

In addition to the growth in spending and taxing, there has also been a vast expansion in the laws and regulations governing economic affairs.

Nineteenth-century America came as close as any economy has come to being a pure laissez-faire society—the system that the British historian Thomas Carlyle labeled "anarchy plus the constable." This philosophy permitted people great personal freedom to pursue their economic ambitions and produced a century of rapid material progress. But critics saw many flaws in this laissez-faire idyll. Historians record periodic business crises, extremes of poverty and inequality, deep-seated racial discrimination, and poisoning of water, land, and air by pollution. Muckrakers and progressives called for a bridle on capitalism so that the people could steer this wayward beast in more humane directions.

Beginning in the 1890s, the United States gradually turned away from the belief that "government governs best which governs least." Presidents Theodore Roosevelt, Woodrow Wilson, Franklin Roosevelt, and Lyndon Johnson—in the face of strenuous opposition—pushed out the boundaries of federal control over the economy, devising new regulatory and fiscal tools to combat the economic ailments of their time.

Eye Therapies Exhibit 2127, 328 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Constitutional powers of government were interpreted broadly and used to "secure the public interest" and to "police" the economic system. In 1887, the federal Interstate Commerce Commission (ICC) was established to regulate rail traffic across state boundaries. Soon afterward, the Sherman Antitrust Act and other laws were aimed against monopolistic combinations in "restraint of trade."

During the 1930s, a whole set of industries came under *economic regulation,* in which government sets the prices, conditions of exit and entry, and safety standards. Regulated industries since that time have included the airlines, trucking, and barge and water traffic; electric, gas, and telephone utilities; financial markets; and oil and natural gas, as well as pipelines.

In addition to regulating the prices and standards of business, the nation attempted to protect health and safety through increasingly stringent *social regulation.* Following the revelations of the muckraking era of the early 1900s, pure food and drug acts were passed. During the 1960s and 1970s, Congress passed a series of acts that regulated mine safety and then worker safety more generally; regulated air and water pollution; authorized safety standards for automobiles and consumer products; and regulated strip mining, nuclear power, and toxic wastes.

Over the last three decades, the growth in government programs slowed. Economists argued persuasively that many economic regulations were impeding competition and keeping prices up rather than down. In the area of social regulations, economists have emphasized the need to ensure that the marginal benefits of regulations exceed their marginal costs. Today, "entitlement programs" (programs available to everyone who meets certain well-defined eligibility criteria), such as pensions and health care, are now the major spending programs for most high-income countries.

Still, there is no likelihood of a return to the laissez-faire era. Government programs have changed the very nature of capitalism. Private property is less and less wholly private. Free enterprise has become progressively less free. Irreversible evolution is part of history.

THE FUNCTIONS OF GOVERNMENT

We are beginning to get a picture of how government directs and interacts with the economy. What are the appropriate economic goals for government action in a modern mixed economy? Let's examine the four major functions:

1. Improving economic efficiency
2. Reducing economic inequality
3. Stabilizing the economy through macroeconomic policies
4. Conducting international economic policy

Improving Economic Efficiency

A central economic purpose of government is to assist in the socially desirable allocation of resources. This is the *microeconomic* side of government policy; it concentrates on the *what* and *how* of economic life. Microeconomic policies differ among countries according to customs and political philosophies. Some countries emphasize a hands-off, laissez-faire approach, leaving most decisions to the market. Other countries lean toward heavy government regulation, or even public ownership of businesses, in which production decisions are made by government planners.

The United States is fundamentally a market economy. On any microeconomic issue, most people presume that the market will solve the economic problem at hand. But sometimes there is good reason for government to override the allocational decisions of market supply and demand.

The Limits of the Invisible Hand. Earlier chapters have explained how the invisible hand of perfect competition would lead to an efficient allocation of resources. But this invisible-hand result holds only under limited conditions. All goods must be produced efficiently by perfectly competitive firms. All goods must be private goods like loaves of bread, the total of which can be cut up into separate slices of consumption for different individuals. There can be no externalities like air pollution. Consumers and firms must be fully informed about the prices and characteristics of the goods they buy and sell.

If all these idealized conditions were met, the invisible hand could provide perfectly efficient production and distribution of national output, and there would be no need for government intervention to promote efficiency.

Yet even in this ideal case, if there were to be a division of labor among people and regions, and if a price mechanism were to work, government would

Eye Therapies Exhibit 2127, 329 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

have an important role. Courts and police forces would be needed to ensure fulfillment of contracts, nonfraudulent and nonviolent behavior, freedom from theft and external aggression, and the legislated rights of property.

Inescapable Interdependencies. Laissez-faire with minimal government intervention might be a good system if the idealized conditions listed above were truly present. In reality, each and every one of the idealized conditions enumerated above is violated to some extent in all human societies. Unregulated factories do tend to pollute the air, water, and land. When contagious diseases threaten to break out, private markets have little incentive to develop effective public-health programs. Consumers are sometimes poorly informed about the characteristics of the goods they buy. The market is not ideal. There are market failures.

In other words, government often deploys its weapons to correct significant market failures, of which the most important are the following:

- *The breakdown of perfect competition.* When monopolies or oligopolies collude to fix prices or drive firms out of business, government may apply antitrust policies or regulations.
- *Externalities and public goods.* The unregulated market may produce too much air pollution and too little investment in public health or basic science. Government can use its influence to control harmful externalities or to fund programs in science and public health. Government can levy taxes on activities which impose external public costs (such as cigarette smoking), or it can subsidize activities which are socially beneficial (such as education or prenatal health care).
- *Imperfect information.* Unregulated markets tend to provide too little information for consumers to make well-informed decisions. In an earlier era, hucksters hawked snake oil remedies that might just as easily kill you as cure you. This led to food and drug regulations requiring that pharmaceutical companies provide extensive data on the safety and efficacy of new drugs before they can be sold. The government also requires that companies provide information on energy efficiency of major household appliances like refrigerators and water heaters. In addition, government may use its spending power to collect and provide needed information itself, as it does with automobile crash-and-safety data.

Clearly, there is much on the agenda of possible allocational problems for government to handle.

Reducing Economic Inequality

Even when the invisible hand is marvelously efficient, it may at the same time produce a very unequal distribution of income. Under laissez-faire, people end up rich or poor depending on where they were born, on their inherited wealth, on their talents and efforts, on their luck in finding oil, and on their gender or the color of their skin. To some people, the distribution of income arising from unregulated competition looks as arbitrary as the Darwinian distribution of food and plunder in the jungle.

In the poorest societies, there is little excess income to take from the better-off and provide to the unfortunate. However, as a nation becomes wealthier, it can devote more resources to provide basic necessities and social insurance for all of its residents. These activities are the role of the "welfare state"—in which governments provide a minimum living standard to all—which is surveyed in detail in the next chapter. The welfare states of North America and Western Europe now devote a significant share of their revenues to maintaining minimum standards of health, nutrition, and income.

Income redistribution is usually accomplished through taxation and spending policies. Most wealthy countries now rule that children shall not go hungry because of the economic circumstances of their parents; that the poor shall not die because of insufficient money for needed medical care; that the young shall receive free public education; and that the old shall live out their years with a minimum level of income. In the United States, these government activities are provided primarily by transfer programs, such as food stamps, Medicaid, and social security.

But attitudes about redistribution evolve as well. With rising tax burdens and government budget deficits, along with rising costs of income-support programs, taxpayers increasingly resist redistributive programs and progressive taxation.

Stabilizing the Economy through Macroeconomic Policies

Early capitalism was prone to financial panics and bouts of inflation and depression. Today government

Eye Therapies Exhibit 2127, 330 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

has the responsibility of preventing calamitous business depressions by the proper use of monetary and fiscal policy, as well as regulation of the financial system. In addition, government tries to smooth out the ups and downs of the business cycle, in order to avoid either large-scale unemployment at the bottom of the cycle or high inflation at the top of the cycle. More recently, government has become concerned with finding economic policies which boost long-term economic growth. These questions are considered at length in the chapters on macroeconomics.

Conducting International Economic Policy

As we will see in Chapter 18's review of international trade, the United States has become increasingly linked to the global economy in recent years. Government now plays a critical role representing the interests of the nation on the international stage and negotiating beneficial agreements with other countries on a wide range of issues. We can group the international issues of economic policy into four main areas:

- *Reducing trade barriers.* An important part of economic policy involves harmonizing laws and reducing trade barriers so as to encourage fruitful international specialization and division of labor. In recent years, nations have negotiated a series of trade agreements to lower tariffs and other trade barriers on agricultural products, manufactured goods, and services.

  Such agreements are often contentious. They sometimes harm certain groups, as when removing textile tariffs reduces employment in that industry. In addition, international agreements may require giving up national sovereignty as the price of raising incomes. Suppose that one country's laws protect intellectual property rights, such as patents and copyrights, while another country's laws allow free copying of books, videos, and software. Whose laws shall prevail?
- *Conducting assistance programs.* Rich nations have numerous programs designed to improve the lot of the poor in other countries. These involve direct foreign aid, disaster and technical assistance, the establishment of institutions like the World Bank to give low-interest-rate loans to poor countries, and concessionary terms on exports to poor nations.
- *Coordinating macroeconomic policies.* Nations have seen that fiscal and monetary policies of other nations affect inflation, unemployment, and financial conditions at home. The international monetary system cannot manage itself; establishing a smoothly functioning exchange-rate system is a prerequisite for efficient international trade. When the American credit crisis erupted in 2008, it quickly spread to Europe and threatened several European banks. Central banks needed to act in a coordinated fashion to ensure that a bank failure, or even the fear of failure, in one country did not spread like wildfire to the entire international financial system. Particularly in tightly integrated regions, like Western Europe, countries work to coordinate their fiscal, monetary, and exchange-rate policies, or even adopt a common currency, so that inflation, unemployment, or financial crises in one country do not spill over to hurt the entire area.
- *Protecting the global environment.* The most recent facet of international economic policy is to work with other nations to protect the global environment in cases where several countries contribute to or are affected by spillovers. The most active areas historically have been protecting fisheries and water quality in rivers. When the Antarctic ozone hole threatened public health, countries reached an agreement to limit the use of ozone-depleting chemicals. Other treaties are designed to reduce the threats of deforestation, global warming, and species extinction. Clearly, international environmental problems can be resolved only through the cooperation of many nations.

Even the staunchest conservatives agree that government has a major role to play in representing the national interest in the anarchy of nations.

PUBLIC-CHOICE THEORY

For the most part, our analysis has concentrated on the *normative* theory of government—on the appropriate policies that the government *should follow* to increase the welfare of the population. But economists are not starry-eyed about the government any more than they are about the market. Governments

Eye Therapies Exhibit 2127, 331 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

can make bad decisions or carry out good ideas badly. Indeed, just as there are market failures such as monopoly and pollution, so are there "government failures" in which government interventions lead to waste or redistribute income in an undesirable fashion.

These issues are the domain of **public-choice theory,** which is the branch of economics and political science that studies the way that governments make decisions. Public-choice theory examines the way different voting mechanisms can function and shows that there are no ideal mechanisms to sum up individual preferences into social choices. This approach also analyzes government failures, which arise when state actions fail to improve economic efficiency or when the government redistributes income unfairly. Public-choice theory points to issues such as the short time horizons of elected representatives, the lack of a hard budget constraint, and the role of money in financing elections as sources of government failures. A careful study of government failures is crucial for understanding the limitations of government and ensuring that government programs are not excessively intrusive or wasteful.



The Economics of Politics

Economists focus most of their analysis on the workings of the marketplace. But serious economists have also pondered the government's role in society. Joseph Schumpeter pioneered public-choice theory in *Capitalism, Socialism, and Democracy* (1942), and Kenneth Arrow's Nobel Prize–winning study on social choice brought rigor to this field. The landmark study by Anthony Downs, *An Economic Theory of Democracy* (1957), sketched a powerful new theory which held that politicians choose economic policies in order to be reelected. Downs showed that this theory implies that political parties would move toward the center of the political spectrum because of electoral competition.

Among the most important applications of public-choice theory were those to economic regulation. George Stigler argued that regulatory agencies have been "captured" by the regulated and often served the industries they regulated more than consumers. Studies by James Buchanan and Gordon Tullock in *The Calculus of Consent* (1959) defended checks and balances and advocated the use of unanimity in political decisions, arguing that unanimous decisions do not coerce anyone. Public-choice economics has been applied to such areas as farm policy and the courts, and it formed the theoretical basis for a proposed constitutional amendment to balance the budget.

B. GOVERNMENT EXPENDITURES

Nowhere can the changes in government's role be seen more clearly than in the area of government spending. Look back at Figure 16-1 on page 304. It shows the share of national output going to government spending, which includes things like purchases of goods, salaries of government workers, social security and other transfers, and interest on the government debt. You can see that government's share rose for most of the twentieth century, with temporary bulges during wartime, but it has leveled off in recent years.

FISCAL FEDERALISM

While we have been referring to government as if it were a single entity, in fact Americans face three levels of government: federal, state, and local. This reflects a division of fiscal responsibilities among the different levels of government—a system known as *fiscal federalism*. The boundaries are not always clear-cut, but in general the federal government directs activities that concern the entire nation—paying for defense, space exploration, and foreign affairs. Local governments educate children, police streets, and remove garbage. States build highways, run university systems, and administer welfare programs.

The total U.S. spending at the different levels of government is shown in Table 16-1. The dominance of the federal role is a comparatively recent phenomenon. Before the twentieth century, local government was by far the most important of the three levels. The federal government did little more than support the military, pay interest on the national

Eye Therapies Exhibit 2127, 332 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Level of government	Total expenditures, 2007 ($, billion)	Percent of total
All levels	4,429	100.0
Federal	2,515	56.8
State	857	19.3
Local	1,058	23.9

TABLE 16-1. Federal, State, and Local Government Current Expenditures

In the early days of the Republic, most spending was at the state and local levels. Today, more than half of total government outlays are federal.

Source: U.S. Bureau of Economic Analysis.

debt, and finance a few public works. Most of its tax collection came from liquor and tobacco excises and import tariffs. But two world wars and the rise of the welfare state, with transfer programs such as social security and Medicare, increased spending gradually. The advent of the national income tax in 1913 provided a source of funds that no state or locality could match.

To understand fiscal federalism, economists emphasize that spending decisions should be allocated among the levels of government according to the spillovers from government programs. In general, localities are responsible for *local public goods,* activities whose benefits are largely confined to local residents. Since libraries are used by townspeople and streetlights illuminate city roads, decisions about these goods are appropriately made by local residents. Many federal functions involve *national public goods,* which provide benefits to all the nation's citizens. For example, an AIDS vaccine would benefit people from every state, not just those living near the laboratory where it is discovered. What about global concerns such as protecting the ozone layer or slowing global warming? These are *global public goods* because they transcend the boundaries of individual countries.

An efficient system of fiscal federalism takes into account the way the benefits of public programs spill over political boundaries. The most efficient arrangement is to locate the tax and spending decisions so that the beneficiaries of programs pay the taxes and can weigh the tradeoffs.

Federal Expenditures

Let's look now at the different levels of government. The U.S. government is the world's biggest enterprise. It buys more automobiles and steel, meets a bigger payroll, and handles more money than any other organization anywhere. The numbers involved in federal finance are astronomical—in the billions and trillions of dollars. The federal budget expenditures for 2009 are projected to be $3107 billion, or $3.1 trillion; this enormous number amounts to roughly $27,000 for each American household.

Table 16-2 lists the major categories of federal expenditure for fiscal year 2009. (The federal fiscal year 2009 covers October 1, 2008, through September 30, 2009.)

The most rapidly expanding items in the last three decades have been entitlement programs, which provide benefits or payments to any persons who meet certain eligibility requirements set down by law. The major entitlements are social security (old-age, survivors, and disability insurance), health programs (including Medicare for those over 65 and Medicaid for indigent families), and income-security programs (including subsidies for food and unemployment insurance). In fact, virtually the entire growth in federal spending in recent years can be accounted for by entitlement programs, which increased from 28 percent of the budget in 1960 to 60 percent in 2009.

State and Local Expenditures

Although the battles over the federal budget command the headlines, state and local units provide many of the essential functions in today's economy. Figure 16-3 illustrates the way states and localities spend their money. By far the largest item is education because most of the nation's children are educated in schools financed primarily by local governments. By attempting to equalize the educational resources available to every child, public education helps level out the otherwise great disparities in economic opportunity.

In recent years, the fastest-growing categories of spending for states and localities have been health care and prisons. In the last two decades, the number of prisoners in state prisons tripled, as the United States fought a war on crime partly by using longer prison sentences, especially for drug offenders. At the same time, state and local governments were forced to absorb their share of rising health-care costs.

Eye Therapies Exhibit 2127, 333 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Federal Expenditures, Fiscal Year 2009

Description	Expenditures ($, billion)	Percent of total
Total expenditures	**3,107.4**	**100.0**
National defense	675.1	21.7
Social security	649.3	20.9
Medicare	413.3	13.3
Income security	401.7	12.9
Health	299.4	9.6
Net interest	260.2	8.4
Veterans benefits and services	91.9	3.0
Education, training, employment, and social services	88.3	2.8
Transportation	83.9	2.7
Administration of justice	51.1	1.6
International affairs	38.0	1.2
Natural resources and environment	35.5	1.1
General science, space and technology	29.2	0.9
Community and regional development	23.3	0.8
General government	21.5	0.7
Agriculture	19.1	0.6
Commerce and housing credit	4.2	0.1
Energy	3.1	0.1

TABLE 16-2. Federal Spending Is Dominated by Defense and Entitlement Programs

About one-fifth of federal spending is for defense or pensions due to past wars. More than half of spending today is for rapidly growing entitlement programs—income security, social security, and health. Note how small is the traditional cost of government.

Source: Office of Management and Budget, Budget of the U.S. Government, Fiscal Year 2009, available at *www.whitehouse.gov/omb/budget/fy2009/hist.html.*

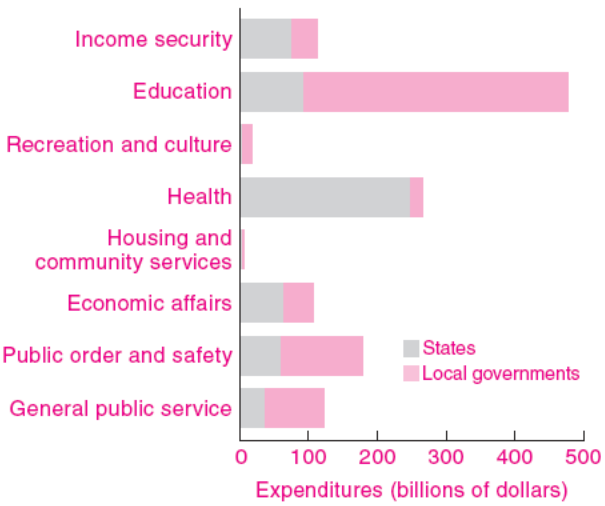


FIGURE 16-3. Distribution of Spending by State and Local Governments, 2006

State and local programs include providing education, financing hospitals, and maintaining the streets. Education and health take an increasing fraction of state and local spending.

Source: Bureau of Economic Analysis.

CULTURAL AND TECHNOLOGICAL IMPACTS

Government programs have subtle impacts on the country beyond the dollar spending. The federal government has changed the landscape through the interstate highway system. By making automotive travel much faster, this vast network lowered transportation costs, displaced the railroads, and brought goods to every corner of the country. It also helped accelerate urban sprawl and the growth of the suburban culture.

The government has put the United States on the map in many areas of science and technology. Government support gave a powerful start to the electronics industries. The development of the transistor by Bell Labs, for example, was partially funded by the U.S. military, anxious for better radar and communications. Today's computer and airplane industries were boosted in their early years by strong government support. The Internet was

Eye Therapies Exhibit 2127, 334 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

developed by the Department of Defense to create a network that would continue to function in the event of nuclear war.

The government today plays an especially important role in basic science. Of all the basic research in the United States, 85 percent is funded by the government or by nonprofit institutions like universities. Often, if you follow a successful invention upstream to its source, you will find that government subsidized the inventor's education and supported basic university research. Economic studies indicate that these funds were well spent, moreover, for the social rates of return to research and development exceed the returns on investments in most other areas.

C. ECONOMIC ASPECTS OF TAXATION

Taxes are what we pay for a civilized society.

Justice Oliver Wendell Holmes

Governments must pay for their programs. The funds come mainly from taxes, and any shortfall is a deficit that is borrowed from the public.

But in economics we always need to pierce the veil of monetary flows to understand the flow of real resources. Behind the dollar flows of taxes, what the government really needs is the economy's scarce land, labor, and capital. When a nation goes to war, people argue about how to finance the military spending. But in reality, what really happens is that people are diverted from their civilian jobs, airplanes transport troops rather than tourists, and oil goes to airplanes rather than cars. When the government gives out a grant for biotechnology research, its decision really means that a piece of land that might have been used for an office building is now being used for a laboratory.

In taxing, government is in reality deciding how to draw the required resources from the nation's households and businesses for public purposes. The money raised through taxation is the vehicle by which real resources are transferred from private goods to collective goods.

PRINCIPLES OF TAXATION

Benefit vs. Ability-to-Pay Principles

Once the government has decided to collect some amount of taxes, it has many possible taxes available to it. It can tax income, tax profits, or tax sales. It can tax the rich or tax the poor, tax the old or tax the young. Are there any guidelines that can help construct a fair and efficient tax system?

Indeed there are. Economists and political philosophers have proposed two major principles for organizing a tax system:

- The **benefit principle,** which holds that individuals should be taxed in proportion to the benefit they receive from government programs. Just as people pay private goods like dollars in proportion to their consumption of private goods like bread, a person's taxes should be related to his or her use of collective goods like public roads or parks.
- The **ability-to-pay principle,** which states that the amount of taxes people pay should relate to their income or wealth. The higher the wealth or income, the higher the taxes. Usually tax systems organized on the ability-to-pay principle are also *redistributive,* meaning that they raise funds from higher-income people to increase the incomes and consumption of poorer groups.

For instance, if the construction of a new bridge is funded by tolls on the bridge, that's a reflection of the benefit principle, since you pay for the bridge only if you use it. But if the bridge were funded out of income-tax collections, that would be an example of the ability-to-pay principle.

Horizontal and Vertical Equity

Whether they are organized along benefit or ability-to-pay lines, most modern tax systems attempt to incorporate modern views about fairness or equity. One important principle is that of **horizontal equity,** which states that those who are essentially equal should be taxed equally.

The notion of equal treatment of equals has deep roots in Western political philosophy. If you and I are alike in every way except the color of our eyes, all principles of taxation would hold that we should pay equal taxes. In the case of benefit taxation, if we receive exactly the same services from the highways or parks, the principle of horizontal equity states that

Eye Therapies Exhibit 2127, 335 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

we should therefore pay equal taxes. Or if a tax system follows the ability-to-pay approach, horizontal equity dictates that people who have equal incomes should pay the same taxes.

A more controversial principle is **vertical equity,** which concerns the tax treatment of people with different levels of income. Abstract philosophical principles provide little guidance in resolving the issues of fairness here. Imagine that A and B are alike in every respect except that B has 10 times the property and income of A. Does that mean that B should pay the same absolute tax dollars as A for government services such as police protection? Or that B should pay the same percentage of income in taxes? Or, since the police spend more time protecting the property of well-to-do B, is it perhaps fair for B to pay a larger fraction of income in taxes?

Be warned that general and abstract principles cannot determine the tax structure for a nation. When Ronald Reagan campaigned for lower taxes, he did so because he thought high taxes were unfair to those who had worked hard and saved for the future. A decade later, Bill Clinton said, "We now have real fairness in the tax code with over 80 percent of the new tax burden being borne by those who make over $200,000 a year." What looks fair to the goose seems foul to the gander.

Horizontal equity is the principle that equals should be treated equally. Vertical equity holds that people in unequal circumstances should be treated unequally and fairly, but there is no consensus on exactly how vertical equity should be applied.

Pragmatic Compromises in Taxation

How have societies resolved these thorny philosophical questions? Governments have generally adopted pragmatic solutions that are only partially based on benefit and ability-to-pay approaches. Political representatives know that taxes are highly unpopular. After all, the cry of "taxation without representation" helped launch the American Revolution. Modern tax systems are an uneasy compromise between lofty principles and political pragmatism. As the canny French finance minister Colbert wrote three centuries ago, "Raising taxes is like plucking a goose: you want to get the maximum number of feathers with the minimum amount of hiss."

What practices have emerged? Often, public services primarily benefit recognizable groups, and those groups have no claim for special treatment by virtue of their average incomes or other characteristics. In such cases, modern governments generally rely on benefit taxes.

Thus, local roads are usually paid for by local residents. "User fees" are charged for water and sewage treatment, which are treated like private goods. Taxes collected on gasoline may be devoted (or "earmarked") to roads.

Progressive and Regressive Taxes. Benefit taxes are a declining fraction of government revenues. Today, advanced countries rely heavily on **progressive income taxes.** With progressive taxes, a family with $50,000 of income is taxed more than one with $20,000 of income. Not only does the higher-income family pay a larger income tax, but it in fact pays a higher fraction of its income.

This progressive tax is in contrast to a strictly **proportional tax,** in which all taxpayers pay exactly the same proportion of income. A **regressive tax** takes a larger fraction of income in taxes from poor families than it does from rich families.

A tax is called *proportional, progressive,* or *regressive* depending on whether it takes from high-income people the same fraction of income, a larger fraction of income, or a smaller fraction of income than it takes from low-income people.

The different kinds of taxes are illustrated in Figure 16-4. What are some examples? A personal income tax that is graduated to take more and more out of each extra dollar of income is progressive. Economists have found, by contrast, that the cigarette tax is regressive. The reason is that the number of cigarettes purchased rises less rapidly than income. For example, some studies have determined that the income elasticity of cigarette use is around 0.6. This means that a 10 percent increase in income leads to a 6 percent increase in expenditures on cigarettes, and also to a 6 percent increase in cigarette taxes. Thus, high-income groups pay a smaller fraction of their income in cigarette taxes than do low-income groups.

Direct and Indirect Taxes. Taxes are classified as direct or indirect. **Indirect taxes** are ones that are levied on goods and services and thus only "indirectly"

Eye Therapies Exhibit 2127, 336 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

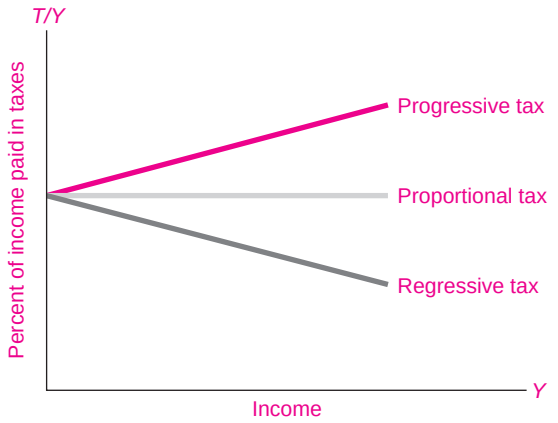


FIGURE 16-4. Progressive, Proportional, and Regressive Taxes

Taxes are progressive if they take a larger fraction of income as income rises; proportional if they are a constant fraction of income; and regressive if they place a larger relative burden on low-income families than on high-income families.

Federal Tax Receipts, Fiscal Year 2009

	Receipts (% of total)
Progressive:	
Individual income taxes	46.6
Estate and gift taxes	1.0
Corporate income taxes	12.6
Proportional:	
Payroll taxes	35.2
Regressive:	
Excise taxes	2.6
Customs duties	1.1
Other taxes and receipts	1.0
Total	**100.0**

TABLE 16-3. Income and Payroll Taxes Are the Main Federal Revenue Sources

Progressive taxes are still the leading source of federal revenues, but proportional payroll taxes are closing fast. Regressive consumption taxes have declined sharply at the federal level.

Source: See Table 16-2.

on individuals. Examples are excise and sales taxes, cigarette and gasoline taxes, tariffs on imports, and property taxes. By contrast, **direct taxes** are levied directly upon individuals or firms. Examples of direct taxes are personal income taxes, social security or other payroll taxes, and inheritance and gift taxes. Direct taxes have the advantage of being easier to tailor to fit personal circumstances, such as size of family, income, age, and more generally the ability to pay. By contrast, indirect taxes have the advantage of being easier to collect, since they can be levied at the retail or wholesale level.

FEDERAL TAXATION

Let us now try to understand the principles by which the federal system of taxation is organized. Table 16-3 provides an overview of the major taxes collected by the federal government and shows whether they are progressive, proportional, or regressive.

The Individual Income Tax

Our discussion begins with the individual income tax, which is the most complex part of the tax system. The income tax is a direct tax, and it is the tax which most clearly reflects the ability-to-pay principle.

The individual income tax arrived late in our nation's history. The Constitution forbade any direct tax that was not apportioned among the states according to population. This was changed in 1913, when the Sixteenth Amendment to the Constitution provided that "Congress shall have power to lay and collect taxes on income, from whatever source-derived."

How does the federal income tax work? The principle is simple, although the forms are complicated. You start by calculating your income; you next subtract certain expenses, deductions, and exemptions to obtain taxable income. You then calculate your taxes on the basis of your taxable income.

Suppose you have just graduated from college and take a job in California with a salary of $60,000 in 2009. Table 16-4 shows a calculation of the total direct tax payments that you should expect. It will be worthwhile going line by line to understand the different items.

Line 1 begins with your salary. The first set of taxes is social insurance taxes. We will postpone our

Eye Therapies Exhibit 2127, 337 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

1	Annual salary	$60,000
2	Social security taxes:	
3	Pension	3,720
4	Medicare	870
5	Federal adjusted gross income = (1)	60,000
6	Less:	
7	Personal exemption	3,500
8	Standard deduction	5,450
9	Federal taxable income = (5) − (7) − (8)	51,050
10	Income tax:	
11	Federal	9,106
12	State (California)	2,672
13	Total taxes = (3) + (4) + (11) + (12)	16,368
14	Income after tax = (1) − (13)	43,632
15	Tax rate	
16	Average = (13)/(1)	27.3%
17	Marginal*	42.0%

*Marginal tax rate is the additional total taxes per additional dollar of income. This would be calculated by repeating all the lines for an additional $1000 of income and then dividing the extra number of dollars of taxes by 1000.

TABLE 16-4. Calculation of Individual Income Taxes, 2009

The table shows an illustrative calculation of total taxes for a single worker living in California in 2009. The worker has a total salary of $60,000. Social security taxes are for future social security benefits and pay health benefits for current retired workers. Income taxes are levied by the federal government and most states.

The average tax rate is 27.3 percent. Economists focus on the marginal tax rate, which is the additional tax per additional dollar of income. For our worker, the marginal tax rate is calculated to be 42 percent.

Source: Internal Revenue Service and State of California (preliminary tax tables).

discussion of these to the next section. Line 5 shows your *adjusted gross income*—that is, total wages, interest, dividends, and other income earned. If you were single, you would have a *personal exemption* of $3500. If you do not own a house, you are likely to take the *standard deduction* of $5450. Subtracting both of these yields your *federal taxable income* of $51,050.

Next, you go to the tax tables. These currently show a tax of $9106 on this income. You would also have taxes due to the state, $2672 in this case.

Adding up all the taxes, you find you owe $16,368. This represents 27.3 percent of your income. This is called the **effective** or **average tax rate,** which is equal to total taxes divided by total income.

The last row introduces an important new concept. The **marginal tax rate** is the extra tax that is paid per dollar of additional income. We have met the term "marginal" before, and it always means "extra." If you were to earn an additional $1000 of income, you would pay an additional $420 in taxes. This means that your marginal tax rate is $420/$1000, or 42 percent. The marginal tax rate is a critical tool for tax analysis because people and companies tend to respond to their marginal tax rates, not their average tax rates. Moreover, when marginal tax rates are extremely high, incentives to work are dulled and effort may significantly decrease.

The marginal tax rate is a central concept of tax analysis. It refers to the extra tax paid per dollar of extra income and is particularly important for understanding the incentive effects of taxation.

Figure 16-5 shows the estimated marginal tax rate for households with incomes up to $100,000. Low-income households have a "negative income tax," because they receive an earned-income tax credit.

The notion of marginal tax rates is extremely important in modern economics. Remember the

Eye Therapies Exhibit 2127, 338 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

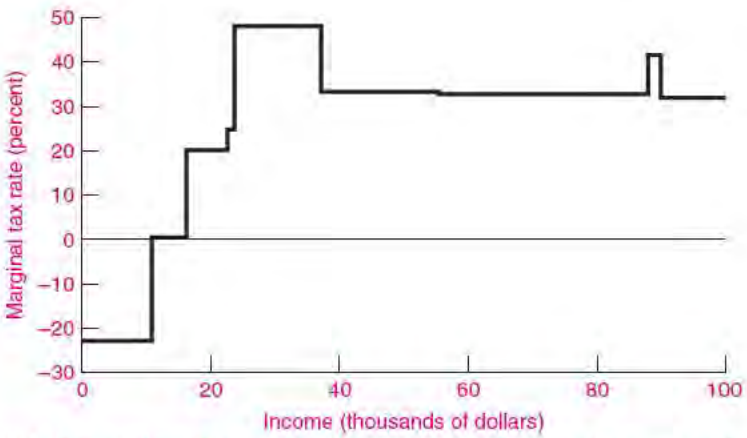


FIGURE 16-5. Marginal Tax Rate of U.S. Households by Income Category, 2005

The marginal tax rate is the extra tax that is paid per dollar of additional income. The figure shows the estimated marginal tax rates of households in 2005. These include social insurance as well as federal and average state taxes. Because of the earned-income tax credit, low-income workers get a tax rebate—this is a "negative income tax" on wages. Note that the marginal tax rates in this figure differ from those in Table 16-4 because California has relatively high taxes and because the CBO uses different assumptions about exemptions and deductions.

Source: Congressional Budget Office, *Effective Marginal Tax Rates on Labor Income*, November 2005, available at *www.cbo.gov*.

marginal principle. People should be concerned only with the extra costs or benefits that occur. They should "let bygones be bygones." Under this principle, the major effect of any tax on incentives comes from the marginal tax rate.



Radical Tax Reform: The Flat Tax

The individual income tax is a powerful engine for raising revenues. But it has become enormously complex over the century since its introduction. Moreover, it is full of loopholes or "tax preferences" that provide benefits to particular forms of income or expenditure and even to individual groups of taxpayers. For example, expenditures on mortgage interest and medical care are deductible from income—they are, in effect, subsidized spending.

Economists have campaigned tirelessly for a more streamlined tax system—one that *broadens* the tax base, and thus raises revenues by eliminating unnecessary tax breaks, and can therefore *lower marginal tax rates*. One of the most radical and innovative proposals for fundamental tax reform is the *flat tax*, which was developed in detail by Stanford's Robert Hall and Alvin Rabushka.[1] Their proposal incorporates the following major features (see question 9 at the end of this chapter for an example):

- It taxes consumption rather than income. As we will discuss later in this chapter, taxing consumption serves to increase the incentive to save and can help boost the declining national savings rate.
- It integrates the corporate income tax with the individual income tax. This removes one of the major distortions in the U.S. tax code.
- It eliminates virtually all loopholes and tax preferences. Gone are subsidies for medical care, owner-occupied homes, and charitable contributions.
- It provides a basic exemption of around $20,000 per family and then imposes a constant marginal tax rate of 19 percent above that level.

The economic effects of a flat tax would be far-reaching. Heavily taxed entities such as corporations would find their taxes lowered and would experience a major capital

[1] *The Flat Tax*, rev. ed. Hoover Institute Press, Palo Alto, Calif., 2007.

Eye Therapies Exhibit 2127, 339 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

gain. High-income wage earners would find their taxes cut in half. At the same time, the amount of owner-occupied housing and medical expenditures would shrink and charitable giving would drop sharply.

Hall and Rabushka emphasize above all the importance of reducing the marginal tax rates. They argue that the flat tax would "give an enormous boost to the U.S. economy by dramatically improving incentives to work, save, invest, and take entrepreneurial risks. The flat tax would save taxpayers hundreds of billions in direct and indirect compliance costs."

The plan's critics point out that it would lead to a major redistribution of income to high-income people at the expense of low- and middle-income households. The losers will question whether the rich, whose share has risen dramatically over the last three decades, deserve yet another windfall. We see here yet another example of the tradeoff between fairness and efficiency that runs through many of the most controversial economic policy issues.

Social Insurance Taxes

Virtually all industries now come under the Social Security Act. Workers receive retirement benefits that depend on their earnings history and past social security taxes. The social insurance program also funds a disability program and health insurance for the poor and elderly.

To pay for these benefits, employees and employers are charged a *payroll tax*. As shown in Table 16-4, in 2008, this consisted of a total of 15.3 percent of all wage income below a ceiling of $102,000 a year per person, along with a payroll tax of 2.9 percent of annual wage income above $102,000. The tax is split equally between employer and employee.

Table 16-3 shows the payroll tax as a proportional tax because it taxes a fixed fraction of employment earnings. The tax incidence is more complicated, however, because the payroll tax includes only labor earnings (which makes it regressive) and finances retirement most generously for low-income people (which makes it progressive).

Corporation Taxes

The federal government collects a wide variety of other taxes, some of which are shown in Table 16-3. The *corporate income tax* is a tax on the profits of corporations.

The corporation income tax has been heavily criticized by some economists. Critics oppose the tax, arguing that corporations are but legal fictions and should not be taxed. By taxing first corporate profits and then the dividends paid by corporations and received by individuals, the government subjects corporations to double taxation.

Consumption Taxes

While the United States relies heavily on income taxes, a radically different approach is consumption taxes, which are taxes on purchases of goods and services rather than on income. The rationale is that people should be penalized for what they *use* rather than what they *produce*. Sales taxes are the most familiar example of consumption taxes. The United States has no national sales tax, although there are a number of *federal excise taxes* on specific commodities such as cigarettes, alcohol, and gasoline. Sales and excise taxes are generally regressive because they consume a larger fraction of the income of poor families than of high-income families.

Many have argued that the United States should rely more heavily on sales or consumption taxes. One tax, widely used outside the United States, is the *value-added tax*, or VAT. The VAT is like a sales tax, but it collects taxes at each stage of production. Thus, if a VAT were levied on bread, it would be collected from the farmer for wheat production, from the miller for flour production, from the baker at the dough stage, and from the grocer at the delivered-loaf stage.

The advocates of consumption taxes argue that the country is currently saving and investing less than is necessary for future needs and that by substituting consumption taxes for income taxes, the national savings rate would increase. Critics of consumption taxes respond that such a change is undesirable because sales taxes are more regressive than today's income tax. The *flat tax*, discussed earlier, is actually equivalent to a highly simplified system of personal consumption taxation (see question 9 below).

STATE AND LOCAL TAXES

Under the U.S. system of fiscal federalism, state and local governments rely on a very different set of taxes than does the federal government. Figure 16-6 illustrates the main sources of funds that finance state and local expenditures.

Eye Therapies Exhibit 2127, 340 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

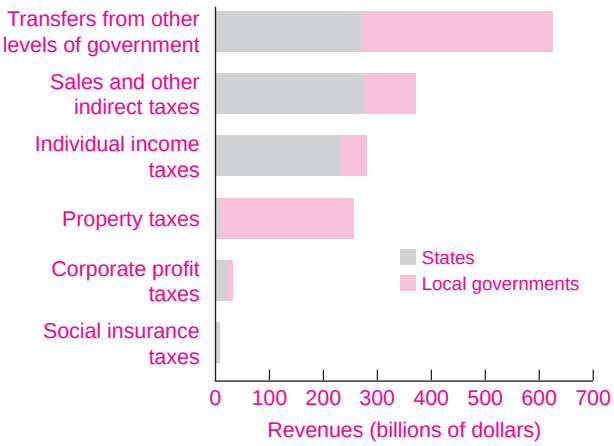


FIGURE 16-6. States and Localities Rely on Transfers and Indirect Taxes

Cities rely heavily on property taxes because houses and land cannot easily flee to the suburbs to avoid a city's tax. States get most revenues from sales and income taxes.

Source: Bureau of Economic Analysis.

Property Tax

The *property tax* is levied primarily on real estate—land and buildings. Each locality sets an annual tax rate which is levied on the assessed value of the land and structures. In many localities, the assessed value may be much smaller than the true market value. The property tax accounts for about 30 percent of the total revenues of state and local finance. Figure 16-6 shows that localities are the main recipient of property taxes.

Because about one-fourth of property values are from land, the property tax has elements of a capital tax and elements of a Henry George–type land tax. Economists believe that the land component of the property tax has little distortion, while the capital component will drive investment from high-tax central cities out to the low-tax suburbs.

Other Taxes

Most other state and local taxes are closely related to the analogous federal taxes. States get most of their revenues from *general sales taxes* on goods and services. Each purchase at the department store or restaurant incurs a percentage tax (food and other necessities are exempt in some states). States tax the net income of corporations. Forty-three states imitate the federal government, on a much smaller scale, by taxing individuals according to the size of their incomes.

There are other miscellaneous revenues. Many states levy "highway user taxes" on gasoline. A growing source of revenue is lotteries and legalized gambling, in which the states benefit from encouraging people to impoverish themselves.

EFFICIENCY AND FAIRNESS IN THE TAX SYSTEM

The Goal of Efficient Taxation

In recent years, economists have focused increasingly on the efficiency of different tax systems. The first point to recall here is that efficiency depends primarily on the marginal tax rates faced by taxpayers. Look back at Figure 16-5 to recall how the marginal tax rates differ across income groups.

Taxes on Labor Income. How do high marginal tax rates affect economic behavior? In the area of labor supply, the impacts are mixed. As we saw in Chapter 13, the impact of tax rates on hours worked is unclear because the income and substitution effects of wage changes work in opposite directions. As a result of progressive taxes, some people may choose more leisure over more work. Other people may work harder in order to make their millions. Many high-income doctors, artists, celebrities, and business executives, who enjoy their jobs and the sense of power or accomplishment that they bring, will work as hard for $800,000 after tax as for $1,000,000 after tax.

Figure 16-7 shows how an increase in the tax rate on labor will affect labor supply; note the paradox that hours worked may actually decline after a tax-rate cut if the labor supply curve is backward-bending.

Taxes on Capital Income. In the area of saving and investment, taxes are likely to have major effects on amounts supplied and efficiency. When taxes are high in one sector, resources will flow into more lightly taxed areas. For example, because corporate profits are double-taxed, people's savings will flow out of the corporate sector and into lightly taxed sectors. If risky investments are taxed unfavorably, investors may prefer safer investments.

Impacts of Globalization. With increased openness of economies, countries need to ensure that mobile factors of production like capital or highly skilled workers are not lured away to low-tax countries. This

Eye Therapies Exhibit 2127, 341 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

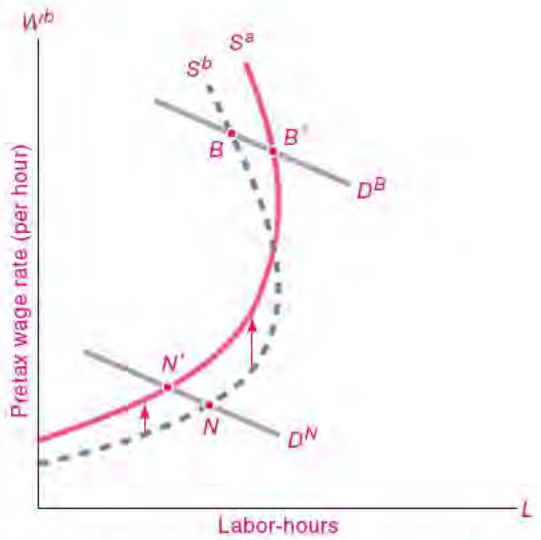


FIGURE 16-7. Response of Work to Taxes Depends on Shape of Supply Curve

Supply and demand plots labor supplied against pretax wage. Before-tax supply curve of labor (S^b) shifts vertically upward to after-tax supply (S^a) after imposition of a 25 percent income tax on labor earnings. If demand for labor intersects supply in the normal region at bottom, we see an expected decline in labor supplied from N to N'. If the labor supply is backward-bending, as at top, the labor supplied actually rises with the tax increase, going from B to B'.

concern is particularly important for company taxes, for companies can easily move their headquarters to some island tax haven.

Efficiency vs. Fairness

Economists have long been concerned with the impact of taxes on economic efficiency. Recall from Chapter 14 that Henry George argued that a tax on land will have little impact on efficiency because the supply of land is completely inelastic. The modern theory of efficient taxation puts forth the *Ramsey tax rule*, which states that the government should levy the heaviest taxes on those inputs and outputs that are most price-inelastic in supply or demand.[2] The rationale for the Ramsey tax rule is that if a commodity is very price-inelastic in supply or demand, a tax on the commodity will have little impact upon consumption and production. In some circumstances, Ramsey taxes may constitute a way of raising revenues with a minimum loss of economic efficiency.

But economies and politics do not run on efficiency alone. While stiff taxation of land rents or food might be efficient, many would think them unfair. A sober reminder of the dilemma was the proposal to introduce a poll tax in Britain in 1990. A *poll tax* is a *lump-sum tax*, or a fixed tax per person. The advantage of this tax is that, like a land tax, it would induce no inefficiencies. After all, people are unlikely to decamp to Russia or commit hari-kari to avoid the tax, so the economic distortions would arguably be minimal.

Alas, the British government underestimated the extent to which the populace felt this tax to be unfair. The poll tax is highly regressive because it places a much higher proportional burden on low-income people than on high-income people. Criticism of the poll tax played a key role in bringing down the Thatcher government after 11 years in power. This illustrates clearly the difficult choice between efficiency and fairness in taxes and other areas of economic policy.



Taxing "Bads" rather than "Goods": Green Taxes

While economists have rarely advocated poll taxes, they have favored an approach wherein the tax system would weigh more heavily on "bads" than on "goods." The main source of inefficiency is that taxes generally tax "goods"—economic activities like working, investing in capital, saving, or taking risk—and thereby discourage these activities. An alternative approach is to tax "bads." Traditional taxes on bads include "sin taxes": taxes on alcohol, cigarettes, and other substances that have harmful health effects.

A new approach to taxation is to tax pollution and other undesirable externalities; such taxes are called *green taxes* because they are designed to help the environment as well as to raise revenues. Say that the nation decides to help slow global warming by levying a "carbon tax," which is a tax on carbon-dioxide emissions from power plants and other sources. By standard economic reasoning we know that the tax will lead firms to lower their carbon-dioxide emissions, thereby improving the environment. In addition, this green tax will provide revenues, which the government can use either to finance its activities or to reduce

[2] Recall Chapter 14's discussion of Henry George's single tax and the extension to efficient or Ramsey taxes.

Eye Therapies Exhibit 2127, 342 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

tax rates on beneficial activities like working or saving. So green taxes are doubly effective: the state gets revenue, and the environment is improved because the taxes discourage harmful externalities.

FINAL WORD

Our introductory survey of government's role in the economy is a sobering reminder of the responsibilities and shortcomings of collective action. On the one hand, governments must defend their borders, stabilize their economies, protect the public health, and regulate pollution. On the other hand, policies often reflect primarily the attempt to redistribute income from consumers to politically powerful interest groups.

Does this mean we should abandon the visible hand of government for the invisible hand of markets? Economics cannot answer such deep political questions. But economics can examine the strengths and weaknesses of both collective and market choices, and point to mechanisms (such as green taxes or subsidies to research and development) by which a mended invisible hand may be more efficient and fair than the extremes of either pure laissez-faire or unbridled bureaucratic rulemaking.



SUMMARY

A. Government Control of the Economy

1. The economic role of government has increased sharply over the last century. The government influences and controls private economic activity by using taxes, expenditures, and direct regulation.
2. A modern welfare state performs four economic functions: (*a*) It remedies market failures; (*b*) it redistributes income and resources; (*c*) it establishes fiscal and monetary policies to stabilize the business cycle and promote long-term economic growth; and (*d*) it manages international economic affairs.
3. Public-choice theory analyzes how governments actually behave. Just as the invisible hand can break down, so there are government failures, in which government interventions lead to waste or redistribute income in an undesirable fashion.

B. Government Expenditures

4. The American system of public finance is one of fiscal federalism. The federal government concentrates its spending on issues of national concern—on national public goods like defense and space exploration. States and localities generally focus on local public goods—those whose benefits are largely confined within state or city boundaries.
5. Government spending and taxation today take approximately one-third of total national output. Of this total, about 55 percent is spent at the federal level, and the balance is divided between state and local governments. Only a small fraction of government outlays is devoted to traditional functions like police and the courts.

C. Economic Aspects of Taxation

6. Notions of "benefits" and "ability to pay" are two principal theories of taxation. A tax is progressive, proportional, or regressive as it takes a larger, equal, or smaller fraction of income from rich families than it does from poor families. Direct and progressive taxes on incomes are in contrast to indirect and regressive sales and excise taxes.
7. More than half of federal revenues come from personal and corporate income taxes. The rest comes from taxes on payrolls or consumption goods. Local governments raise most of their revenue from property taxes, while sales taxes are most important for states.
8. The individual income tax is levied on "income from whatever source derived," less certain exemptions and deductions. The marginal tax rate, denoting the fraction paid in taxes for every dollar of additional income, is the key to determining the impact of taxes on incentives to work and save.
9. The fastest-growing federal tax is the payroll tax, used to finance social security. This is an "earmarked" levy, with funds going to provide public pensions and health and disability benefits. Because there are visible benefits at the end of the stream of payments, the payroll tax has elements of a benefit tax.
10. Economists point to the Ramsey tax rule, which emphasizes that efficiency will be promoted when taxes are levied more heavily on those activities that are relatively price-inelastic. A new approach is green taxes, which levy fees on environmental externalities, reducing harmful activities while raising revenues that would otherwise be imposed on goods or productive inputs. But in all taxes, equity and political acceptability are severe constraints.

Eye Therapies Exhibit 2127, 343 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CONCEPTS FOR REVIEW

Functions of Government

three tools of government economic control:
- taxes
- expenditures
- regulation

market failures vs. government failures
public-choice theory
four functions of government:
- efficiency
- distribution
- stabilization
- international representation

Government Expenditures and Taxation

fiscal federalism and local vs. national public goods
economic impact of government spending
benefit and ability-to-pay principles
horizontal and vertical equity
direct and indirect taxes
entitlement programs
progressive, proportional, and regressive taxes
Ramsey and green taxes

FURTHER READING AND INTERNET WEBSITES

Further Reading

An excellent review of tax issues is contained in the symposium on tax reform in *Journal of Economic Perspectives*, Summer 1987. The classic study of the flat tax referred to in the text is also online, at *www.hoover.org/publications/books/3602666.html*.

Websites

Data on government budget and tax trends can be found at government sites. For example, overall trends are presented by the Bureau of Economic Analysis at *www.bea.gov*. Budget information for the federal government comes from the Office of Management and Budget at *www.whitehouse.gov/omb*.

The Internal Revenue Service (IRS) has a lively site with a plethora of tax statistics at *www.irs.gov* and *www.irs.gov/taxstats/index.html*.

Two organizations which study taxation and have good websites are the National Tax Association at *www.ntanet.org* and the Brookings Institution at *www.brookings.org*. Policy papers by a British research institute that focuses on social security and taxation can be found at *www.ifs.org.uk*.

QUESTIONS FOR DISCUSSION

1. Recall Justice Oliver Wendell Holmes's statement, "Taxes are what we pay for a civilized society." Interpret this statement, remembering that in economics we always need to pierce the veil of monetary flows to understand the flow of real resources.
2. In considering whether you want a pure laissez-faire economy or government regulation, discuss whether there should be government controls over prostitution, addictive drugs, heart transplants, assault weapons, and alcohol. Discuss the relative advantages of high taxes and prohibition for such goods (recall the discussion of drug prohibition in Chapter 5).
3. Critics of the U.S. tax system argue that it harms incentives to work, save, and innovate and therefore reduces long-run economic growth. Can you see why "green taxes" might promote economic efficiency and economic growth? Consider, for example, taxes on sulfur or carbon-dioxide emissions or on leaky oil tankers. Construct a list of taxes that you think would increase efficiency, and compare their effects with the effects of taxes on labor or capital income.
4. Tax economists often speak of lump-sum taxes, which are levied on individuals without regard to their economic activity. Lump-sum taxes are efficient because they impose zero marginal tax rates on all inputs and outputs.

   Assume that the government imposes a lump-sum tax of $200 on each individual. Show the effect of this on the supply and demand for labor in a graph. Does the marginal revenue product of labor still equal the wage in equilibrium?

Eye Therapies Exhibit 2127, 344 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

In a lifetime framework, the dynamic equivalent of a lump-sum tax is an "endowment tax," which would tax individuals on the basis of their potential labor incomes. Would you favor such a change? Describe some of the difficulties in implementing an endowment tax.

5. Make a list of different federal taxes in order of their progressiveness. If the federal government were to trade in income taxes for consumption or sales taxes, what would be the effect in terms of overall progressiveness of the tax system?
6. Some public goods are local, spilling out to residents of small areas; others are national, benefiting an entire nation; some are global, affecting all nations. A private good is one whose spillover is negligible. Give some examples of purely private goods and of local, national, and global public goods or externalities. For each, indicate the level of government that could design relevant policies most efficiently, and suggest one or two appropriate government actions that could solve the externality.
7. Recall from our discussion of tax incidence that the incidence of a tax refers to its ultimate economic burden and to its total effect on prices, outputs, and other economic magnitudes. Below are some incidence questions that can be answered using supply and demand. Use graphs to explain your answers.
   a. In the 1993 Budget Act, Congress raised federal gasoline taxes by 4.3 cents a gallon. Assuming the wholesale price of gasoline is determined in world markets, what is the relative impact of the tax on American producers and consumers?
   b. Social insurance taxes are generally levied on labor earnings. What is their incidence if labor supply is perfectly inelastic? If labor supply is backward-bending?
   c. Assume that firms must earn a given post-tax rate of return on investment, where the return is determined in world capital markets. What is the incidence of a tax on corporate income in a small open economy?
8. An interesting question involves the *Laffer curve*, named for California economist and sometime senatorial candidate Arthur Laffer. In Figure 16-8, the Laffer curve shows how revenues rise as *tax rates* are increased, reach a maximum at point *L*, and then decline to zero at a 100 percent tax rate as activity is completely discouraged. The exact shape of the Laffer curve for different taxes is highly controversial.

   A common mistake in discussing taxes is the post hoc fallacy (see Chapter 1's discussion of this). Proponents of lower taxes often invoke the Laffer curve in their arguments. They point to tax cuts of the 1960s to suggest that the economy is to the right of the peak of Mt. Laffer, say, at *B*. They say, in effect, "After the Kennedy-Johnson tax cuts of 1964, federal revenues actually rose from $110 billion in 1963 to $133 billion in 1966. Therefore, cutting taxes raises revenues." Explain why this does not prove that the economy was to the right of *L*. Further explain why this is an example of the post hoc fallacy. Give a correct analysis.
9. Under the flat tax, all personal and corporate income is taxed only once at a low fixed rate. Table 16-5 shows how such a flat tax might work. Compare the average and marginal tax rates of the flat tax with the tax schedule shown in Table 16-4 in the text. List advantages and disadvantages of both. Which is more progressive?

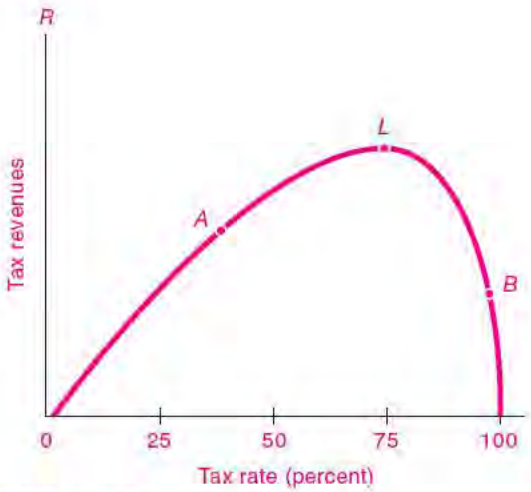


FIGURE 16-8. The Laffer Curve

(1) Adjusted gross income ($)	(2) Deductions and exemptions ($)	(3) Taxable income ($)	(4) Individual income tax ($)
5,000	20,000	0	0
10,000	20,000	0	0
20,000	20,000	0	0
50,000	20,000	30,000	6,000
100,000	20,000	80,000	16,000
1,000,000	20,000	980,000	196,000

TABLE 16-5.

Eye Therapies Exhibit 2127, 345 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

Efficiency vs. Equality: The Big Tradeoff

17



[The conflict] between equality and efficiency [is] our biggest socioeconomic tradeoff, and it plagues us in dozens of dimensions of social policy. We can't have our cake of market efficiency and share it equally.

Arthur Okun (1975)

About a century ago, many Western governments began to intervene in the marketplace and introduce a social safety net as a bulwark against socialist pressures—this new conception of society was called the "welfare state." Attitudes toward the welfare state evolved gradually into the mixed market economy found today in the democracies of Europe and North America. In these countries, the market is responsible for production and pricing of most goods and services, while governments manage the economy and provide a safety net for the poor, unemployed, and aged.

One of the most controversial aspects of government policy involves policies toward the poor. Should families have guaranteed incomes? Or perhaps just minimum levels of food, shelter, and health care? Should taxation be progressive, redistributing incomes from the rich to the poor? Or should taxation be aimed primarily at promoting economic growth and efficiency?

Surprisingly, these questions have been just as contentious as societies have become richer. You might think that as a country becomes more prosperous, it would devote a larger share of its income to programs helping the needy at home and abroad. This has not always proved to be the case. As tax burdens have risen over the last half-century, tax revolts have sparked reductions in tax rates. People are also increasingly aware that attempts to equalize incomes can harm incentives and efficiency. Today, people ask: How much of the economic pie must be sacrificed in order to divide it more equally? How should we redesign income-support programs to retain the objective of reducing want and inequality without bankrupting the nation?

The purpose of this chapter is to examine the distribution of income along with the dilemmas of policies designed to reduce inequality. These issues are among the most controversial economic questions of today. Remember the first chapter suggestion that economics best serves the public interest in using cool heads to inform warm hearts. This chapter surveys the trends in inequality and the relative merits of different approaches and indicates how cool-headed economic analysis can help promote both fairness and continued growth of the mixed economy.

A. THE SOURCES OF INEQUALITY

To measure the inequality of control over economic resources, we need to concern ourselves with both income and wealth differences. Recall that by **personal**

Eye Therapies Exhibit 2127, 346 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

income we mean the total receipts or cash earned by a person or household during a given time period (usually a year). The major components of personal income are labor earnings, property income (such as rents, interest, and dividends), and government transfer payments. **Disposable personal income** consists of personal income less any taxes paid. **Wealth** or "net worth" consists of the dollar value of financial and tangible assets minus the amount of money owed to banks and other creditors. You can refresh your memory about the major sources of income and wealth by reviewing Tables 12-1 and 12-2 (look at pages 230 and 232).

THE DISTRIBUTION OF INCOME AND WEALTH

Statistics show that in 2006 the median income of American families was $48,200—this means that half of all families received less than this figure while half received more. This number concerns the *distribution of income,* which shows the variability or dispersion of incomes. To understand the income distribution, consider the following experiment: Suppose one person from each household writes down the yearly income of his or her household on an index card. We can then sort these cards into *income classes.* Some of the cards go into the lowest 20 percent, the group with an average income of $11,551. Some go into the next class. A few go into the top 5 percent of households, those with an average income of $362,514.

The actual income distribution of American households in 2006 is shown in Table 17-1. Column (1) shows the different income-class fifths, or quintiles, plus the top 5 percent of households. Column (2) shows the average income in each income class. Column (3) shows the percentage of the households in each income class, while column (4) shows the percentage of total national income that goes to the households in an income class.

Table 17-1 enables us to see at a glance the wide range of incomes in the U.S. economy. Half of the population makes less than $50,000 per year. As you move up the distribution, the number of people gets smaller and smaller. If we made an income pyramid out of building blocks, with each layer portraying $500 of income, the peak would be far higher than Mount Everest, but most people would be within a few feet of the ground.

How to Measure Inequality among Income Classes

How can we measure the degree of income inequality? At one pole, if incomes were absolutely equally distributed, there would be no difference between the lowest 20 percent and the highest 20 percent of the population: each quintile would receive exactly 20 percent of the nation's income. That's what absolute equality means.

The reality is very different. In 2006, the lowest fifth, with 20 percent of the households, earned less than 4 percent of the total income. Meanwhile the

(1) Income class of households	(2) Average	(3) Percentage of all households in this class	(4) Percentage of total income received by households in this class
Lowest fifth	$11,551	20	3.4
Second fifth	$29,442	20	8.7
Third fifth	$49,968	20	14.8
Fourth fifth	$79,111	20	23.4
Highest fifth	$169,971	20	49.7
Top 5 percent	$362,514	5	21.2

TABLE 17-1. Distribution of Money Incomes of American Households, 2006

How was total income distributed among households in 2006? We group households into the fifth (or quintile) with the lowest income, the fifth with the second-lowest income, and so on.

Source: U.S. Bureau of the Census, Current Population Report, *Income, Poverty, and Health Insurance Coverage in the United States: 2007,* available at *www.census.gov/hhes/www/income/income.html.*

Eye Therapies Exhibit 2127, 347 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

situation is reversed for the top 5 percent of households, which get 21 percent of the income.

We can show the degree of inequality in a diagram known as the **Lorenz curve,** a widely used device for analyzing income and wealth inequality. Figure 17-1 is a Lorenz curve showing the amount of inequality listed in the columns of Table 17-2; that is, it contrasts the patterns of (1) absolute equality, (2) absolute inequality, and (3) actual 2006 American inequality.

Absolute equality is depicted by the numbers in column (4) of Table 17-2. When they are plotted, these become the diagonal 45° dashed green line of Figure 17-1's Lorenz diagram.

At the other extreme, we have the hypothetical case of absolute inequality, where one person has all the income. Absolute inequality is shown in column (5) of Table 17-2 and by the lowest curve on the Lorenz diagram—the dashed, right-angled blue line.

Any actual income distribution, such as that for 2006, will fall between the extremes of absolute equality and absolute inequality. The green-colored column (6) in Table 17-2 presents the data derived from the first two columns in a form suitable for plotting as an actual Lorenz curve. This actual Lorenz curve appears in Figure 17-1 as the solid green intermediate curve. The shaded area indicates the deviation from absolute equality, hence giving us a measure of the degree of inequality of income distribution.

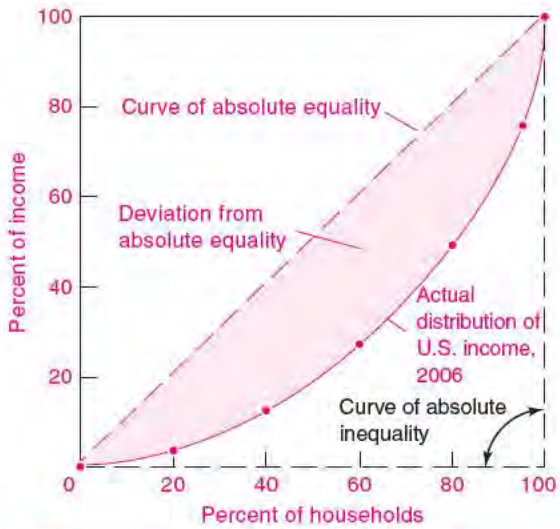


FIGURE 17-1. Lorenz Curve Shows Income Inequality

By plotting the figures from Table 17-2's column (6), we see that the solid green actual-distribution-of-income curve lies between the two extremes of absolute equality and absolute inequality. The shaded area of this Lorenz curve (as a percentage of the triangle's area) measures the relative inequality of income. (How would the curve have looked back in the roaring 1920s when inequality was greater? In an egalitarian Utopia where all have equal inheritances and opportunities?)

(1) Income class of households	(2) Percentage of total income received by households in this class	(3) Percentage of households in this class and lower ones	(4) Percentage of Income Received by This Class and Lower Ones: Absolute equality	(5) Absolute inequality	(6) Actual distribution
Lowest fifth	3.4	20	20	0	3.4
Second fifth	8.7	40	40	0	12.1
Third fifth	14.8	60	60	0	26.9
Fourth fifth	23.4	80	80	0	50.3
Highest fifth	49.7	100	100	100	100.0

TABLE 17-2. Actual and Polar Cases of Inequality

By cumulating the income shares of each quintile shown in column (2), we can compare in column (6) the actual distribution with polar extremes of complete inequality and equality.

Source: Table 19-1.

Eye Therapies Exhibit 2127, 348 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



The Gini Coefficient

Economists often need to calculate quantitative measures of inequality. One useful measure is the *Gini coefficient*. This is measured by calculating the shaded area in the Lorenz curve of Figure 17-1 and multiplying it by 2. The Gini coefficient is equal to 1 under complete inequality and 0 under complete equality. To see this, recall that a society with equal incomes would have the Lorenz curve run along the 45° line, so the shaded area would be zero. Conversely, when the Lorenz curve runs along the axes, the area is one-half, which, when multiplied by 2, gives a Gini coefficient of 1.

Using the Gini coefficient approach, the Census Bureau calculates that inequality was little changed from 1967 to 1980 (the Gini coefficient rose from .399 to .403) but then rose steadily from 1980 to 2006 (from .403 to .469).

Distribution of Wealth

One major source of the inequality of income is inequality of ownership of *wealth*, which is the net ownership of financial claims and tangible property. Those who are fabulously wealthy—whether because of inheritance, skill, or luck—enjoy incomes far above the amount earned by the average household. Those without wealth begin with an income handicap.

In market economies, wealth is much more unequally distributed than is income, as Figure 17-2 shows. In the United States, the top 10 percent of households in 2004 owned 70 percent of wealth, and the top 1 percent of the households owned around 35 percent of all wealth.

Societies are ambivalent about large wealth holdings. A century ago, President T. Roosevelt criticized "malefactors of great wealth" and introduced sharply progressive income and inheritance taxes. A century later, conservatives attempted to abolish all inheritance and gift taxes, labeling them as "death taxes."

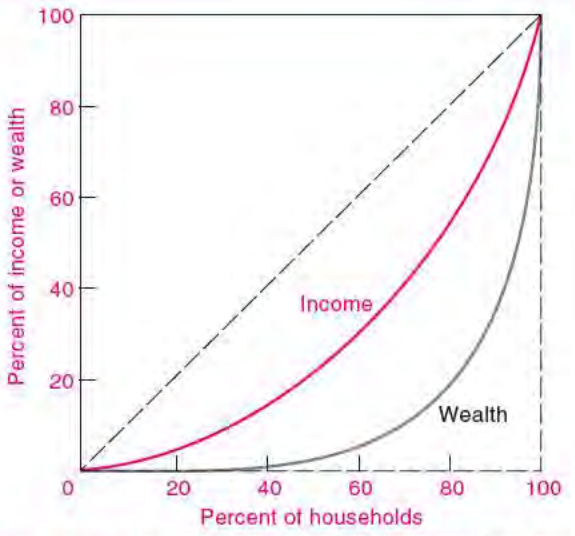


FIGURE 17-2. Inequality of Wealth Is Greater Than for Income

Holdings of wealth tend to be more concentrated than annual incomes.

Source: For income, see Table 17-1. Source for wealth is Federal Reserve Board, *Survey of Consumer Finances, 2004*, available at *www.federalreserve.gov/Pubs/oss/oss2/2004/scf2004home_modify.html*.

Inequality across Countries

Countries show quite different income distributions depending upon their economic and social structures. Table 17-3 shows the inequality of different countries as measured by the ratio of the income of

	Ratio of income of top 10% to income of bottom 10%
Japan	4.5
Czech Republic	5.2
Sweden	6.2
Germany	6.9
Korea, Republic of	7.8
France	9.0
Spain	9.0
Canada	10.0
Italy	11.7
Australia	12.7
United Kingdom	13.6
United States	15.7
South Africa	31.9
Argentina	38.9
Brazil	67.0
Namibia	129.0

TABLE 17-3. Comparative Inequality in Different Countries

This shows the ratio of the income of the top 10 percent of the population to the income of the bottom 10 percent. Inequality differs greatly across countries. Japan and Western Europe have the least inequality, while South American countries show the greatest.

Source: World Bank, *World Development Indicators*, 2005, available at *devdata.worldbank.org/wdi2005/index2.htm*.

Eye Therapies Exhibit 2127, 349 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the top 10 percent to that of the bottom 10 percent of the income distribution. Market-oriented countries like the United States tend to have the most unequal income distributions among the high-income countries. The welfare states of western Europe tend to have the least inequality. The sources of high inequality in the United States are discussed later in this chapter.

The experience of developing countries shows an interesting relationship. Inequality begins to rise as countries begin to industrialize, after which inequality then declines. The greatest extremes of inequality occur in middle-income countries, particularly Latin American countries like Brazil and Argentina.

POVERTY IN AMERICA

"You will always have the poor with you," according to the Scriptures. Poverty is indeed an enduring concern in the United States and in the wider world. Before we can analyze antipoverty programs, we must examine the definition of poverty.



The Elusive Concept of Poverty

The word "poverty" means different things to different people. Clearly, poverty is a condition in which people have inadequate incomes, but it is hard to draw an exact line between the poor and the nonpoor. Economists have therefore devised certain techniques which provide the official definition of poverty.

Poverty was officially defined in the 1960s in the United States as an income insufficient to buy basic food, clothing, shelter, and other necessities. This was calculated from family budgets and double-checked by examining the fraction of incomes that was spent on food. Since that time, the poverty budget has been updated by the government's consumer price index to reflect changes in the cost of living. According to the standard definition, the subsistence cost of living for a family of four was $21,200 in 2008. This figure represents the "poverty line" or demarcation between poor and nonpoor families. The poverty line also varies by family size.

While an exact figure for measuring poverty is helpful, scholars recognize that "poverty" is a relative term. The notion of a subsistence budget includes subjective questions of taste and social convention. Housing that is today considered substandard often includes household appliances and plumbing that were unavailable to the millionaires and robber barons of an earlier age.

Because of shortcomings in the current definition, a panel of experts of the National Academy of Sciences recommended that the definition of poverty be changed to reflect *relative-income status*. The panel recommended that a family be considered poor if its consumption is less than 50 percent of the median family's consumption of food, clothing, and housing. Poverty in the relative-income sense would decline when inequality decreased; poverty would be unchanged if the economy prospered with no change in the distribution of income and consumption. In this new world, a rising tide would lift all boats but not change the fraction of the population considered poor. This new approach is being weighed carefully by the government.

Who Are the Poor?

Poverty hits some groups harder than others. Table 17-4 shows the incidence of poverty in different groups for 2006. Whites have lower poverty rates than blacks and Hispanics. The elderly no longer have above-average poverty.

Poverty in Major Groups, 2006

Population group	Percentage of group in poverty
Total population	12.3
By racial and ethnic group:	
White (non-Hispanic)	8.2
Black	24.3
Hispanic	20.6
By age:	
Under 18 years	17.4
18 to 64 years	10.8
65 years and over	9.4
By type of family:	
Married couple	5.7
Female householder, no husband present	30.5
Male householder, no wife present	13.8

TABLE 17-4. Incidence of Poverty in Different Groups, 2006

Whites and married couples have lower-than-average poverty rates. Blacks, Hispanics, and female-headed households have above-average poverty rates.

Source: U.S. Bureau of the Census, *Poverty in the United States: 2006*, CPS 2007 Annual Social and Economic Supplement, downloaded from *pubdb3.census.gov/macro/032007/pov/toc.htm*.

Eye Therapies Exhibit 2127, 350 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Perhaps the most troubling trend is that single-parent families headed by women are an increasingly large share of the poor population. In 1959, about 18 percent of poor families were headed by women raising children alone. By 2006, the poverty rate of that group was 30 percent. Social scientists worry that children in single-parent families will receive inadequate nutrition and education and will find it difficult to escape from poverty when they are adults.

Why are so many female-headed and minority families poor? What is the role of discrimination? Experienced observers conclude that blatant racial or gender discrimination in which firms simply pay minorities or women less is vanishing today. Yet the relative poverty of women and blacks continues at a high rate. How can we reconcile these two apparently contradictory trends? The major factor at work is the increasing gap between earnings of highly educated and skilled workers and those of unskilled and less educated workers. Over the last 25 years, the wage differential between these two groups has grown sharply. The growing wage gap has hit minority groups particularly hard.

Who Are the Rich?

At the other extreme are the high earners. Many of the top earners get primarily *property income,* which consists of income on assets like stocks, bonds, and real estate. A generation ago, many of the richest Americans got their wealth through inheritances. Today, entrepreneurship is a much more important road to riches. Most of the richest people in America got that way by taking risks and creating profitable new businesses, such as computer software companies, television networks, and retail chains. The people who invented new products or services or organized the companies that brought them to market got rich on the "Schumpeterian profits" from these innovations. This group of wealthy individuals includes folk heroes like Bill Gates (head of software giant Microsoft), the Waltons (founders of Wal-Mart), and Warren Buffett (investment guru). In an earlier era, the rich lived on stocks, bonds, and land rents.

Another major change among top earners is that wages (including proprietorships) today account for 85 percent of the income of the top 1 percent, whereas that share was only about 50 percent at the beginning of the twentieth century. The high earners are increasingly working in finance and business. What single profession makes the most money? In recent years, it has been investment bankers and specialists working in financial markets. The average earnings in the securities industry in 2006 was $206,000 for all workers, and the top managers and analysts make many times that amount.

Why are there such vast differences in compensation among jobs? Some of the differences come from investments in human capital, such as the years of training needed to become a top doctor. Abilities also play a role, for example, in limiting jobs in finance to those who have a deep appreciation of the decimal point. Some jobs pay more because they are dangerous or unpleasant (recall the discussion of compensating differentials in Chapter 13). Moreover, when the supply of labor is limited in an occupation (say, because of union restrictions or professional licensing rules), the supply restrictions drive up the wages and salaries of that occupation.

Trends in Inequality

The inequality of income in the United States has gone through a complete cycle over the last century. The history of inequality in the United States is shown in Figure 17-3. This shows the ratio of the incomes received by the top fifth of families to those received by the bottom fifth. We can see three distinct periods: falling inequality until World War II, stable shares until the 1970s, and then rising inequality over the last three decades. We see that the ratio of upper- to lower-group incomes has almost doubled. Also, examine the income shares of the four top groups, shown in Figure 17-4. The most striking trend is the very top 0.1 percent of the income pyramid. The 133 thousand families in that group had an average income of $6.3 million in 2006.

Diminishing Inequality. Inequality peaked in 1929 and then declined sharply in the Great Depression as stock prices reduced capital income of the upper groups. The long postwar boom brought prosperity to the middle-class workers, and the share of top income groups declined to its trough in the late 1960s. The share of total income going to the poorest fifth of families rose from 3.8 percent to about 5 percent between 1929 and 1975.

Why did inequality narrow over this period? Inequality declined in part because of the narrowing of wage inequality. With increasing education of

Eye Therapies Exhibit 2127, 351 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

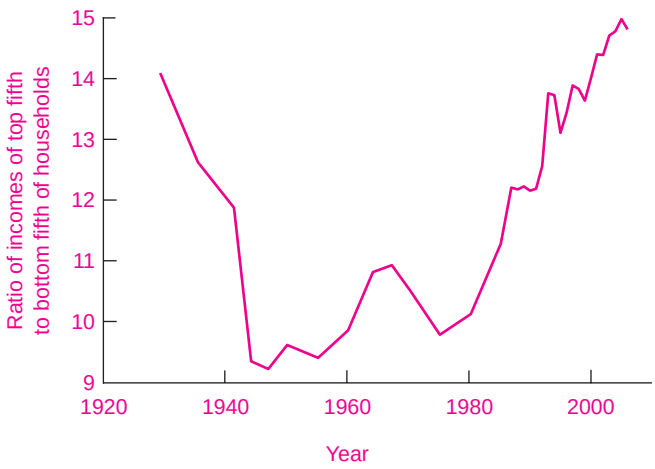


FIGURE 17-3. Trends in Inequality in the United States, 1929–2006

A useful measure of inequality is the ratio of the incomes of the top fifth of the population to those of the bottom fifth. The share of top incomes declined after 1929 with the stock market collapse of the 1930s, the low unemployment and reduced barriers to women and minorities during World War II, and the migration from the farm to the city. Since 1980, income inequality has grown sharply with higher immigration and decline of wages of the unskilled.

Source: U.S. Bureau of the Census, with historical series spliced together by authors.

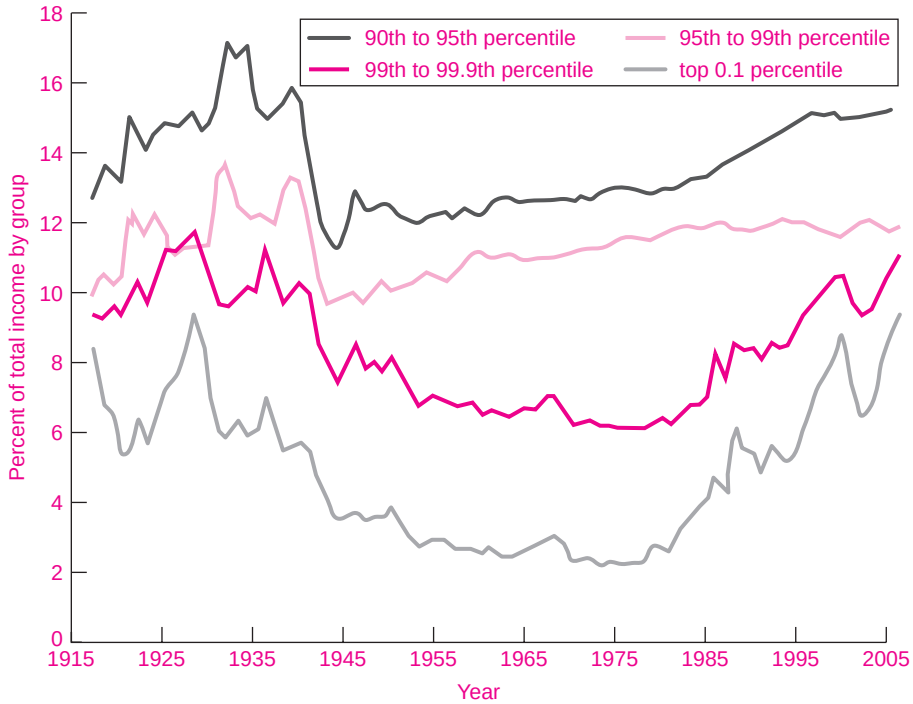


FIGURE 17-4. Income Shares of Top Income Groups, United States, 1917–2006

Inequality fell over most of the twentieth century and then began to rise around 1970. The most dramatic gains were in the very top group—the top 0.1 percent of households. Their share rose from 2 percent of income in 1975 to over 9 percent in the latest year.

Source: The methods were developed in Thomas Piketty and Emmanuel Saez, "Income Inequality in the United States, 1913–1998," *Quarterly Journal of Economics*, 2003. The data here are from their update of March 2008, downloaded from *elsa.berkeley.edu/~saez/*.

Eye Therapies Exhibit 2127, 352 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

lower-income groups and unionization of the workforce, the wage gap declined. Government policies like social security made a big difference for the elderly population, while programs like cash assistance and food stamps for the indigent and unemployment insurance boosted the incomes of other low-income groups. Our progressive income-tax system, which taxed high incomes more heavily than low incomes, tended to reduce the degree of inequality.

Widening Gaps. In the last quarter-century, several of these trends have reversed themselves. The share of total income going to the bottom quintile declined sharply in the 1980s, sinking from 5.4 percent in 1975 to 3.4 percent in 2006. Average real incomes for families in the bottom fifth are well below their peak. Although the incomes of the poor stagnated during the last quarter-century, the share of income going to the richest Americans soared.

Why did inequality rise in recent decades? After years of intensive debate on this question, a tentative verdict has been proposed in a recent survey by Robert J. Gordon and Ian Dew-Becker. Their conclusions are:

- Virtually none of the rising inequality came from changes in the overall share of labor in national income. That share has been virtually unchanged since 1970.
- The decline of trade unions contributed slightly to increased inequality for men.
- The impact of foreign trade on relative wages appears minimal, while immigration appears to have adversely affected foreign-born workers who are close "substitutes" for immigrants.
- Technological change appears primarily to have depressed the relative wages of the middle-income groups while boosting the incomes of complementary highly skilled workers and having little effect on unskilled service-sector workers.
- The very top of the income distribution has increased its share sharply because of three phenomena. First, the pay of superstars has risen as technology has increased the audience of athletes and entertainers. Second, the incomes of top professionals, particularly in finance, have increased with the increased globalization of the U.S. economy. Third, they endorse the idea that the separation of ownership from control has allowed "the outsized gains in CEO pay."

This concludes our description of the measurement and sources of inequality. In the next section, we turn to an analysis of government programs to combat poverty and reduce inequality. High-income democracies everywhere are rethinking these programs as they redefine the role of the state.

B. ANTIPOVERTY POLICIES

All societies take steps to provide for their poor citizens. But what is given to the poor must come from other groups, and that is undoubtedly the major point of resistance to redistributive programs. In addition, economists worry about the impact of redistribution upon the efficiency and morale of a country. In this section, we review the rise of the welfare state, consider the costs of income redistribution, and survey the current system of income maintenance.

The Rise of the Welfare State

The early classical economists believed the distribution of income was unalterable. They argued that attempts to alleviate poverty by government interventions in the economy were foolish endeavors that would simply end up reducing total national income. This view was contested by the English economist and philosopher John Stuart Mill. While cautioning against interferences with the market mechanism, he argued eloquently that government policies could reduce inequality.

A half-century later, at the end of the nineteenth century, political leaders in Western Europe took steps that marked a historic turning point in the economic role of government. Bismarck in Germany, Gladstone and Disraeli in Britain, followed by Franklin Roosevelt in the United States introduced a new concept of government responsibility for the welfare of the populace.

This marked the rise of the **welfare state,** in which government takes steps to protect individuals against specified contingencies and to guarantee people a minimum standard of living.

Important welfare-state programs include public pensions, accident and sickness insurance, unemployment insurance, health insurance, food and housing

Eye Therapies Exhibit 2127, 353 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

programs, family allowances, and income supplements for certain groups of people. These policies were introduced gradually from 1880 through to the modern era. The welfare state came late to the United States, being introduced in the New Deal of the 1930s with unemployment insurance and social security. Medical care for the aged and the poor was added in the 1960s. In 1996 the federal government turned back the clock by removing the guarantee of a minimum income. The debate over redistribution never ends.

THE COSTS OF REDISTRIBUTION

One of the goals of a modern mixed economy is to provide a safety net for those who are temporarily or permanently unable to provide adequate incomes for themselves. One reason for these policies is to promote greater equality.

What are the different concepts of equality? To begin with, democratic societies affirm the principle of equality of *political rights*—generally including the right to vote, the right to trial by jury, and the right to free speech and association. In the 1960s, liberal philosophers espoused the view that people should also have equal *economic opportunity*. In other words, all people should play by the same rules on a level playing field. All should have equal access to the best schools, training, and jobs. Then discrimination on the basis of race or gender or religion would disappear. Many steps were taken to promote greater equality, but inequalities of opportunity have proved very stubborn.

A third, and the most far-reaching, ideal is equality of *economic outcomes*. In this utopia, people would have the same consumption whether they were smart or dull, eager or lazy, lucky or unfortunate. Wages would be the same for doctor and nurse, lawyer and secretary. "From each according to his abilities, to each according to his needs" was Karl Marx's formulation of this philosophy.

Today, even the most radical socialist recognizes that some differences in economic outcome are necessary if the economy is to function efficiently. Without some differential reward for different kinds of work, how can we ensure that people will do the unpleasant as well as the enjoyable work, that they will work on dangerous offshore oil derricks as well as in beautiful parks? Insisting on equality of outcomes would severely hamper the functioning of the economy.



The Leaky Bucket

In taking steps to redistribute income from the rich to the poor, governments may harm economic efficiency and reduce the amount of national income available to distribute. On the other hand, if equality is a social good, it is one worth paying for.

The question of how much we are willing to pay in reduced efficiency for greater equity was addressed by Arthur Okun in his "leaky bucket" experiment. He noted that if we value equality, we would approve when a dollar is taken in a bucket from the very rich and given to the very poor. But, he continued, suppose the bucket of redistribution has a leak in it. Suppose only a fraction—maybe only one-half—of each dollar paid by the rich in taxes actually reaches the poor. Then redistribution in the name of equity has been at the expense of economic efficiency.[1]

Okun presented a fundamental dilemma. Redistributional measures like the progressive income tax, analyzed in Chapter 16, will reduce real output by reducing incentives to work and save. As a nation considers its income-distribution policies, it will want to weigh the benefit of greater equality against the impact of these policies on total national income.

Redistribution Costs in Diagrams

We can illustrate Okun's point by using the income-possibility curve of Figure 17-5. This graph shows the incomes available to different groups when government programs redistribute income.

We begin by dividing the population in half; the real income of the lower half is measured on the vertical axis of Figure 17-5, while the income of the upper half is measured on the horizontal axis. At point *A*, which is the pre-redistribution point, no taxes are levied and no transfers are given, so people simply live with their market incomes. In a competitive economy, point *A* will be efficient and the no-redistribution policy maximizes total national income.

However, at laissez-faire point *A*, the upper-income group receives substantially more income than the lower half. People might strive for greater equality by tax and transfer programs, hoping to move toward the point of equal incomes at *E*. If such

[1] Arthur M. Okun, *Equality and Efficiency: The Big Tradeoff* (Brookings Institution, Washington, D.C., 1975).

Eye Therapies Exhibit 2127, 354 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

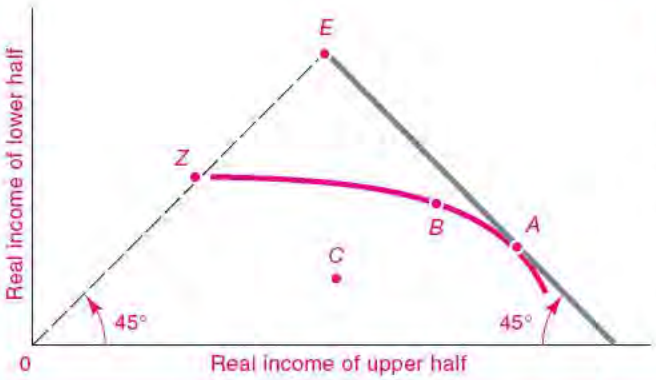


FIGURE 17-5. Redistributing Income May Harm Economic Efficiency

Point *A* marks the most efficient outcome, with maximal national output. If society could redistribute with no loss of efficiency, the economy would move toward point *E*. Because redistributive programs generally create distortions and efficiency losses, the path of redistribution might move along the green line *ABZ*. Society must decide how much efficiency to sacrifice to gain greater equality. Why would everyone want to avoid redistributional programs that take the economy from point *B* to point *C*?

steps could be taken without reducing national output, the economy would move along the blue line from *A* toward *E*. The slope of the *AE* line is −45°, reflecting the assumption about efficiency that the redistributive bucket has no leaks, so every dollar taken from the upper half increases the income of the lower half by exactly $1. Along the −45° line, total national income is constant, indicating that redistributional programs have no impact upon the total national income.

Most redistributive programs do affect efficiency. If a country redistributes income by imposing high tax rates on the wealthiest people, their saving and work effort may be reduced or misdirected, with a resulting lower total national output. They may spend more money on tax lawyers or invest less in high-yielding but risky innovations. Also, if society puts a guaranteed floor beneath the incomes of the poor, the sting of poverty will be reduced and the poor may work less. All these reactions to redistributive programs reduce the total size of real national income.

In terms of Okun's experiment, we might find that for every $100 of taxation on the rich, the income of the poor increased by only $50, with the rest dissipated because of reduced effort or administrative costs. The bucket of redistribution has developed a leak. Costly redistribution is shown by the *ABZ* curve in Figure 17-5. Here, the hypothetical frontier of real incomes bends away from the −45° line because taxes and transfers produce inefficiencies.

The experience of socialist countries exemplifies how attempts to equalize incomes by expropriating property from the rich can end up hurting everyone. By prohibiting private ownership of businesses, socialist governments reduced the inequalities that arise from large property incomes. But the reduced incentives for work, investment, and innovation crippled this radical experiment of "to each according to his needs" and impoverished entire countries. By 1990, comparisons of living standards in East and West had convinced many socialist countries that private ownership of business would benefit the living standards of workers as well as capitalists.

How Big Are the Leaks?

Okun characterized our redistributive system of taxes and transfers as a leaky bucket. But just how big are the leaks in the American economy? Is the country closer to Figure 17-5's point *A*, where the leaks are negligible? Or to *B*, where they are substantial? Or to *Z*, where the redistributive bucket is in fact a sieve? To find the answer, we must examine the major inefficiencies induced by high tax rates and by generous income-support programs: administrative costs, damage to work and saving incentives, and socioeconomic costs.

- The government must hire tax collectors to raise revenues and social security accountants to disburse them. These are clear inefficiencies or regrettable necessities, but they are small: the Internal Revenue Service spends only half a penny on administrative costs for each dollar of collected revenues.
- As the tax collector's bite grows larger and larger, might I not become discouraged and end up working less? Tax rates might conceivably be so high that total revenues are actually lower

Eye Therapies Exhibit 2127, 355 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

than they would be at more modest tax rates. Empirical evidence, however, suggests that the damage of taxes on work effort is limited. For a few groups, the labor supply curve may actually be backward-bending, indicating that a tax on wages might increase rather than decrease work effort. Most studies find that taxes have only a small impact on labor effort for middle-income and high-income workers. However, there may well be substantial impacts of the tax and transfer system on the behavior of poor people.

- Perhaps the most important potential leakage from the revenue bucket is the savings component. Some believe that current government programs discourage saving and investment. Some economic studies indicate that by taxing income rather than consumption, total saving is reduced. Additionally, economists worry that the nation's saving rate has declined sharply because of generous social programs—especially social security and Medicare—that reduce the need for people to save for old age and health contingencies.
- Some claim that the leaks cannot be found in the cost statistics of the economist; instead, the costs of equality are seen in attitudes rather than in dollars. Are people so turned off by the prospect of high taxes that they turn on to drugs and idleness? Is the welfare system leading to a permanent underclass, a society of people who are trapped in a culture of dependency?
- Some people criticize the entire notion of costly redistribution, arguing as follows: Poverty is rooted in malnourishment in the early years, broken families, illiteracy at home, poor education, and lack of job training. Poverty begets poverty; the vicious cycle of malnutrition, poor education, drug dependency, low productivity, and low incomes leads to yet another generation of poor families. These analysts contend that enhanced programs to provide health care and adequate food for poor families will increase productivity and efficiency rather than decrease output. By breaking the vicious cycle of poverty today, we will be raising the skills, human capital, and productivity of the children of poverty tomorrow.

Adding Up the Leaks

When all the leaks are added up, how big are they? Okun argued that the leaks are small, particularly when funds for redistributive programs are drawn from the tap of a broad-based income tax. Others disagree strenuously, pointing to high marginal tax rates and overly generous transfer programs as confusing and destructive of economic efficiency.

What is the reality? While much research has been undertaken on the cost of redistribution, the truth has proved elusive. A cautious verdict is that there are but modest losses to economic efficiency from redistributional programs of the kind used in the United States today. For many people, the efficiency costs of redistribution are a reasonable price to pay for reducing the economic and human costs of poverty in malnutrition, poor health, lost job skills, and human misery. But countries whose welfare-state policies have gone far beyond those in the United States see major inefficiencies. Egalitarian countries like Sweden and the Netherlands, which provided cradle-to-grave protection for their citizens, found declining labor-force participation, growing unemployment, and rising budget deficits. These countries have taken steps to reduce the burden of the welfare state.

Countries need to design their policies carefully to avoid the extremes of unacceptable inequality or great inefficiency.

ANTIPOVERTY POLICIES: PROGRAMS AND CRITICISMS

All societies provide for their aged, their young, and their sick. Sometimes, the support comes from families or religious organizations. Over most of the last century, central governments have increasingly assumed the responsibility for providing income support for the poor and needy. Yet, as governments have assumed larger responsibilities for more people, the fiscal burdens of transfer programs have grown steadily. Today, most high-income countries face the prospect of rising tax burdens to finance health and retirement programs as well as income-support programs for poor families. This rising tax burden has provoked a sharp backlash against "welfare programs," particularly in the United States. Let's review the major antipoverty programs and recent reforms.

Eye Therapies Exhibit 2127, 356 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Income-Security Programs

What are the major income-security programs today? Let's look briefly at a few of the programs that have been established in the United States.

Most income-security programs are targeted at the elderly rather than the poor. The major programs are social security, which is a contributory federal retirement program, and Medicare, which is a subsidized health program for those over 65 years old. These two programs are the largest transfer programs in the United States and in most other high-income countries.

Programs specifically targeted to poor households are a patchwork quilt of federal, state, and local programs. Some of these are cash assistance. Others subsidize particular goods or services, such as the food-stamps program or Medicaid, which provides poor families with free health care. Most of the programs targeted to poor families have shrunk sharply over the last two decades.

The most controversial program was cash assistance to poor parents with small children. This program was drastically reformed in 1996, and we will discuss the reform below.

How much do all federal programs add up to in terms of budget expenditures? All federal poverty programs today amount to 20 percent of the total federal budget.

Incentive Problems of the Poor

One of the major obstacles faced by poor families is that the rules in most welfare programs severely reduce the incentives of low-income adults to seek work. If a poor person on welfare gets a job, the government will trim back food stamps, income-support payments, and rent subsidies, and the person might even lose medical benefits. We might say that poor people face high marginal "tax rates" (or, more accurately, "benefit-reduction rates") because welfare benefits are sharply reduced as earnings rise.

THE BATTLE OVER WELFARE REFORM

The traditional welfare system has few defenders. Some want to dismantle it; others, to strengthen it. Some wish to devolve responsibility for income support to states, localities, or families; others, to broaden the federal role. These disparate approaches reflect disparate views of poverty and lead to strikingly different policy proposals.

Two Views of Poverty

Social scientists put forth a wide variety of proposals to cure or alleviate poverty. The different approaches often reflect differing views of the roots of poverty. Proponents of strong government action see poverty as the result of social and economic conditions over which the poor have little control. They stress malnutrition, poor schools, broken families, discrimination, lack of job opportunities, and a dangerous environment as central determinants of the fate of the poor. If you hold this view, you might well believe that government bears a responsibility to alleviate poverty—either by providing income to the poor or by correcting the conditions that produce poverty.

A second view holds that poverty grows out of maladaptive individual behavior—behavior that is the responsibility of individuals and is properly cured by the poor themselves. In earlier centuries, laissez-faire apologists held that the poor were shiftless, lazy, or drunk; as a charity worker wrote almost a century ago, "Want of employment . . . is, as often as not, [caused by] drink." Sometimes the government itself is blamed for breeding dependency on government programs that squelch individual initiative. Critics who hold these views advocate that the government should cut back on welfare programs so that people will develop their own resources.

The poverty debate was succinctly summarized by the eminent social scientist William Wilson:

> Liberals have traditionally emphasized how the plight of disadvantaged groups can be related to the problems of the broader society, including problems of discrimination and social class subordination. . . . Conservatives, in contrast, have traditionally stressed the importance of different group values and competitive resources in accounting for the experiences of the disadvantaged.[2]

Much of today's debate can be better understood if these two views and their implications are factored into the political equation.

[2] William Julius Wilson, "Cycles of Deprivation and the Underclass Debate," *Social Service Review,* December 1985, pp. 541–559.

Eye Therapies Exhibit 2127, 357 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Income-Support Programs in the United States Today

Most high-income countries provide guaranteed income supplements for poor families with children, and that model was followed by the United States until 1996. At that time, the country took a radically different approach to increasing incomes of the poor. First, the government augmented a program to supplement wages of working families. Second, it fundamentally altered cash assistance programs, abolishing a federal entitlement for poor families.

The Earned-Income Tax Credit

The wage supplement program is called the *earned-income tax credit* or *EITC*. This credit applies to labor incomes and is in effect a wage supplement. In 2008, the EITC provided a supplement to wage income of as much as 40 percent, up to a maximum of $4824 for a family with two children. A single father or mother would receive some credit for an income up to around $39,000 of wages. It is known as a "refundable" credit because it is actually paid to an individual when the individual owes no taxes.

What is the difference between a traditional cash-assistance program and the earned-income tax credit? Cash assistance provides a minimum benefit for poor families and then reduces the benefit as market income increases. The earned-income tax credit, by contrast, gives nothing to those who do not work and supplements the earnings of those who do work. The philosophy of the EITC in essence is, "Those who do not work shall not get government dollars."

The 1996 U.S. Welfare Reform

From the 1930s until 1996, poor families could also benefit from a federal cash-assistance program known as Aid to Families with Dependent Children. This was an *entitlement program,* meaning that anyone who met certain qualifications could receive the benefits as a matter of law.

President Bill Clinton had run on a platform of "reforming welfare as we know it." In 1996, he teamed up with a Republican Congress and completely changed the rules for cash assistance. The old program was replaced by the Temporary Assistance for Needy Families (TANF) program, which removed the federal entitlement to cash benefits and turned the program over to the 50 states.

The major provisions of the new program were the following:

- The primary responsibility for the income support of poor people was turned over to state and local governments. This replaced the earlier system in which the federal government picked up most of the costs of income support.
- The entitlement for federal cash assistance under TANF was removed.
- Each family is subject to a lifetime limit of 5 years of benefits under the federally supported program. After 5 years, TANF funds can no longer be used to support the family, even if it moves to a new state or has been off the welfare rolls for a number of years.
- Adults in the program must engage in work activities after 2 years of benefits.
- Legal immigrants may be excluded from TANF benefits.
- Other major low-income-support programs were largely unchanged.

Appraisal. The 1996 welfare reform was a major change in social policy. One aspect is the effect on *labor markets*. To the extent that the loss of benefits forces people to seek work, this will increase the supply of relatively uneducated and unskilled labor. This increased supply will tend to lower wages of the lowest-paid workers and increase income inequality. (This effect operates much the same way that the sharp increase in immigration has contributed to lowering of wages of the unskilled in the last three decades.) If the equilibrium wages of some workers are driven down below the minimum wage, this may also lead to an increase in the unemployment rate of these groups.

One important feature of the new law, emphasized by social and economic conservatives, was the *transfer of responsibility* for income support for poor families to the states. The idea behind this change was that states would reverse the century-long trend of increasing generosity of welfare programs. Critics of this transfer believed that placing decision-making responsibility in the states would give strong incentives for states to trim welfare benefits to reduce the costs and the fiscal burden of the low-income population. This has been called a "race to the bottom" in which the equilibrium is for states to have the

Eye Therapies Exhibit 2127, 358 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

lowest-possible benefits and drive low-income households elsewhere.

The *impacts* of the expanded EITC and 1996 welfare reform have surprised most analysts. Among the major impacts have been the following:

- The fall in welfare caseloads has been unprecedented, widespread, and continuous. From 1995 to 2008, the number of households on welfare has fallen by more than 70 percent. While a decline was expected, its size and duration were surprising.
- There was a large increase in the labor-force participation rate of single women with young children. The combination of economic incentives and a strong labor market was successful in pushing women off welfare and into jobs.

ECONOMIC POLICY FOR THE 21ST CENTURY

How should government's role in the economy be redefined? We close with three final reflections:

1. We have examined the key economic functions of the government. The government combats market failures, redistributes income, stabilizes the economy, manages international affairs, and promotes long-term economic growth. Each of these is essential. No serious person today advocates shutting down the government. No one today proposes to allow nuclear dumping, to let poor orphans starve in the streets, to privatize the central bank, or to open the borders to all flows of people and drugs. The question is not whether government should regulate the economy but how and where it should intervene.
2. While government plays a central role in a civilized society, we must constantly reassess the mission and instruments of government policy. Governments have a monopoly on political power, and this imposes a special responsibility for government to operate efficiently. Every public dollar spent on wasteful programs could be used for promoting scientific research or alleviating hunger. Every inefficient tax reduces people's consumption opportunities, whether for food or education or housing. The central premise of economics is that resources are scarce—and this applies to the government as well as to the private sector.
3. While economics can analyze the major public-policy controversies, it cannot have the final word. For underlying all public-policy debates are normative assumptions and value judgments about what is just and fair. What an economist does, therefore, is try very hard to keep positive science cleanly separated from normative judgments—to draw a line between the economic calculations of the head and the human feelings of the heart. But keeping description separate from prescription does not mean that the professional economist is a bloodless computer. Economists are as divided in their political philosophies as is the rest of the population. Conservative economists argue strenuously for reducing the scope of government and ending programs to redistribute income. Liberal economists are just as passionate in advocating reducing poverty or using macroeconomic policies to combat unemployment. Economic science cannot say which political point of view is right or wrong. But it can arm us for the great debate.



SUMMARY

A. The Sources of Inequality

1. In the previous century, the classical economists believed that inequality was a universal constant, unchangeable by public policy. This view does not stand up to scrutiny. Poverty made a glacial retreat over the early part of the twentieth century, and absolute incomes for those in the bottom part of the income distribution rose sharply. Since around 1980, this trend has reversed, and inequality has increased.
2. The Lorenz curve is a convenient device for measuring the spreads or inequalities of income distribution. It shows what percentage of total income goes to the poorest 1 percent of the population, to the poorest 10 percent, to the poorest 95 percent, and so forth.

Eye Therapies Exhibit 2127, 359 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The Gini coefficient is a quantitative measure of inequality.

3. Poverty is essentially a relative notion. In the United States, poverty was defined in terms of the adequacy of incomes in the early 1960s. By this standard of measured income, little progress in reducing inequality has been made in the last decade.
4. Income inequality declined markedly over most of the twentieth century. Then, beginning around 1975, the gap between rich and poor began to widen. The largest income gains have gone to the very top of the income distribution, to the richest 0.1 percent of people. Analysts believe that the "rich man's crash" of 2007–2009 will narrow income gaps at the very top. Wealth is even more unequally distributed than is income, both in the United States and in other capitalist economies.

B. Antipoverty Policies

5. Political philosophers write of three types of equality: (*a*) equality of political rights, such as the right to vote; (*b*) equality of opportunity, providing equal access to jobs, education, and other social systems; and (*c*) equality of outcomes, whereby people are guaranteed equal incomes or consumptions. Whereas the first two types of equality are increasingly accepted in most advanced democracies like the United States, equality of outcomes is generally rejected as impractical and too harmful to economic efficiency.
6. Equality has costs as well as benefits; the costs show up as drains from Okun's "leaky bucket." That is, attempts to reduce income inequality by progressive taxation or transfer payments may harm economic incentives to work or save and may thereby reduce the size of national output.
7. Major programs to alleviate poverty are welfare payments, food stamps, Medicaid, and a group of smaller or less targeted programs. As a whole, these programs are criticized because they impose high benefit-reduction rates (or marginal "tax" rates) on low-income families when families begin to earn wages or other income.

CONCEPTS FOR REVIEW

trends of income distribution
Lorenz curve of income and wealth
Gini coefficient
poverty
welfare state
Okun's "leaky bucket"
equality: political, of opportunity, of outcomes
equality vs. efficiency
income-possibility curve: ideal and realistic cases

FURTHER READING AND INTERNET WEBSITES

Further Reading

An influential book on equality versus efficiency is Arthur Okun, *Equality and Efficiency: The Big Tradeoff* (Brookings Institution, Washington, D.C., 1975).

For a nontechnical review of issues in health-care reform, see the symposium in *Journal of Economic Perspectives,* Summer 1994.

Websites

The Census Department collects poverty data. See *www.census.gov/hhes/www/poverty.html.* For information on welfare and poverty, see *www.welfareinfo.org.* The site *www.doleta.gov* describes the results of welfare reform from the perspective of individuals.

The Urban Institute (*www.urban.org*) and the Joint Center for Poverty Research (*www.jcpr.org*) are organizations devoted to analyzing trends in poverty and income distribution.

Eye Therapies Exhibit 2127, 360 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

QUESTIONS FOR DISCUSSION

1. Let each member of the class anonymously write down on a card an estimate of his or her family's annual income. From these, draw up a frequency table showing the distribution of incomes. What is the median income? The mean income?
2. What effect would the following have on the Lorenz curve of after-tax incomes? (Assume that the taxes are spent by the government on a representative slice of GDP.)
   a. A proportional income tax (i.e., one taxing all incomes at the same rate)
   b. A progressive income tax (i.e., one taxing high incomes more heavily than low incomes)
   c. A sharp increase in taxes on cigarettes and food

   Draw four Lorenz curves to illustrate the original income distribution and the income distribution after each of the three tax categories.
3. Review Okun's leaky bucket experiment. Get a group together and have each member of the group write down on a piece of paper how large a leak should be tolerated when government transfers $100 from the top income quintile to the bottom income quintile. Do you think it should be 99 percent? Or 50 percent? Or zero? Each person should write a short justification of the maximum number. Tabulate the results and then discuss the differences.
4. Consider two ways of supplementing the income of the poor: (*a*) cash assistance (say, $500 per month) and (*b*) categorical benefits such as subsidized food or medical care. List the pros and cons of using each strategy. Can you explain why the United States tends to use mainly strategy (*b*)? Do you agree with this decision?
5. In a country called Econoland, there are 10 people. Their incomes (in thousands) are $3, $6, $2, $8, $4, $9, $1, $5, $7, and $5. Construct a table of income quintiles like Table 17-2. Plot a Lorenz curve. Calculate the Gini coefficient defined in Section A.
6. People continue to argue about what form assistance for the poor should take. One school says, "Give people money and let them buy health services and the foods they need." The other school says, "If you give money to the poor, they may spend it on beer and drugs. Your dollar goes further in alleviating malnourishment and disease if you provide the services "in kind" (meaning by directly providing the good or service rather than providing money to buy the good or service.) The dollar that you earn may be yours to spend, but society's income-support dollar is a dollar that society has the right to channel directly to its targets."

   The argument of the first school might rest on demand theory: Let each household decide how to maximize its utility on a limited budget. Chapter 5 shows why this argument might be right. But what if the parents' utility includes mainly beer and lottery tickets and no milk or clothing for the children? Might you agree with the second view? From your own personal experience and reading, which of these two arguments would you endorse? Explain your reasoning.

Eye Therapies Exhibit 2127, 361 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

International Trade

18



TO THE CHAMBER OF DEPUTIES:
We are subject to the intolerable competition of a foreign rival, who enjoys such superior facilities for the production of light that he can inundate our national market at reduced price. This rival is no other than the sun. Our petition is to pass a law shutting up all windows, openings, and fissures through which the light of the sun is used to penetrate our dwellings, to the prejudice of the profitable manufacture we have been enabled to bestow on the country. Signed: The Candle Makers

F. Bastiat

A. THE NATURE OF INTERNATIONAL TRADE

As we go about our daily lives, it is easy to overlook the importance of international trade. America ships enormous volumes of food, airplanes, computers, and machinery to other countries; and in return we get vast quantities of oil, footwear, cars, coffee, and other goods and services. While Americans pride themselves on their ingenuity, it is sobering to realize how many of our products—including gunpowder, classical music, clocks, railroads, penicillin, and radar—arose from the inventions of long-forgotten people in faraway places.

What are the economic forces that lie behind international trade? Simply put, trade promotes specialization, and specialization increases productivity. Over the long run, increased trade and higher productivity raise living standards for all nations. Gradually, countries have realized that opening up their economies to the global trading system is the most secure road to prosperity.

This chapter extends our analysis by examining the principles governing *international trade*, through which nations export and import goods, services, and capital. International economics involves many of the most controversial questions of the day. Should the nation be concerned that so many of its consumer goods are made abroad? Do we gain from free trade, or should we tighten up the rules on trading with Mexico and China? Are workers hurt in competition with "cheap foreign labor"? How should the principles governing trade be extended to intellectual property rights, such as patents and copyrights? The economic stakes are high in finding sound answers to these questions.

Eye Therapies Exhibit 2127, 362 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

International vs. Domestic Trade

In a deep economic sense, trade is trade, whether it involves people within the same nation or people in different countries. There are, however, three important differences between domestic and international trade, and these have important practical and economic consequences:

1. *Expanded trading opportunities.* The major advantage of international trade is that it expands the scope of trade. If people were forced to consume only what they produced at home, the world would be poorer on both the material and the spiritual planes. Canadians could drink no wine, Americans could eat no bananas, and most of the world would be without jazz and Hollywood movies.
2. *Sovereign nations.* Trading across frontiers involves people and firms living in different nations. Each nation is a sovereign entity which regulates the flow of people, goods, and finance crossing its borders. This contrasts with domestic trade, where there is a single currency, where trade and money flow freely within the borders, and where people can migrate easily to seek new opportunities. Countries sometimes build barriers to international trade, using tariffs or quotas, to "protect" affected workers or firms from foreign competition.
3. *International finance.* Most nations have their own currencies. I want to pay for a Japanese car in U.S. dollars, while Toyota wants to be paid in Japanese yen. Dollars are translated into yen by the foreign exchange rate, which is the relative price of different currencies. The international financial system must ensure a smooth flow and exchange of dollars, yen, and other currencies—or else risk a breakdown in trade. The financial aspects of international trade are analyzed in the chapters on macroeconomics.

Trends in Foreign Trade

What are the major components of international trade for the United States? Table 18-1 shows the composition of U.S. foreign trade for 2007. The bulk of trade is in goods, particularly manufactured goods, although trade in services has increased rapidly. The data reveal that the United States exports surprisingly large amounts of primary commodities (such as food) and imports large quantities of sophisticated, capital-intensive manufactured goods (like automobiles and computer parts). Moreover, we find a great deal of two-way, or intra-industry, trade. Within a particular industry, the United States exports and imports at the same time because a high degree of product differentiation means that different countries tend to have niches in different parts of a market.

International Trade in Goods and Services, 2007 (billions of dollars)

	Exports	Imports
Goods	**1,149**	**1,965**
Food and beverages	84	50
Industrial supplies	316	269
Capital goods	446	284
Motor vehicles	121	204
Consumer goods	146	308
Other goods	36	49
Services	**479**	**372**
Travel	97	76
Passenger fares	25	29
Other transportation	52	67
Royalties and license fees	71	28
Other private services	217	135
Military sales and government	17	37
Total goods and services	**1,628**	**2,337**

TABLE 18-1. International Trade in Goods and Services

The United States exports a wide array of goods and services from food to intellectual property. In 2007, U.S. imports exceeded exports by around $700 billion. The United States exports primarily specialized capital goods like machinery. At the same time, it imports many other manufactured goods, like cars and cameras, because other countries specialize in different market niches and enjoy economies of scale.

Source: U.S. Bureau of Economic Analysis, available at *www.bea.gov/international/*.

THE REASONS FOR INTERNATIONAL TRADE IN GOODS AND SERVICES

What are the economic factors that lie behind the patterns of international trade? Nations find it beneficial to participate in international trade for several

Eye Therapies Exhibit 2127, 363 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

reasons: diversity in the conditions of production, differences in tastes among nations, and decreasing costs of large-scale production.

Diversity in Natural Resources

Trade may take place because of the diversity in productive possibilities among countries. In part, these differences reflect endowments of natural resources. One country may be blessed with a supply of petroleum, while another may have a large amount of fertile land. Or a mountainous country may generate large amounts of hydroelectric power which it sells to its neighbors, while a country with deep-water harbors may become a shipping center.

Differences in Tastes

A second reason for trade lies in preferences. Even if the conditions of production were identical in all regions, countries might engage in trade if their tastes for goods were different.

For example, suppose that Norway and Sweden both produce fish from the sea and meat from the land in about the same amounts but the Swedes have a great fondness for meat while the Norwegians are partial to fish. A mutually beneficial export of meat from Norway and fish from Sweden would take place. Both countries would gain from this trade; the sum of human happiness is increased, just as when Jack Sprat trades fat meat for his wife's lean.

Differences in Costs

Perhaps the most important reason for trade is differences among countries in production costs. We see vast differences in labor costs among nations. In 2006, for example, China's hourly wage of $1 was about one-thirtieth of that in Western Europe. Companies looking to compete effectively strive to find those parts of the production chain that can profitably be located in China to use unskilled Chinese workers. When an iPod or mobile phone is labeled "Made in China," that probably means that it was assembled in China, while the design, patents, marketing, and hard drives were produced in other countries.

An important feature in today's world is that some companies or countries enjoy economies of scale; that is, they tend to have lower average costs of production as the volume of output expands. So when a particular country gets a head start in producing a particular product, it can become the high-volume, low-cost producer. The economies of scale give it a significant cost and technological advantage over other countries, which find it cheaper to buy from the leading producer than to make the product themselves.

Large-scale production is an important advantage in industries with major research-and-development expenses. As the leading aircraft maker in the world, Boeing can spread the enormous cost of designing, developing, and testing a new plane over a large sales volume. That means it can sell planes at a lower price than competitors with a smaller volume. Boeing's only real competitor, Airbus, got off the ground through large subsidies from several European countries to cover its research-and-development costs.

The example of decreasing cost helps explain the important phenomenon of extensive intra-industry trade shown in Table 18-1. Why is it that the United States both imports and exports computers and related equipment? Consider a company such as Intel, which produces high-end semiconductors. Intel has facilities in the United States as well as in China, Malaysia, and the Philippines, and the company often ships products manufactured in one country to be assembled and tested in another country. Similar patterns of intra-industry specialization are seen with cars, steel, textiles, and many other manufactured products.

B. COMPARATIVE ADVANTAGE AMONG NATIONS

THE PRINCIPLE OF COMPARATIVE ADVANTAGE

It is only common sense that countries will produce and export goods for which they are uniquely qualified. But there is a deeper principle underlying *all* trade—in a family, within a nation, and among nations—that goes beyond common sense. The *principle of comparative advantage* holds that a country can benefit from trade even if it is absolutely more efficient (or absolutely less efficient) than other countries in the production of every good. Indeed, trade according to comparative advantage provides mutual benefits to all countries.

Eye Therapies Exhibit 2127, 364 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Uncommon Sense

Take a world in which there are only two goods, computers and clothing. Suppose that the United States has higher output per worker (or per unit of input) than the rest of the world in making both computers and clothing. But suppose the United States is relatively more efficient in the production of computers than it is in clothing. For example, it might be 50 percent more productive in computers and 10 percent more productive in clothing than other countries. In this case, it would benefit the United States to export that good in which it is relatively more efficient (computers) and import that good in which it is relatively less efficient (clothing).

Or consider a poor country like Mali. How could impoverished Mali, whose workers use handlooms and have productivity that is only a fraction of that of workers in industrialized countries, hope to export any of its textiles? Surprisingly, according to the principle of comparative advantage, Mali can benefit by exporting the goods in which it is *relatively* more efficient (like textiles) and importing those goods which it produces *relatively* less efficiently (like turbines and automobiles).

The **principle of comparative advantage** holds that each country will benefit if it specializes in the production and export of those goods that it can produce at relatively low cost. Conversely, each country will benefit if it imports those goods which it produces at relatively high cost.

This simple principle provides the unshakable basis for international trade.

Ricardo's Analysis of Comparative Advantage

Let us illustrate the fundamental principles of international trade by considering America and Europe two centuries ago. If labor (or resources, more generally) is absolutely more productive in America than in Europe, does this mean that America will import nothing? And is it economically wise for Europe to "protect" its markets with tariffs or quotas?

These questions were first answered in 1817 by the English economist David Ricardo, who showed that international specialization benefits a nation. He called this result the law of comparative advantage.

For simplicity, Ricardo worked with only two regions and only two goods, and he chose to measure all production costs in terms of labor-hours. We will follow his lead here, analyzing food and clothing for Europe and America.[1]

American and European Labor Requirements for Production

	Necessary Labor for Production (labor-hours)	
Product	**In America**	**In Europe**
1 unit of food	1	3
1 unit of clothing	2	4

TABLE 18-2. Comparative Advantage Depends Only on Relative Costs

In a hypothetical example, America has lower labor costs in both food and clothing. American labor productivity is between 2 and 3 times Europe's (twice in clothing, thrice in food).

Table 18-2 shows the illustrative data. In America, it takes 1 hour of labor to produce a unit of food, while a unit of clothing requires 2 hours of labor. In Europe the cost is 3 hours of labor for food and 4 hours of labor for clothing. We see that America has *absolute advantage* in both goods, for it can produce either one with greater absolute efficiency than can Europe. However, America has *comparative advantage* in food, while Europe has *comparative advantage* in clothing. The reason is that food is *relatively inexpensive* in America compared to Europe, while clothing is *relatively inexpensive* in Europe compared to America.

From these facts, Ricardo proved that both regions will benefit if they specialize in their areas of comparative advantage—that is, if America specializes in the production of food while Europe specializes in the production of clothing. In this situation, America will export food to pay for European clothing, while Europe will export clothing to pay for American food.

To analyze the effects of trade, we must measure the amounts of food and clothing that can be produced and consumed in each region (1) if there is no international trade and (2) if there is free trade with each region specializing in its area of comparative advantage.

[1] An analysis of comparative advantage with many countries and many commodities is presented later in this chapter.

Eye Therapies Exhibit 2127, 365 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Before Trade. Start by examining what occurs in the absence of any international trade, say, because all trade is illegal or because of a prohibitive tariff. Table 18-2 shows the real wage of the American worker for an hour's work as 1 unit of food or ½ unit of clothing. The European worker earns only ⅓ unit of food or ¼ unit of clothing per hour of work.

Clearly, if perfect competition prevails in each isolated region, the prices of food and clothing will be different in the two places because of the difference in production costs. In America, clothing will be 2 times as expensive as food because it takes twice as much labor to produce a unit of clothing as it does to produce a unit of food. In Europe, clothing will be only ⅓ as expensive as food.

After Trade. Now suppose that all tariffs are repealed and free trade is allowed. For simplicity, further assume that there are no transportation costs. What is the flow of goods when trade is opened up? Clothing is relatively more expensive in America (with a price ratio of 2 as compared to ⅓), and food is relatively more expensive in Europe (with a price ratio of ¾ as compared to ½). Given these relative prices, and with no tariffs or transportation costs, food will soon be shipped from America to Europe and clothing from Europe to America.

As European clothing penetrates the American market, American clothiers will find prices falling and profits shrinking, and they will begin to shut down their factories. By contrast, European farmers will find that the prices of foodstuffs begin to fall when American products hit the European markets; they will suffer losses, some will go bankrupt, and resources will be withdrawn from farming.

After all the adjustments to international trade have taken place, the prices of clothing and food must be equalized in Europe and America (just as the water in two connecting pipes must come to a common level once you remove the barrier between them). Without further knowledge about the exact supplies and demands, we cannot know the exact level to which prices will move. But we do know that the relative prices of food and clothing must lie somewhere between the European price ratio (which is ¾ for the ratio of food to clothing prices) and the American price ratio (which is ½). Let us say that the final ratio is ⅔, so 2 units of clothing trade for 3 units of food. For simplicity, we measure prices in American dollars and assume that the free-trade price of food is $2 per unit, which means that the free-trade price of clothing must be $3 per unit.

With free trade, the regions have shifted their productive activities. America has withdrawn resources from clothing in favor of food, while Europe has contracted its farm sector and expanded its clothing manufacture. *Under free trade, countries shift production toward their areas of comparative advantage.*

The Economic Gains from Trade

What are the economic effects of opening up the two regions to international trade? America as a whole benefits from the fact that imported clothing costs less than clothing produced at home. Likewise, Europe benefits by specializing in clothing and consuming food that is less expensive than domestically produced food.

We can most easily reckon the gains from trade by calculating the effect of trade upon the real wages of workers. Real wages are measured by the quantity of goods that a worker can buy with an hour's pay. Using Table 18-2, we can see that the real wages after trade will be greater than the real wages before trade for workers in both Europe *and* America. For simplicity, assume that each worker buys 1 unit of clothing and 1 unit of food. Before trade, this bundle of goods costs an American worker 3 hours of work and a European worker 7 hours of work.

After trade has opened up, the price of clothing is $3 per unit while the price of food is $2 per unit. An American worker must still work 1 hour to buy a unit of food, because food is domestically produced; but at the price ratio of 2 to 3, the American worker need work only 1½ hours to produce enough to buy 1 unit of European clothing. Therefore the bundle of goods costs the American worker 2½ hours of work when trade is allowed—this represents an increase of 20 percent in the real wage of the American worker.

For European workers, a unit of clothing will still cost 4 hours of labor in a free-trade situation. To obtain a unit of food, however, the European worker need produce only ⅔ of a unit of clothing (which requires ⅔ × 4 hours of labor) and then trade that ⅔ clothing unit for 1 unit of American food. The total European labor needed to obtain the bundle of consumption is then 4 + 2⅔ = 6⅔, which represents an

Eye Therapies Exhibit 2127, 366 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

increase in real wages of about 5 percent over the no-trade situation.

When countries concentrate on their areas of comparative advantage under free trade, each country is better off. Compared to a no-trade situation, workers in each region can obtain a larger quantity of consumer goods for the same amount of work when they specialize in their areas of comparative advantage and trade their own production for goods in which they have a relative disadvantage.

Outsourcing as Another Kind of Trade

Recently, Americans have become concerned about outsourcing (sometimes also called "offshoring"). What exactly is the issue here? *Outsourcing* refers to locating services or production processes abroad. Prominent examples are telemarketing, medical diagnostics, publishing, web development, and engineering. These differ from the more conventional international trade in goods because they relate to services that were expensive to locate in foreign countries in an earlier era, whereas today, with rapid and low-cost communication, such processes can be economically located where costs are lower. Just as low-cost ocean shipping made possible greater international trade in grains in the nineteenth century, low-cost communication makes it possible to have Indian architects work on designs for New York firms today.

Many economists respond to outsourcing by arguing that it is just an extension of the principle of comparative advantage to more sectors. For example, when he was G. W. Bush's chief economist, Greg Mankiw stated, "I think outsourcing is a growing phenomenon, but it's something that we should realize is probably a plus for the economy in the long run." His comment ignited a firestorm of controversy among both Republicans and Democrats, and one political figure called it "Alice in Wonderland economics."

Most economists tend to agree with Mankiw that outsourcing is another example of comparative advantage at work. But there are policy consequences for governments. A careful analysis by Princeton economist (and adviser to Democratic presidents) Alan Blinder suggested the following advice for the country, and perhaps also for today's students:

> Rich countries such as the United States will have to reorganize the nature of work to exploit their big advantage in non-tradable services: they are close to where the money is. That will mean, in part, specializing more in the delivery of services where personal presence is either imperative or highly beneficial. Thus, the U.S. work force of the future will likely have more divorce lawyers and fewer attorneys who write routine contracts, more internists and fewer radiologists, more salespeople and fewer typists. The market system is very good at making adjustments like these, even massive ones. It has done so before and will do so again. But it takes time and can move in unpredictable ways.

GRAPHICAL ANALYSIS OF COMPARATIVE ADVANTAGE

We can use the production-possibility frontier (*PPF*) to expand our analysis of comparative advantage. We will continue with the simple numerical example developed in this chapter, but the theory is equally valid in a competitive world with many different inputs.

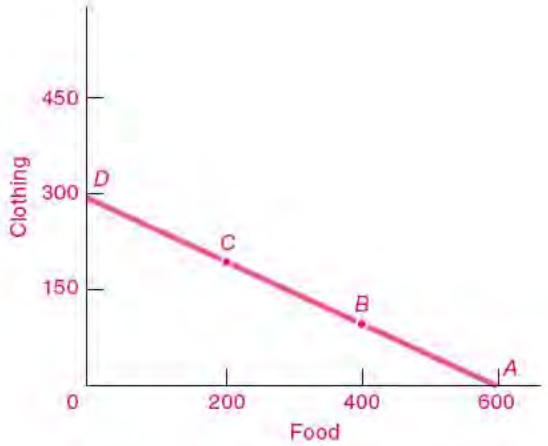
America without Trade

Chapter 1 introduced the *PPF*, which shows the combinations of commodities that can be produced with a society's given resources and technology. Using the production data shown in Table 18-2, and assuming that both Europe and America have 600 units of labor, we can easily derive each region's *PPF*. The table that accompanies Figure 18-1 shows the possible levels of food and clothing that America can produce with its inputs and technology. Figure 18-1 plots the production possibilities; the green line *DA* shows America's *PPF*. The *PPF* has a slope of $-½$, which represents the terms on which food and clothing can be substituted in production. In competitive markets with no international trade, the price ratio of food to clothing will also be one-half.

So far we have concentrated on production and ignored consumption. Note that if America is isolated from all international trade, it can consume only what it produces. Say that, for the incomes and demands in the marketplace, point *B* in Figure 18-1 marks America's production and consumption in the absence of trade. Without trade, America produces and consumes 400 units of food and 100 units of clothing.

We can do exactly the same thing for Europe. But Europe's *PPF* will look different from America's

Eye Therapies Exhibit 2127, 367 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



America's Production-Possibility Schedule
(1-to-2 constant-cost ratio)

Possibilities	Food (units)	Clothing (units)
A	600	0
B	400	100
C	200	200
D	0	300

FIGURE 18-1. American Production Data

The constant-cost line *DA* represents America's domestic production-possibility frontier. America will produce and consume at *B* in the absence of trade.

because Europe has different efficiencies in producing food and clothing. Europe's price ratio is ¾, reflecting the relative cost of food and clothing in that region.

Opening Up to Trade

Now allow trade between the two regions. Food can be exchanged for clothing at some price ratio. We call the ratio of export prices to import prices the **terms of trade.** To indicate the trading possibilities, we put the two *PPF*s together in Figure 18-2. America's green *PPF* shows its domestic production possibilities, while Europe's blue *PPF* shows the terms on which it can domestically substitute food and clothing. Note that Europe's *PPF* is drawn closer to the origin than America's because Europe has lower productivities in both industries; it has an absolute disadvantage in the production of both food and clothing.

Europe need not be discouraged by its absolute disadvantage, however, for it is the difference in relative productivities or comparative advantage that makes trade beneficial. The gains from trade are illustrated by the outer lines in Figure 18-2. If America could trade at Europe's pretrade relative prices, it could produce 600 units of food and move northwest along the outer blue line in Figure 18-2(*a*)—where the blue line represents the price ratio or terms of trade that are generated by Europe's *PPF*. Similarly, if Europe could trade at America's pretrade prices, Europe could specialize in clothing and move southeast along the green line in Figure 18-2(*b*)—where the green line is America's pretrade price ratio.

This leads to an important and surprising conclusion: Small countries have the most to gain from international trade. Small countries affect world prices the least and therefore can trade at world prices that are very different from domestic prices. Additionally, countries that are very different from other countries gain most, while large countries have the least to gain. (These points are raised in question 3 at the end of this chapter.)

Equilibrium Price Ratio. Once trade opens up, some set of prices must hold in the world marketplace depending upon the overall market supplies and demands. Without further information we cannot specify the exact price ratio, but we can determine what the price range will be. The prices must lie somewhere between the prices of the two regions. That is, we know that the relative price of food to clothing must lie somewhere in the range between ½ and ¾.

The final price ratio will depend upon the relative demands for food and clothing. If food were very much in demand, the food price would be relatively high. If food demand were so high that Europe produced food as well as clothing, the price ratio would be that of Europe's pretrade relative prices, or ¾. On the other hand, if clothing demand were so strong that America produced clothing as well as food, the terms of trade would equal America's pretrade price ratio of ½. If each region specializes completely in the area of its comparative advantage, with Europe producing only clothing and America producing only food, the price ratio will lie somewhere between ½ and ¾. The exact ratio will depend on the strength of demand.

Assume now that the demands are such that the final price ratio is ⅔, with 3 units of food selling for

Eye Therapies Exhibit 2127, 368 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

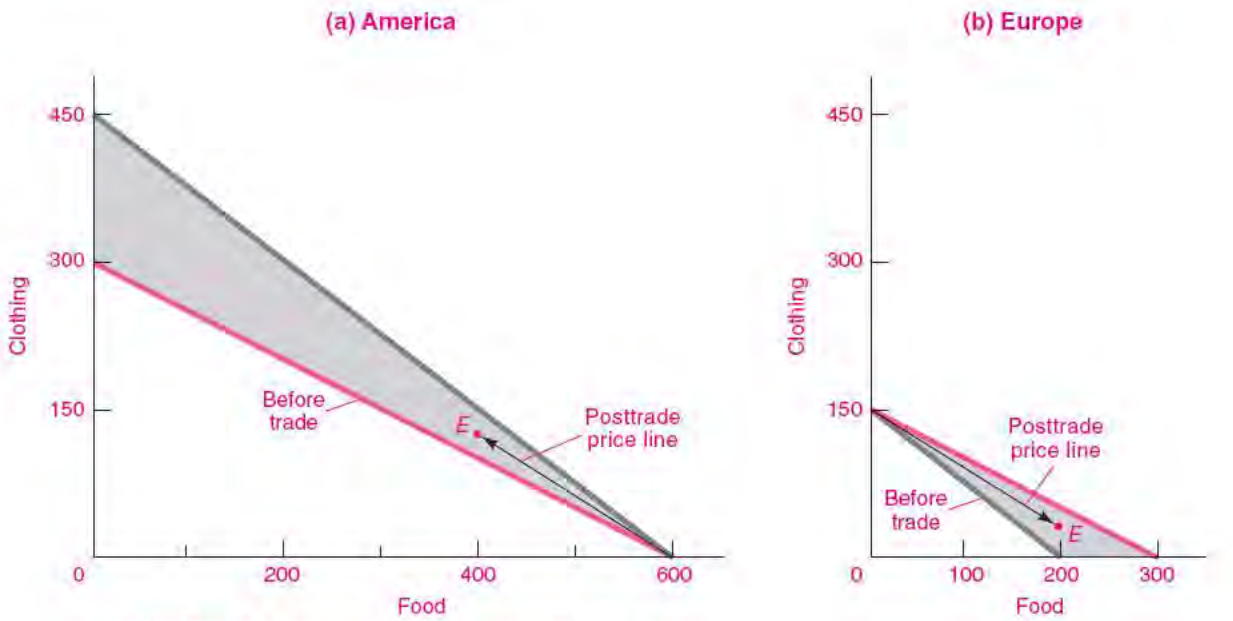


FIGURE 18-2. Comparative Advantage Illustrated

Through trade, both Europe and America improve their available consumption. If no trade is allowed, each region must be satisfied with its own production. It is therefore limited to its production-possibility curve, shown for each region as the line marked "Before trade." After borders are opened and competition equalizes the relative prices of the two goods, the relative-price line will be as shown by the arrows. If each region is faced with prices given by the arrows, can you see why its consumption possibilities must improve?

2 units of clothing. With this price ratio, each region will then specialize—America in food and Europe in clothing—and export some of its production to pay for imports at the world price ratio of ⅔.

Figure 18-2 illustrates how trade will take place. Each region will face a consumption-possibility curve according to which it can produce, trade, and consume. *The consumption-possibility curve begins at the region's point of complete specialization and then runs out at the world price ratio of* ⅔. Figure 18-2(*a*) shows America's consumption possibilities as a thin blue arrow with a slope of −⅔ coming out of its complete-specialization point at 600 units of food and no clothing. Similarly, Europe's posttrade consumption possibilities are shown in Figure 18-2(*b*) by the blue arrow running southeast from its point of complete specialization with a slope of −⅔.

The final outcome is shown by the points *E* in Figure 18-2. At this free-trade equilibrium, Europe specializes in producing clothing and America specializes in producing food. Europe exports 133⅓ units of clothing for 200 units of America's food. Both regions are able to consume more than they could produce alone; both regions have benefited from international trade.

Figure 18-3 illustrates the benefits of trade for America. The green inner line shows the *PPF*, while the blue outer line shows the consumption possibilities at the world price ratio of ⅔. The green arrows show the amounts exported and imported. America ends up at point *B'*. Through trade it moves along the blue line *D'A* just as if a fruitful new invention had pushed out its *PPF*.

The lessons of this analysis are summarized in Figure 18-4. This figure shows the *world* production possibility frontier. The world *PPF* represents the maximum output that can be obtained from the world's resources when goods are produced in the most efficient manner—that is, with the most efficient division of labor and regional specialization.

Eye Therapies Exhibit 2127, 369 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

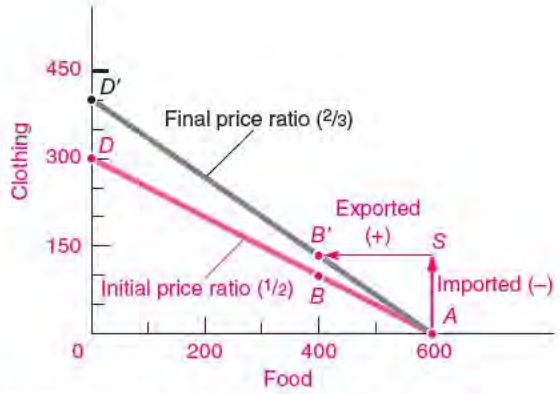


FIGURE 18-3. America before and after Trade

Free trade expands the consumption options of America. The green line *DA* represents America's production-possibility curve; the blue line *D'A* is the new consumption-possibility curve when America is able to trade freely at the price ratio of ⅔ and, in consequence, to specialize completely in the production of food (at *A*). The green arrows from *S* to *B'* and *A* to *S* show the amounts exported (+) and imported (−) by America. As a result of free trade, America ends up at *B'*, with more of both goods available than would be the case if it consumed only what it produced along *DA*.



FIGURE 18-4. Free Trade Allows the World to Move to Its Production-Possibility Frontier

We show here the effect of free trade from the viewpoint of the world as a whole. Before trade is allowed, each region is on its own national *PPF*. Because the no-trade equilibrium is inefficient, the world is inside its *PPF* at point *B*.

Free trade allows each region to specialize in the goods in which it has comparative advantage. As a result of efficient specialization, the world moves out to the efficiency frontier at point *E*.

The world *PPF* is built up from the two regional *PPF*s in Figure 18-2 by determining the maximum level of world output that can be obtained from the individual regional *PPF*s. For example, the maximum quantity of food that can be produced (with no clothing production) is seen in Figure 18-2 to be 600 units in America and 200 units in Europe, for a world maximum of 800 units. This same point (800 food, 0 clothing) is then plotted in the world *PPF* in Figure 18-4. Additionally, we can plot the point (0 food, 450 clothing) in the world *PPF* by inspection of the regional *PPF*s. All the individual points in between can be constructed by a careful calculation of the maximum world outputs that can be produced if the two regions are efficiently specializing in the two goods.

Before opening up borders to trade, the world is at point *B*. This is an inefficient point—inside the world *PPF*—because regions have different levels of relative efficiency in different goods. After opening the borders to trade, the world moves to the free-trade equilibrium at *E*, where countries are specializing in their areas of comparative advantage.

Free trade in competitive markets allows the world to move to the frontier of its production-possibility curve.

EXTENSIONS TO MANY COMMODITIES AND COUNTRIES

The world of international trade consists of more than two regions and two commodities. However, the principles we explained above are essentially unchanged in realistic situations.

Many Commodities

When two regions or countries produce many commodities at constant costs, the goods can be arranged in order according to the comparative advantage or cost of each. For example, the commodities might be microprocessors, computers, aircraft, automobiles, wine, and croissants—all arranged in the comparative-advantage sequence shown in Figure 18-5. As you can see from the figure, of all the commodities, microprocessors are least expensive in America relative to the costs in Europe. Europe has its greatest comparative advantage in croissants. Two decades ago, America was dominant in the commercial-aircraft market, but

Eye Therapies Exhibit 2127, 370 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

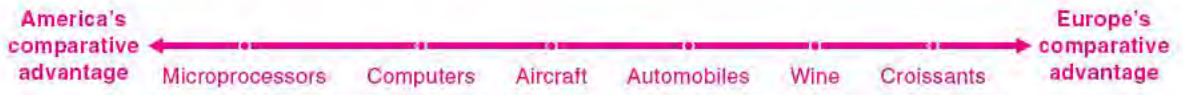


FIGURE 18-5. With Many Commodities, There Is a Spectrum of Comparative Advantages

Europe has now gained a substantial market share, so aircraft have been moving right on the line.

We can be virtually certain that the introduction of trade will cause America to produce and export microprocessors, while Europe will produce and export croissants. But where will the dividing line fall? Between aircraft and automobiles? Or wine and croissants? Or will the dividing line fall on one of the commodities rather than between them? Perhaps automobiles will be produced in both places.

You will not be surprised to find that the answer depends upon the demands and supplies of the different goods. We can think of the commodities as beads arranged on a string according to their comparative advantage; the strength of supply and demand will determine where the dividing line between American and European production will fall. An increased demand for microprocessors and computers, for example, would tend to raise the relative prices of American goods. This shift might lead America to specialize so much more in areas of its comparative advantage that it would no longer be profitable to produce in areas of comparative disadvantage, like automobiles.

Many Countries

What about the case of many countries? Introducing many countries need not change our analysis. As far as a single country is concerned, all the other nations can be lumped together into one group as "the rest of the world." The advantages of trade have no special relationship to national boundaries. The principles already developed apply between groups of countries and, indeed, between regions within the same country. In fact, they are just as applicable to trade between our northern and southern states as to trade between the United States and Canada.

Triangular and Multilateral Trade

With many countries brought into the picture, it will generally be beneficial to engage in *triangular* or *multilateral trade* with many other countries. Bilateral trade between two countries is generally unbalanced.

Consider the simple example of triangular trade flows presented in Figure 18-6, where the arrows show the direction of exports. America buys consumer electronics from Japan, Japan buys oil and primary commodities from developing countries, and developing countries buy computers from America. In reality, trade patterns are more complex than this triangular example.

QUALIFICATIONS AND CONCLUSIONS

We have now completed our look at the elegant theory of comparative advantage. Its conclusions apply for any number of countries and commodities. Moreover, it can be generalized to handle many inputs, changing factor proportions, and diminishing returns. But we cannot conclude without noting two important qualifications to this elegant theory:

1. *Classical assumptions.* From a theoretical point of view, the major defect of comparative-advantage theory lies in its classical assumptions. This theory assumes a smoothly working competitive economy. But trade might lead to worsening environmental problems if there are local or global public goods (see Chapter 14 for a further discussion). Moreover, inefficiencies might arise in the presence of inflexible prices and wages, business cycles, and involuntary unemployment. When there are macroeconomic or microeconomic

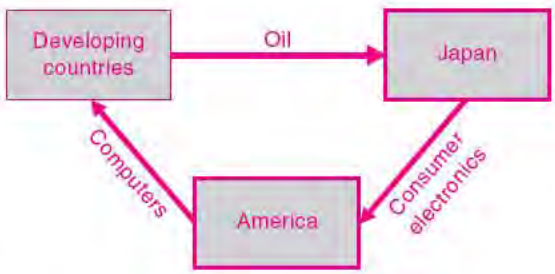


FIGURE 18-6. Triangular Trade Benefits All

In reality, international trade, like domestic trade, is many-sided.

Eye Therapies Exhibit 2127, 371 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

market failures, trade might well push a nation *inside* its *PPF*. When the economy is in depression or the price system malfunctions because of environmental or other reasons, we cannot be sure that countries will gain from trade.

Given these reservations, there can be little wonder that the theory of comparative advantage sells at a big discount during business downturns. In the Great Depression of the 1930s, as unemployment soared and real outputs fell, nations built high tariff walls at their borders and the volume of foreign trade shrank sharply. Additionally, during the prosperous 1990s, free trade was increasingly attacked by environmental advocates, who saw it as a means of allowing companies to dump pollutants in oceans or in countries with lax regulations. Environmentalists were among the leading critics of the latest attempts to promote freer trade (see the section "Negotiating Free Trade" at the end of this chapter).

2. *Income distribution.* A second proviso concerns the impact on particular people, sectors, or factors of production. We showed above that opening a country to trade will raise a country's national income. The country can consume more of all goods and services than would be possible if the borders were sealed to trade.

But this does not mean that *everyone* will benefit from trade, as shown by the Stolper-Samuelson theorem. We can illustrate this theorem using an example. Suppose that America has a relatively skilled labor force, while China has a relatively unskilled labor force. Moreover, suppose that skilled labor is used more heavily in aircraft, while unskilled labor is used more heavily in clothing. Now move from a situation of no trade to a situation of free trade. As in the example, we would expect that America will export aircraft and import clothing. The price of aircraft in America would rise, and the price of clothing would fall.

The interesting point is the impact on labor. As a result of the shift in domestic production, the demand for unskilled labor falls because of the decline in clothing prices and production, while the demand for skilled labor rises because of the rise in aircraft prices and production. In a world of flexible wages, this leads to a decline in the wages of unskilled labor and a rise in the wages of skilled labor in America. More generally, free trade tends to increase the prices of factors that are intensive in exports and to reduce the prices of factors that are intensive in imports. (In a world with inflexible wages, it may lead to unemployment of unskilled workers, as our discussion of macroeconomics shows.)

Recent studies indicate that unskilled workers in high-income countries have suffered reductions in real wages in the last three decades because of the increased imports of goods from low-wage developing countries. Wage losses occur because imports of goods like clothing are produced by unskilled workers in developing countries. In a sense, these workers are close substitutes for the unskilled workers in the clothing industry of high-income countries. The increased international trade in clothing reduces the prices of clothing, and that tends to reduce the wages of unskilled workers in high-income countries.

The theory of comparative advantage shows that other sectors will gain more than the injured sectors will lose. Moreover, over long periods of time, those displaced from low-wage sectors eventually gravitate to higher-wage jobs. But those who are temporarily injured by international trade are genuinely harmed and are vocal advocates for protection and trade barriers.

Notwithstanding its limitations, the theory of comparative advantage is one of the deepest truths in all of economics. Nations that disregard comparative advantage pay a heavy price in terms of their living standards and economic growth.

C. PROTECTIONISM

Go back to the beginning of this chapter and reread the "Petition of the Candle Makers," written by the French economist Frederic Bastiat to satirize solemn proposals to protect domestic goods from imports. Today, people often regard foreign competition with suspicion, and campaigns to "Buy American" sound patriotic.

Yet economists since the time of Adam Smith have marched to a different drummer. Economists generally believe that free trade promotes a mutually beneficial division of labor among nations; free and open trade allows *each* nation to expand its production and consumption possibilities, raising the

Eye Therapies Exhibit 2127, 372 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

world's living standard. Protectionism prevents the forces of comparative advantage from working to maximum advantage.

This section reviews the economic arguments about protectionism.

SUPPLY-AND-DEMAND ANALYSIS OF TRADE AND TARIFFS

Free Trade vs. No Trade

The theory of comparative advantage can be illuminated through the analysis of supply and demand for goods in foreign trade. Consider the clothing market in America. Assume, for simplicity, that America is a small part of the market and therefore cannot affect the world price of clothing. (This assumption will allow us to analyze supply and demand very easily; the more realistic case in which a country can affect world prices will be considered later in this chapter.)

Figure 18-7 shows the supply and demand curves for clothing in America. The demand curve of American consumers is drawn as *DD* and the domestic supply curve of American firms as *SS*. We assume that the price of clothing is determined in the world market and is equal to $4 per unit. Although transactions in international trade are carried out in different currencies, for now we can simplify by converting the foreign supply schedule into a dollar supply curve by using the current exchange rate.

No-Trade Equilibrium. Suppose that transportation costs or tariffs for clothing were prohibitive (say, $100 per unit of clothing). Where would the no-trade equilibrium lie? In this case, the American market for clothing would be at the intersection of *domestic*

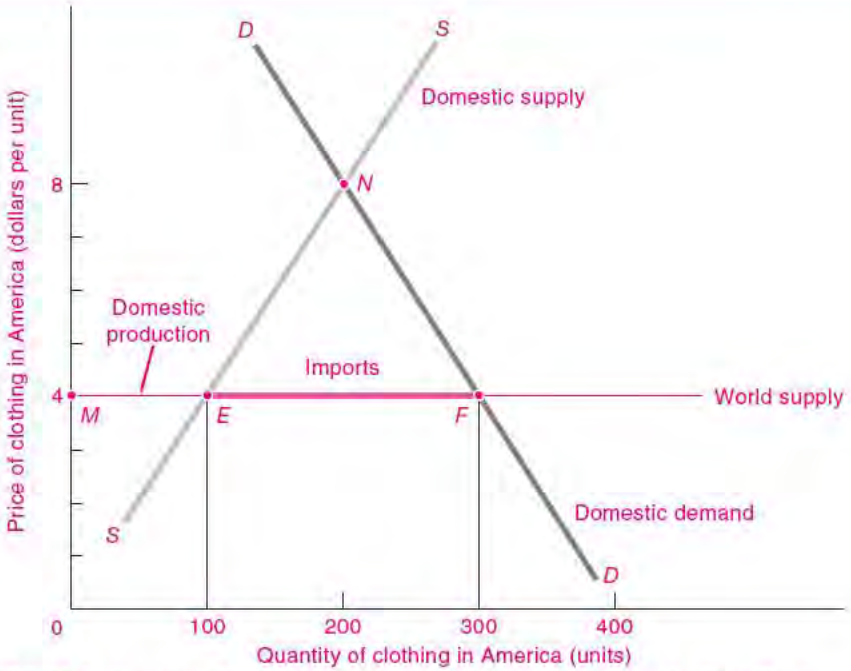


FIGURE 18-7. American Production, Imports, and Consumption under Free Trade

We see here the free-trade equilibrium in the market for clothing. America has a comparative disadvantage in clothing. Therefore, at the no-trade equilibrium at *N*, America's price would be $8, while the world price is $4.

Assuming that American demand does not affect the world price of $4 per unit, the free-trade equilibrium comes when America produces *ME* (100 units) and imports the difference between domestic demand and domestic supply, shown as *EF* (or 200 units).

Eye Therapies Exhibit 2127, 373 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

supply and demand, shown at point *N* in Figure 18-7. At this no-trade point, prices would be relatively high at $8 per unit, and domestic producers would be meeting all the demand.

Free Trade. Now open the American clothing market to international trade. In the absence of transport costs, tariffs, and quotas, the price in America must be equal to the world price. Why? Because if the American price were above the Chinese price, sharp-eyed entrepreneurs would buy where clothing was cheap (China) and sell where clothing was expensive (America); China would therefore export clothing to America. Once trade flows fully adjusted to supplies and demands, the price in America would equal the world price level. (In a world with transportation and tariff costs, the price in America would equal the world price adjusted for these costs.)

Figure 18-7 illustrates how prices, quantities, and trade flows will be determined under free trade in our clothing example. The horizontal line at $4 represents the supply curve for imports; it is horizontal, or perfectly price-elastic, because American demand is assumed to be too small to affect the world price of clothing.

Once trade opens up, imports flow into America, lowering the price of clothing to the world price of $4 per unit. At that level, domestic producers will supply the amount *ME*, or 100 units, while at that price consumers will want to buy 300 units. The difference, shown by the heavy line *EF*, is the amount of clothing imports. Who decided that we would import just this amount of clothing and that domestic producers would supply only 100 units? A Chinese planning agency? A cartel of clothing firms? No, the amount of trade was determined by supply and demand.

Moreover, the level of prices in the no-trade equilibrium determined the direction of the trade flows. America's no-trade prices were higher than China's, so goods flowed into America. Remember this rule: *Under free trade, indeed in markets generally, goods flow uphill from low-price regions to high-price regions.* When markets are opened to free trade, clothing flows uphill from the lower-price Chinese market to the higher-price American market until the price levels are equalized.

Trade Barriers

For centuries, governments have used tariffs and quotas to raise revenues and influence the development of individual industries. Since the eighteenth century—when the British Parliament attempted to impose tariffs on tea, sugar, and other commodities on its American colonies—tariff policy has proved fertile soil for revolution and political struggle.

We can use supply-and-demand analysis to understand the economic effects of tariffs and quotas. To begin with, note that a **tariff** is a tax levied on imports. A **quota** is a limit on the quantity of imports. The United States has quotas on many products, including textiles, watches, and cheeses.

Table 18-3 shows the average tariff rates for major countries in 2003. Note that tariffs vary widely for different goods in most countries. It would take deep study to understand why tariffs on imports of horses are zero while those on asses are 6.8 percent of value in the United States. On the other hand, it does not take much study to understand why textiles and steel have tight quotas or high tariffs, because these are industries with political clout in Congress or the White House.

Country or region	Average tariff rate, 2003 (%)
Hong Kong (China)	0.0
Switzerland	0.0
Japan	3.3
United States	3.9
Canada	4.2
European Union	4.4
Russia	11.3
China	12.0
Mexico	17.3
Pakistan	17.2
India	33.0
Iran	30.0
Average of major groups:	
Low-income countries	5.9
Middle-income countries	14.1

TABLE 18-3. Average Tariff Rates, 2003

Tariff rates vary widely among regions. The United States and regions like Singapore and Hong Kong (China) have low tariff rates today, although there are exceptions such as for textiles and steel. Countries like India and China continue to maintain protectionist trade barriers.

Source: World Trade Organization and government organizations.

Eye Therapies Exhibit 2127, 374 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Prohibitive Tariff. The easiest case to analyze is a *prohibitive tariff*—one that is so high that it chokes off all imports. Looking back at Figure 18-7, what would happen if the tariff on clothing were more than $4 per unit (that is, more than the difference between America's no-trade price of $8 and the world price of $4)? This would be a prohibitive tariff, shutting off all clothing trade. Any importer who buys clothing at the world price of $4 would sell it in America at the no-trade price of $8. But this price would not cover the cost of the good plus the tariff. Prohibitive tariffs thus kill off all trade.

Nonprohibitive Tariff. Lower tariffs (less than $4 per unit of clothing) would injure but not kill off trade. Figure 18-8 shows the equilibrium in the clothing market with a $2 tariff. Again assuming no transportation costs, a $2 tariff means that foreign clothing will sell in America for $6 per unit (equal to the $4 world price plus the $2 tariff).

The equilibrium result of a $2 tariff is that domestic consumption (or quantity demanded) is lowered from 300 units in the free-trade equilibrium to 250 units after the tariff is imposed, the amount of domestic production is raised by 50 units, and the quantity of imports is lowered by 100 units. This example summarizes the economic impact of tariffs:

A tariff will tend to raise price, lower the amounts consumed and imported, and raise domestic production of the covered good.

Quotas. Quotas have the same qualitative effect as tariffs. A prohibitive quota (one that prevents all imports) is equivalent to a prohibitive tariff. The price and quantity would move back to the no-trade equilibrium at *N* in Figure 18-8. A less stringent quota might limit imports to 100 clothing units; this quota would equal the heavy line *HJ* in Figure 18-8. A quota of 100 units would lead to the same equilibrium price and output as did the $2 tariff.

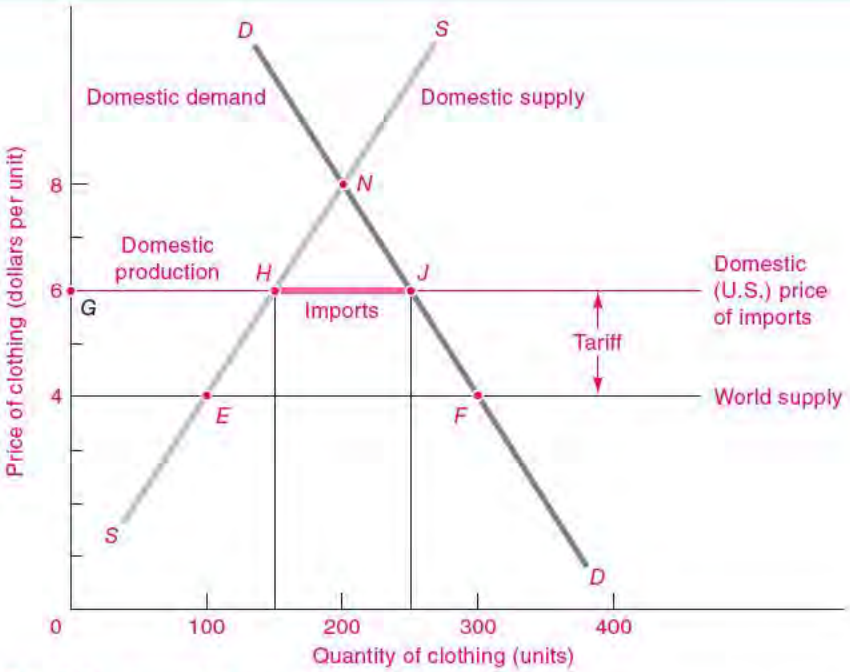


FIGURE 18-8. Effect of a Tariff

A tariff lowers imports and consumption and raises domestic production and price. Starting from the free-trade equilibrium in Fig. 18-7, America now puts a $2 tariff on clothing imports. The price of Chinese clothing imports rises to $6 (including the tariff).

The market price rises from $4 to $6, so the total amount demanded falls. Imports shrink from 200 to 100 units, while domestic production rises from 100 to 150 units.

Eye Therapies Exhibit 2127, 375 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Although there is no essential difference between tariffs and quotas, some subtle differences do exist. A tariff gives revenue to the government, perhaps allowing other taxes to be reduced and thereby offsetting some of the harm done to consumers in the importing country. A quota, on the other hand, puts the profit from the resulting price difference into the pocket of the importers or exporters lucky enough to get a permit or import license. They can afford to use the proceeds to wine, dine, or even bribe the officials who give out import licenses.

Because of these differences, economists generally regard tariffs as the lesser evil. However, if a government is determined to impose quotas, it should auction off the scarce import-quota licenses. An auction will ensure that the government rather than the importer gets the revenue from the scarce right to import; in addition, the bureaucracy will not be tempted to allocate quota rights by bribery, friendship, or nepotism.

Transportation Costs. What of transportation costs? The cost of moving bulky and perishable goods has the same effect as tariffs, reducing the extent of beneficial regional specialization. For example, if it costs $2 per unit to transport clothing from China to the United States, the supply-and-demand equilibrium would look just like Figure 18-8, with the American price $2 above the Chinese price.

But there is one difference between protection and transportation costs: Transport costs are imposed by nature—by oceans, mountains, and rivers—whereas restrictive tariffs are squarely the responsibility of nations. Indeed, one economist called tariffs "negative railroads." Imposing a tariff has the same economic impact as throwing sand in the engines of vessels that transport goods to our shores from other lands.

The Economic Costs of Tariffs

What happens when America puts a tariff on clothing, such as the $2 tariff shown in Figure 18-8? There are three effects: (1) The domestic producers, operating under a price umbrella provided by the tariff, can expand production; (2) consumers are faced with higher prices and therefore reduce their consumption; and (3) the government gains tariff revenue.

Tariffs create economic inefficiencies. When tariffs are imposed, the economic loss to consumers exceeds the revenue gained by the government plus the extra profits earned by producers.

Diagrammatic Analysis. Figure 18-9 shows the economic cost of a tariff. The supply and demand curves are identical to those in Figure 18-8, but three areas are highlighted. (1) Area *B* is the tariff revenue collected by the government. It is equal to the amount of the tariff times the units of imports and totals $200. (2) The tariff raises the price in domestic markets from $4 to $6, and producers increase their output to 150. Hence total profits rise by $250, shown by area *LEHM* and equal to $200 on old units plus an additional $50 on the 50 new units. (3) Finally, note that a tariff imposes a heavy cost on consumers. The total consumer-surplus loss is given by area *LMJF* and is equal to $550.

The overall social impact is, then, a gain to producers of $250, a gain to the government of $200, and a loss to consumers of $550. The net social cost (counting each of these dollars equally) is therefore $100. We can reckon this as equal to the sum of *A* and *C*. The interpretation of these areas is important:

- Area *A* is the net loss that comes because domestic production is more costly than foreign production. When the domestic price rises, businesses are thereby induced to increase the use of relatively costly domestic capacity. They produce output up to the point where the marginal cost is $6 per unit instead of up to $4 per unit under free trade. Firms reopen inefficient old factories or work existing factories extra shifts. From an economic point of view, these plants have a comparative disadvantage because the new clothing produced by these factories could be produced more cheaply abroad. The new social cost of this inefficient production is area *A*, equal to $50.
- In addition, there is a net loss to the country from the higher price, shown by area *C*. This is the loss in consumer surplus that cannot be offset by business profits or tariff revenue. This area represents the economic cost incurred when consumers shift their purchases from low-cost imports to high-cost domestic goods. This area is also equal to $50.

Hence, the total social loss from the tariff is $100, calculated either way.

Eye Therapies Exhibit 2127, 376 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

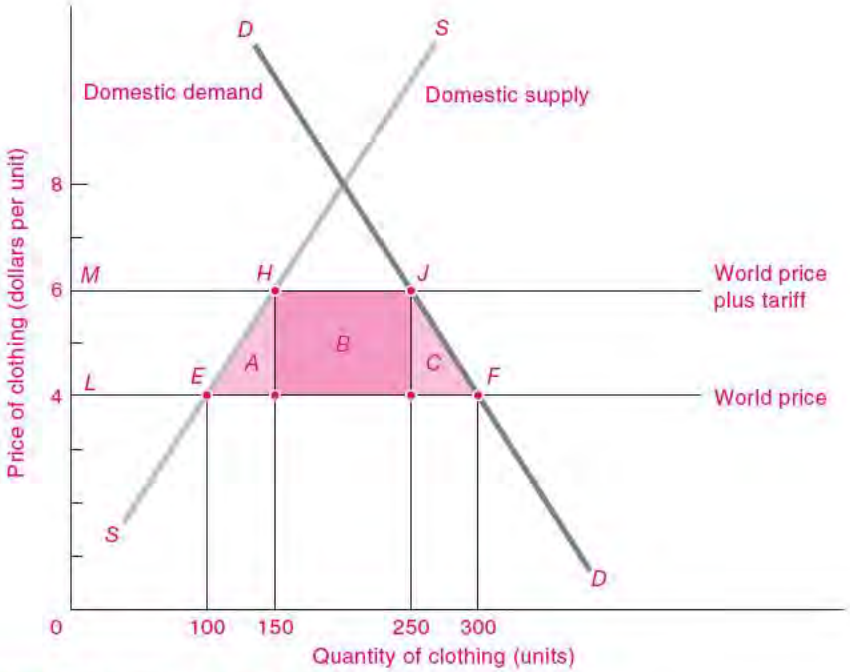


FIGURE 18-9. Economic Cost of a Tariff

Imposing a tariff raises revenues and leads to inefficiency. We see the impact of the tariff as three effects. Rectangle *B* is the tariff revenue gained by the government. Triangle *A* is the excess cost of production by firms producing under the umbrella of the tariff. Triangle *C* is the net loss in consumer surplus from the inefficiently high price. Areas *A* and *C* are the irreducible inefficiencies caused by the tariff.

Figure 18-9 illustrates one feature that is important in understanding the politics and history of tariffs. When a tariff is imposed, part of the economic impact comes because tariffs redistribute income from consumers to the protected domestic producers and workers. In the example shown in Figure 18-9, areas *A* and *C* represent efficiency losses from inefficiently high domestic production and inefficiently low consumption, respectively. Under the simplifying assumptions used above, the efficiency losses sum up to $100. The redistribution involved is much larger, however, equaling $200 raised in tariff revenues levied upon consumers of the commodity plus $250 in higher profits. Consumers will be unhappy about the higher product cost, while domestic producers and workers in those firms will benefit. We can see why battles over import restrictions generally center more on the redistributive gains and losses than on the issues of economic efficiency.

Imposing a tariff has three effects: It encourages inefficiently high domestic production; it raises prices, thus inducing consumers to reduce their purchases of the tariffed good below efficient levels; and it raises revenues for the government. Only the first two of these necessarily impose efficiency costs on the economy.



The Cost of Textile Protection

Let's flesh out this analysis by examining the effects of a particular tariff, one on clothing. Today, tariffs on imported textiles and apparel are among the highest levied by the United States. How do these high tariffs affect consumers and producers?

To begin with, the tariffs raise domestic clothing prices. Because of the higher prices, many factories, which would otherwise be bankrupt in the face of a declining comparative advantage in textiles, remain open. They are just barely

Eye Therapies Exhibit 2127, 377 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

profitable, but they manage to eke out enough sales to continue domestic production. Domestic employment in textiles exceeds the free-trade situation, although—because of pressure from foreign competition—textile wages are among the lowest of any manufacturing industry.

From an economic point of view, the nation is wasting resources in textiles. These workers, materials, and capital would be more productively used in other sectors—perhaps in aircraft or financial services or Internet commerce. The nation's productive potential is lower because it keeps factors of production working in an industry in which it has lost its comparative advantage.

Consumers, of course, pay for this protection of the textile industry with higher prices. They get less satisfaction from their incomes than they would if they could buy textiles from Korea, China, or Indonesia at prices that exclude the high tariffs. Consumers are induced to cut back on their clothing purchases, channeling funds into food, transportation, and recreation, whose relative prices are lowered by the tariffs.

Finally, the government gets revenues from tariffs on textiles. These revenues can be used to buy public goods or to reduce other taxes, so (unlike the consumer loss or the productive inefficiency) this effect is not a real social burden.

THE ECONOMICS OF PROTECTIONISM

Having examined the impact of tariffs on prices and quantities, we now turn to an analysis of the arguments for and against protectionism. The arguments for tariff or quota protection against the competition of foreign imports take many different forms. Here are the main categories: (1) noneconomic arguments that suggest it is desirable to sacrifice economic welfare in order to subsidize other national objectives, (2) arguments that are based on a misunderstanding of economic logic, and (3) analyses that rely on market power or macroeconomic imperfections.

Noneconomic Goals

If you are ever on a debating team given the assignment of defending free trade, you will strengthen your case at the beginning by conceding that there is more to life than economic welfare. A nation surely should not sacrifice its liberty, culture, and human rights for a few dollars of extra income.

The U.S. semiconductor industry provides a useful example here. In the 1980s, the Defense Department claimed that without an independent semiconductor industry, the military would become excessively dependent on Japanese and other foreign suppliers for chips to use in high-technology weaponry. This led to an agreement to protect the industry. Economists were skeptical about the value of this approach. Their argument did not question the goal of national security. Rather, it focused on the efficiency of the means of achieving the desired result. They thought that protection was more expensive than a policy targeting the domestic industry, perhaps a program to buy a minimum number of high-quality chips.

National security is not the only noneconomic goal in trade policy. Countries may desire to preserve their cultural traditions or environmental conditions. France argued that its citizens need to be protected from "uncivilized" American movies. The fear is that the French film industry could be drowned by the new wave of stunt-filled, high-budget Hollywood thrillers. As a result, France has maintained strict quotas on the number of U.S. movies and television shows that can be imported.

Unsound Grounds for Tariffs

Mercantilism. To Abraham Lincoln has been attributed the remark, "I don't know much about the tariff. I do know that when I buy a coat from England, I have the coat and England has the money. But when I buy a coat in America, I have the coat and America has the money."

This reasoning represents an age-old fallacy typical of the so-called mercantilist writers of the seventeenth and eighteenth centuries. They considered a country fortunate which sold more goods than it bought, because such a "favorable" balance of trade meant that gold would flow into the country to pay for its export surplus.

The mercantilist argument confuses means and ends. Accumulating gold or other monies will not improve a country's living standard. Money is worthwhile not for its own sake but for what it will buy from other countries. Most economists today therefore reject the idea that raising tariffs to run a trade surplus will improve a country's economic welfare.

Tariffs for Special Interests. The single most important source of pressure for protective tariffs is powerful

Eye Therapies Exhibit 2127, 378 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

special-interest groups. Firms and workers know very well that a tariff on their particular products will help *them* even if it imposes costs on others. Adam Smith understood this point well when he wrote:

> To expect freedom of trade is as absurd as to expect Utopia. Not only the prejudices of the public, but what is much more unconquerable, the private interests of many individuals, irresistibly oppose it.

If free trade is so beneficial to the nation as a whole, why do the proponents of protectionism continue to wield such a disproportionate influence on legislatures? The few who benefit gain much from specific protection and therefore devote large sums to lobbying politicians. By contrast, individual consumers are only slightly affected by the tariff on one product; because losses are small and widespread, individuals have little incentive to spend resources expressing an opinion on every tariff case. A century ago, outright bribery was used to buy the votes necessary to pass tariff legislation. Today, powerful political action committees (PACs), financed by labor or business, round up lawyers and drum up support for tariffs or quotas on textiles, lumber, steel, sugar, and other goods.

If political votes were cast in proportion to total economic benefit, nations would legislate most tariffs out of existence. But each dollar of economic interests does not get proportional representation. It is much harder to persuade consumers about the benefits of free trade than it is to organize a few companies or labor unions to argue against "cheap Chinese labor." In every country, the special interests of protected firms and workers are the tireless enemies of free trade.

A dramatic case is the U.S. quota on sugar, which benefits a few producers while costing American consumers over $1 billion a year. The average consumer is probably unaware that the sugar quota costs about a penny a day per person, so there is little incentive to lobby for free trade in sugar.

Competition from Cheap Foreign Labor. Of all the arguments for protection, the most persistent is that free trade exposes U.S. workers to competition from low-wage foreign labor. The only way to preserve high U.S. wages, so the argument goes, is to protect domestic workers by keeping out or putting high tariffs on goods produced in low-wage countries. An extreme version of this contention is that under free trade U.S. wages would decline to the low level of foreign wages. This point was trumpeted by presidential candidate Ross Perot during the debates over the North American Free Trade Agreement (NAFTA) when he argued:

> Philosophically, [NAFTA] is wonderful, but realistically it will be bad for our country. That thing is going to create a giant sucking sound in the United States at a time when we need jobs coming in, not jobs going out. Mexican wages will come up to $7½ an hour and our wages will come down to $7½ an hour.

This argument sounds plausible, but it is all wrong because it ignores the principle of comparative advantage. The reason American workers have higher wages is that they are on average more productive. If America's wage is 5 times that in Mexico, it is because the marginal product of American workers is on average 5 times that of Mexican workers. Trade flows according to comparative advantage, not wage rates or absolute advantage.

Having shown that the nation gains from importing the goods produced by "cheap foreign labor" in which it has a comparative disadvantage, we should not ignore the impacts that trade may have on particular firms and workers. Remember the Stolper-Samuelson theorem explained above. If America has a comparative disadvantage in industries like textiles or toys, and these industries are intensive in unskilled labor, reducing trade barriers will tend to reduce the wages of unskilled labor in America. There may also be temporary effects on workers whose wages drop while they look for alternative jobs. The difficulties of displaced workers will be greater when the overall economy is depressed or when the local labor markets have high unemployment. Over the long run, labor markets will reallocate workers from declining to advancing industries, but the transition may be costly for many people.

In summary:

The cheap-foreign-labor argument is flawed because it ignores the theory of comparative advantage. A country will benefit from trade even though its wages are far above those of its trading partners. High wages come from high efficiency, not from tariff protection.

Eye Therapies Exhibit 2127, 379 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Retaliatory Tariffs. While many people would agree that a world of free trade would be the best of all possible worlds, they note that this is not the world we live in. They reason, "As long as other countries impose import restrictions or otherwise discriminate against our products, we have no choice but to play the protection game in self-defense. We'll go along with free trade only as long as it is fair trade. But we insist on a level playing field." On several occasions in the 1990s, the United States went to the brink of trade wars with Japan and China, threatening high tariffs if the other country did not stop some objectionable trade practice.

Those who advocate this approach argue that it can beat down the walls of protectionism in other countries. This rationale was described in an analysis of protection in the *Economic Report of the President:*

> Intervention in international trade . . . even though costly to the U.S. economy in the short run, may, however, be justified if it serves the strategic purpose of increasing the cost of interventionist policies by foreign governments. Thus, there is a potential role for carefully targeted measures . . . aimed at convincing other countries to reduce their trade distortions.

While potentially valid, this argument should be used with great caution. Just as threatening war leads to armed conflict as often as to arms control, protectionist bluffs may end up hurting the bluffer as well as the opponent. Historical studies show that retaliatory tariffs usually lead other nations to raise their tariffs still higher and are rarely an effective bargaining chip for multilateral tariff reduction.

Import Relief. In the United States and other countries, firms and workers that are injured by foreign competition attempt to get protection in the form of tariffs or quotas. Today, relatively little direct tariff business is conducted on the floor of Congress. Congress realized that tariff politics was too hot to handle and has set up specialized agencies to investigate and rule on complaints. Generally, a petition for relief is analyzed by the U.S. Department of Commerce and the U.S. International Trade Commission. Relief measures include the following actions:

- The *escape clause* was popular in earlier periods. It allows temporary import relief (tariffs, quotas, or export quotas negotiated with other countries) when an industry has been "injured" by imports. Injury occurs when the output, employment, and profits in a domestic industry have fallen while imports have risen.
- *Antidumping tariffs* are levied when foreign countries sell in the United States at prices below average costs or at prices lower than those in the home market. When dumping is found, a "dumping duty" is placed on the imported good.
- *Countervailing duties* are imposed to offset the cost advantage for imports that arises when foreigners subsidize exports to the United States. They have become the most popular form of import relief and have been pursued in hundreds of cases.

What is the justification for such measures? Import relief sounds reasonable, but it actually is completely counter to the theory of comparative advantage. That theory says that an industry which cannot compete with foreign firms ought to be injured by imports. *From an economic vantage point, less productive industries are actually being killed off by the competition of more productive domestic industries.*

This sounds ruthless indeed. No industry willingly dies. No region gladly undergoes conversion to new industries. Often the shift from old to new industries involves considerable unemployment and hardship. The weak industry and region feel they are being singled out to carry the burden of progress.

Potentially Valid Arguments for Protection

Finally, we can consider three arguments for protection that may have true economic merit:

- Tariffs may shift the terms of trade in a country's favor.
- Temporary tariff protection for an "infant industry" with growth potential may be efficient in the long run.
- A tariff may under certain conditions help reduce unemployment.

The Terms-of-Trade or Optimal-Tariff Argument. One valid argument for imposing tariffs is that doing so will shift the terms of trade in a country's favor and against foreign countries. The phrase *terms of trade* refers to the ratio of export prices to import prices. The idea is that when a large country levies tariffs on its imports, the reduced demand for the good in world markets will lower the equilibrium price and thereby reduce the pretariff cost of the

Eye Therapies Exhibit 2127, 380 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

good to the country. Such a change will improve the country's terms of trade and increase domestic real income. The set of tariffs that maximizes domestic real income is called the *optimal tariff*.

The terms-of-trade argument goes back over 150 years to the free-trade proponent John Stuart Mill. It is the only argument for tariffs that is valid under conditions of full employment and perfect competition. Suppose that the U.S. imposes an "optimal" tariff on imported oil. The tariff will increase the price of domestic oil and will reduce the world demand for oil. The world market price of oil will therefore be bid down. So part of the tariff actually falls on the oil producer. (We can see that a very small country could not use this argument, since it cannot affect world prices.)

Have we not therefore found a theoretically secure argument for tariffs? The answer would be yes if we could forget that this is a "begger-thy-neighbor" policy and could ignore the reactions of other countries. But other countries are likely to react. After all, if the United States were to impose an optimal tariff of 30 percent on its imports, why should the European Union and Japan not put 30 or 40 percent tariffs on their imports? In the end, as every country calculated and imposed its own nationalistic optimal tariff, the overall level of tariffs might spiral upward in the tariff version of an arms race.

Ultimately, such a situation would surely not represent an improvement of either world or individual economic welfare. When all countries impose optimal tariffs, it is likely that *everyone's* economic welfare will decline as the impediments to free trade become larger. All countries are likely to benefit if all countries abolish trade barriers.

Tariffs for Infant Industries. In his famous *Report on Manufactures* (1791), Alexander Hamilton proposed to encourage the growth of manufacturing by protecting "infant industries" from foreign competition. According to this doctrine, which received the cautious support of free-trade economists like John Stuart Mill and Alfred Marshall, there are lines of production in which a country could have a comparative advantage if only they could get started.

Such infant industries would not be able to survive the rough treatment by larger bullies in the global marketplace. With some temporary nurturing, however, they might grow up to enjoy economies of mass production, a pool of skilled labor, inventions well adapted to the local economy, and the technological efficiency typical of many mature industries. Although protection will raise prices to the consumer at first, the mature industry would become so efficient that cost and price would actually fall. A tariff is justified if the benefit to consumers at that later date would be more than enough to make up for the higher prices during the period of protection.

This argument must be weighed cautiously. Historical studies have turned up some genuine cases of protected infant industries that grew up to stand on their own feet. And studies of successful newly industrialized countries (such as Singapore and Taiwan) show that they have often protected their manufacturing industries from imports during the early stages of industrialization. But subsidies will be a more efficient and transparent way of nurturing young industries. In fact, the history of tariffs reveals many cases like steel, sugar, and textiles in which perpetually protected infants have not shed their diapers after these many years.



Brazil's Tragic Protection of Its Computer Industry

Brazil offers a striking example of the pitfalls of protectionism. In 1984, Brazil passed a law actually banning most foreign computers. The idea was to provide a protected environment in which Brazil's own infant computer industry could develop. The law was vigorously enforced by special "computer police" who would search corporate offices and classrooms looking for illegal imported computers.

The results were startling. Technologically, Brazilian-made computers were years behind the fast-moving world market, and consumers paid 2 or 3 times the world price—when they could get them at all. At the same time, because Brazilian computers were so expensive, they could not compete on the world market, so Brazilian computer companies could not take advantage of economies of scale by selling to other countries. The high price of computers hurt competitiveness in the rest of the economy as well. "We are effectively very backward because of this senseless nationalism," said Zelia Cardoso de Mello, Brazil's economy minister in 1990. "The computer problem effectively blocked Brazilian industry from modernizing."

The combination of pressure from Brazilian consumers and businesses and U.S. demands for open markets

Eye Therapies Exhibit 2127, 381 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

forced Brazil to drop the ban on imported computers in 1992. Within a year, electronics stores in São Paulo and Rio de Janeiro were filled with imported laptop computers, laser printers, and cellular telephones, and Brazilian companies could begin to exploit the computer revolution. Each country and each generation learns anew the lessons of comparative advantage.

Tariffs and Unemployment. Historically, a powerful motive for protection has been the desire to increase employment during a period of recession or stagnation. Protection creates jobs by raising the price of imports and diverting demand toward domestic production; Figure 18-8 demonstrates this effect. As domestic demand increases, firms will hire more workers and unemployment will fall. This too is a beggar-thy-neighbor policy, for it raises domestic demand at the expense of output and employment in other countries.

However, while economic protection may raise employment, it does not constitute an effective program to pursue high employment, efficiency, and stable prices. Macroeconomic analysis shows that there are better ways of reducing unemployment than by imposing import protection. By the appropriate use of monetary and fiscal policy, a country can increase output and lower unemployment. Moreover, the use of general macroeconomic policies will allow workers displaced from low-productivity jobs in industries losing their comparative advantage to move to high-productivity jobs in industries enjoying a comparative advantage.

This lesson was amply demonstrated in the 1990s. From 1991 to 1999, the United States created 16 million net new jobs while maintaining open markets and low tariffs; its trade deficit increased sharply during this period. By contrast, the countries of Europe created virtually no new jobs while moving toward a position of trade surpluses.

Tariffs and import protection are an inefficient way to create jobs or to lower unemployment. A more effective way to increase productive employment is through domestic monetary and fiscal policy.

Other Barriers to Trade

While this chapter has mainly spoken of tariffs, most points apply equally well to any other impediments to trade. Quotas have much the same effects as tariffs, for they prevent the comparative advantages of different countries from determining prices and outputs in the marketplace. In recent years, countries have negotiated quotas with other countries. The United States, for example, forced Japan to put "voluntary" export quotas on automobiles and negotiated similar export quotas on televisions, shoes, and steel.

We should also mention the so-called nontariff barriers (or NTBs). These consist of informal restrictions or regulations that make it difficult for countries to sell their goods in foreign markets. For example, American firms complained that Japanese regulations shut them out of the telecommunications, tobacco, and construction industries.

How important are the nontariff barriers relative to tariffs? Economic studies indicate that nontariff barriers were actually more important than tariffs during the 1960s; in recent years, they have effectively doubled the protection found in the tariff codes. In a sense, nontariff barriers have been substitutes for more conventional tariffs as the latter have been reduced.

MULTILATERAL TRADE NEGOTIATIONS

Given the tug-of-war between the economic benefits of free trade and the political appeal of protection, which force has prevailed? The history of U.S. tariffs, shown in Figure 18-10, has been bumpy. For most of American history, the United States was a high-tariff nation. The pinnacle of protectionism came after the infamous Smoot-Hawley tariff of 1930, which was opposed by virtually every American economist yet sailed through Congress.

The trade barriers erected during the Great Depression helped raise prices and exacerbated economic distress. In the trade wars of the 1930s, countries attempted to raise employment and output by raising trade barriers at the expense of their neighbors. Nations soon learned that at the end of the tariff-retaliation game, all were losers.

Negotiating Free Trade

At the end of World War II, the international community established a number of institutions to promote peace and economic prosperity through cooperative policies.

Eye Therapies Exhibit 2127, 382 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

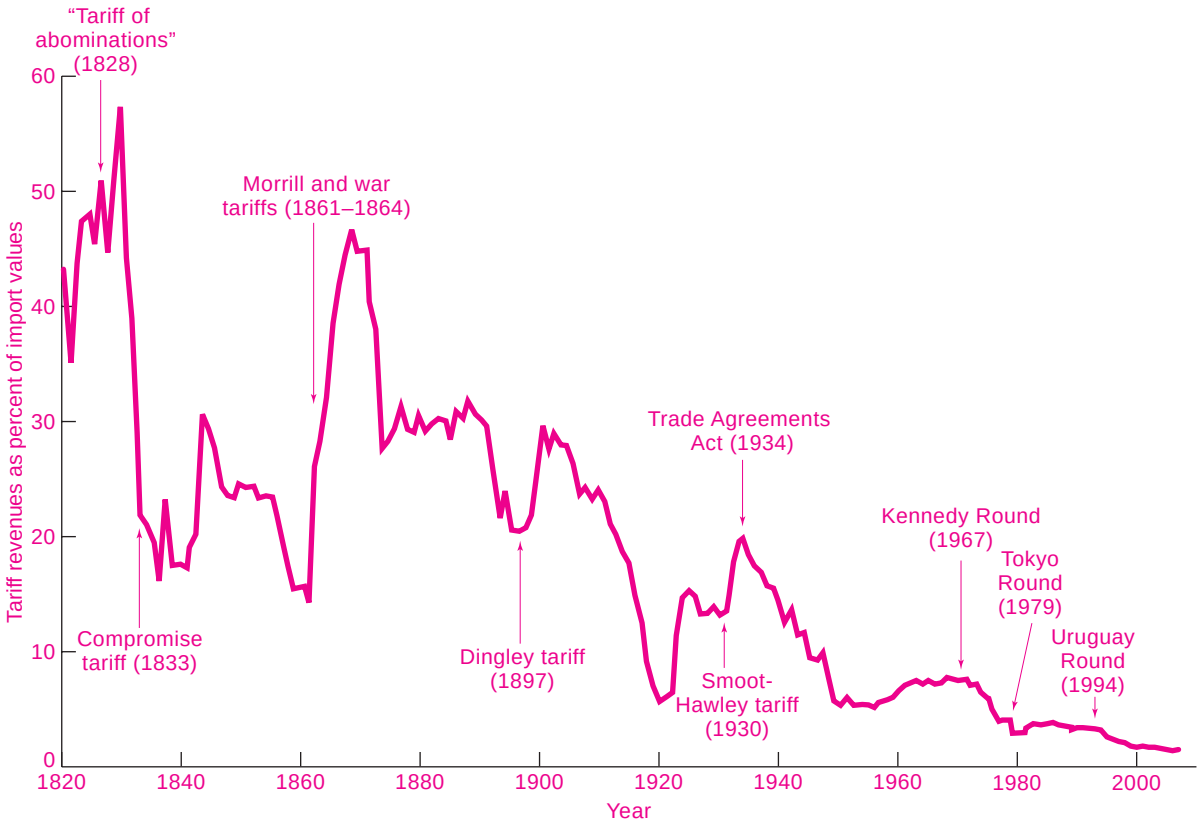


FIGURE 18-10. America Was Historically a High-Tariff Nation

Tariffs were high for most of our nation's history, but trade negotiations since the 1930s have lowered tariffs significantly.

Multilateral Agreements. One of the most successful multilateral agreements was the General Agreement on Tariffs and Trade (GATT). Its provisions were incorporated into the World Trade Organization (WTO) at the beginning of 1995. Their charters speak of raising living standards through "substantial reduction of tariffs and other barriers to trade and the elimination of discriminatory treatment in international commerce." As of 2008, the WTO had 153 member countries, which accounted for 90 percent of international trade.

Among the principles underlying the WTO are (1) countries should work to lower trade barriers; (2) all trade barriers should be applied on a nondiscriminatory basis across nations (i.e., all nations should enjoy "most-favored-nation" status); (3) when a country increases its tariffs above agreed-upon levels, it must compensate its trading partners for the economic injury; and (4) trade conflicts should be settled by consultations and arbitration.

Multilateral trade negotiations successfully lowered trade barriers in the half-century following World War II. The latest successful negotiations were the Uruguay Round, which included 123 countries and was completed in 1994. In 2001, countries launched a new round in Doha, Qatar. Among the items on the agenda are agriculture, intellectual property rights, and the environment. The new negotiations have been controversial both among developing countries, which believe that the rich countries are protecting agriculture too heavily, and among antiglobalization groups, which argue that growing trade is hurting the environment. In the face of deep divisions, the Doha Round has made no progress as of 2008.

Eye Therapies Exhibit 2127, 383 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Regional Approaches. Over the last few years, governments have taken a number of steps to promote free trade or to broaden regional markets. Among the most important were the following.

The most controversial proposal for lowering trade barriers was the North American Free Trade Agreement (NAFTA), which was hotly debated and passed by Congress by a close vote in 1993. Mexico is the third-largest trading partner of the United States, and most U.S.-Mexico trade is in manufactured goods. NAFTA not only allows goods to pass tariff-free across the borders but also liberalizes regulations on investments by the United States and Canada in Mexico. Proponents of the plan argued that it would allow a more efficient pattern of specialization and would enable U.S. firms to compete more effectively against firms in other countries; opponents, particularly labor groups, argued that it would increase the supply of goods produced by low-skilled labor and thereby depress the wages of workers in the affected industries.

Economists caution, however, that regional trading agreements like NAFTA can cause inefficiency if they exclude potential trading countries. They point to the stagnation in the Caribbean countries, which were excluded from the free-trade provisions of NAFTA, as a cautionary example of the dangers of the regional approach.

The most far-reaching trade accord has been the movement toward a single market among the major European countries. Since World War II, the nations of the European Union (EU) have developed a common market with minimal barriers to international trade or movement of factors of production. The first step involved eliminating all internal tariff and regulatory barriers to trade and labor and capital flows. The most recent step was the introduction of a common currency (the Euro) for most of the members of the EU. European unification is one of history's most eloquent tributes to the power of an idea—the idea that free and open trade promotes economic efficiency and technological advance.

Appraisal

After World War II, policymakers around the world believed firmly that free trade was essential for world prosperity. These convictions translated into several successful agreements to lower tariffs, as Figure 18-10 shows. The free-trade philosophy of economists and market-oriented policymakers has been severely tested by periods of high unemployment, by exchange-rate disturbances, and recently by antiglobalization forces. Nevertheless, most countries have continued the trend toward increased openness and outward orientation.

Economic studies generally show that countries have benefited from lower trade barriers as trade flows and living standards have grown. But the struggle to preserve open markets is constantly tested as the political and economic environment changes.



SUMMARY

A. The Nature of International Trade

1. Specialization, division of labor, and trade increase productivity and consumption possibilities. The gains from trade hold among nations as well as within a nation. Engaging in international exchange is more efficient than relying only on domestic production. International trade differs from domestic trade because it broadens the market, because trade takes place among sovereign nations, and because countries usually have their own monies which must be converted using foreign exchange rates.
2. Diversity is the fundamental reason that nations engage in international trade. Within this general principle, we see that trade occurs (*a*) because of differences in the conditions of production, (*b*) because of decreasing costs (or economies of scale), and (*c*) because of diversity in tastes.

B. Comparative Advantage among Nations

3. Recall that trade occurs because of differences in the conditions of production or diversity in tastes. The foundation of international trade is the Ricardian principle of comparative advantage. The principle of comparative advantage holds that each country will benefit if it specializes in the production and export of those goods that it can produce at relatively low cost.

Eye Therapies Exhibit 2127, 384 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Conversely, each country will also benefit if it imports those goods which it produces at relatively high cost. This principle holds even if one region is absolutely more or less productive than another in all commodities. As long as there are differences in *relative* or *comparative* efficiencies among countries, every country must enjoy a comparative advantage or a comparative disadvantage in the production of some goods.

4. The law of comparative advantage predicts more than just the geographic pattern of specialization and the direction of trade. It also demonstrates that countries are made better off and that real wages (or, more generally, total national income) are improved by trade and the resulting enlarged world production. Quotas and tariffs, designed to "protect" workers or industries, will lower a nation's total income and consumption possibilities.
5. Even with many goods or many countries, the same principles of comparative advantage apply. With many commodities, we can arrange products along a continuum of comparative advantage, from relatively more efficient to relatively less efficient. With many countries, trade may be triangular or multilateral, with countries having large bilateral (or two-sided) surpluses or deficits with other individual countries.

C. Protectionism

6. Completely free trade equalizes prices of tradeable goods at home with those in world markets. Under trade, goods flow uphill from low-price to high-price markets.
7. A tariff raises the domestic prices of imported goods, leading to a decline in consumption and imports along with an increase in domestic production. Quotas have very similar effects and may, in addition, lower government revenues.
8. A tariff causes economic waste. The economy suffers losses from decreased domestic consumption and from the wasting of resources on goods lacking comparative advantage. The losses generally exceed government revenues from the tariff.
9. Most arguments for tariffs simply rationalize special benefits to particular pressure groups and cannot withstand economic analysis. Three arguments that can stand up to careful scrutiny are the following: (*a*) The terms-of-trade or optimal tariff can in principle raise the real income of a large country at the expense of its trading partners. (*b*) In a situation of less-than-full employment, tariffs might push an economy toward fuller employment, but monetary or fiscal policies could attain the same employment goal with fewer inefficiencies than this beggar-thy-neighbor policy. (*c*) Sometimes, infant industries may need temporary protection in order to realize their true long-run comparative advantages.
10. The principle of comparative advantage must be qualified if markets malfunction because of unemployment or exchange-market disturbances. Moreover, individual sectors or factors may be injured by trade if imports lower their returns. Opening up to trade may hurt the factors that are most embodied in imported goods.

CONCEPTS FOR REVIEW

Principles of International Trade

absolute and comparative advantage (or disadvantage)
principle of comparative advantage
economic gains from trade
triangular and multilateral trade
world vs. national *PPF*s
consumption vs. production possibilities with trade
Stolper-Samuelson theorem

Economics of Protectionism

price equilibrium with and without trade
tariff, quota, nontariff barriers
effects of tariffs on price, imports, and domestic production
mercantilist, cheap-foreign-labor, and retaliatory arguments
the optimal tariff, unemployment, and infant-industry exceptions

FURTHER READING AND INTERNET WEBSITES

Further Reading

The theory of comparative advantage was discovered and discussed by David Ricardo in *Principles of Political Economy and Taxation* (1819, various publishers). This is online at several sites, including *www.econlib.org/library/Ricardo/ricP.html*. A classic review of the debate about free trade is Jagdish Bhagwati, *Protectionism* (MIT Press, Cambridge, Mass., 1990). Some of the best popular writing

Eye Therapies Exhibit 2127, 385 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

on international economics is found in *The Economist,* which is also available at *www.economist.com.*

Mankiw's remarks on outsourcing, as well as some reactions, can be found at *www.cnn.com/2004/US/02/12/bush.outsourcing/.* Blinder's article, "Offshoring: The Next Industrial Revolution?" appeared in *Foreign Affairs,* March–April 2006, and is available at *www.foreignaffairs.org/.*

Websites

The World Bank (*www.worldbank.org*) has information on its programs and publications at its site, as does the International Monetary Fund, or IMF (*www.imf.org*). The United Nations website has links to most international institutions and their databases (*www.unsystem.org*). Another good source of information about high-income countries is the Organisation for Economic Cooperation and Development, or OECD (*www.oecd.org*). U.S. trade data are available at *www.census.gov.*

You can find information on many countries through their statistical offices. A compendium of national agencies is available at *www.census.gov/main/www/stat_int.html.*

One of the best sources for policy writing on international economics is *www.iie.com/homepage.htm,* the website of the Peterson Institute for International Economics.

QUESTIONS FOR DISCUSSION

1. State whether or not each of the following is correct and explain your reasoning. If the quotation is incorrect, provide a corrected statement.
   a. "We Mexicans can never compete profitably with the Northern colossus. Her factories are too efficient, she has too many computers and machine tools, and her engineering skills are too advanced. We need tariffs, or we can export nothing!"
   b. "If American workers are subjected to the unbridled competition of cheap Mexican labor, our real wages must necessarily fall drastically."
   c. "The principle of comparative advantage applies equally well to families, cities, and states as it does to nations and continents."
   d. The quotation from Ross Perot on page 356.
2. Reconstruct Figure 18-1 and its accompanying table to show the production data for Europe; assume that Europe has 600 units of labor and that labor productivities are those given in Table 18-2.
3. What if the data in Table 18-2 changed from (1, 2; 3, 4) to (1, 2; 2, 4)? Show that all trade is killed off. Use this to explain the adage *"Vive la différence!"* (freely translated as "Let diversity thrive!"). Why do the largest gains in trade flow to small countries whose pretrade prices are very different from prevailing world prices?
4. *Follow-up to question 3:* Suppose that the data in Table 18-2 pertain to a newly industrialized country (NIC) and America. What are the gains from trade between the two countries? Now suppose that NIC adopts American technology and has production possibilities identical to those in the American column of Table 18-2. What will happen to international trade? What will happen to NIC's living standards and real wages? What will happen to America's living standards? Is there a lesson here for the impact of converging economies on trade and welfare?
5. A U.S. senator wrote the following: "Trade is supposed to raise the incomes of all nations involved—or at least that is what Adam Smith and David Ricardo taught us. If our economic decline has been caused by the economic growth of our competitors, then these philosophers—and the entire discipline of economics they founded—have been taking us on a 200-year ride."

   Explain why the first sentence is correct. Also explain why the second sentence does not follow from the first. Can you give an example of how economic growth of Country J could lower the standard of living in Country A? (*Hint:* The answer to question 4 will help uncover the fallacy in the quotation.)
6. Modern protectionists have used the following arguments for protecting domestic industries against foreign competition:
   a. In some situations, a country can improve its standard of living by imposing protection if no one else retaliates.
   b. Wages in China are a tiny fraction of those in the United States. Unless we limit the imports of Chinese manufactures, we face a future in which our trade deficit continues to rise under the onslaught of competition from low-wage workers.
   c. A country might be willing to accept a small drop in its living standard to preserve certain industries that it deems necessary for national security, such as supercomputers or oil, by protecting them from foreign competition.
   d. *For those who have studied macroeconomics:* If inflexible wages and prices or an inappropriate exchange rate leads to recession and high unemployment,

Eye Therapies Exhibit 2127, 386 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

tariffs might increase output and lower the unemployment rate.

In each case, relate the argument to one of the traditional defenses of protectionism. State the conditions under which it is valid, and decide whether you agree with it.

7. The United States has had quotas on steel, shipping, automobiles, textiles, and many other products. Economists estimate that by auctioning off the quota rights, the Treasury would gain at least $10 billion annually. Use Figure 18-9 to analyze the economics of quotas as follows: Assume that the government imposes a quota of 100 on imports, allocating the quota rights to importing countries on the basis of last year's imports. What would be the equilibrium price and quantity of clothing? What would be the efficiency losses from quotas? Who would get revenue rectangle *B*? What would be the effect of auctioning off the quota rights?

PART FIVE

Macroeconomics: Economic Growth and Business Cycles

CHAPTER

Overview of Macroeconomics

19



The whole purpose of the economy is production of goods or services for consumption now or in the future. I think the burden of proof should always be on those who would produce less rather than more, on those who would leave idle people or machines or land that could be used. It is amazing how many reasons can be found to justify such waste: fear of inflation, balance-of-payments deficits, unbalanced budgets, excessive national debt, loss of confidence in the dollar.

James Tobin,
National Economic Policy

Are jobs plentiful or hard to find? Are real wages and living standards growing rapidly, or are consumers struggling to make ends meet as price inflation reduces real wages? Is there a period of financial exuberance with stock prices rising rapidly? Or is the central bank using monetary policy to fight off the effects of falling housing prices and a financial crisis? What are the impacts of globalization and foreign trade on domestic employment and output? These questions are central to macroeconomics, which is the subject of the following chapters.

Macroeconomics is the study of the behavior of the economy as a whole. It examines the forces that affect firms, consumers, and workers in the aggregate. It contrasts with **microeconomics,** which studies individual prices, quantities, and markets.

Two central themes will run through our survey of macroeconomics:

- The short-term fluctuations in output, employment, financial conditions, and prices that we call the *business cycle*
- The longer-term trends in output and living standards known as *economic growth*

The development of macroeconomics was one of the major breakthroughs of twentieth-century economics, leading to a much better understanding of how to combat periodic economic crises and how to stimulate long-term economic growth. In response to the Great Depression, John Maynard Keynes developed his revolutionary theory, which helped explain the forces producing economic fluctuations and suggested how governments can

Eye Therapies Exhibit 2127, 390 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

control the worst excesses of the business cycle. At the same time, economists have endeavored to understand the mechanics of long-term economic growth.

Macroeconomic issues dominated the U.S. political and economic agenda for much of the last century. In the 1930s, when production, employment, and prices collapsed in the United States and across much of the industrial world, economists and political leaders wrestled with the calamity of the Great Depression. During the Vietnam War in the 1960s and the energy crises of the 1970s, the burning issue was "stagflation," a combination of slow growth and rising prices. The 1990s witnessed a period of rapid growth, falling unemployment, and stable prices—years when everything went right, labeled by some as "the fabulous decade." Then asset-market bubbles burst twice in the first decade of the 2000s. The first shock was a sharp decline in the prices of technology stocks in 2000, and this was followed by a sharp decline in housing prices after 2007. The 2007–2009 housing-price decline produced a profound financial crisis and led to a deep and long recession.

Sometimes, macroeconomic failures raise life-and-death questions for countries and even for ideologies. The communist leaders of the former Soviet Union proclaimed that they would overtake the West economically. History proved that to be a hollow promise, as Russia, a country teeming with natural resources and military might, was unable to produce adequate butter for its citizens along with the guns for its imperial armies. Eventually, macroeconomic failures brought down the communist regimes of the Soviet Union and Eastern Europe and convinced people of the economic superiority of private markets as the best approach to encouraging rapid economic growth.

This chapter will serve as an introduction to macroeconomics. It presents the major concepts and shows how they apply to key historical and policy questions of recent years. But this introduction is only a first course to whet the appetite. Not until you have mastered all the chapters in Parts Five through Seven can you fully enjoy the rich macroeconomic banquet that has been a source of both inspiration for economic policy and continued controversy among macroeconomists.

A. KEY CONCEPTS OF MACROECONOMICS

THE BIRTH OF MACROECONOMICS

The 1930s marked the first stirrings of the science of macroeconomics, founded by John Maynard Keynes as he tried to understand the economic mechanism that produced the Great Depression. After World War II, reflecting both the increasing influence of Keynesian views and the fear of another depression, the U.S. Congress formally proclaimed federal responsibility for macroeconomic performance. It enacted the landmark Employment Act of 1946, which stated:

> The Congress hereby declares that it is the continuing policy and responsibility of the federal government to use all practicable means consistent with its needs and obligations . . . to promote maximum employment, production, and purchasing power.

For the first time, Congress affirmed the government's role in promoting output growth, fostering employment, and maintaining price stability. The Employment Act usefully frames the three central questions of macroeconomics:

1. *Why do output and employment sometimes fall, and how can unemployment be reduced?* All market economies show patterns of expansion and contraction known as *business cycles*. The latest business-cycle recession in the United States occurred after a severe financial-market crisis that began in 2007. Housing and stock prices fell sharply, and banks tightened credit and lending. As a result, output and employment fell sharply. Political leaders around the world used the tools of monetary and fiscal policy to reduce unemployment and stimulate economic activity.

   From time to time countries experience high unemployment that persists for long periods, sometimes as long as a decade. Such a period occurred in the United States during the Great Depression, which began in 1929. In the following years, unemployment rose to almost one-quarter of the workforce, while industrial production fell by one-half. One of the deepest

Eye Therapies Exhibit 2127, 391 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and most prolonged economic downturns of the modern era came in Japan, which experienced declining prices and was unable to shake off high unemployment and slow economic growth after 1990.

Macroeconomics studies the sources of persistent unemployment and high inflation. Having considered the symptoms, macroeconomists suggest possible remedies, such as using monetary policy to alter interest rates and credit conditions or using fiscal instruments such as taxes and spending. The lives and fortunes of millions of people depend upon whether economists find correct diagnoses for major macroeconomic ailments—and upon whether governments apply the right medicine at the right time.

2. *What are the sources of price inflation, and how can it be kept under control?* A market economy uses prices as a yardstick to measure economic values and conduct business. When prices are rising—a phenomenon we call *inflation*—the price yardstick loses its value. During periods of high inflation, people may get confused about relative prices and make mistakes in their spending and investment decisions. Tax burdens may rise. Households on fixed incomes find that inflation is eating away at their real incomes.

   Macroeconomic policy has increasingly emphasized low and stable inflation as a key goal. Many countries set "inflation targets" for their economic policy, with targets often being in the range from 1 to 3 percent per year. Except for brief spikes, the United States has succeeded in containing inflation over the last two decades, with an average inflation rate of 3 percent per year for the consumer price index. Many countries have not been so successful. Formerly socialist countries like Russia and many Latin American and developing countries experienced inflation rates of 50, 100, or 1000 percent per year in the last two decades. The inflationary record in the last few years was in troubled Zimbabwe, where inflation was around 20,000,000 percent per year in 2008. A chicken that cost 10 thousand Zimbabwean dollars at the beginning of the year would cost 10 trillion Zimbabwean dollars at the end! Why was the United States able to contain the inflationary tiger, while Zimbabwe failed to do so? Macroeconomics can suggest the proper role of monetary and fiscal policies, of exchange-rate systems, and of an independent central bank in containing inflation.

3. *How can a nation increase its rate of economic growth?* The single most important goal of macroeconomics concerns a nation's long-term economic growth. This refers to the growth in the per capita output of a country. Such growth is the central factor in determining the growth in real wages and living standards. Most countries of North America and Western Europe have enjoyed rapid economic growth for two centuries, and residents in these countries have high average incomes. Over the last five decades, Asian countries such as Japan, South Korea, and Taiwan produced dramatic gains in living standards for their peoples. China's growth has similarly been outstanding in recent years. A few countries, particularly those of sub-Saharan Africa, have suffered declining per capita output and living standards.

   Nations want to know the ingredients in a successful growth recipe. Economic historians have found that the key factors in long-term economic growth include reliance on well-regulated private markets for most economic activity, stable macroeconomic policy, high rates of saving and investment, openness to international trade, and accountable and noncorrupt governing institutions.

All economies face inevitable tradeoffs among these goals. Increasing the rate of growth of output over the long run may require greater investment in education and capital, but higher investment requires lower current consumption of items like food, clothing, and recreation. Additionally, policymakers are sometimes forced to rein in the economy through macroeconomic policies when it grows too fast in order to prevent rising inflation or when financial conditions exhibit irrational exuberance.

There are no magic formulas for ensuring low and stable inflation, high employment, and rapid growth. Macroeconomists have vigorous debates about both the goals and the appropriate policies for reaching the goals. But sound macroeconomic policies are essential if a country wishes to achieve its economic objectives in the most effective manner.

Eye Therapies Exhibit 2127, 392 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



The Patron Saint of Macroeconomics

Every discussion of macroeconomic policy must begin with John Maynard Keynes. Keynes (1883–1946) was a many-sided genius who won eminence in the fields of mathematics, philosophy, and literature. In addition, he found time to run a large insurance company, advise the British treasury, help govern the Bank of England, edit a world-famous economics journal, collect modern art and rare books, start a repertory theater, and marry a leading Russian ballerina. He was also an investor who knew how to make money by shrewd speculation, both for himself and for his college, King's College, Cambridge.

His principal contribution, however, was his invention of a new way of looking at macroeconomics and macroeconomic policy. Before Keynes, most economists and policymakers accepted the highs and lows of business cycles as being as inevitable as the tides. These long-held views left them helpless in the face of the Great Depression of the 1930s. But Keynes took an enormous intellectual leap in his 1936 book, *The General Theory of Employment, Interest, and Money*. He made a twofold argument: First, he argued that it is possible for high unemployment and underutilized capacity to persist in market economies. In addition, he argued that government fiscal and monetary policies can affect output and thereby reduce unemployment and shorten economic downturns.

These propositions had an explosive impact when Keynes first introduced them, engendering much controversy and dispute. In the years after World War II, Keynesian economics came to dominate macroeconomics and government policy. Since then, new developments incorporating supply factors, expectations, and alternative views of wage and price dynamics have undermined the earlier Keynesian consensus. While few economists now believe that government action can eliminate business cycles, as Keynesian economics once seemed to promise, neither economics nor economic policy has been the same since Keynes's great discovery.

OBJECTIVES AND INSTRUMENTS OF MACROECONOMICS

Having surveyed the principal issues of macroeconomics, we now turn to a discussion of the major goals and instruments of macroeconomic policy. How do economists evaluate the success of an economy's overall performance? What are the tools that governments can use to pursue their economic goals? Table 19-1 lists the major objectives and instruments of macroeconomic policy.

Objectives	
Output:	
	High level and rapid growth of output
Employment:	
	High level of employment with low involuntary unemployment
Stable prices	
Instruments	
Monetary policy:	
	Buying and selling bonds, regulating financial institutions
Fiscal policy:	
	Government expenditures
	Taxation

TABLE 19-1. Goals and Instruments of Macroeconomic Policy

The top part of the table displays the major goals of macroeconomic policy. The lower half shows the major instruments or policy measures available to modern economies. Policymakers change the instruments of policy to affect the pace and direction of economic activity.

Measuring Economic Success

The major macroeconomic goals are a high level and rapid growth of output, low unemployment, and stable prices. We will use this section both to define the major macroeconomic terms and to discuss their importance. A more detailed treatment of the data of macroeconomics is postponed to the next chapter. Some key data are provided in the appendix to this chapter.

Output. The ultimate objective of economic activity is to provide the goods and services that the population desires. What could be more important for an economy than to produce ample shelter, food, education, and recreation for its people?

The most comprehensive measure of the total output in an economy is the **gross domestic product** (GDP). GDP is the measure of the market value of all

Eye Therapies Exhibit 2127, 393 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



FIGURE 19-1. Growth Rate of U.S. Real Gross Domestic Product, 1929–2008

Real GDP is the most comprehensive measure of an economy's output. This figure shows the rate of growth from one year to the next. Note the string of negative growth rates in the Great Depression of the 1930s. Also, we see the Great Moderation of the last few years, in which output was less volatile than in earlier periods.

Source: U.S. Bureau of Economic Analysis at *www.bea.gov*. Shaded regions are major economic downturns.

final goods and services—beer, cars, rock concerts, donkey rides, and so on—produced in a country during a year. There are two ways to measure GDP. *Nominal GDP* is measured in actual market prices. *Real GDP* is calculated in constant or invariant prices (where we measure the number of cars times the prices of cars in a given year such as 2000).

Real GDP is the most closely watched measure of output; it serves as the carefully monitored pulse of a nation's economy. Figure 19-1 shows the growth rate of real GDP in the United States since 1929. The growth rate is defined as

$$\%\ \text{growth rate of real GDP in year } t = 100 \times \frac{\text{GDP}_t - \text{GDP}_{t-1}}{\text{GDP}_{t-1}}$$

For example, real GDP in 2006 was $11,294.8 billion and in 2007 was $11,523.9 billion (both in 2000 prices). A calculator will show that the growth of real GDP in 2007 was 2.0 percent over the year. It is worthwhile making sure you can replicate this calculation. Note the sharp economic decline during the Great Depression of the 1930s, the boom during World War II, and the recessions in 1974, 1982, 1991, and 2008.

Despite the short-term fluctuations seen in business cycles, advanced economies generally exhibit a steady long-term growth in real GDP and an improvement in living standards; this process is known as *economic growth*. The American economy has proved itself a powerful engine of progress over a period of more than a century, as shown by the growth in potential output.

Potential GDP represents the maximum sustainable level of output that the economy can produce. When an economy is operating at its

Eye Therapies Exhibit 2127, 394 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

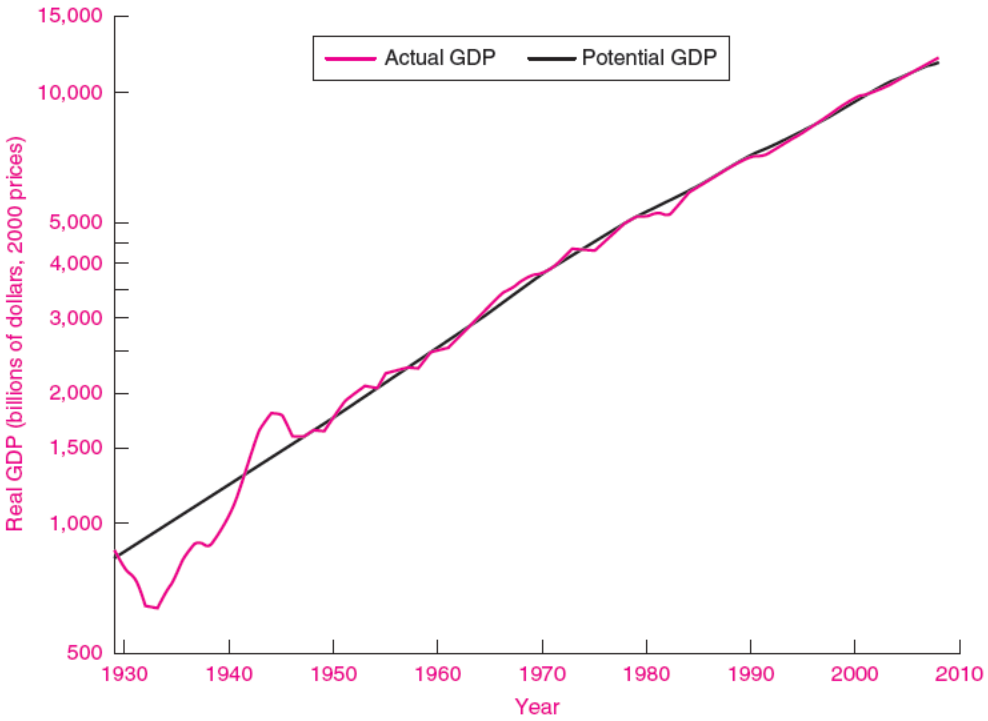


FIGURE 19-2. Actual and Potential GDP in the United States

Business cycles occur when actual output departs from its potential. The smooth blue line shows potential or trend output over the period 1929–2008. Potential output has grown about 3.4 percent annually. Note the large gap between actual and potential output during the Great Depression of the 1930s.

Source: U.S. Bureau of Economic Analysis, Congressional Budget Office, and authors' estimates. Note that actual GDP is directly estimated from underlying data while potential output is an analytical concept derived from actual GDP and unemployment data.

potential, there are high levels of utilization of the labor force and the capital stock. When output rises above potential output, price inflation tends to rise, while a below-potential level of output leads to high unemployment.

Potential output is determined by the economy's productive capacity, which depends upon the inputs available (capital, labor, land, etc.) and the economy's technological efficiency. Potential GDP tends to grow steadily because inputs like labor and capital and the level of technology change quite slowly over time. By contrast, actual GDP is subject to large business-cycle swings if spending patterns change sharply.

During business downturns, actual GDP falls below its potential, and unemployment rises. In 1982, for example, the U.S. economy produced about $400 billion less than its potential output. This represented $5000 lost per family during a single year. A *recession* is a period of significant decline in total output, income, and employment, usually lasting more than a few months and marked by widespread contractions in many sectors of the economy. A severe and protracted downturn is called a *depression*. Output can be temporarily above its potential during booms and wartime as capacity limits are strained, but the high utilization rates may bring rising inflation and are usually brought to an end by monetary or fiscal policy.

Figure 19-2 shows the estimated potential and actual output for the period 1929–2008. Note how large the gap between actual and potential output was during the Great Depression of the 1930s.

Eye Therapies Exhibit 2127, 395 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

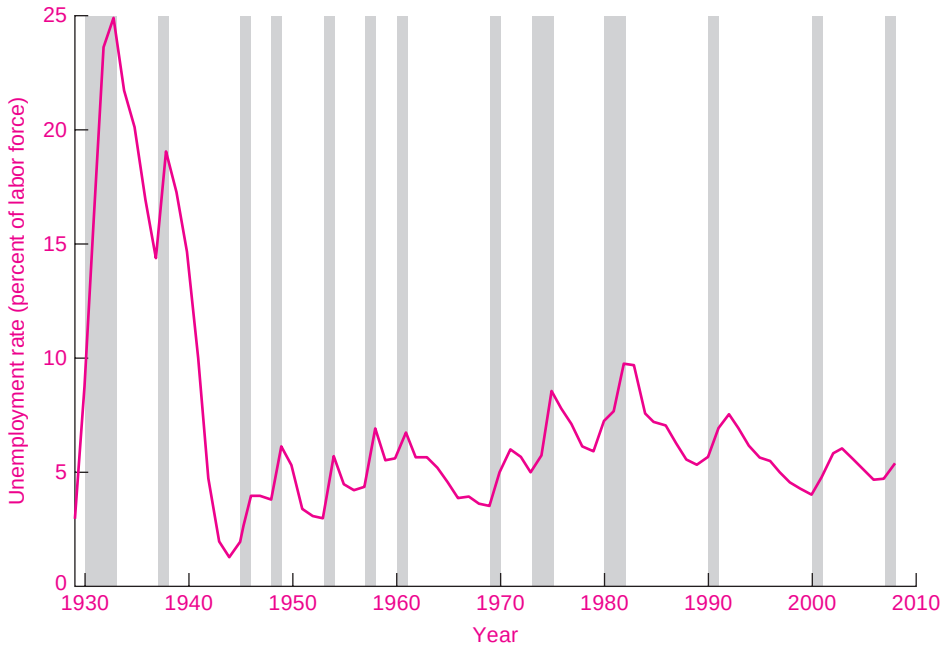


FIGURE 19-3. Unemployment Rises in Recessions, Falls during Expansions

The unemployment rate measures the fraction of the labor force that is looking for work but cannot find work. Unemployment rises in business-cycle downturns and falls during expansions. Shaded regions are NBER recessions.

Source: U.S. Bureau of Labor Statistics at *www.bea.gov*.

High Employment, Low Unemployment. Of all the macroeconomic indicators, employment and unemployment are most directly felt by individuals. People want to be able to get high-paying jobs without searching or waiting too long, and they want to have job security and good benefits. In macroeconomic terms, these are the objectives of *high employment*, which is the counterpart of *low unemployment*. Figure 19-3 shows trends in unemployment over the last eight decades. The **unemployment rate** on the vertical axis is the percentage of the labor force that is unemployed. The labor force includes all employed persons and those unemployed individuals who are seeking jobs. It excludes those without work who are not looking for jobs.

The unemployment rate tends to reflect the state of the business cycle: when output is falling, the demand for labor falls and the unemployment rate rises. Unemployment reached epidemic proportions in the Great Depression of the 1930s, when as much as one-quarter of the workforce was idled. Since World War II, unemployment in the United States has fluctuated but has avoided the high rates associated with depressions.

Price Stability. The third macroeconomic objective is *price stability*. This is defined as a low and stable inflation rate.

To track prices, government statisticians construct **price indexes,** or measures of the overall price level. An important example is the **consumer price index** (CPI), which measures the trend in the average price of goods and services bought by consumers. We will generally denote the overall price level by the letter P.

Economists measure price stability by looking at **inflation,** or the **rate of inflation.** The inflation rate is the percentage change in the overall level of prices from one year to the next. For example, the CPI was 201.6 in 2006 and 207.3 in 2007. The inflation-rate calculation is just like the growth-rate calculation above:

$$\text{Rate of inflation in year } t = 100 \times \frac{P_t - P_{t-1}}{P_{t-1}}$$

Eye Therapies Exhibit 2127, 396 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

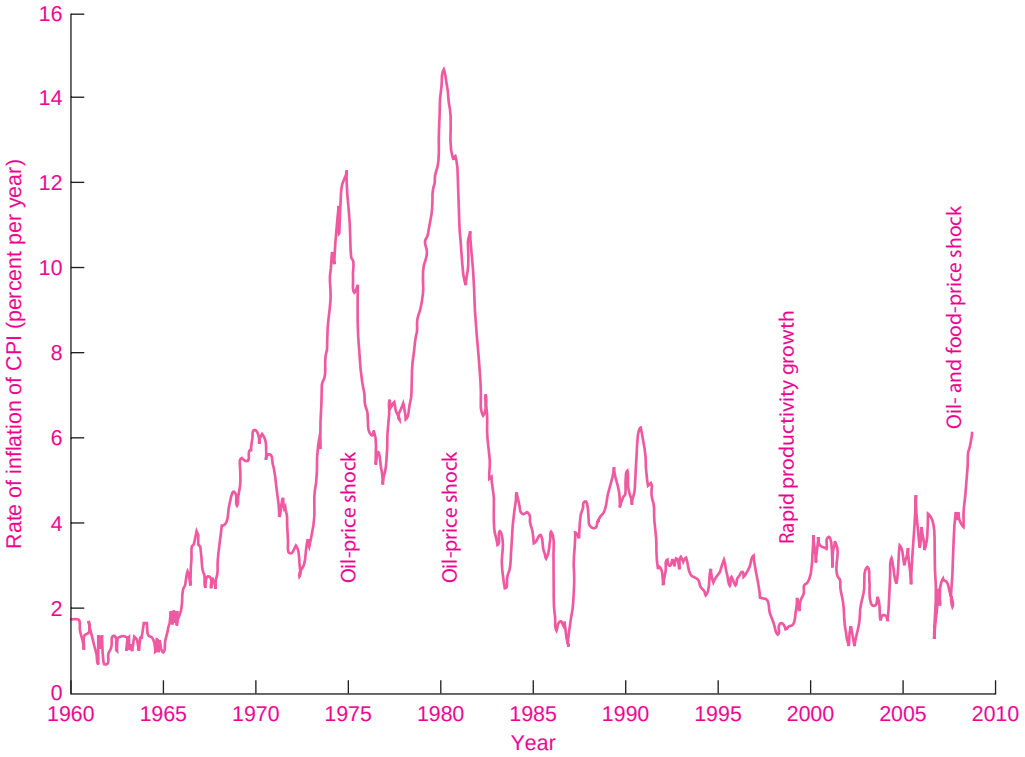


FIGURE 19-4. U.S. Consumer Price Inflation, 1960–2008

The rate of inflation measures the rate of change of prices from one year to the next; here we see the rate of inflation as measured by the consumer price index (CPI). Most inflationary episodes have been associated with shocks to oil or food prices. Note that inflation has moved in a narrow corridor since the mid-1980s.

Source: U.S. Bureau of Labor Statistics. Data show rate of inflation from 12 months earlier.

We thus calculate the inflation rate for 2007 as

$$\text{Rate of inflation in 2007} = 100 \times \frac{207.3 - 201.6}{201.6} = 2.8\% \text{ per year}$$

Figure 19-4 shows the inflation rate for the CPI from 1960 to 2008. Since the end of the inflationary period in the early 1980s, inflation has averaged 3 percent per year through 2008.

A *deflation* occurs when prices decline (which means that the rate of inflation is negative). At the other extreme is a *hyperinflation*, a rise in the price level of a thousand or a million percent a year. In such situations, as in Weimar Germany in the 1920s, Brazil in the 1980s, Russia in the 1990s, or Zimbabwe in recent years, prices are virtually meaningless and the price system breaks down.

Price stability is important because a smoothly functioning market system requires that prices accurately convey information about relative scarcities. History has shown that high inflation imposes many costs—some visible and some hidden—on an economy. With high inflation, taxes become highly variable, the real values of people's pensions are eroded, and people spend real resources to avoid depreciating rubles or pesos. But declining prices (deflation) are also costly. Hence, most nations seek the golden mean of slowly rising prices as the best way of encouraging the price system to function efficiently.

Eye Therapies Exhibit 2127, 397 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

To summarize:

The goals of macroeconomic policy are:

1. A high and growing level of national output
2. High employment with low unemployment
3. A stable or gently rising price level

The Tools of Macroeconomic Policy

Put yourself in the shoes of the chief economist advising the government. Unemployment is rising and GDP is falling. Or perhaps the burst of a speculative bubble in housing prices has led to massive defaults, banking losses, and a credit crunch. Or your country has a balance-of-payments crisis, with a large trade deficit and a foreign-exchange rate that is in free fall. What policies will help reduce inflation or unemployment, speed economic growth, or correct a trade imbalance?

Governments have certain instruments that they can use to affect macroeconomic activity. A *policy instrument* is an economic variable under the control of government that can affect one or more of the macroeconomic goals. By changing monetary, fiscal, and other policies, governments can avoid the worst excesses of the business cycle or increase the growth rate of potential output. The major instruments of macroeconomic policy are listed in the bottom half of Table 19-1.

Fiscal Policy. **Fiscal policy** denotes the use of taxes and government expenditures. *Government expenditures* come in two distinct forms. First there are government purchases. These comprise spending on goods and services—purchases of tanks, construction of roads, salaries for judges, and so forth. In addition, there are government transfer payments, which increase the incomes of targeted groups such as the elderly or the unemployed. Government spending determines the relative size of the public and private sectors, that is, how much of our GDP is consumed collectively rather than privately. From a macroeconomic perspective, government expenditures also affect the overall level of spending in the economy and thereby influence the level of GDP.

The other part of fiscal policy, *taxation,* affects the overall economy in two ways. To begin with, taxes affect people's incomes. By leaving households with more or less disposable or spendable income, taxes affect the amount people spend on goods and services as well as the amount of private saving. Private consumption and saving have important effects on investment and output in the short and long run.

In addition, taxes affect the prices of goods and factors of production and thereby affect incentives and behavior. The United States has often employed special tax provisions (such as an investment tax credit or accelerated depreciation) as ways of increasing investment and boosting economic growth. Many provisions of the tax code have an important impact on economic activity through their effect on the incentives to work and to save.

Monetary Policy. The second major instrument of macroeconomic policy is **monetary policy,** which the government conducts through managing the nation's money, credit, and banking system. You may have read how our central bank, the Federal Reserve System, affects the economy by determining short-term interest rates. How does the Federal Reserve or any other central bank actually accomplish this? It does so primarily by setting short-run interest-rate targets and through buying and selling government securities to attain those targets. Through its operations, the Federal Reserve influences many financial and economic variables, such as interest rates, stock prices, housing prices, and foreign exchange rates. These financial variables affect spending on investment, particularly in housing, business investment, consumer durables, and exports and imports.

Historically, the Fed has raised interest rates when inflation threatened to rise too high. This led to reduced investment and consumption, causing a decline in GDP and lower inflation. In the most recent slowdown, which started in 2007, the Fed acted quickly to lower interest rates, provide credit, and extend its lending facilities outside traditional banking institutions.

The central bank is a key macroeconomic institution for every country. Japan, Britain, Russia, and the countries of the European Union all have powerful central banks. In an "open economy"—that is, one whose borders are open to goods, services, and financial flows—the exchange-rate system is also a central part of monetary policy.

Monetary policy is the tool that countries most often rely on to stabilize the business cycle, although it becomes less potent in deep recessions. The exact way that central banks can affect economic activity

Eye Therapies Exhibit 2127, 398 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

will be thoroughly analyzed in the chapters on monetary policy.

Summary:

A nation has two major kinds of policies that can be used to pursue its macroeconomic goals—fiscal policy and monetary policy.

1. Fiscal policy consists of government expenditure and taxation. Government expenditure influences the relative size of collective spending and private consumption. Taxation subtracts from incomes, reduces private spending, and affects private saving. In addition, it affects investment and potential output. Fiscal policy is primarily used to affect long-term economic growth through its impact on national saving and investment; it is also used to stimulate spending in deep or sharp recessions.
2. Monetary policy, conducted by the central bank, determines short-run interest rates. It thereby affects credit conditions, including asset prices such as stock and bond prices and exchange rates. Changes in interest rates, along with other financial conditions, affect spending in sectors such as business investment, housing, and foreign trade. Monetary policy has an important effect on both actual GDP and potential GDP.

INTERNATIONAL LINKAGES

No nation is an island unto itself. Nations increasingly participate in the world economy and are linked together through trade and finance—this is the phenomenon called *globalization*. As the costs of transportation and communication have declined, international linkages have become tighter than they were a generation ago. International trade has replaced empire-building and military conquest as the surest road to national wealth and influence.

The trade linkages of imports and exports of goods and services are seen when the United States imports cars from Japan or exports computers to Mexico. Financial linkages come in activities such as foreigners' buying U.S. bonds for their sovereign debt funds or Americans' diversifying their pension funds with emerging-market stocks.

Nations keep a close watch on their international transactions. One particularly important measure is the *balance on current account*. This represents the numerical difference between the value of exports and the value of imports, along with some other adjustments. (The current account is closely related to *net exports,* which is the difference between the value of exports and the value of imports of goods and services.) When exports exceed imports, the difference is a surplus, while a negative balance is a deficit. In 2007, exports totaled $2463 billion, while total imports and net transfers were $3194 billion; the difference was the U.S. current-account deficit of $731 billion.

For most of the twentieth century, the United States had a surplus in its foreign trade, exporting more than it imported. But trading patterns changed dramatically in the last quarter-century. As saving in the United States declined and foreign saving increased, a substantial part of foreign saving flowed to the United States. The counterpart of foreigners saving in the United States was that the current account turned sharply to deficit. As foreign investment in the nation increased, the United States by 2008 owed on balance around $2½ trillion to foreigners. Some economists worry that the large foreign debt poses major risks for the United States—risks that we will analyze in later chapters.

As economies become more closely linked, international economic policy becomes more important, particularly in small open economies. But remember that international trade and finance are not ends in themselves. Rather, international exchange serves the ultimate goal of improving living standards.

The major areas of concern are trade policies and international financial management. *Trade policies* consist of tariffs, quotas, and other regulations that restrict or encourage imports and exports. Most trade policies have little effect on short-run macroeconomic performance, but from time to time, as was the case in the 1930s, restrictions on international trade are so severe that they cause major economic dislocations, inflations, or recessions.

A second set of policies is *international financial management*. A country's international trade is influenced by its foreign exchange rate, which represents the price of its own currency in terms of the currencies of other nations. Foreign exchange systems are an integral part of monetary policy. In small open economies, managing the exchange rate is the single most important macroeconomic policy.

The international economy is an intricate web of trading and financial connections among countries.

Eye Therapies Exhibit 2127, 399 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

When the international economic system runs smoothly, it contributes to rapid economic growth; when trading systems break down, production and incomes suffer throughout the world. Countries therefore consider the impacts of trade policies and international financial policies on their domestic objectives of high output, high employment, and price stability.

B. AGGREGATE SUPPLY AND DEMAND

The economic history of nations can be seen in their macroeconomic performance. Economists have developed aggregate supply-and-demand analysis to help explain the major trends in output and prices. We begin by explaining this important tool of macroeconomics and then use it to understand some important historical events.

INSIDE THE MACROECONOMY: AGGREGATE SUPPLY AND DEMAND

Definitions of Aggregate Supply and Demand

How do different forces interact to determine overall economic activity? Figure 19-5 shows the relationships among the different variables inside the macroeconomy. It separates variables into two categories: those affecting aggregate supply and those affecting aggregate demand. While the division is simplified, dividing variables into these two categories helps us understand what determines the levels of output, prices, and unemployment.

The lower part of Figure 19-5 shows the forces affecting aggregate supply. **Aggregate supply** refers to the total quantity of goods and services that the nation's businesses willingly produce and sell in a given period. Aggregate supply (often written *AS*) depends upon the price level, the productive capacity of the economy, and the level of costs.

In general, businesses would like to sell everything they can produce at high prices. Under some circumstances, prices and spending levels may be depressed, so businesses might find they have excess capacity. Under other conditions, such as during a wartime boom, factories may be operating at capacity as businesses scramble to produce enough to meet all their orders.

We see, then, that aggregate supply depends on the price level that businesses can charge as well as on the economy's capacity or potential output. Potential output in turn is determined by the availability of productive inputs (labor and capital being the most important) and the managerial and technical efficiency with which those inputs are combined.

National output and the overall price level are determined by the twin blades of the scissors of aggregate supply and demand. The second blade is **aggregate demand,** which refers to the total amount that different sectors in the economy willingly spend in a given period. Aggregate demand (often written *AD*) equals total spending on goods and services. It depends on the level of prices, as well as on monetary policy, fiscal policy, and other factors.

The components of aggregate demand include *consumption* (the cars, food, and other consumption goods bought by consumers); *investment* (construction of houses and factories as well as business equipment); *government purchases* (such as spending on teachers and missiles); and *net exports* (the difference between exports and imports). Aggregate demand is affected by the prices at which the goods are offered, by exogenous forces like wars and weather, and by government policies.

Using both blades of the scissors of aggregate supply and demand, we achieve the resulting equilibrium, as is shown in the right-hand circle of Figure 19-5. National output and the price level settle at that level where demanders willingly buy what businesses willingly sell. The resulting output and price level determine employment, unemployment, and international trade.

Aggregate Supply and Demand Curves

Aggregate supply and demand curves are often used to help analyze macroeconomic conditions. Recall that in Chapter 3 we used market supply and demand curves to analyze the prices and quantities of individual products. An analogous graphical apparatus can help us understand how monetary policy or technological change acts through aggregate supply and demand to determine national output and the price level.

Eye Therapies Exhibit 2127, 400 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

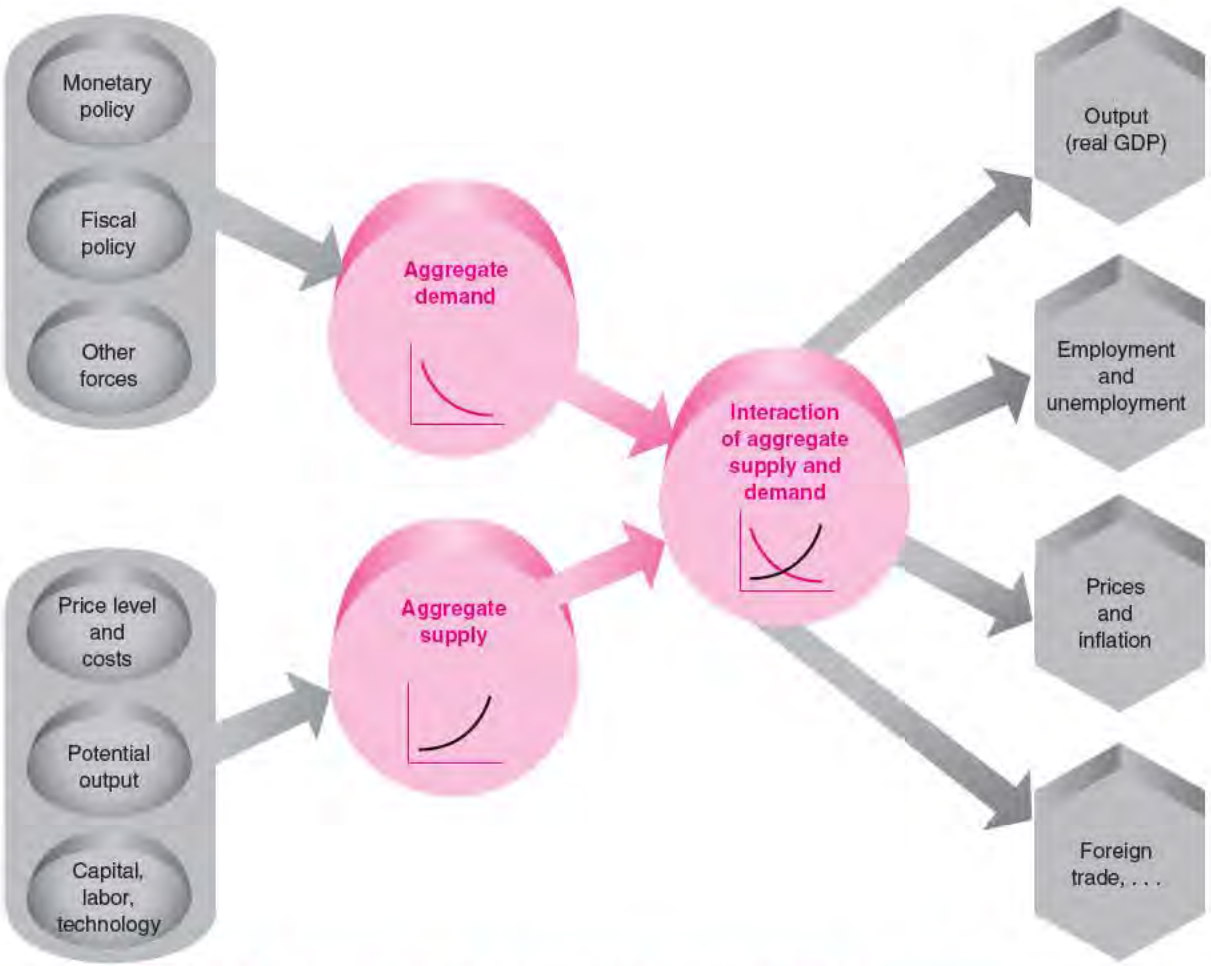


FIGURE 19-5. Aggregate Supply and Demand Determine the Major Macroeconomic Variables

This key diagram shows the major factors affecting overall economic activity. On the left are the major variables determining aggregate supply and demand; these include policy variables, like monetary and fiscal policies, along with stocks of capital and labor. In the center, aggregate supply and demand interact. The chief outcomes are shown on the right in hexagons: output, employment, the price level, and international trade.

Figure 19-6 shows the aggregate supply and demand schedules for the output of an entire economy. On the horizontal axis is the total output (real GDP) of the economy. On the vertical axis is the overall price level (as measured by the "price of GDP"). We use the symbol Q for real output and P for the price level.

The downward-sloping curve is the **aggregate demand schedule,** or *AD* curve. It represents what everyone in the economy—consumers, businesses, foreigners, and governments—would buy at different aggregate price levels (with other factors affecting aggregate demand held constant). From the curve, we see that at an overall price level of 150, total spending would be $3000 billion (per year). If the price level rises to 200, total spending would fall to $2300 billion.

The upward-sloping curve is the **aggregate supply schedule,** or *AS* curve. This curve represents the

Eye Therapies Exhibit 2127, 401 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

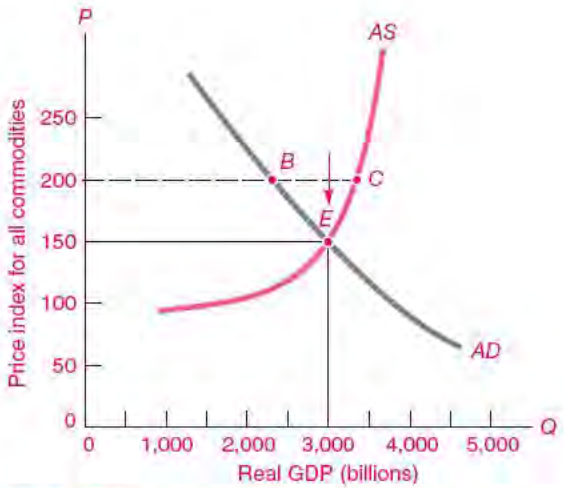


FIGURE 19-6. Aggregate Price and Output Are Determined by the Interaction of Aggregate Supply and Demand

The *AD* curve represents the quantity of total spending at different price levels, with other factors held constant. The *AS* curve shows what firms will produce and sell at different price levels, other things equal.

National output and the overall price level are determined at the intersection of the aggregate demand and supply curves, at point *E*. This equilibrium occurs at an overall price level where firms willingly produce and sell what consumers and other demanders willingly buy.

quantity of goods and services that businesses are willing to produce and sell at each price level (with other determinants of aggregate supply held constant). According to the curve, businesses will want to sell $3000 billion at a price level of 150; they will want to sell a higher quantity, $3300 billion, if prices rise to 200. As the level of total output demanded rises, businesses will want to sell more goods and services at a higher price level.



Warning on *AS* and *AD* Curves

Before proceeding, here is one important word of caution: Do not confuse the macroeconomic *AD* and *AS* curves with the microeconomic *DD* and *SS* curves. The microeconomic supply and demand curves show the quantities and prices of individual commodities, with such things as national income and other goods' prices held as given. By contrast, the aggregate supply and demand curves show the determination of total output and the overall price level, with such things as the money supply, fiscal policy, and the capital stock held constant.

Aggregate supply and demand explain how *total taxes* affect aggregate demand, national output, and the overall price level. Microeconomic supply and demand might consider the way increases in *gasoline taxes* affect purchases of gasoline, holding income constant. The two sets of curves have a superficial resemblance, but they explain very different phenomena.

Note as well that we have drawn the *AS* curve as upward-sloping and the *AD* curve as downward-sloping. We explain the reasons for these slopes in later chapters.

Macroeconomic Equilibrium. We now see how aggregate output and the price level adjust or equilibrate to bring aggregate supply and aggregate demand into balance. That is, we use the *AS* and *AD* concepts to see how *equilibrium values of price and quantity* are determined or to find the *P* and *Q* that satisfy the buyers and sellers all taken together. For the *AS* and *AD* curves shown in Figure 19-6, the overall economy is in equilibrium at point *E*. Only at that point, where the level of output is $Q = 3000$ and $P = 150$, are spenders and sellers satisfied. Only at point *E* are demanders willing to buy exactly the amount that businesses are willing to produce and sell.

How does the economy reach its equilibrium? Indeed, what do we mean by equilibrium? A **macroeconomic equilibrium** is a combination of overall price and quantity at which all buyers and sellers are satisfied with their overall purchases, sales, and prices.

Figure 19-6 illustrates the concept. If the price level were higher than equilibrium, say, at $P = 200$, businesses would want to sell more than purchasers would want to buy; businesses would desire to sell quantity *C*, while buyers would want to purchase only amount *B*. Goods would pile up on the shelves as firms produced more than consumers bought. Because of the excess aggregate supply of goods, firms would cut production and shave their prices. The overall price level would begin to decline or rise less rapidly. As the price level declined from its original too high level, the gap between desired total spending and desired total sales would narrow. Eventually, prices would decline to the point where overall demand and production were in balance. At the macroeconomic equilibrium, there would be

Eye Therapies Exhibit 2127, 402 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

neither excess supply nor excess demand—and no pressure to change the overall price level.

MACROECONOMIC HISTORY: 1900–2008

We can use the aggregate supply-and-demand apparatus to analyze recent American macroeconomic history. We focus on the economic expansion during the Vietnam War, the deep recession caused by the monetary contraction of the early 1980s, and the phenomenal record of economic growth during the twentieth century. This chapter's appendix also provides data on major macroeconomic variables.

Wartime Boom. The American economy entered the 1960s having experienced multiple recessions (see Figure 19-3). President John Kennedy brought Keynesian economics to Washington. His economic advisers recommended expansionary policies, and Congress enacted measures to stimulate the economy, particularly cuts in personal and corporate taxes in 1963 and 1964. GDP grew rapidly during this period, unemployment declined, and inflation was contained. By 1965, the economy was at its potential output.

Unfortunately, the government underestimated the magnitude of the buildup for the Vietnam War; defense spending grew by 55 percent from 1965 to 1968. Even when it became clear that a major inflationary boom was under way, President Johnson postponed painful fiscal steps to slow the economy. Tax increases and civilian expenditure cuts came only in 1968, which was too late to prevent inflationary pressures from overheating the economy. The Federal Reserve accommodated the expansion with rapid money growth and low interest rates. As a result, the economy grew very rapidly over the period 1966–1970. Under the pressure of low unemployment and high factory utilization, inflation began to rise, inaugurating the "Great Inflation" that lasted from 1966 through 1981.

Figure 19-7 illustrates the events of this period. The tax cuts and defense expenditures shifted the aggregate demand curve to the right from *AD* to *AD′*, with the equilibrium shifting from *E* to *E′*. Output and employment rose sharply, and inflation rose as output exceeded capacity limits. Economists learned

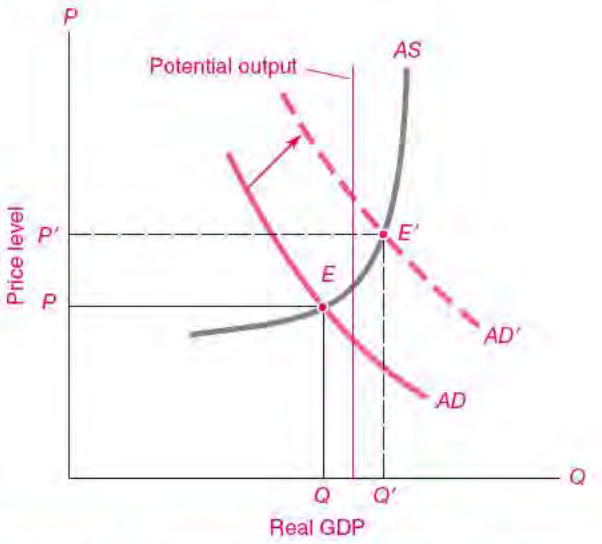


FIGURE 19-7. Wartime Boom Is Propelled by Increasing Aggregate Demand

During wartime, increased military spending increases aggregate spending, moving aggregate demand from *AD* to *AD′*, with equilibrium output increasing from *E* to *E′*. When output rises far above potential output, the price level moves up sharply from *P* to *P′*, and wartime inflation ensues.

that it was easier to stimulate the economy than to persuade policymakers to raise taxes to slow the economy when inflation threatened. This lesson led many to question the wisdom of using fiscal policies to stabilize the economy.

Tight Money, 1979–1982. The 1970s were a time of troubles, with rising oil prices, grain shortages, a sharp increase in import prices, union militancy, and accelerating wages. Price inflation became embedded in the U.S. and many other economies. As Figure 19-4 on page 374 shows, inflation rose to double-digit levels in the 1978–1980 period.

Double-digit inflation was unacceptable. In response, the Federal Reserve, under the leadership of economist Paul Volcker, prescribed the strong medicine of tight money to slow the inflation. Interest rates rose sharply in 1979 and 1980, the stock market fell, and credit was hard to find. The Fed's tight-money policy slowed spending by

Eye Therapies Exhibit 2127, 403 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

consumers and businesses. Particularly hard-hit were interest-sensitive components of aggregate demand. After 1979, housing construction, automobile purchases, business investment, and net exports declined sharply.

We can picture how tight money reduced aggregate demand in Figure 19-7 simply by reversing the arrow. That is, tight monetary policy reduced spending and produced a leftward and downward shift of the aggregate demand curve—exactly the opposite of the effect of the tax cuts and defense buildup during the 1960s.

The effects of the tight money were twofold. First, output moved below its potential and unemployment rose sharply (see Figure 19-3 on page 373). Second, tight money and high unemployment produced a dramatic decline in inflation, from an average of 12 percent per year in the 1978–1980 period to an average of around 4 percent per year in the subsequent period (see Figure 19-4). Tight monetary policies succeeded in bringing an end to the Great Inflation, but the nation paid through higher unemployment and lower output during the period of tight money.

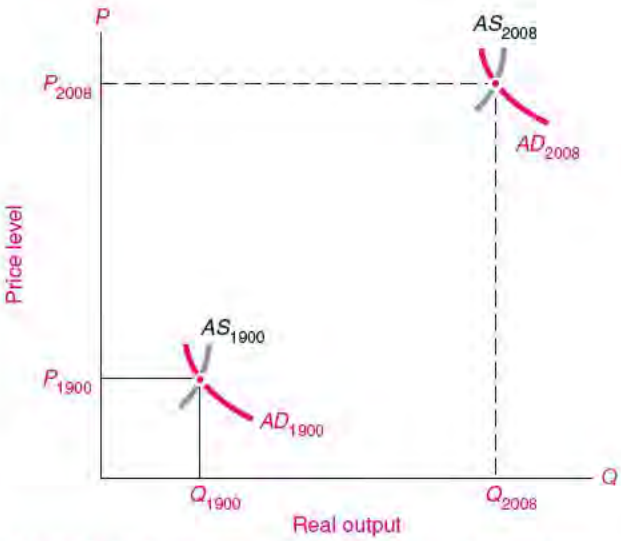


FIGURE 19-8. Growth in Potential Output Determines Long-Run Economic Performance

Over the twentieth century, increases in labor, capital, and efficiency led to a vast increase in the economy's productive potential, shifting aggregate supply far to the right. In the long run, aggregate supply is the primary determinant of output growth.

The Growth Century. The final act in our macroeconomic drama concerns the growth of output and prices over the entire period since 1900. Output has grown by a factor of 34 since the beginning of the twentieth century. How can we explain this phenomenal increase?

A careful look at American economic growth reveals that the growth rate during the twentieth century averaged 3⅓ percent per year. Part of this growth was due to growth in the scale of production as inputs of capital, labor, and even land grew sharply over this period. Just as important were improvements in efficiency due to new products (such as automobiles) and new processes (such as electronic computing). Other, less visible factors also contributed to economic growth, such as improved management techniques and improved services (including such innovations as the assembly line and overnight delivery).

Many economists believe that the measured growth understates true growth because our official statistics tend to miss the contribution to living standards from new products and improvements in product quality. For example, with the introduction of the indoor toilet, millions of people no longer had to struggle through the winter snows to relieve themselves in outhouses, yet this increased comfort never showed up in measured gross domestic product.

How can we picture the tremendous rise in output in our *AS-AD* apparatus? Figure 19-8 shows the way. The increase in inputs and improvements in efficiency led to a massive rightward shift of the *AS* curve from AS_{1900} to AS_{2008}. Production costs also increased sharply. For example, average earnings rose from $0.15 per hour in 1900 to over $30 per hour in 2008. These cost increases shifted the *AS* curve upward. The overall effect, then, was the increase in both output and prices shown in Figure 19-8.

The Role of Macroeconomic Policy

Macroeconomic policy played a central role in the improved business-cycle conditions of the last half-century. The discovery and application of macroeconomics, along with a good appreciation of the role and limitations of monetary and fiscal policy, reduced business-cycle volatility and led to the

Eye Therapies Exhibit 2127, 404 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Great Moderation. The application of fiscal policy, and especially monetary policy, helped lower unemployment and ensured largely stable prices over the last two decades. When the United States faced a major shock to its financial system in 2007–2009, central bankers remembered *and understood* the lessons of the Great Depression. They knew that financial fears are contagious, that bank collapses can lead to bank runs, and that instability breeds more instability. Knowledge of macroeconomic history and theory, and the intervention of the central bank as a lender of last resort, can cushion a banking shock and prevent bank crises from turning into deep depressions.

There is no miracle cure for macroeconomic shocks, however. When a steep decline in output and employment hit the United States in 2007–2009, monetary and fiscal policies were launched to soften the blow, but they could not completely offset it. Up to now, the knowledge is available to prevent depressions, but not to banish recessions.



SUMMARY

A. Key Concepts of Macroeconomics

1. Macroeconomics is the study of the behavior of the entire economy: It analyzes long-run growth as well as the cyclical movements in total output, unemployment and inflation, and international trade and finance. This contrasts with microeconomics, which studies the behavior of individual markets, prices, and outputs.
2. The United States proclaimed its macroeconomic goals in the Employment Act of 1946, which declared that federal policy was "to promote maximum employment, production, and purchasing power." Since then, the nation's priorities among these three goals have shifted. But all market economies still face three central macroeconomic questions: (*a*) Why do output and employment sometimes fall, and how can unemployment be reduced? (*b*) What are the sources of price inflation, and how can it be kept under control? (*c*) How can a nation increase its rate of economic growth?
3. In addition to these perplexing questions is the hard fact that there are inevitable conflicts or tradeoffs among these goals: Rapid growth in future living standards may mean reducing consumption today, and curbing inflation may involve a temporary period of high unemployment.
4. Economists evaluate the success of an economy's overall performance by how well it attains these objectives: (*a*) high levels and rapid growth of output (measured by real gross domestic product) and consumption; (*b*) a low unemployment rate and high employment, with an ample supply of good jobs; (*c*) low and stable inflation.
5. Before the science of macroeconomics was developed, countries tended to drift around in the shifting macroeconomic currents without a rudder. Today, there are numerous instruments with which governments can steer the economy: (*a*) Fiscal policy (government spending and taxation) helps determine the allocation of resources between private and collective goods, affects people's incomes and consumption, and provides incentives for investment and other economic decisions. (*b*) Monetary policy—particularly the setting of short-term interest rates by the central bank—affects all interest rates, asset prices, credit conditions, and exchange rates. The most heavily affected sectors are housing, business investment, consumer durables, and net exports.
6. The nation is but a small part of an increasingly integrated global economy in which countries are linked together through trade of goods and services and through financial flows. A smoothly running international economic system contributes to rapid economic growth, but the international economy can throw sand in the engine of growth when trade flows are interrupted or the international financial mechanism breaks down. Dealing with international trade and finance is high on the agenda of all countries.

B. Aggregate Supply and Demand

7. The central concepts for understanding the determination of national output and the price level are aggregate supply (*AS*) and aggregate demand (*AD*). Aggregate demand consists of the total spending in an economy by households, businesses, governments, and foreigners. It represents the total output that would be willingly bought at each price level, given the monetary and fiscal policies and other factors affecting demand. Aggregate supply describes how much output businesses would willingly produce and sell given prices, costs, and market conditions.

Eye Therapies Exhibit 2127, 405 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

8. *AS* and *AD* curves have the same shapes as the familiar supply and demand curves analyzed in microeconomics. But beware of potential confusions of microeconomic and aggregate supply and demand.
9. The overall macroeconomic equilibrium, determining both aggregate price and output, comes where the *AS* and *AD* curves intersect. At the equilibrium price level, purchasers willingly buy what businesses willingly sell. Equilibrium output can depart from full employment or potential output.
10. Recent American history shows an irregular cycle of aggregate demand and supply shocks and policy reactions. In the mid-1960s, war-bloated deficits plus easy money led to a rapid increase in aggregate demand. The result was a sharp upturn in prices and inflation. At the end of the 1970s, economic policymakers reacted to the rising inflation by tightening monetary policy and raising interest rates. The result lowered spending on interest-sensitive demands such as housing, investment, and net exports. Since the mid-1980s, the U.S. economy has experienced a period of low inflation and infrequent and, until recently, mild recessions.
11. Over the long run, the growth of potential output increased aggregate supply enormously and led to steady growth in output and living standards.

CONCEPTS FOR REVIEW

Major Macroeconomic Concepts

macroeconomics vs. microeconomics
gross domestic product (GDP), actual and potential
employment, unemployment, unemployment rate
inflation, deflation
consumer price index (CPI)
net exports
fiscal policy (government expenditures, taxation)
monetary policy

Aggregate Supply and Demand

aggregate supply, aggregate demand
AS curve, *AD* curve
equilibrium of *AS* and *AD*
sources of long-run economic growth

FURTHER READING AND INTERNET WEBSITES

Further Reading

The great classic of macroeconomics is John Maynard Keynes, *The General Theory of Employment, Interest, and Money* (Harcourt, New York, first published in 1935). Keynes was one of the most graceful writers among economists. An online edition of *The General Theory* is available at *www.marxists.org/reference/subject/economics/keynes/general-theory/*.

There are many good intermediate textbooks on macroeconomics. You may consult these when you want to dig more deeply into specific topics.

Websites

Macroeconomic issues are a central theme of analysis in *Economic Report of the President*. Various years are available online at *www.access.gpo.gov/eop*. Another good source on macroeconomic issues is the Congressional Budget Office, which issues periodic reports on the economy and the state of the budget at *www.cbo.gov*.

Research organizations often contain excellent online discussions of current macroeconomic issues. See especially the websites of the Brookings Institution, *www.brookings.org*, and the American Enterprise Institute, *www.aei.org*.

Some excellent blogs containing macroeconomics are the following: A blog of leading European and some American economists contains much interesting economic commentary at *www.voxeu.org;* the *International Herald Tribune* has a fine group of expert writers at *blogs.iht.com/tribtalk/business/globalization*.

Eye Therapies Exhibit 2127, 406 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

QUESTIONS FOR DISCUSSION

1. What are the major objectives of macroeconomics? Write a brief definition of each of these objectives. Explain carefully why each objective is important.
2. Using the data from the appendix to this chapter, calculate the following:
   a. The inflation rate in 1981 and 2007
   b. The growth rate of real GDP in 1982 and 1984
   c. The average inflation rate from 1970 to 1980 and from 2000 to 2007
   d. The average growth rate of real GDP from 1929 to 2008

   {*Hint:* The formulas in the text give the technique for calculating 1-year growth rates. Growth rates for multiple years use the following formula:

$$g_t^{(n)} = 100 \times \left[\left(\frac{X_t}{X_{t-n}} \right)^{1/n} - 1 \right]$$

   where $g_t^{(n)}$ is the average annual growth rate of the variable X for the n years between year $(t - n)$ and year t. For example, assume that the CPI in $(t - 2)$ is 100.0 while the CPI in year t is 106.09. Then the average rate of inflation is $100 \times \left[\left(\frac{106.09}{100.0} \right)^{1/2} - 1 \right] = 3$ percent per year.}
3. What would be the effect of each of the following on aggregate demand or on aggregate supply, as indicated (always holding other things constant)?
   a. A large cut in personal and business taxes (on *AD*)
   b. An arms-reduction agreement reducing defense spending (on *AD*)
   c. An increase in potential output (on *AS*)
   d. A monetary loosening that lowers interest rates (on *AD*)
4. For each of the events listed in question 3, use the *AS-AD* apparatus to show the effect on output and on the overall price level.
5. Put yourself in the shoes of an economic policymaker. The economy is in equilibrium with $P = 100$ and $Q = 3000$ = potential GDP. You refuse to "accommodate" inflation; that is, you want to keep prices absolutely stable at $P = 100$, no matter what happens to output. You can use monetary and fiscal policies to affect aggregate demand, but you cannot affect aggregate supply in the short run. How would you respond to:
   a. A surprise increase in investment spending
   b. A sharp food-price increase following catastrophic flooding of the Mississippi River
   c. A productivity decline that reduces potential output
   d. A sharp decrease in net exports that followed a deep depression in East Asia
6. In 1981–1983, the Reagan administration implemented a fiscal policy that reduced taxes and increased government spending.
   a. Explain why this policy would tend to increase aggregate demand. Show the impact on output and prices assuming only an *AD* shift.
   b. The supply-side school holds that tax cuts would affect aggregate supply mainly by increasing potential output. Assuming that the Reagan fiscal measures affected *AS* as well as *AD*, show the impact on output and the price level. Explain why the impact of the Reagan fiscal policies on output is unambiguous while the impact on prices is unclear.
7. The Clinton economic package as passed by Congress in 1993 had the effect of tightening fiscal policy by raising taxes and lowering spending. Show the effect of this policy (a) assuming that there is no counteracting monetary policy and (b) assuming that monetary policy completely neutralized the impact on GDP and that the lower deficit leads to higher investment and higher growth of potential output.
8. The United States experienced a major economic downturn in the early 1980s. Consider the data on real GDP and the price level in Table 19-2.
   a. For the years 1981 to 1985, calculate the rate of growth of real GDP and the rate of inflation. Can you determine in which year there was a steep business downturn or recession?
   b. In an *AS-AD* diagram like Figure 19-6 (page 379), draw a set of *AS* and *AD* curves that trace out the price and output equilibria shown in the table. How would you explain the recession that you have identified?

Year	Real GDP ($, billion, 2000 prices)	Price level* (2000 = 100)
1980	5,161.7	54.1
1981	5,291.7	59.1
1982	5,189.3	62.7
1983	5,423.8	65.2
1984	5,813.6	67.7
1985	6,053.7	69.7

*Note that the price index shown is the price index for GDP, which measures the price trend for all components of GDP.

TABLE 19-2.

Eye Therapies Exhibit 2127, 407 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Appendix 19

MACROECONOMIC DATA FOR THE UNITED STATES

Year	Nominal GDP ($, billion)	Real GDP, 2000 prices ($, billion)	Unemployment rate (%)	CPI 1982–1984 = 100	Inflation rate (CPI) (% per year)	Federal budget surplus (+) or deficit (−) ($, billion)	Net exports ($, billion)
1929	103.6	865.2	3.2	17.1	0.0	1.0	0.4
1933	56.4	635.5	24.9	13.0	−5.2	−0.9	0.1
1939	92.2	950.7	17.2	13.9	−1.4	−2.1	0.8
1945	223.1	1,786.3	1.9	18.0	2.2	−29.0	−0.8
1948	269.2	1,643.2	3.8	24.0	7.4	3.6	5.5
1950	293.8	1,777.2	5.2	24.1	1.1	5.5	0.7
1960	526.4	2,501.8	5.5	29.6	1.5	7.2	4.2
1970	1,038.5	3,771.9	5.0	38.8	5.7	−15.2	4.0
1971	1,127.1	3,898.7	6.0	40.5	4.1	−28.4	0.6
1972	1,238.3	4,104.9	5.6	41.8	3.2	−24.4	−3.4
1973	1,382.7	4,341.4	4.9	44.4	6.1	−11.3	4.1
1974	1,500.0	4,319.5	5.6	49.3	10.4	−13.8	−0.8
1975	1,638.3	4,311.2	8.5	53.8	8.7	−69.0	16.0
1976	1,825.3	4,540.9	7.7	56.9	5.6	−51.7	−1.6
1977	2,030.9	4,750.6	7.1	60.6	6.3	−44.1	−23.1
1978	2,294.7	5,015.0	6.1	65.2	7.4	−26.5	−25.4
1979	2,563.3	5,173.5	5.9	72.6	10.7	−11.3	−22.5
1980	2,789.5	5,161.7	7.2	82.4	12.7	−53.6	−13.1
1981	3,128.4	5,291.7	7.6	90.9	9.9	−53.3	−12.5
1982	3,255.0	5,189.3	9.7	96.5	6.0	−131.9	−20.0
1983	3,536.7	5,423.8	9.6	99.6	3.1	−173.0	−51.7
1984	3,933.2	5,813.6	7.5	103.9	4.3	−168.1	−102.7
1985	4,220.3	6,053.8	7.2	107.6	3.5	−175.0	−115.2
1986	4,462.8	6,263.6	7.0	109.7	1.9	−190.8	−132.7
1987	4,739.5	6,475.1	6.2	113.6	3.5	−145.0	−145.2
1988	5,103.8	6,742.7	5.5	118.3	4.0	−134.5	−110.4
1989	5,484.4	6,981.4	5.3	123.9	4.7	−130.1	−88.2
1990	5,803.1	7,112.5	5.6	130.7	5.3	−172.0	−78.0
1991	5,995.9	7,100.5	6.9	136.2	4.1	−213.7	−27.5
1992	6,337.7	7,336.6	7.5	140.3	3.0	−297.4	−33.2
1993	6,657.4	7,532.7	6.9	144.5	2.9	−273.5	−65.0
1994	7,072.2	7,835.5	6.1	148.2	2.6	−212.3	−93.6
1995	7,397.7	8,031.7	5.6	152.4	2.8	−197.0	−91.4
1996	7,816.9	8,328.9	5.4	156.9	2.9	−141.8	−96.2
1997	8,304.3	8,703.5	4.9	160.5	2.3	−55.8	−101.6
1998	8,747.0	9,066.9	4.5	163.0	1.5	38.8	−159.9
1999	9,268.4	9,470.4	4.2	166.6	2.2	103.6	−260.5
2000	9,817.0	9,817.0	4.0	172.2	3.3	189.5	−379.5
2001	10,128.0	9,890.7	4.7	177.0	2.8	46.7	−367.0
2002	10,469.6	10,048.9	5.8	179.9	1.6	−247.9	−424.4
2003	10,960.8	10,301.1	6.0	184.0	2.3	−372.1	−499.4
2004	11,685.9	10,675.7	5.5	188.9	2.6	−370.6	−615.4
2005	12,433.9	11,003.5	5.1	195.3	3.3	−318.3	−714.6
2006	13,194.7	11,319.4	4.6	201.6	3.2	−220.0	−762.0
2007	13,807.6	11,523.9	4.6	207.3	2.8	−399.4	−707.8
2008	14,304.4	11,666.0	5.8	215.2	4.1	−456.5	−727.9

TABLE 19A-1.

Table 19A-1 contains some of the major macroeconomic data discussed in this chapter. Major data can be obtained through government websites at *www.fedstats.gov, www.bea.gov,* or *www.bls.gov.*

Eye Therapies Exhibit 2127, 408 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

20

Measuring Economic Activity



When you can measure what you are speaking about, and express it in numbers, you know something about it; when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science.

Lord Kelvin

The single most important concept in macroeconomics is the gross domestic product (GDP), which measures the total value of goods and services produced in a country during a year. GDP is part of the *national income and product accounts* (or *national accounts*), which are a body of statistics that enables policymakers to determine whether the economy is contracting or expanding and whether a severe recession or inflation threatens. When economists want to determine the level of economic development of a country, they look at its GDP per capita.

While the GDP and the rest of the national accounts may seem to be arcane concepts, they are truly among the great inventions of modern times. Much as a satellite in space can survey the weather across an entire continent, so can the GDP give an overall picture of the state of the economy. In this chapter, we explain how economists measure GDP and other major macroeconomic indicators.

GROSS DOMESTIC PRODUCT: THE YARDSTICK OF AN ECONOMY'S PERFORMANCE

What is the *gross domestic product*? GDP is the name we give to the total market value of the final goods and services produced within a nation during a given year. It is the figure you get when you apply the measuring rod of money to the diverse goods and services—from apples to zithers—that a country produces with its land, labor, and capital resources. GDP equals the total production of consumption and investment goods, government purchases, and net exports to other lands.

The gross domestic product (GDP) is the most comprehensive measure of a nation's total output of goods and services. It is the sum of the dollar values of consumption (C), gross investment (I), government purchases of goods and services (G), and

Eye Therapies Exhibit 2127, 409 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

net exports (X) produced within a nation during a given year.

In symbols:

$$\text{GDP} = C + I + G + X$$

GDP is used for many purposes, but the most important one is to measure the overall performance of an economy. If you were to ask an economic historian what happened during the Great Depression, the best short answer would be:

> Between 1929 and 1933, GDP fell from $104 billion to $56 billion. This sharp decline in the dollar value of goods and services produced by the American economy caused high unemployment, hardship, a steep stock market decline, bankruptcies, bank failures, riots, and political turmoil.

Similarly, if you were to ask a macroeconomist about the second half of the twentieth century, she might reply:

> The second half of the twentieth century was a unique economic period. During those years, the affluent regions of the North—consisting of Japan, the United States, and Western Europe—experienced the most rapid growth of output per capita in recorded history. From the end of World War II until 2000, for example, real GDP per capita in the United States expanded by almost 250 percent.

We now discuss the elements of the national income and product accounts. We start by showing different ways of measuring GDP and distinguishing real from nominal GDP. We then analyze the major components of GDP. We conclude with a discussion of the measurement of the general price level and the rate of inflation.

Two Measures of National Product: Goods Flow and Earnings Flow

How do economists actually measure GDP? One of the major surprises is that we can measure GDP in two entirely independent ways. As Figure 20-1 shows, GDP can be measured either as a flow of products or as a sum of earnings.

To demonstrate the different ways of measuring GDP, we begin by considering an oversimplified world in which there is no government, no foreign trade, and no investment. For the moment, our little economy produces only *consumption goods,* which are items that are purchased by households to satisfy their wants. (Important note: Our first example is oversimplified to show the basic ideas. In the realistic examples that follow, we will add investment, government, and the foreign sector.)

Flow-of-Product Approach. Each year the public consumes a wide variety of final goods and services: goods such as apples, computer software, and blue jeans; services such as health care and haircuts. We include only *final goods*—goods ultimately bought and used by consumers. Households spend their incomes for these consumer goods, as is shown in the upper loop of Figure 20-1. Add together all the consumption dollars spent on these final goods, and you will arrive at this simplified economy's total GDP.

Thus, in our simple economy, you can easily calculate national income or product as the sum of the annual flow of final goods and services: (price of blue jeans × number of blue jeans) plus (price of apples × number of apples) and so forth for all other final goods. The gross domestic product is defined as the total money value of the flow of final products produced by the nation.

National accountants use market prices as weights in valuing different commodities because market prices reflect the relative economic value of diverse goods and services. That is, the relative prices of different goods reflect how much consumers value their last (or marginal) units of consumption of these goods.

Earnings or Income Approach. The second and equivalent way to calculate GDP is the income accounts (also called the earnings or cost approach). Look at the lower loop in Figure 20-1. Through it flow all the costs of doing business; these costs include the wages paid to labor, the rents paid to land, the profits paid to capital, and so forth. But these business costs are also the earnings that households receive from firms. By measuring the annual flow of these earnings or incomes, statisticians will again arrive at the GDP.

Hence, a second way to calculate GDP is as the total of factor earnings (wages, interest, rents, and

Eye Therapies Exhibit 2127, 410 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

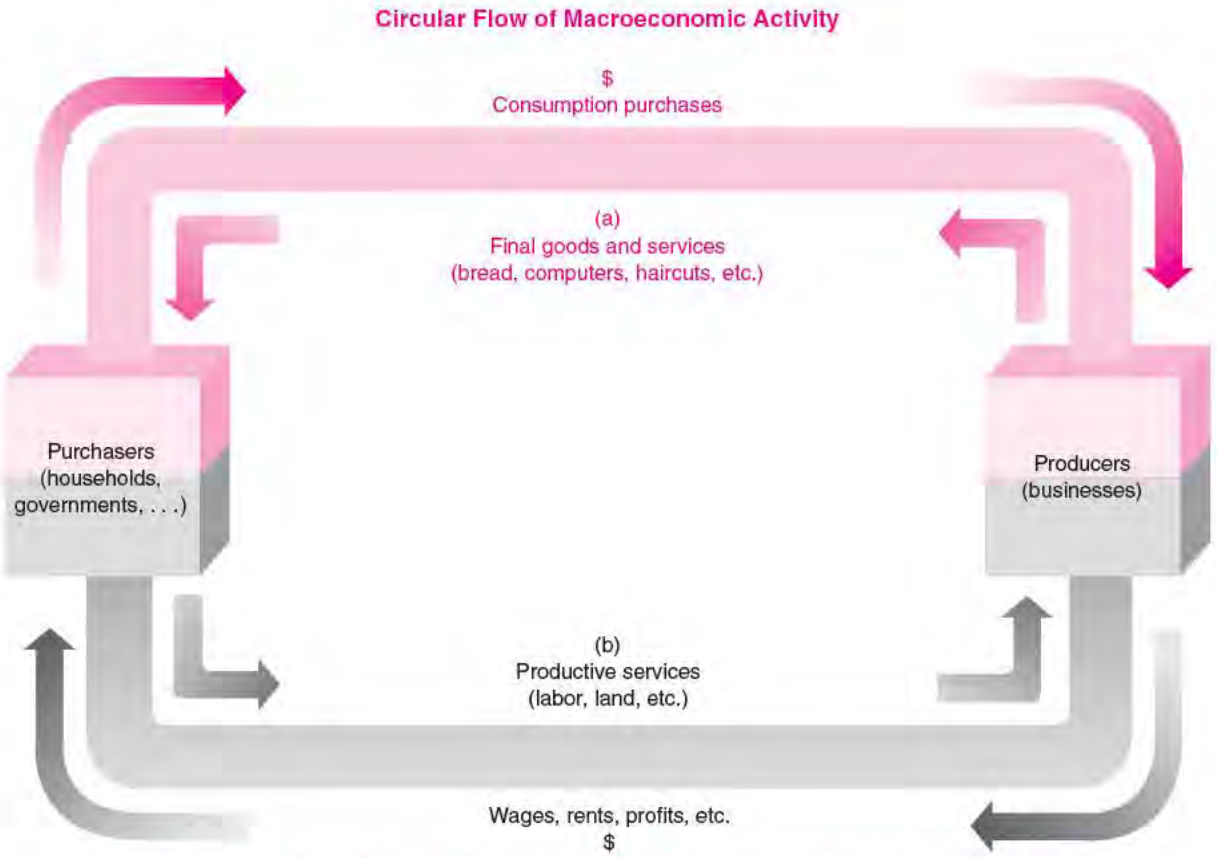


FIGURE 20-1. Gross Domestic Product Can Be Measured Either as (*a*) a Flow of Final Products or, Equivalently, as (*b*) a Flow of Earnings or Incomes

In the upper loop, purchasers buy final goods and services. The total dollar flow of their spending each year is one measure of gross domestic product. The lower loop measures the annual flow of costs of output: the earnings that businesses pay out in wages, rent, interest, dividends, and profits.

The two measures of GDP must always be identical. Note that this figure is the macroeconomic counterpart of Fig. 2-1, which presented the circular flow of supply and demand.

profits) that are the costs of producing society's final products.

Equivalence of the Two Approaches. Now we have calculated GDP by the upper-loop flow-of-product approach and by the lower-loop earnings-flow approach. Which is the better approach? The surprise is that *they are exactly the same.*

We can see why the product and earnings approaches are identical by examining a simple barbershop economy. Say the barbers have no expenses other than labor. If they sell 10 haircuts at $8 each, GDP is $80. But the barbers' earnings (in wages and profits) are also exactly $80. Hence, the GDP here is identical whether measured as a flow of products ($80 worth of haircuts) or as a flow of costs and incomes ($80 worth of wages and profits).

In fact, the two approaches are identical because we have included "profits" in the lower loop along with other incomes. What exactly is profit? Profit is what remains from the sale of a product after you have paid the other factor costs—wages, interest, and rents. It

Eye Therapies Exhibit 2127, 411 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

(a) Income Statement of Typical Farm

Output in Farming		Earnings	
Sales of goods (corn, apples, etc.)	$1,000	Costs of production:	
		Wages	$ 800
		Rents	100
		Interest	25
		Profits (residual)	75
Total	$1,000	Total	$1,000

(b) National Product Account (millions of dollars)

Upper-Loop Flow of Product		Lower-Loop Flow of Earnings	
Final output (10 × 1,000)	$10,000	Costs or earnings:	
		Wages (10 × 800)	$ 8,000
		Rents (10 × 100)	1,000
		Interest (10 × 25)	250
		Profits (10 × 75)	750
GDP total	$10,000	GDP total	$10,000

TABLE 20-1. Construction of National Product Accounts from Business Accounts

Part (a) shows the income statement of a typical farm. The left side shows the value of production, while the right side shows the farm's costs. Part (b) then adds up or aggregates the 10 million identical farms to obtain total GDP. Note that GDP from the product side exactly equals GDP from the earnings side.

is the residual that adjusts automatically to make the lower loop's costs or earnings exactly match the upper loop's value of goods and services.

To sum up:

GDP, or gross domestic product, can be measured in two different ways: (1) as the flow of spending on final products, or (2) as the total costs or incomes of inputs. Both approaches yield exactly the same measure of GDP.

National Accounts Derived from Business Accounts

You might wonder where on earth economists find all the data for the national accounts. In practice, government economists draw on a wide array of sources, including surveys, income-tax returns, retail-sales statistics, and employment data.

The most important source of data is business accounts. An *account* for a firm or nation is a numerical record of all flows (outputs, costs, etc.) during a given period. We can show the relationship between business accounts and national accounts by constructing the accounts for an economy made up only of farms. The top half of Table 20-1 shows the results of a year's farming operations for a single, typical farm. We put sales of final products on the left-hand side and the various costs of production on the right. The bottom half of Table 20-1 shows how to construct the GDP accounts for our simple agrarian economy in which all final products are produced on 10 million identical farms. The national accounts simply add together or *aggregate* the outputs and costs of the 10 million identical farms to get the two different measures of GDP.

The Problem of "Double Counting"

We defined GDP as the total production of final goods and services. A *final product* is one that is produced and sold for consumption or investment. GDP excludes *intermediate goods*—goods that are used up to produce other goods. GDP therefore includes

Eye Therapies Exhibit 2127, 412 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

bread but not flour, and home computers but not computer chips.

For the flow-of-product calculation of GDP, excluding intermediate products poses no major complications. We simply include the bread and home computers in GDP but avoid including the flour and yeast that went into the bread or the chips and plastic that went into the computers. If you look again at the upper loop in Figure 20-1, you will see that bread and computers appear in the flow of products, but you will not find any flour or computer chips.

What has happened to products like flour and computer chips? They are intermediate products and are simply cycling around inside the block marked "Producers." If they are not bought by consumers, they never show up as final products in GDP.

"Value Added" in the Lower Loop. A new statistician who is being trained to make GDP measurements might be puzzled, saying:

> I can see that, if you are careful, your upper-loop product approach to GDP will avoid including intermediate products. But aren't you in some trouble when you use the lower-loop cost or earnings approach?
>
> After all, when we gather income statements from the accounts of firms, won't we pick up what grain merchants pay to wheat farmers, what bakers pay to grain merchants, and what grocers pay to bakers? Won't this result in double counting or even triple counting of items going through several productive stages?

These are good questions, but there is an ingenious technique that resolves the problem. In making lower-loop earnings measurements, statisticians are very careful to include in GDP only a firm's value added. **Value added** is the difference between a firm's sales and its purchases of materials and services from other firms.

In other words, in calculating the GDP earnings or value added by a firm, the statistician includes all costs except for payments made to other businesses. Hence business costs in the form of wages, salaries, interest payments, and dividends are included in value added, but purchases of wheat or steel or electricity are excluded from value added. Why are all the purchases from other firms excluded from value added to obtain GDP? Because those purchases will get properly counted in GDP in the values added by other firms.

Table 20-2 uses the stages of bread production to illustrate how careful adherence to the value-added approach enables us to subtract purchases of intermediate goods that show up in the income statements

Bread Receipts, Costs, and Value Added (cents per loaf)

Stage of production	(1) Sales receipts	(2) *Less:* Cost of intermediate products		(3) Value added (wages, profits, etc.) (3) = (1) − (2)
Wheat	23	0	=	23
Flour	53	23	=	30
Baked dough	110	53	=	57
Final product: bread	190	110	=	80
Total	376	186		190 (sum of value added)

TABLE 20-2. GDP Sums Up Value Added at Each Production Stage

To avoid double counting of intermediate products, we calculate value added at each stage of production. This involves subtracting all the costs of materials and intermediate products bought from other businesses from total sales. Note that every blue intermediate-product item both appears in column (1) and is subtracted in the next stage of production in column (2). (By how much would we overestimate GDP if we counted all receipts, not just value added? The overestimate would be 186 cents per loaf.)

Eye Therapies Exhibit 2127, 413 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

of farmers, millers, bakers, and grocers. The final calculation shows the desired equality between (1) final sales of bread and (2) total earnings, calculated as the sum of all values added in all the different stages of bread production.

Value-added approach: To avoid double counting, we take care to include only final goods in GDP and to exclude the intermediate goods that are used up in making the final goods. By measuring the value added at each stage, taking care to subtract expenditures on the intermediate goods bought from other firms, the lower-loop earnings approach properly avoids all double counting and records wages, interest, rents, and profits exactly one time.

DETAILS OF THE NATIONAL ACCOUNTS

Now that we have an overview of the national income and product accounts, we will proceed, in the rest of this chapter, on a whirlwind tour of the various sectors. Before we start on the journey, look at Table 20-3 to get an idea of where we are going. This table shows a summary set of accounts for both the product and the income sides. If you understand the structure of the table and the definitions of the terms in it, you will be well on your way to understanding GDP and its family of components.

Real vs. Nominal GDP: "Deflating" GDP by a Price Index

We define GDP as the dollar value of goods and services. In measuring the dollar value, we use the measuring rod of *market prices* for the different goods and services. But prices change over time, as inflation generally sends prices upward year after year. Who would want to measure things with a rubber yardstick—one that stretches in your hands from day to day—rather than a rigid and invariant yardstick?

The problem of changing prices is one of the problems economists have to solve when they use money as their measuring rod. Clearly, we want a measure of the nation's output and income that uses an invariant yardstick. Economists can replace the elastic yardstick with a reliable one by removing the price-increase component so as to create a real or quantity index of national output.

Here is the basic idea: We can measure the GDP for a particular year using the actual market prices of that year; this gives us the **nominal GDP,** or GDP at current prices. But we are usually more interested in determining what has happened to the **real GDP,** which is an index of the volume or quantity of goods and services produced. Real GDP is calculated by tracking the volume or quantity of production after removing the influence of changing prices or inflation. Hence, nominal GDP is calculated using changing prices, while real GDP represents the change in the volume of total output after price changes are removed.

Product Approach	Earnings Approach
Components of gross domestic product:	**Earnings or income approach to gross domestic product:**
Consumption (C)	Compensation of labor (wages, salaries, and supplements)
+ Gross private domestic investment (I)	+ Corporate profits
+ Government purchases (G)	+ Other property income (rent, interest, proprietors' income)
+ Net exports (X)	+ Depreciation
	+ Net production taxes
Equals: Gross domestic product	**Equals: Gross domestic product**

TABLE 20-3. Overview of the National Income and Product Accounts

This table presents the major components of the two sides of the national accounts. The left side shows the components of the product approach (or upper loop); the symbols C, I, G, and X are often used to represent these four items of GDP. The right side shows the components of the earnings or income approach (or lower loop). Each approach will ultimately add up to exactly the same GDP.

Eye Therapies Exhibit 2127, 414 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Date	(1) Nominal GDP (current $, billion)	(2) Index number of prices (GDP deflator, 1929 = 1)	(3) Real GDP ($, billion, 1929 prices) (3) = (1)/(2)
1929	104	1.00	$\frac{104}{1.00} = 104$
1933	56	0.74	$\frac{56}{0.74} = 76$

TABLE 20-4. Real (or Inflation-Corrected) GDP Is Obtained by Dividing Nominal GDP by the GDP Deflator

Using the price index of column (2), we deflate column (1) to get real GDP in column (3). (Riddle: Can you show that 1929's real GDP was $77 billion in terms of 1933 prices? *Hint:* With 1933 as a base of 1, 1929's price index is 1.35.)

The difference between nominal GDP and real GDP is the **price of GDP,** sometimes called the **GDP deflator.**

A simple example will illustrate the general idea. Say that a country produces 1000 bushels of corn in year 1 and 1010 bushels in year 2. The price of a bushel is $1 in year 1 and $2 in year 2. We can calculate nominal GDP (PQ) as $\$1 \times 1000 = \$1000$ in year 1 and $\$2 \times 1010 = \$2020$ in year 2. Nominal GDP therefore grew by 102 percent between the two years.

But the actual amount of output did not grow anywhere near that rapidly. To find real output, we need to consider what happened to prices. One common approach is to use the first year as the base year. The *base year* is the year in which we measure prices. We can, for index purposes, set the price index for the first year (the base year) at $P_1 = 1$. This means that output will be measured in prices of the base year. From the data in the previous paragraph, we see that the GDP deflator is $P_2 = \$2/\$1 = 2$ in year 2. Real GDP (Q) is equal to nominal GDP (PQ) divided by the GDP deflator (P). Hence real GDP was equal to $\$1000/1 = \$1000$ in year 1 and $\$2020/2 = \$1010$ in year 2. Thus the growth in real GDP, which corrects for the change in prices, is 1 percent and equals the growth in the output of corn, as it should.

A 1929–1933 comparison will illustrate the deflation process for an actual historical episode. Table 20-4 gives nominal GDP figures of $104 billion for 1929 and $56 billion for 1933. This represents a 46 percent drop in nominal GDP from 1929 to 1933. But the government estimates that prices on average dropped about 26 percent over this period. If we choose 1929 as our base year, with the GDP deflator of 1 in that year, this means that the 1933 price index was 0.74. So our $56 billion of GDP in 1933 was really worth much more than half the $104 billion GDP of 1929. Table 20-4 shows that, in terms of 1929 prices, or dollars of 1929 purchasing power, real GDP fell to $76 billion. Hence, part of the near-halving shown by the nominal GDP was due to the rapidly declining price level, or deflation, during the Great Depression.

The green line in Figure 20-2 shows the growth of nominal GDP since 1929, expressed in the actual dollars and prices that were current in each historical year. Then, for comparison, the real GDP, expressed in 2000 dollars, is shown in blue. Clearly, much of the increase in nominal GDP over the last eight decades was due to inflation in the price units of our money yardstick.

Table 20-4 shows the simplest way of calculating real GDP and the GDP deflator. Sometimes these calculations give misleading results, particularly when the relative prices and quantities of important goods are changing rapidly. For example, over the last three decades, computer prices have been falling very sharply while the quantity of computers produced has risen rapidly (we return to this issue in our discussion of price indexes below).

Eye Therapies Exhibit 2127, 415 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

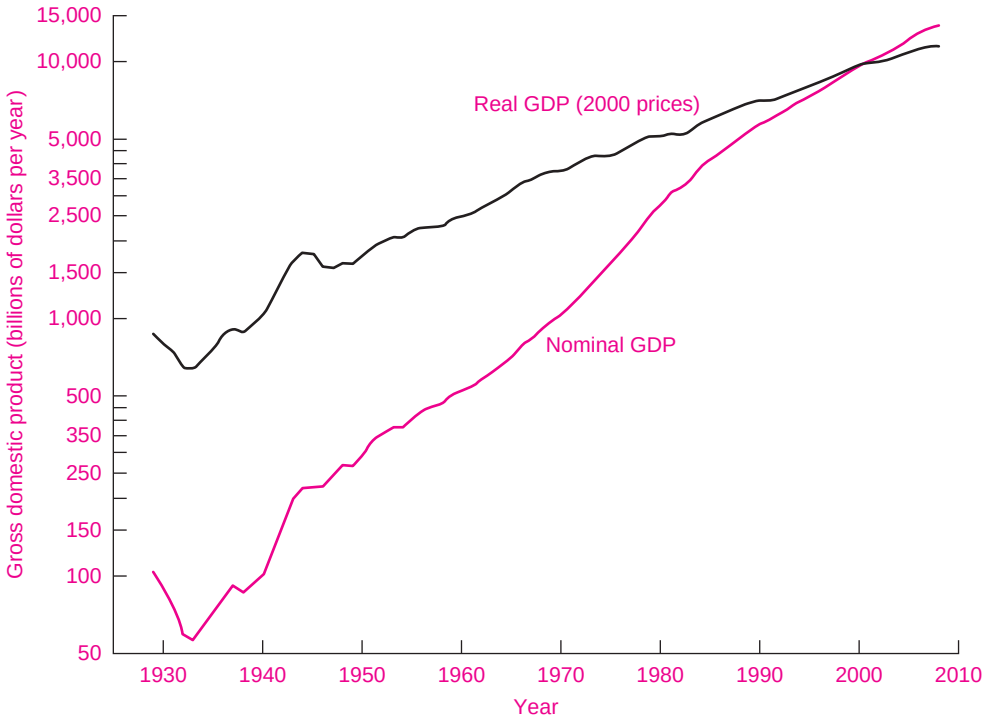


FIGURE 20-2. Nominal GDP Grows Faster than Real GDP because of Price Inflation

The rise in nominal GDP exaggerates the rise in output. Why? Because growth in nominal GDP includes increases in prices as well as growth in output. To obtain an accurate measure of real output, we must correct GDP for price changes.

Source: U.S. Bureau of Economic Analysis.

When relative prices of different goods are changing very rapidly, using prices of a fixed year will give a misleading estimate of real GDP growth. To correct for this bias, statisticians use a procedure known as *chain weighting*. Instead of the relative weights on each good being kept fixed (say, by the use of weights for a given year, like 1990), the weights of the different goods and services change each year to reflect the changes in spending patterns in the economy. Today, the official U.S. government measures of real GDP and the GDP price index rely upon chain weights. The technical names for these constructs are "real GDP in chained dollars" and the "chain-type price index for GDP." As a shorthand, we generally refer to these as real GDP and the GDP price index.

Further Details on Chain Weights. The details of using chain weights are somewhat involved, but we can get the basic idea using a simple example. The calculation of chain weights involves linking the output or price series together by multiplying the growth rates from one period to another. An example for a haircut economy will show how this works. Say that the value of the haircuts was $300 in 2003. Further suppose that the quantity of haircuts increased by 1 percent from 2003 to 2004 and by 2 percent from 2004 to 2005. The value of real GDP (in chained 2003 dollars) would be $300 in 2003, then $300 × 1.01 = $303 in 2004, and then $303 × 1.02 = $309.06 in 2005. With many different goods and services, we would add together the growth rates of the different components of apples, bananas, catamarans, and so on, and weight the growth rates by the expenditure or output shares of the different goods.

To summarize:

Nominal GDP (PQ) represents the total money value of final goods and services produced in a given year, where the values are expressed in terms of the

Eye Therapies Exhibit 2127, 416 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

market prices of each year. Real GDP (Q) removes price changes from nominal GDP and calculates GDP in terms of the quantities of goods and services. The following equations provide the link between nominal GDP, real GDP, and the GDP price index:

$$Q = \text{real GDP} = \frac{\text{nominal GDP}}{\text{GDP price index}} = \frac{PQ}{P}$$

To correct for rapidly changing relative prices, the U.S. national accounts use chain weights to construct real GDP and price indexes.

Consumption

The first important part of GDP is consumption, or "personal consumption expenditures." Consumption is by far the largest component of GDP, equaling about two-thirds of the total in recent years. Figure 20-3 shows the fraction of GDP devoted to consumption over the last eight decades. Consumption expenditures are divided into three categories: durable goods such as automobiles, nondurable goods such as food, and services such as medical care. The most rapidly growing sector is services.

Investment and Capital Formation

So far, our analysis has banished all capital. In real life, however, nations devote part of their output to production of capital—durable items that increase future production. Increasing capital requires the sacrifice of current consumption to increase future consumption. Instead of eating more pizza now, people build new pizza ovens to make it possible to produce more pizza for future consumption.

In the accounts, **investment** consists of the additions to the nation's capital stock of buildings, equipment, software, and inventories during a year. The

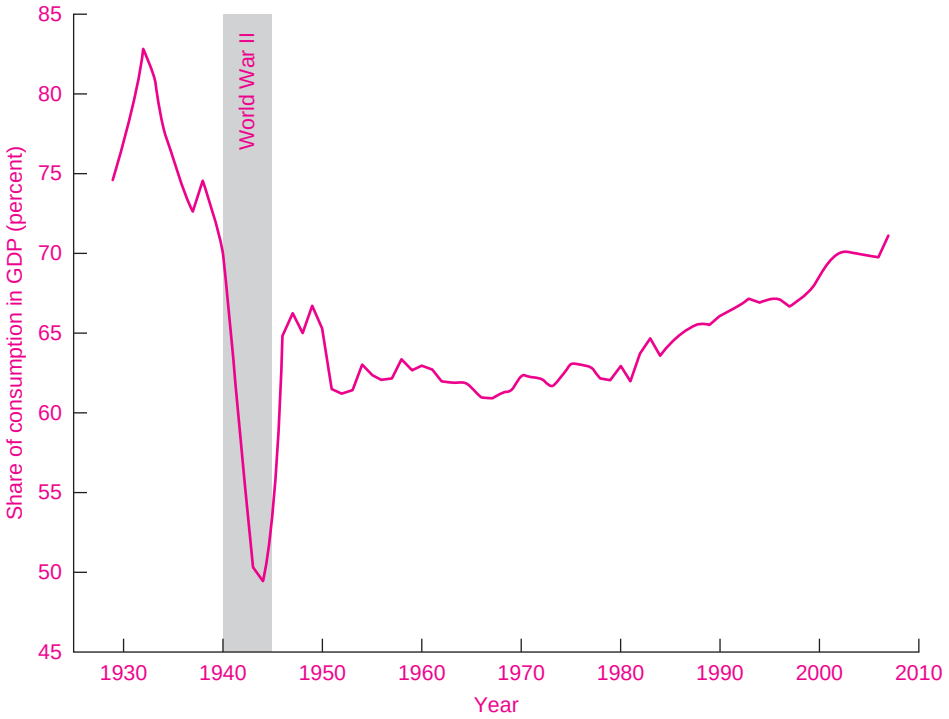


FIGURE 20-3. Share of Consumption in National Output Has Risen Recently

The share of consumption in total GDP rose during the Great Depression as investment prospects soured, then shrank sharply during World War II when the war effort displaced civilian needs. In recent years, consumption has grown more rapidly than total output as the national saving rate and government purchases have declined.

Source: U.S. Bureau of Economic Analysis.

Eye Therapies Exhibit 2127, 417 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

national accounts include mainly tangible capital (such as buildings and computers) and omit most intangible capital (such as research-and-development or educational expenses).



Real Investment versus Financial Investment

Economists define "investment" (or sometimes *real investment*) as production of durable capital goods. In common usage, "investment" often denotes using money to buy General Motors stock or to open a savings account. For clarity, economists call this *financial investment*. Try not to confuse these two different uses of the word "investment."

If I take $1000 from my safe and buy some stocks, this is not what macroeconomists call investment. I have simply exchanged one financial asset for another. Investment takes place when a durable capital good is produced.

How does investment fit into the national accounts? Economic statisticians recognize that if people are using part of society's production for capital formation, such outputs must be included in the upper-loop flow of GDP. Investments represent additions to the stock of durable capital that increase production possibilities in the future. So we must modify our original definition to read:

Gross domestic product is the sum of all final products. Along with consumption goods and services, we must also include gross investment.

Net vs. Gross Investment. Our revised definition includes "gross investment" along with consumption. What does the word "gross" mean in this context? It indicates that investment includes all investment goods produced. Gross investment is not adjusted for **depreciation,** which measures the amount of capital that has been used up in a year. Thus gross investment includes all the machines, factories, and houses built during a year—even though some were produced simply to replace old capital goods that burned down or were thrown on the scrap heap.

If you want to get a measure of the increase in society's capital, gross investment is not a sensible measure. Because it does not subtract depreciation, gross investment is too large a number—too gross.

An analogy to population will make clear the importance of considering depreciation. If you want to measure the increase in the size of the population, you cannot simply count the number of births, for this would clearly exaggerate the net change in population. To get population growth, you must also subtract the number of deaths.

The same point holds for capital. To find the net increase in capital, you must start with gross investment and subtract the deaths of capital in the form of depreciation, or the amount of capital used up.

Thus to estimate the increase in the capital stock we measure *net investment*. Net investment is always births of capital (gross investment) less deaths of capital (capital depreciation):

Net investment equals gross investment minus depreciation.

Government Purchases

Some of our national output is purchased by federal, state, and local governments, and these purchases are clearly part of our GDP. Some government purchases are consumption-type goods (like food for the military), while some are investment-type items (such as schools or roads). In measuring government's contribution to GDP, we simply add all these government purchases to the flow of private consumption, private investment, and, as we will see later, net exports.

Hence, all the government payroll expenditures on its employees plus the costs of goods it buys from private industry (lasers, roads, and airplanes) are included in this third category of flow of products, called "government consumption expenditures and gross investment." This category equals the contribution of federal, state, and local governments to GDP.

Exclusion of Transfer Payments. Does this mean that every dollar of government expenditure is included in GDP? Definitely not. GDP includes only government purchases; it excludes spending on transfer payments.

Government **transfer payments** are payments to individuals that are not made in exchange for goods or services supplied. Examples of government transfers include unemployment insurance, veterans' benefits, and old-age or disability payments. These

Eye Therapies Exhibit 2127, 418 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

payments meet important social purposes. But they are not purchases of current goods or services, and they are therefore omitted from GDP.

Thus if you teach in the local public school and receive a salary from the government, your salary is a factor payment and your services are included in GDP. If you receive a social security benefit as a retired worker, that payment is a transfer payment and is excluded from GDP. Similarly, government interest payments are treated as transfers and are excluded from GDP.

Finally, do not confuse the way the national accounts measure government spending on goods and services (G) with the official government budget. When the Treasury measures its expenditures, it includes purchases of goods and services (G) *plus* transfers.

Taxes. In using the flow-of-product approach to compute GDP, we need not worry about how the government finances its spending. It does not matter whether the government pays for its goods and services by taxing, by printing money, or by borrowing. Wherever the dollars come from, the statistician computes the governmental component of GDP as the actual cost to the government of the goods and services.

But while it is fine to ignore taxes in the flow-of-product approach, we must account for taxes in the earnings or cost approach to GDP. Consider wages, for example. Part of my wage is turned over to the government through personal income taxes. These direct taxes definitely do get included in the wage component of business expenses, and the same holds for direct taxes (personal or corporate) on interest, rent, and profits.

Or consider the sales tax and other indirect taxes that manufacturers and retailers have to pay on a loaf of bread (or on the wheat, flour, and dough stages). Suppose these indirect taxes total 10 cents per loaf, and suppose wages, profit, and other value-added items cost the bread industry 90 cents. What will the bread sell for in the product approach? For 90 cents? Surely not. The bread will sell for $1, equal to 90 cents of factor costs plus 10 cents of indirect taxes.

Thus the cost approach to GDP includes both indirect and direct taxes as elements of the cost of producing final output.

Net Exports

The United States is an open economy engaged in importing and exporting goods and services. The last component of GDP—and an increasingly important one in recent years—is **net exports,** the difference between exports and imports of goods and services.

How do we draw the line between our GDP and other countries' GDPs? The U.S. GDP represents all goods and services produced within the boundaries of the United States. Production differs from sales in the United States in two respects. First, some of our production (Iowa wheat and Boeing aircraft) is bought by foreigners and shipped abroad, and these items constitute our *exports.* Second, some of what we consume at home (Mexican oil and Japanese cars) is produced abroad, and such items are American *imports.*

A Numerical Example. We can use a simple farming economy to understand how the national accounts work. Suppose that Agrovia produces 100 bushels of corn and 7 bushels are imported. Of these, 87 bushels are consumed (in C), 10 go for government purchases to feed the army (as G), and 6 go into domestic investment as increases in inventories (I). In addition, 4 bushels are exported, so net exports (X) are 4 – 7, or minus 3.

What, then, is the composition of the GDP of Agrovia? It is the following:

$$\begin{aligned}\text{GDP} &= 87 \text{ of } C + 10 \text{ of } G + 6 \text{ of } I - 3 \text{ of } X \\ &= 100 \text{ bushels}\end{aligned}$$

Gross Domestic Product, Net Domestic Product, and Gross National Product

Although GDP is the most widely used measure of national output in the United States, two other concepts are frequently cited: net domestic product and gross national product.

Recall that GDP includes *gross* investment, which is net investment plus depreciation. A little thought suggests that including depreciation is rather like including wheat as well as bread. A better measure would include only *net* investment in total output. By subtracting depreciation from GDP we obtain **net domestic product** (NDP). If NDP is a sounder measure of a nation's output than GDP, why do national accountants focus on GDP? They do so because

Eye Therapies Exhibit 2127, 419 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

1. **GDP from the product side is the sum of four major components:**
   - Personal consumption expenditures on goods and services (C)
   - Gross private domestic investment (I)
   - Government consumption expenditures and gross investment (G)
   - Net exports of goods and services (X), or exports minus imports
2. **GDP from the cost side is the sum of the following major components:**
   - Compensation (wages, salaries, and supplements)
   - Property income (corporate profits, proprietors' incomes, interest, and rents)
   - Production taxes and depreciation of capital

   (Remember to use the value-added technique to prevent double counting of intermediate goods bought from other firms.)
3. **The product and cost measures of GDP are identical** (by adherence to the rules of value-added bookkeeping and the definition of profit as a residual).
4. **Net domestic product (NDP) equals GDP minus depreciation.**

TABLE 20-5. Key Concepts of the National Income and Product Accounts

depreciation is somewhat difficult to estimate, whereas gross investment can be estimated fairly accurately.

An alternative measure of national output, widely used until recently, is **gross national product** (GNP). What is the difference between GNP and GDP? GNP is the total output produced with labor or capital *owned by U.S. residents,* while GDP is the output produced with labor and capital *located inside the United States.*

For example, some of the U.S. GDP is produced in Honda plants that are owned by Japanese corporations operating in the U.S. The profits from these plants are included in U.S. GDP but not in U.S. GNP because Honda is a Japanese company. Similarly, when an American economist flies to Japan to give a paid lecture on baseball economics, payment for that lecture would be included in Japanese GDP and in American GNP. For the United States, GDP is very close to GNP, but these may differ substantially for very open economies.

To summarize:

Net domestic product (NDP) equals the total final output produced within a nation during a year, where output includes net investment, or gross investment less depreciation:

$$\text{NDP} = \text{GDP} - \text{depreciation}$$

Gross national product (GNP) is the total final output produced with inputs owned by the residents of a country during a year.

Table 20-5 provides a comprehensive definition of important components of GDP.

GDP and NDP: A Look at Numbers

Armed with an understanding of the concepts, we can turn to look at the actual data in the important Table 20-6.

Flow-of-Product Approach. Look first at the left side of Table 20-6. It gives the upper-loop, flow-of-product approach to GDP. Each of the four major components appears there, along with the dollar total for each component for 2007. Of these, C and G and their obvious subclassifications require little discussion.

Gross private domestic investment does require one comment. Its total ($2130 billion) includes all new business investment, residential construction, and increase in inventory of goods. This gross total is the amount before a subtraction for depreciation of capital. After subtracting $1721 billion of depreciation from gross investment, we obtain $410 billion of net investment.

Finally, note the large negative entry for net exports, −$708 billion. This negative entry represents the fact that in 2007 the United States imported $708 billion more in goods and services than it exported.

Adding up the four components on the left gives the total GDP of $13,808 billion. This is the harvest

Eye Therapies Exhibit 2127, 420 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Gross Domestic Product, 2007 (billions of current dollars)

Production Approach			Earnings or Cost Approach	
1. Personal consumption expenditures		9,710	1. Compensation of employees	7,812
Durable goods	1,083		2. Proprietors' income	1,056
Nondurable goods	2,833		3. Rental income	40
Services	5,794		4. Net interest	664
2. Gross private domestic investment		2,130	5. Corporate profits (with adjustments)	1,642
Fixed investment			6. Depreciation	1,721
Nonresidential	1,504		7. Production taxes, statistical	
Residential	630		discrepancy, and miscellaneous	872
Change in private inventories	−4			
3. Net exports of goods and services		−708		
Exports	1,662			
Imports	2,370			
4. Government consumption expenditures and gross investment		2,675		
Federal	979			
State and local	1,696			
Gross domestic product		**13,808**	**Gross domestic product**	**13,808**

TABLE 20-6. The Two Ways of Looking at the GDP Accounts, in Actual Numbers

The left side measures flow of products (at market prices). The right side measures flow of costs (factor earnings and depreciation).

Source: U.S. Bureau of Economic Analysis.

we have been working for: the money measure of the American economy's overall performance for 2007.

Flow-of-Cost Approach. Now turn to the right-hand side of the table, which gives the lower-loop, flow-of-cost approach. Here we have all *costs of production* plus *taxes* and *depreciation*.

Compensation of employees represents wages, salaries, and other employee supplements. Net interest is a similar item.

Rent income of persons includes rents received by landlords. In addition, if you own your own home, you are treated as *paying rent to yourself*. This is one of many "imputations" (or derived data) in the national accounts. It makes sense if we really want to measure the housing services the American people are enjoying and do not want the estimate to change when people decide to own a home rather than rent one.

Production taxes are included as a separate item along with some small adjustments, including the inevitable "statistical discrepancy," which reflects the fact that the officials never have every bit of needed data.[1]

Depreciation on capital goods that were used up must appear as an expense in GDP, just like other expenses. Profit is a residual—what is left over after all other costs have been subtracted from total sales. There are two kinds of profits: profit of corporations and net earnings of unincorporated enterprises.

Income of unincorporated enterprises consists of earnings of partnerships and single-ownership businesses. This includes much farm and professional

[1] Statisticians work with incomplete reports and fill in data gaps by estimation. Just as measurements in a chemistry lab differ from the ideal, so do errors creep into both upper- and lower-loop GDP estimates. These are balanced by an item called the "statistical discrepancy." Along with the civil servants who are heads of units called "Wages," "Interest," and so forth, there actually used to be someone with the title "Head of the Statistical Discrepancy." If data were perfect, that individual would have been out of a job.

Eye Therapies Exhibit 2127, 421 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

income. Finally, corporate profits before taxes are shown.

On the right side, the flow-of-cost approach gives us the same $13,808 billion of GDP as does the flow-of-product approach. The right and left sides do agree.

From GDP to Disposable Income

The basic GDP accounts are of interest not only for themselves but also because of their importance for understanding how consumers and businesses behave. Some further distinctions will help illuminate the way the nation's books are kept.

National Income. To help us understand the division of total income among the different factors of production, we construct data on *national income (NI)*. *NI* represents the total incomes received by labor, capital, and land. It is constructed by subtracting depreciation from GDP. National income equals total compensation of labor, rental income, net interest, income of proprietors, and corporate profits.

The relationship between GDP and national income is shown in the first two bars of Figure 20-4. The left-hand bar shows GDP, while the second bar shows the subtractions required to obtain *NI*.

From GDP to National Income to Disposable Income

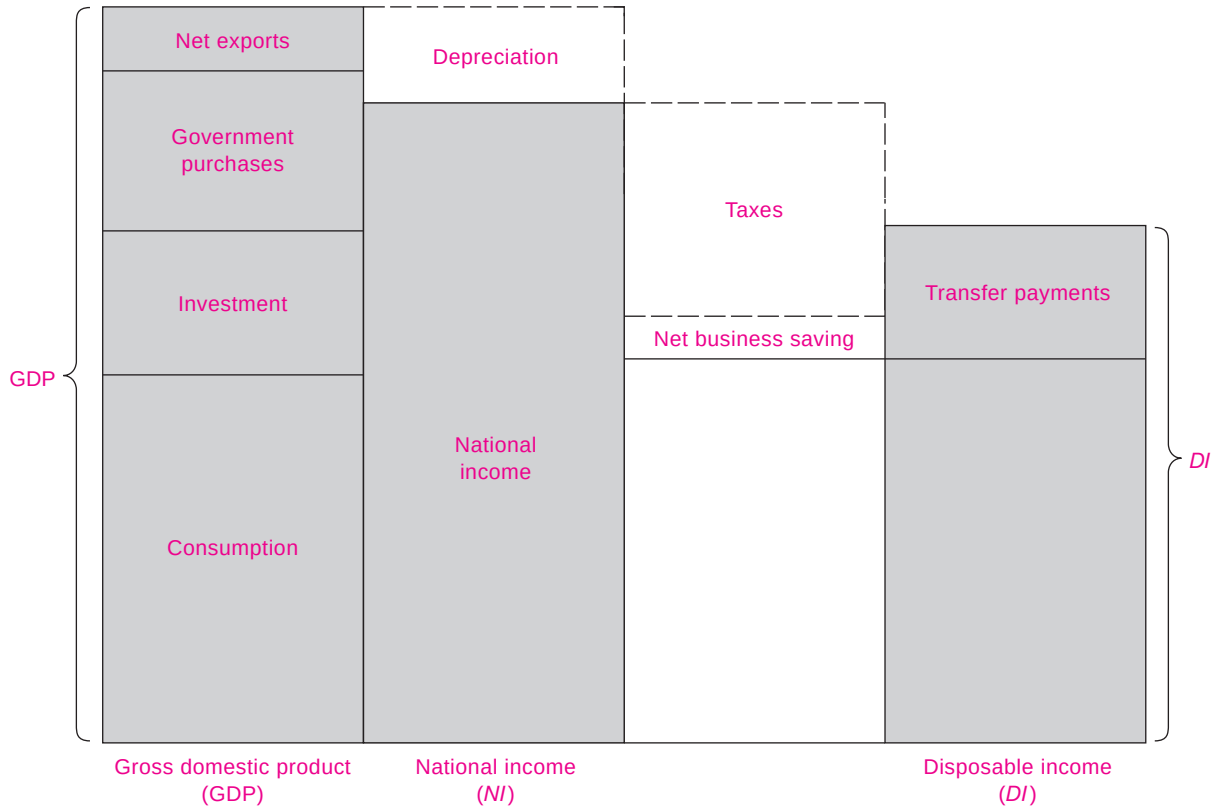


FIGURE 20-4. Starting with GDP, We Can Calculate National Income (*NI*) and Disposable Personal Income (*DI*)

Important income concepts are (1) GDP, which is total gross income to all factors; (2) national income, which is the sum of factor incomes and is obtained by subtracting depreciation from GDP; and (3) disposable personal income, which measures the total incomes of the household sector, including transfer payments but subtracting taxes.

Eye Therapies Exhibit 2127, 422 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Disposable Income. A second important concept asks, How many dollars per year do households actually have available to spend? The concept of disposable personal income (usually called **disposable income,** or *DI*) answers this question. To get disposable income, you calculate the market and transfer incomes received by households and subtract personal taxes.

Figure 20-4 shows the calculation of *DI*. We begin with national income in the second bar. We then subtract all taxes and further subtract net business saving. (Net business saving is profits after depreciation less dividends.) Finally, we add back the transfer payments that households receive from governments. This constitutes *DI,* shown as the right-hand bar in Figure 20-4. Disposable income is what actually gets into the hands of consumers to dispose of as they please. (This discussion omits some minor items such as the statistical discrepancy and net foreign factor incomes that are usually close to zero.)

As we will see in the next chapters, *DI* is what people divide between (1) consumption spending and (2) personal saving.

Saving and Investment

As we have seen, output can be either consumed or invested. Investment is an essential economic activity because it increases the capital stock available for future production. One of the most important points about national accounting is the identity between saving and investment. We will show that, under the accounting rules described above, *measured saving is exactly equal to measured investment.* This equality is an *identity,* which means that it must hold by definition.

In the simplest case, assume for the moment that there is no government or foreign sector. Investment is that part of national output which is not consumed. Saving is that part of national income which is not consumed. But since national income and output are equal, this means that saving equals investment. In symbols:

I = product-approach GDP minus C

S = earnings-approach GDP minus C

However, both approaches always give the same measure of GDP, so

$I = S$: the identity between measured saving and investment

That is the simplest case. We also need to consider the complete case which brings businesses, government, and net exports into the picture. On the saving side, *total* or *national saving* (S^T) is composed of *private saving* by households and businesses (S^P) along with *government saving* (S^G). Government saving equals the government's budget surplus or the difference between tax revenues and expenditures.

On the investment side, total or *national investment* (I^T) starts with *gross private domestic investment* (I) but also adds *net foreign investment,* which is approximately the same as net exports (X). Hence, the complete saving-investment identity is given by[2]

$$\begin{aligned}\text{National investment} &= \text{private investment} + \text{net exports} \\ &= \text{private saving} + \text{government saving} = \text{national saving}\end{aligned}$$

or

$$I^T = I + X = S^P + S^G = S^T$$

National saving equals national investment by definition. The components of investment are private domestic investment and foreign investment (or net exports). The sources of saving are private saving (by households and businesses) and government saving (the government budget surplus). Private investment plus net exports equals private saving plus the budget surplus. These identities must hold always, whatever the state of the business cycle.

BEYOND THE NATIONAL ACCOUNTS

Advocates of the existing economic and social system often argue that market economies have produced a growth in real output never before seen in human history. "Look how GDP has grown because of the genius of free markets," say the admirers of capitalism.

But critics point out the deficiencies of GDP. GDP includes many questionable entries and omits many

[2] For this discussion, we consider only private investment and therefore treat all government purchases as consumption. In most national accounts today, government purchases are divided between consumption and tangible investments. If we include government investment, then this amount will add to both national investment and the government surplus.

Eye Therapies Exhibit 2127, 423 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

valuable economic activities. As one dissenter said, "Don't speak to me of all your production and your dollars, your gross domestic product. To me, GDP stands for gross domestic pollution!"

What are we to think? Isn't it true that GDP includes government production of bombs and missiles along with salaries paid to prison guards? Doesn't an increase in crime boost sales of home alarms, which adds to the GDP? Doesn't cutting our irreplaceable redwoods show up as a positive output in our national accounts? Doesn't GDP fail to account for environmental degradation such as acid rain and global warming?

In recent years, economists have begun developing new measures to correct the major defects of the standard GDP numbers and better reflect the true satisfaction-producing outputs of our economy. The new approaches attempt to extend the boundaries of the traditional accounts by including important nonmarket activities as well as correcting for harmful activities that are included as part of national output. Let's consider some of the omitted pluses and minuses.

Omitted Nonmarket Activities. Recall that the standard accounts include primarily market activities. Much useful economic activity takes place outside the market. For example, college students are investing in human capital. The national accounts record the tuition, but they omit the opportunity costs of earnings forgone. Studies indicate that inclusion of nonmarket investments in education and other areas would more than double the national saving rate.

Similarly, many household activities produce valuable "near-market" goods and services such as meals, laundering, and child-care services. Recent estimates of the value of unpaid household work indicate that it might be half as large as total market consumption. Perhaps the largest omission from the market accounts is the value of leisure time. On average, Americans spend as much of their time on utility-producing leisure activities as they do on money-producing work activities. Yet the value of leisure time is excluded from our official national statistics.

You might wonder about the underground economy, which covers a wide variety of market activities that are not reported to the government. These include activities like gambling, prostitution, drug dealing, work done by illegal immigrants, bartering of services, and smuggling. Actually, much underground activity is intentionally excluded because national output excludes illegal activities—these are by social consensus "bads" and not "goods." A swelling cocaine trade will not enter into GDP. For legal but unreported activities, like unreported tips, the Commerce Department makes estimates on the basis of surveys and audits by the Internal Revenue Service.

Omitted Environmental Damage. In addition to omitting activities, sometimes GDP omits some of the harmful side effects of economic activity. An important example is the omission of environmental damages. For example, suppose the residents of Suburbia buy 10 million kilowatt-hours of electricity to cool their houses, paying Utility Co. 10 cents per kilowatt-hour. That $1 million covers the labor costs, plant costs, and fuel costs. But suppose the company damages the neighborhood with pollution in the process of producing electricity. It incurs no monetary costs for this externality. Our measure of output should not only add in the value of the electricity (which GDP does) but also subtract the environmental damage caused by the pollution (which GDP does not).

Suppose that in addition to 10 cents of direct costs, there are 2 cents per kilowatt-hour of environmental damages to human health. These are the "external costs" of pollution not paid by Utility Co., and they total $200,000. To correct for this hidden cost in a set of augmented accounts, we should subtract $200,000 of "pollution bads" from the $1,000,000 flow of "electricity goods." In fact, government statisticians do *not* subtract pollution costs in the economic accounts.

Economists have made considerable progress in developing *augmented national accounts*, which are designed to include activities beyond the traditional definitions of the national accounts. The general principle of augmented accounting is to include as much of economic activity as is feasible, whether or not that activity takes place in the market. Examples of augmented accounts include estimates of the value of research and development, nonmarket investments in human capital, the value of unpaid production in the home, the value of forests, and the value of leisure time. Economists are even developing accounts for the damages from air pollution

Eye Therapies Exhibit 2127, 424 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and global warming. When these further accounts are completed, we will have a more comprehensive financial picture of the economy.

But be warned that even the most refined economic accounts still measure only economic activity. They do not attempt to—indeed, cannot—measure the ultimate satisfactions, pleasures, or pains of people in their everyday lives. This point was eloquently put by Robert Kennedy in one of his last speeches:

> The gross national product does not allow for the health of our children, the quality of their education, or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages; the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage; neither our wisdom nor our learning; neither our compassion nor our devotion to our country.

PRICE INDEXES AND INFLATION

This chapter has up to now focused on measuring national output and its components. But people today worry about overall price trends, that is to say, about inflation. What do these terms mean?

Let us begin with a careful definition:

A **price index** (with symbol P) is a measure of the average level of prices. **Inflation** (with symbol π, or "pi") denotes a rise in the general level of prices. The **rate of inflation** is defined as the rate of change of the general price level and is measured as follows:

$$\text{Rate of inflation in year } t = \pi_t = 100 \times \frac{P_t - P_{t-1}}{P_{t-1}}$$

Most periods in recent history have been ones of positive inflation. The opposite of inflation is **deflation,** which occurs when the general price level is falling. Deflations have been rare in the last half-century. In the United States, the last time consumer prices actually fell from one year to the next was 1955. Sustained deflations, in which prices fall steadily over a period of several years, are associated with depressions, such as those that occurred in the United States in the 1890s and the 1930s. More recently, Japan experienced a deflation over much of the last two decades as its economy suffered a prolonged recession.

Price Indexes

When newspapers tell us "Inflation is rising," they are really reporting the movement of a price index. A price index is a weighted average of the price of a basket of goods and services. In constructing price indexes, economists weight individual prices by the economic importance of each good. The most important price indexes are the consumer price index, the GDP price index, and the producer price index.

The Consumer Price Index (CPI). The most widely used measure of the overall price level is the consumer price index, also known as the CPI, calculated by the U.S. Bureau of Labor Statistics (BLS). The CPI is a measure of the average price paid by urban consumers for a market basket of consumer goods and services. Each month, government statisticians record the prices of around 80,000 goods and services for more than 200 major categories. The prices are then arranged into the following eight major groups, listed with some examples:

- Food and beverages (breakfast cereal, milk, and snacks)
- Housing (rent of primary residence, owner's equivalent rent, bedroom furniture)
- Apparel (shirts and sweaters, jewelry)
- Transportation (new vehicles, gasoline, motor vehicle insurance)
- Medical care (prescription drugs, physicians' services, eyeglasses)
- Recreation (televisions, sports equipment, admissions)
- Education and communication (college tuition, computer software)
- Other goods and services (haircuts, funeral expenses)

How are the different prices weighted in constructing price indexes? It would clearly be silly merely to add up the different prices or to weight them by their mass or volume. Rather, a price index is constructed by *weighting each price according to the economic importance of the commodity in question.*

In the case of the traditional CPI, each item is assigned a fixed weight proportional to its relative importance in consumer expenditure budgets; the weight for each item is proportional to the total spending by consumers on that item as determined by a survey of consumer expenditures in the

Eye Therapies Exhibit 2127, 425 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

2005–2006 period. As of 2008, housing-related costs were the single biggest category in the CPI, taking up more than 42 percent of consumer spending budgets. By comparison, the cost of new cars and other motor vehicles accounts for only 7 percent of the CPI's consumer expenditure budgets.



Calculating the CPI

It is worth spending a moment on the exact technique that is used to calculate CPI changes. The formula in the text is correct, but we need to explain how the formula works when there are many goods and services. The change in the overall CPI is the weighted average of the change of the components:

$$\%\ \text{change in CPI in period } t = 100 \times \left\{ \sum_{\text{All items}} [\text{weight of good } i \text{ in } (t-1)] \times [\%\ \text{change in the price of good } i \text{ from } (t-1) \text{ to } t] \right\}$$

To take a concrete example, the following table shows the actual price-change and relative-importance data:

Expenditure category	Relative importance, December 2007 (%)	Percentage change over the last year
Food and beverages	14.9	4.4
Housing	42.4	3.0
Apparel	3.7	–1.4
Transportation	17.7	8.2
Medical care	6.2	4.6
Recreation	5.6	1.3
Education and communication	6.1	3.0
Other goods and services	3.3	3.2
All items	**100.0**	**4.0**

The rate of inflation over the period from March 2007 to March 2008 is seen to be 4.0 percent per year. (Question 9 at the end of this chapter examines this calculation further.)

This example captures the essence of how the traditional CPI measures inflation. The only difference between this simplified calculation and the actual ones is that the CPI contains many more commodities and regions. Otherwise, the procedure is exactly the same.

GDP Price Index. Another widely used price index is the *GDP price index* (also sometimes referred to as the GDP deflator), which we met earlier in this chapter. The GDP price index is the price of all goods and services produced in the country (consumption, investment, government purchases, and net exports) rather than of a single component (such as consumption). This index also differs from the traditional CPI because it is a chain-weighted index that takes into account the changing shares of different goods (see the discussion of chain weights on page 393). In addition, there are price indexes for components of GDP, such as for investment goods, computers, personal consumption, and so forth, and these are sometimes used to supplement the CPI.

The Producer Price Index (PPI). This index, dating from 1890, is the oldest continuous statistical series published by the BLS. It measures the level of prices at the wholesale or producer stage. It is based on over 8000 commodity prices, including prices of foods, manufactured products, and mining products. The fixed weights used to calculate the PPI are the net sales of each commodity. Because of its great detail, this index is widely used by businesses.



Getting the Prices Right

Measuring prices accurately is one of the central issues of empirical economics. Price indexes affect not only obvious things like the inflation rate. They also are embedded in measures of real output and productivity. And through government policies, they affect monetary policy, taxes, government transfer programs like social security, and many private contracts.

The purpose of the consumer price index is to measure the cost of living. You might be surprised to learn that this is a difficult task. Some problems are intrinsic to price indexes. One issue is the *index-number problem,* which involves how the different prices are weighted or averaged. Recall that the traditional CPI uses a fixed weight for each good. As a result, the cost of living is

Eye Therapies Exhibit 2127, 426 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

overestimated compared to the situation where consumers substitute relatively inexpensive for relatively expensive goods.

The case of energy prices can illustrate the problem. When gasoline prices rise sharply, people tend to reduce their gasoline purchases, buy smaller cars, and travel less. Yet the CPI assumes that they buy the same quantity of gasoline even though gasoline prices may have doubled. The overall rise in the cost of living is thereby exaggerated. Statisticians have devised ways of minimizing such index-number problems by using different weighting approaches, such as adjusting the weights as expenditures change, but government statisticians are just beginning to experiment with these newer approaches for the CPI.

A more important problem arises because of the difficulty of adjusting price indexes to capture the contribution of *new and improved goods and services*. An example will illustrate this problem. In recent years, consumers have benefited from compact fluorescent lightbulbs; these lightbulbs deliver light at approximately one-fourth the cost of the older, incandescent bulbs. Yet none of the price indexes incorporate the quality improvement. Similarly, as CDs and MP3s replaced long-playing records, as cable TV with hundreds of channels replaced the older technology with a few fuzzy channels, as air travel replaced rail or road travel, and in thousands of other improved goods and services, the price indexes did not reflect the improved quality.

Recent studies indicate that if quality change had been properly incorporated into price indexes, the CPI would have risen less rapidly in recent years. This problem is especially acute for medical care. In this sector, reported prices have risen sharply in the last two decades. Yet we have no adequate measure of the quality of medical care, and the CPI completely ignores the introduction of new products, such as pharmaceuticals which replace intrusive and expensive surgery.

A panel of distinguished economists led by Stanford's Michael Boskin examined this issue and estimated that the upward bias in the CPI was slightly more than 1 percent per year. This is a small number with large implications. It indicates that our real-output numbers may have been *underestimated* by the same amount. If the CPI bias carries through to the GDP deflator, then the growth in output per hour worked in the United States would be understated by around 1 percent per year.

This finding also implies that cost-of-living adjustments (which are used for social security benefits and the tax system) have overcompensated people for changes in the cost of living. The bias would have substantial effects on overall taxes and benefits over a period of many years. Price indexes are not just abstruse concepts of interest only to a handful of technicians. Proper construction of price and output indexes affects our government budgets, our retirement programs, and even the way we assess our national economic performance.

In response to its own research and to its critics, the BLS has undertaken a major overhaul of the CPI. The most important innovation was the publication starting in 2002 of a "chained consumer price index" that augments the fixed-weight price index with a changing-weight system (like the chain weights used in the GDP accounts discussed on page 393 above) that accounts for consumer substitution. Over the decade since it was published, the chain CPI did indeed rise more slowly than the traditional CPI. It appears that critics were correct that the traditional CPI overstates inflation, although the size of the overstatement is likely to be less than the large number estimated by the Boskin Commission.[3]

ACCOUNTING ASSESSMENT

This chapter has examined the way economists measure national output and the overall price level. Having reviewed the measurement of national output and analyzed the shortcomings of the GDP, what should we conclude about the adequacy of our measures? Do they capture the major trends? Are they adequate measures of overall social welfare? The answer was aptly stated in a review by Arthur Okun:

> It should be no surprise that national prosperity does not guarantee a happy society, any more than personal prosperity ensures a happy family. No growth of GDP can counter the tensions arising from an unpopular and unsuccessful war, a long overdue self-confrontation with conscience on racial injustice, a volcanic eruption of sexual mores, and an unprecedented assertion of independence by the young. Still, prosperity . . . is a precondition for success in achieving many of our aspirations.[4]

[3] See this chapter's Further Reading section for a symposium on CPI design.

[4] *The Political Economy of Prosperity* (Norton, New York, 1970), p. 124.

Eye Therapies Exhibit 2127, 427 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



SUMMARY

1. The national income and product accounts contain the major measures of income and product for a country. The gross domestic product (GDP) is the most comprehensive measure of a nation's production of goods and services. It comprises the dollar value of consumption (C), gross private domestic investment (I), government purchases (G), and net exports (X) produced within a nation during a given year. Recall the formula:

$$\text{GDP} = C + I + G + X$$

This will sometimes be simplified by combining private domestic investment and net exports into total gross national investment ($I^T = I + X$):

$$\text{GDP} = C + I^T + G$$

2. We can match the upper-loop, flow-of-product measurement of GDP with the lower-loop, flow-of-cost measurement, as shown in Figure 20-1. The flow-of-cost approach uses factor earnings and carefully computes value added to eliminate double counting of intermediate products. And after summing up all (before-tax) wage, interest, rent, depreciation, and profit income, it adds to this total all indirect tax costs of business. GDP does not include transfer items such as social security benefits.
3. By use of a price index, we can "deflate" nominal GDP (GDP in current dollars) to arrive at a more accurate measure of real GDP (GDP expressed in dollars of some base year's purchasing power). Use of such a price index corrects for the "rubber yardstick" implied by changing levels of prices.
4. Net investment is positive when the nation is producing more capital goods than are currently being used up in the form of depreciation. Since depreciation is hard to estimate accurately, statisticians have more confidence in their measures of gross investment than in those of net investment.
5. National income and disposable income are two additional official measurements. Disposable income (DI) is what people actually have left—after all tax payments, corporate saving of undistributed profits, and transfer adjustments have been made—to spend on consumption or to save.
6. Using the rules of the national accounts, measured saving must exactly equal measured investment. This is easily seen in a hypothetical economy with nothing but households. In a complete economy, *private saving and government surplus equal domestic investment plus net foreign investment.* The identity between saving and investment is just that: saving must equal investment no matter whether the economy is in boom or recession, war or peace. It is a consequence of the definitions of national income accounting.
7. Gross domestic product and even net domestic product are imperfect measures of genuine economic welfare. In recent years, statisticians have started correcting for nonmarket activities such as unpaid work at home and environmental externalities.
8. Inflation occurs when the general level of prices is rising (and deflation occurs when it is falling). We measure the overall price level and rate of inflation using price indexes—weighted averages of the prices of thousands of individual products. The most important price index is the consumer price index (CPI), which traditionally measured the cost of a fixed market basket of consumer goods and services relative to the cost of that bundle during a particular base year. Recent studies indicate that the CPI trend has a major upward bias because of index-number problems and omission of new and improved goods, and the government has undertaken steps to correct some of this bias.
9. Recall the useful formulas from this and the prior chapter:
   a. For calculating single-period growth of GDP:

$$\text{Growth of real GDP in year } t = 100 \times \frac{\text{GDP}_t - \text{GDP}_{t-1}}{\text{GDP}_{t-1}}$$

   b. For calculating inflation with a single good:

$$\text{Rate of inflation in year } t = \pi_t = 100 \times \frac{P_t - P_{t-1}}{P_{t-1}}$$

   c. Multiyear growth rate:

$$\text{Growth from } (t-n) \text{ to } t: \quad g_t^{(n)} = 100 \times \left[\left(\frac{X_t}{X_{t-n}} \right)^{1/n} - 1 \right]$$

   d. For calculating the CPI with multiple goods:

$$\%\text{ change in CPI} = 100 \times \left[\sum_{\text{All items}} (\text{weight}_i) \times (\%\text{ change } p_i) \right]$$

Eye Therapies Exhibit 2127, 428 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CONCEPTS FOR REVIEW

national income and product
accounts (national accounts)
real and nominal GDP
GDP deflator
GDP = $C + I + G + X$
net investment =
gross investment − depreciation
GDP in two equivalent views:
product (upper loop)
earnings (lower loop)
intermediate goods, value added
NDP = GDP − depreciation
government transfers
disposable income (*DI*)
investment-saving identity:
$I = S$
$I^T = I + X = S^P + S^G = S^T$
inflation, deflation
price index:
CPI
GDP price index
PPI
growth-rate formulas

FURTHER READING AND INTERNET WEBSITES

Further Reading

A magnificent compilation of historical data on the United States is Susan Carter et al., *Historical Statistics of the United States: Millennial Edition* (Cambridge, 2006). This is available online from many college websites at *hsus.cambridge.org/HSUSWeb/HSUSEntryServlet*. A review of the issues involving measuring the consumer price index is contained in "Symposium on the CPI," *Journal of Economic Perspectives,* Winter 1998.

Robert Kennedy's remarks are from "Recapturing America's Moral Vision," March 18, 1968, in *RFK: Collected Speeches* (Viking Press, New York, 1993).

Websites

The premium site for the U.S. national income and product accounts is maintained by the Bureau of Economic Analysis (BEA) at *www.bea.gov*. This site also contains issues of *The Survey of Current Business,* which discusses recent economic trends.

A comprehensive launching pad for government data in many areas is "FRED," assembled by the Federal Reserve Bank of St. Louis at *research.stlouisfed.org/fred2*. The best single statistical source for data on the United States is *The Statistical Abstract of the United States,* published annually. It is available online at *www.census.gov/compendia/statab/*. Many important data sets can be found at *www.economagic.com/*.

A recent review of alternative approaches to augmented and environmental accounting is contained in a report by the National Academy of Sciences in William Nordhaus and Edward Kokkelenberg, eds., *Nature's Numbers: Expanding the National Accounts to Include the Environment* (National Academy Press, Washington, D.C., 1999), available at *www.nap.edu*.

QUESTIONS FOR DISCUSSION

1. Define carefully the following and give an example of each:
   a. Consumption
   b. Gross private domestic investment
   c. Government consumption and investment purchases (in GDP)
   d. Government transfer payments (not in GDP)
   e. Exports
2. You sometimes hear, "You can't add apples and oranges." Show that we can and do add apples and oranges in the national accounts. Explain how.
3. Examine the data in the appendix to Chapter 19. Locate the figures for nominal and real GDP for 2006 and 2007. Calculate the GDP deflator. What were the rates of growth of nominal GDP and real GDP for 2007? What was the rate of inflation (as measured by

Eye Therapies Exhibit 2127, 429 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the GDP deflator) for 2007? Compare the rate of inflation using the GDP deflator with that using the CPI.

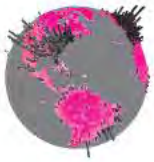
4. Robinson Crusoe produces upper-loop product of $1000. He pays $750 in wages, $125 in interest, and $75 in rent. What must his profit be? If three-fourths of Crusoe's output is consumed and the rest invested, calculate Crusoeland's GDP with both the product and the income approaches and show that they must agree exactly.
5. Here are some brain teasers. Can you see why the following are not counted in U.S. GDP?
   a. The gourmet meals produced by a fine home chef
   b. The purchase of a plot of land
   c. The purchase of an original Rembrandt painting
   d. The value I get in 2009 from playing a 2005 compact disc
   e. Damage to houses and crops from pollution emitted by electric utilities
   f. Profits earned by IBM on production in a British factory
6. Consider the country of Agrovia, whose GDP is discussed in "A Numerical Example" on page 396. Construct a set of national accounts like that in Table 20-6 assuming that wheat costs $5 per bushel, there is no depreciation, wages are three-fourths of national output, indirect business taxes are used to finance 100 percent of government spending, and the balance of income goes as rent income to farmers.
7. Review the discussion of bias in the CPI. Explain why failure to consider the quality improvement of a new good leads to an upward bias in the trend of the CPI. Pick a good you are familiar with. Explain how its quality has changed and why it might be difficult for a price index to capture the increase in quality.
8. In recent decades, women have worked more hours in paid jobs and fewer hours in unpaid housework.
   a. How would this increase in work hours affect GDP?
   b. Explain why this increase in measured GDP will overstate the true increase in output. Also explain how a set of augmented national accounts which includes home production would treat this change from nonmarket work to market work.
   c. Explain the paradox, "When a person marries his or her gardener, GDP goes down."
9. Examine the price-change numbers shown in the example on page 403.
   a. Use the formula to calculate the increase in the CPI from March 2007 to March 2008 to two decimal places. Verify that the number shown in the table is correct to a single decimal place.
   b. The level of the CPI in March 2007 was 205.10. Calculate the CPI for March 2008.
10. Robert Kennedy's remarks about the shortcomings of measures of national output also contained the following: "The Gross National Product includes air pollution and advertising for cigarettes, and ambulances to clear our highways of carnage. It counts special locks for our doors, and jails for the people who break them. GNP includes the destruction of the redwoods and the death of Lake Superior." List ways that the accounts can be redesigned to incorporate these effects.

Eye Therapies Exhibit 2127, 430 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

21

Consumption and Investment



Micawber's equation:
Income 20 pounds; expenditure 19 pounds, 19 shillings and sixpence = happiness.
Income 20 pounds; annual expenditure 20 pounds and sixpence = misery.

Charles Dickens
David Copperfield

The major components of national output are consumption and investment. Naturally, nations want high levels of consumption—items such as housing, food, education, and recreation. The purpose of the economy is, after all, to transform inputs like labor and capital into consumption.

But saving and investment—that part of output that is not consumed—also play a central role in a nation's economic performance. Nations that save and invest large fractions of their incomes tend to have rapid growth of output, income, and wages; this pattern characterized the United States in the nineteenth century, Japan in the twentieth century, and the miracle economies of East Asia in recent decades. By contrast, nations that consume most of their incomes, like many poor countries in Africa and Latin America, have obsolete capital, low educational standards, and backward techniques; they experience low rates of growth of productivity and real wages. High consumption relative to income spells low investment and slow growth; high saving leads to high investment and rapid growth.

The interaction between spending and income plays quite a different role during business-cycle expansions and contractions. When consumption grows rapidly, this increases total spending or aggregate demand, raising output and employment in the short run. America's economic boom of the late 1990s was largely fueled by rapid growth in consumer spending, but when American consumers tightened their belts, this contributed to the recession of 2007–2009.

Because consumption and investment are so central to macroeconomics, we devote this chapter to them.

A. CONSUMPTION AND SAVING

This section considers consumption and saving behavior, beginning with individual spending patterns and then looking at aggregate consumption behavior. Recall from Chapter 20 that *consumption* (or, more precisely, personal consumption expenditures) is expenditures by households on final goods and services. *Saving* is that part of personal disposable income that is not consumed.

Consumption is the largest single component of GDP, constituting 70 percent of total spending over the last decade. What are the major elements of consumption? Among the most important categories

Eye Therapies Exhibit 2127, 431 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Category of consumption	Value of consumption ($, billion, 2007)	Percent of total
Durable goods	**1,083**	11.2%
Motor vehicles and parts	440	
Furniture and household equipment	415	
Other	227	
Nondurable goods	**2,833**	29.2%
Food	1,329	
Clothing and shoes	374	
Energy goods	367	
Other	763	
Services	**5,794**	59.7%
Housing	1,461	
Household operation	526	
Transportation	357	
Medical care	1,681	
Recreation	403	
Other	1,366	
Total personal consumption expenditures	**9,710**	**100.0%**

TABLE 21-1. The Major Components of Consumption

We divide consumption into three categories: durable goods, nondurable goods, and services. The service sector is growing in importance as basic needs for food are met and as health, recreation, and education claim a larger part of family budgets.

Source: U.S. Bureau of Economic Analysis, available at *www.bea.gov*.

are housing, motor vehicles, food, and medical care. Table 21-1 displays the major elements, broken down into the three main categories of durable goods, nondurable goods, and services. The items themselves are familiar, but their relative importance, particularly the increasing importance of services, is worth a moment's study.

Budgetary Expenditure Patterns

How do the patterns of consumption spending differ across different households in the United States? No two families spend their disposable incomes in exactly the same way. Yet statistics show that there is a predictable regularity in the way people allocate their expenditures among food, clothing, and other major items. The thousands of budgetary investigations of household spending patterns show remarkable agreement on the general, qualitative patterns of behavior.[1] Figure 21-1 on page 410 tells the story.

Poor families must spend their incomes largely on the necessities of life: food and shelter. As income increases, expenditure on many food items goes up. People eat more and eat better. There are, however, limits to the extra money people will spend on food when their incomes rise. Consequently, the proportion of total spending devoted to food declines as income increases.

Expenditure on clothing, recreation, and automobiles increases more than proportionately to after-tax

[1] The spending patterns shown in Fig. 21-1 are called "Engel's Laws," after the nineteenth-century Prussian statistician Ernst Engel. The average behavior of consumption expenditure does change fairly regularly with income. But averages do not tell the whole story. Within each income class, there is a considerable spread of consumption around the average.

Eye Therapies Exhibit 2127, 432 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

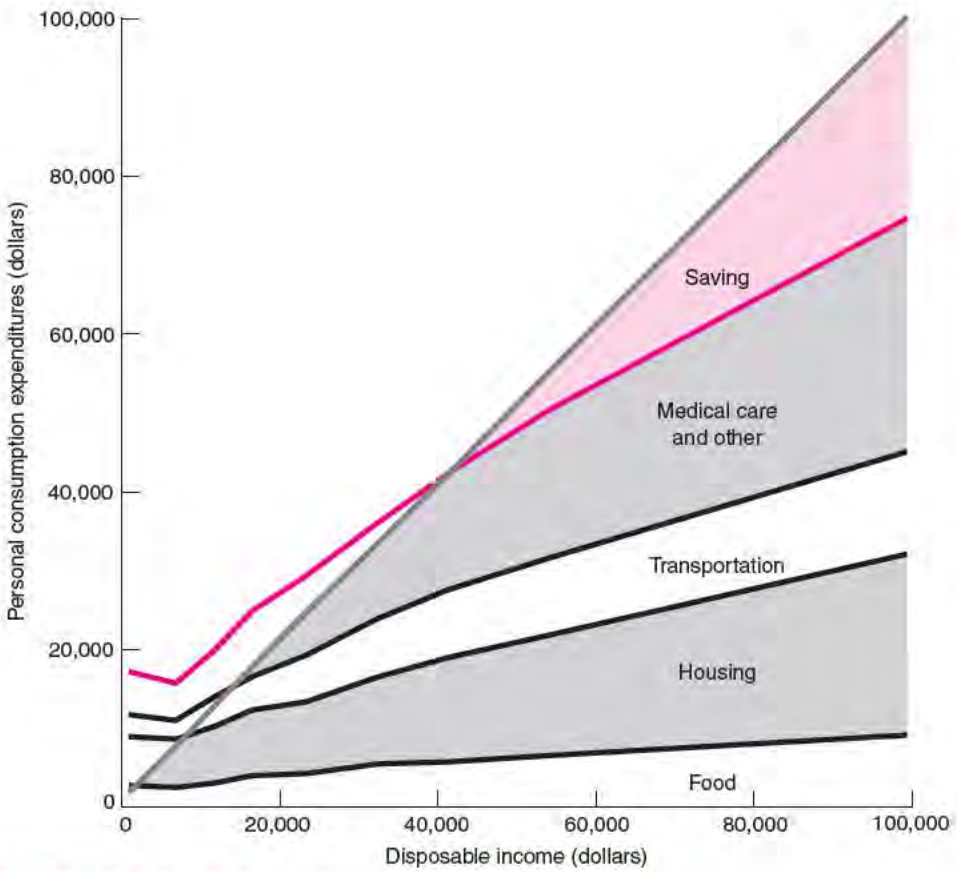


FIGURE 21-1. Family Budget Expenditures Show Regular Patterns

Surveys verify the importance of disposable income as a determinant of consumption expenditures. Notice the drop in food as a percentage of income as incomes rise. Note also that saving is negative at low incomes but rises substantially at high incomes.

Source: U.S. Department of Labor, *Consumer Expenditure Surveys, 1998*, available on the Internet at *www.bls.gov/csxstnd.htm*.

income, until high incomes are reached. Spending on luxury items increases in greater proportion than income. Finally, as we look across families, note that saving rises rapidly as income increases. Saving is the greatest luxury of all.



The Evolution of Consumption in the Twentieth Century

Continual changes in technology, incomes, and social forces have led to dramatic changes in U.S. consumption patterns over time. In 1918, American households on average spent 41 percent of their incomes on food and drink. By comparison, households now spend only about 14 percent on these items. What lies behind this striking decline? The major factor is that spending on food tends to grow more slowly than incomes. Similarly, spending on apparel has fallen from 18 percent of household income at the beginning of the twentieth century to only 4 percent today.

What are the "luxury goods" that Americans are spending more on? One big item is transportation. In 1918, Americans spent only 1 percent of their incomes on vehicles—but of course Henry Ford didn't sell his first Model T until 1908. Today, there are 1.2 cars for every licensed driver in the United States. It is not surprising that

Eye Therapies Exhibit 2127, 433 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

11 cents out of every dollar of spending goes for automotive transportation expenses. What about recreation and entertainment? Households now lay out large sums for televisions, cellular phones, and digital video recorders, items that did not exist 75 years ago. Housing services take about the same fraction of expenditures—15 percent of the total. However, those dollars today can buy a much larger house packed with consumer durables that make housework less of a chore.

Over the last decade, the biggest increase in consumption spending has been for health care. Surprisingly, consumers' out-of-pocket expenses for health care take about the same share of the *household* budget as they did in the early part of the twentieth century. The major increase has come as governments pay for an ever-larger fraction of health care.

CONSUMPTION, INCOME, AND SAVING

Income, consumption, and saving are all closely linked. More precisely, **personal saving** is that part of disposable income that is not consumed; saving equals income minus consumption.

The relationship between income, consumption, and saving for the United States in 2007 is shown in Table 21-2. Begin with personal income (composed, as Chapter 20 showed, of wages, fringe benefits, interest, rents, dividends, transfer payments, and so forth). In 2007, 12.8 percent of personal income went to personal taxes. This left $10,171 billion of **personal disposable income.** Household outlays for consumption (including interest) amounted to 99.4 percent of disposable income, leaving $57 billion as personal saving. The last item in the table shows the important **personal saving rate.** This is equal to personal saving as a percent of disposable income—a tiny 0.6 percent in 2007.

Item	Amount, 2007 ($, billion)
Personal income	11,663
Less: Personal taxes	1,493
Equals: Disposable personal income	10,171
Less: Personal outlays (consumption and interest)	10,113
Equals: Personal saving	57.4
Memo: Personal saving as percent of disposable personal income	0.6

TABLE 21-2. Saving Equals Disposable Income Less Consumption

Source: U.S. Bureau of Economic Analysis, available at *www.bea.gov.*

Economic studies have shown that income is the primary determinant of consumption and saving. Rich people save more than poor people, both absolutely and as a percent of income. The very poor are unable to save at all. Instead, as long as they can borrow or draw down their wealth, they tend to dissave. That is, they tend to spend more than they earn, reducing their accumulated savings or going deeper into debt.

Table 21-3 contains illustrative data on disposable income, saving, and consumption drawn from budget studies on American households. The first column shows seven different levels of disposable income. Column (2) indicates saving at each level of income, and the third column indicates consumption spending at each level of income.

The *break-even point*—where the representative household neither saves nor dissaves but consumes all its income—comes at $25,000. Below the

	(1) Disposable income ($)	(2) Net saving (+) or dissaving (−) ($)	(3) Consumption ($)
A	24,000	−200	24,200
B	25,000	0	25,000
C	26,000	200	25,800
D	27,000	400	26,600
E	28,000	600	27,400
F	29,000	800	28,200
G	30,000	1,000	29,000

TABLE 21-3. Consumption and Saving Are Primarily Determined by Income

Consumption and saving rise with disposable income. The break-even point at which people have zero saving is shown here at $25,000. How much of each extra dollar of income do people devote to extra consumption at this income level? How much to extra saving? (Answer: 80 cents and 20 cents, respectively, when we compare row B and row C.)

Eye Therapies Exhibit 2127, 434 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

break-even point, say, at $24,000, the household actually consumes more than its income; it dissaves (see the −$200 item). Above $25,000 it begins to show positive saving [see the +$200 and other positive items in column (2)].

Column (3) shows the consumption spending for each income level. Since each dollar of income is divided between the part consumed and the remaining part saved, columns (3) and (2) are not independent; they must always exactly add up to column (1).

To understand the way consumption affects national output, we need to introduce some new tools. We need to understand how each dollar of additional income is divided between additional saving and additional consumption. This relationship is shown by:

- The consumption function, relating consumption and income
- Its twin, the saving function, relating saving and income

The Consumption Function

One of the most important relationships in all macroeconomics is the **consumption function.** The consumption function shows the relationship between the level of consumption expenditures and the level of disposable personal income. This concept, introduced by Keynes, is based on the hypothesis that there is a stable empirical relationship between consumption and income.

We can see the consumption function most vividly in the form of a graph. Figure 21-2 plots the seven levels of income listed in Table 21-3. Disposable income [column (1) of Table 21-3] is placed on the horizontal axis, and consumption [column (3)] is on the vertical axis. Each of the income-consumption

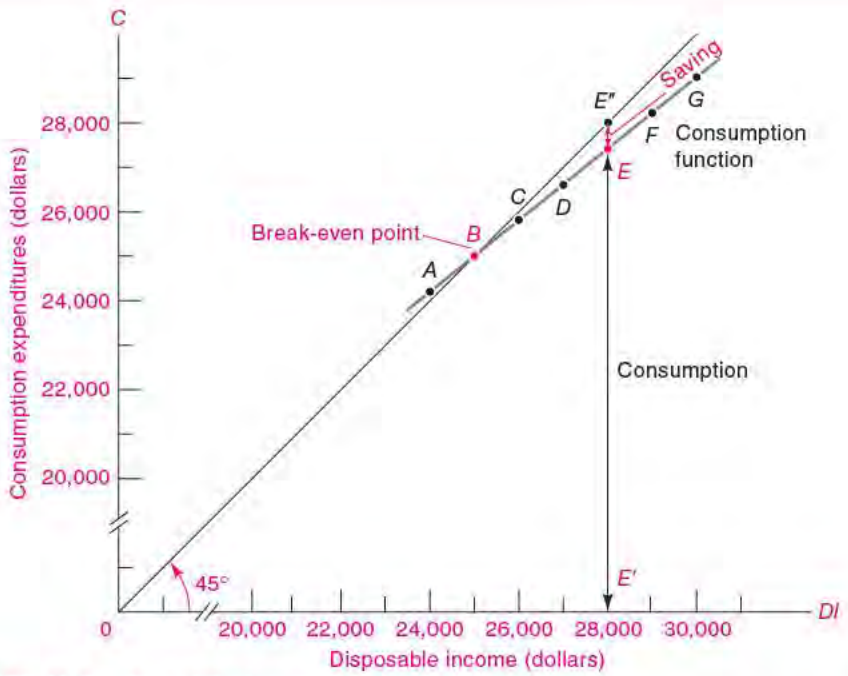


FIGURE 21-2. A Plot of the Consumption Function

The curve through *A, B, C,…, G* is the consumption function. The horizontal axis depicts the level of disposable income (*DI*). For each level of *DI*, the consumption function shows the dollar level of consumption (*C*) for the household. Note that consumption rises with increases in *DI*. The 45° line helps locate the break-even point and helps our eye measure net saving.

Source: Table 21-3.

Eye Therapies Exhibit 2127, 435 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

combinations is represented by a single point, and the points are then connected by a smooth curve.

The relationship between consumption and income shown in Figure 21-2 is called the consumption function.

The "Break-Even" Point. To understand the figure, it is helpful to look at the 45° line drawn northeast from the origin. Because the vertical and horizontal axes have exactly the same scale, the 45° line has a very special property. At any point on the 45° line, the distance up from the horizontal axis (consumption) exactly equals the distance across from the vertical axis (disposable income). You can use your eyes or a ruler to verify this fact.

The 45° line tells us immediately whether consumption spending is equal to, greater than, or less than the level of disposable income. The point where the consumption schedule intersects the 45° line is the **break-even point**—it is the level of disposable income at which households just break even.

This break-even point is at *B* in Figure 21-2. Here, consumption expenditures exactly equal disposable income; the household is neither a borrower nor a saver. To the right of point *B*, the consumption function lies below the 45° line. The relationship between income and consumption can be seen by examining the thin blue line from *E'* to *E* in Figure 21-2. At an income of $28,000, the level of consumption is $27,400 (see Table 21-3). We can see that consumption is less than income by the fact that the consumption function lies below the 45° line at point *E*.

What a household is not spending, it must be saving. The 45° line enables us to find how much the household is saving. Net saving is measured by the vertical distance from the consumption function up to the 45° line, as shown by the *EE"* saving arrow in green.

The 45° line tells us that to the left of point *B* the household is spending more than its income. The excess of consumption over income is "dissaving" and is measured by the vertical distance between the consumption function and the 45° line.

To review:

At any point on the 45° line, consumption exactly equals income and the household has zero saving. When the consumption function lies above the 45° line, the household is dissaving. When the consumption function lies below the 45° line, the household has positive saving. The amount of dissaving or saving is always measured by the vertical distance between the consumption function and the 45° line.

The Saving Function

The **saving function** shows the relationship between the level of saving and income. This is shown graphically in Figure 21-3. Again we show disposable income on the horizontal axis; but now saving, whether negative or positive in amount, is on the vertical axis.

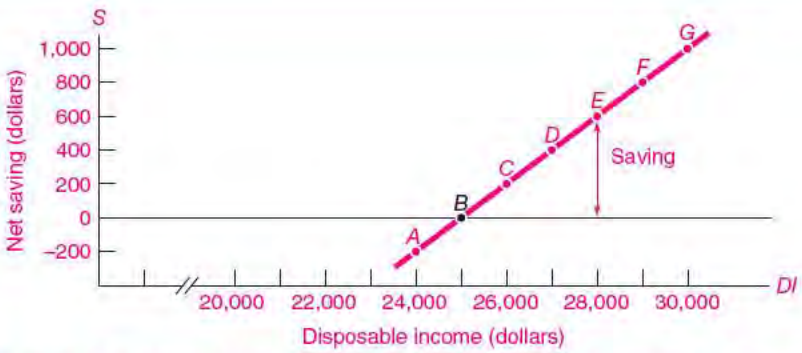


FIGURE 21-3. The Saving Function Is the Mirror Image of the Consumption Function

This saving schedule is derived by subtracting consumption from income. Graphically, the saving function is obtained by subtracting vertically the consumption function from the 45° line in Fig. 21-2. Note that the break-even point *B* is at the same $25,000 income level as in Fig. 21-2.

Eye Therapies Exhibit 2127, 436 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

This saving function comes directly from Figure 21-2. It is the vertical distance between the 45° line and the consumption function. For example, at point *A* in Figure 21-2, we see that the household's saving is negative because the consumption function lies above the 45° line. Figure 21-3 shows this dissaving directly—the saving function is below the zero-saving line at point *A*. Similarly, positive saving occurs to the right of point *B* because the saving function is above the zero-saving line.

The Marginal Propensity to Consume

Modern macroeconomics attaches much importance to the response of consumption to changes in income. This concept is called the marginal propensity to consume, or *MPC*.

The **marginal propensity to consume** is the extra amount that people consume when they receive an extra dollar of disposable income.

The word "marginal" is used throughout economics to mean extra or additional. For example, "marginal cost" means the additional cost of producing an extra unit of output. "Propensity to consume" designates the desired level of consumption. The *MPC* is therefore the additional or extra consumption that results from an extra dollar of disposable income.

Table 21-4 rearranges Table 21-3's data in a more convenient form. First, verify its similarity to Table 21-3. Then, look at columns (1) and (2) to see how consumption expenditure goes up with higher levels of income.

Column (3) shows how we compute the marginal propensity to consume. From B to C, income rises by $1000, going from $25,000 to $26,000. How much does consumption rise? Consumption grows from $25,000 to $25,800, an increase of $800. The extra consumption is therefore 0.80 of the extra income. Out of each extra dollar of income, 80 cents goes to consumption and 20 cents goes to saving.

The example shown here is a linear consumption function—one in which the *MPC* is constant. You can verify that the *MPC* is everywhere 0.80. In reality,

	(1) Disposable income (after taxes) ($)	(2) Consumption expenditure ($)	(3) Marginal propensity to consume *MPC*	(4) Net saving ($) (4) = (1) − (2)	(5) Marginal propensity to save *MPS*
A	24,000	24,200		−200	
			800/1,000 = 0.80		200/1,000 = 0.20
B	25,000	25,000		0	
			800/1,000 = 0.80		200/1,000 = 0.20
C	26,000	25,800		200	
			800/1,000 = 0.80		200/1,000 = 0.20
D	27,000	26,600		400	
			800/1,000 = 0.80		200/1,000 = 0.20
E	28,000	27,400		600	
			800/1,000 = 0.80		200/1,000 = 0.20
F	29,000	28,200		800	
			800/1,000 = 0.80		200/1,000 = 0.20
G	30,000	29,000		1,000	

TABLE 21-4. The Marginal Propensities to Consume and to Save

Each dollar of disposable income not consumed is saved. Each extra dollar of disposable income goes either into extra consumption or into extra saving. Combining these facts allows us to calculate the marginal propensity to consume (*MPC*) and the marginal propensity to save (*MPS*).

Eye Therapies Exhibit 2127, 437 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

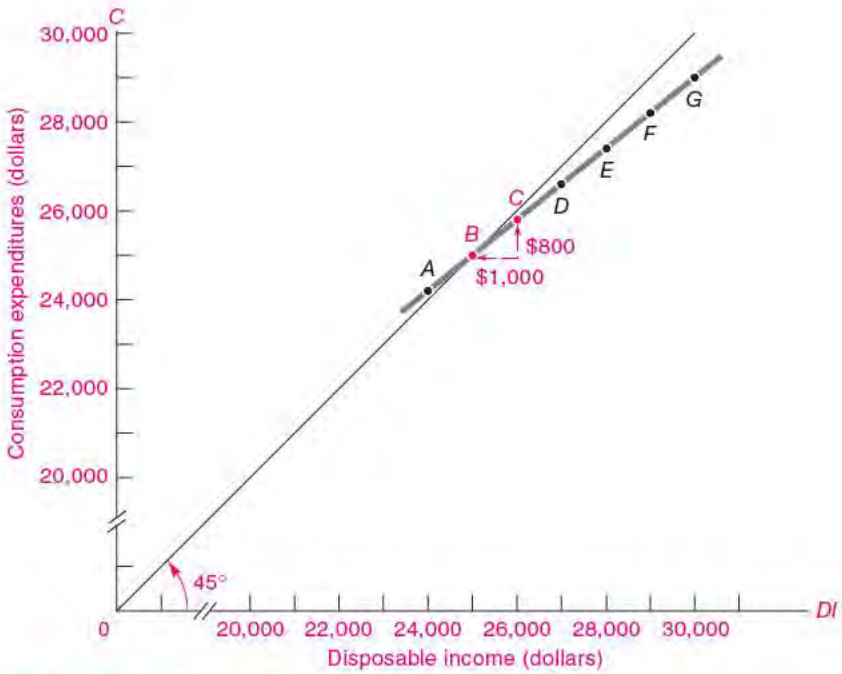


FIGURE 21-4. The Slope of the Consumption Function Is Its *MPC*

To calculate the marginal propensity to consume (*MPC*), we measure the slope of the consumption function by forming a right triangle and relating height to base. From point *B* to point *C*, the increase in consumption is $800 while the change in disposable income is $1000. The slope, equal to the change in *C* divided by the change in *DI*, gives the *MPC*. If the consumption function is everywhere upward-sloping, what does this imply about the *MPC*? If the line is a straight line, with a constant slope, what does this imply about the *MPC*?

consumption functions are unlikely to be exactly linear, but this is a reasonable approximation for our purposes.

Marginal Propensity to Consume as Geometrical Slope. We now know how to calculate the *MPC* from data on income and consumption. Figure 21-4 shows how we can calculate the *MPC* graphically. Near points *B* and *C* a little right triangle is drawn. As income increases by $1000 from point *B* to point *C*, the amount of consumption rises by $800. The *MPC* in this range is therefore $800/$1000 = 0.80. But, as the appendix to Chapter 1 showed, the numerical slope of a line is "the rise over the run."[2] We can therefore see that the slope of the consumption function is the same as the marginal propensity to consume.

The slope of the consumption function, which measures the change in consumption per dollar change in disposable income, is the marginal propensity to consume.

The Marginal Propensity to Save

Along with the marginal propensity to consume goes its mirror image, the marginal propensity to save, or *MPS*. The **marginal propensity to save** is defined as the fraction of an extra dollar of disposable income that goes to extra saving.

Why are *MPC* and *MPS* related like mirror images? Recall that disposable income equals consumption plus saving. This implies that each extra dollar of disposable income must be divided between

[2] For curved lines, we calculate the slope as the slope of the tangent line at a point.

Eye Therapies Exhibit 2127, 438 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

extra consumption and extra saving. Thus if *MPC* is 0.80, then *MPS* must be 0.20. (What would *MPS* be if *MPC* were 0.6? Or 0.99?) Comparing columns (3) and (5) of Table 21-4 confirms that at any income level, *MPC* and *MPS* must always add up to exactly 1, no more and no less. $MPS + MPC = 1$, always and everywhere.

Brief Review of Definitions

Let's review briefly the main definitions we have learned:

1. The *consumption function* relates the level of consumption to the level of disposable income.
2. The *saving function* relates saving to disposable income. Because what is saved equals what is not consumed, saving and consumption schedules are mirror images.
3. The *marginal propensity to consume (MPC)* is the amount of extra consumption generated by an extra dollar of disposable income. Graphically, it is given by the slope of the consumption function.
4. The *marginal propensity to save (MPS)* is the extra saving generated by an extra dollar of disposable income. Graphically, this is the slope of the saving schedule.
5. Because the part of each dollar of disposable income that is not consumed is necessarily saved, $MPS \equiv 1 - MPC$.

NATIONAL CONSUMPTION BEHAVIOR

Up to now we have examined the budget patterns and consumption behavior of typical families at different incomes. Let's now consider consumption for the entire nation. This transition from household behavior to national trends exemplifies the methodology of macroeconomics: We begin by examining economic activity on the individual level and then add up or aggregate the totality of individuals to study the way the overall economy operates.

Why are we interested in national consumption trends? Consumption behavior is crucial for understanding both short-term business cycles and long-term economic growth. In the short run, consumption is a major component of aggregate spending. When consumption changes sharply, the change is likely to affect output and employment through its impact on aggregate demand. This mechanism will be described in the chapters on Keynesian macroeconomics.

Additionally, consumption behavior is crucial because what is not consumed—that is, what is saved—is available for investment in new capital goods, and capital serves as a driving force behind long-term economic growth. *Consumption and saving behavior are key to understanding economic growth and business cycles.*

Determinants of Consumption

We begin by analyzing the major forces that affect consumer spending. What factors in a nation's life and livelihood set the pace of its consumption outlays?

Disposable Income. Figure 21-5 shows how closely consumption followed current disposable income over the period 1970–2008. When *DI* declines in recessions, consumption usually follows the decline. Increases in *DI,* say, following tax cuts, stimulate consumption growth. The effects of the large cuts in personal taxes in 1981–1983 can be seen in the growth of *DI* and *C*.

Permanent Income and the Life-Cycle Model of Consumption. The simplest theory of consumption uses only the current year's income to predict consumption expenditures. Consider the following examples, which suggest why other factors might also be important:

> If bad weather destroys a crop, farmers will draw upon their previous savings to finance consumption.
>
> Similarly, law-school students borrow for consumption purposes while in school because they expect that their postgraduate incomes will be much higher than their meager student earnings.

In both these circumstances, people are in effect asking, "Given my current and future income, how much can I consume today without incurring excessive debts?"

Careful studies show that consumers generally choose their consumption levels with an eye to both current income and long-run income prospects. In order to understand how consumption depends

Eye Therapies Exhibit 2127, 439 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

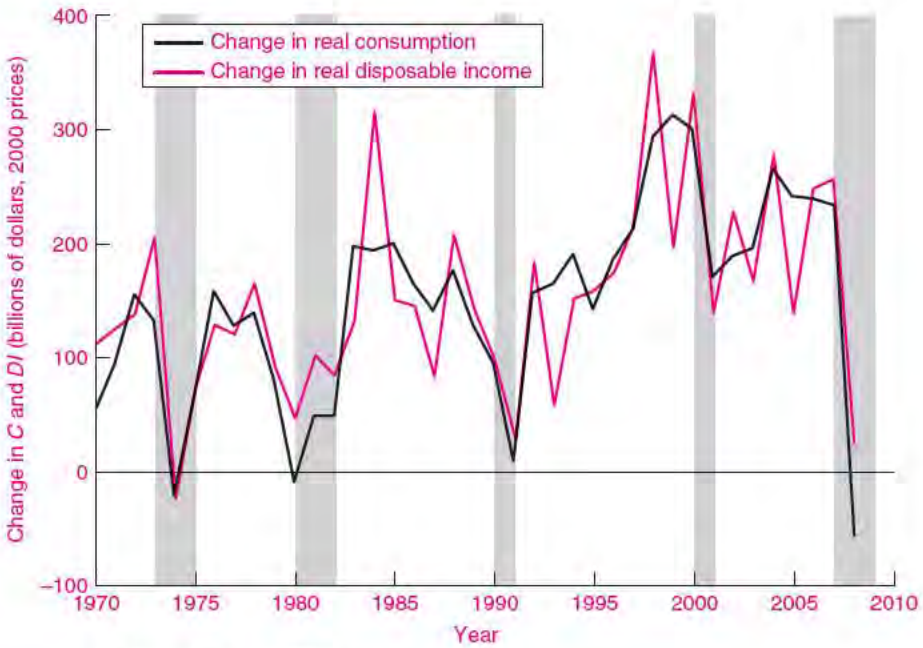


FIGURE 21-5. Changes in Consumption and Disposable Income, 1970–2008

Note how changes in consumption track changes in disposable income. Macroeconomists can forecast consumption accurately based on the historical consumption function. Recessions usually produce declines in consumption as income declines.

Source: U.S. Bureau of Economic Analysis. Real disposable income is calculated using the price index for personal consumption expenditures.

on long-term income trends, economists have developed the permanent-income theory and the life-cycle hypothesis.

Permanent income is the trend level of income—that is, income after removing temporary or transient influences due to windfall gains or losses. According to the permanent-income theory, consumption responds primarily to permanent income. This approach implies that consumers do not respond equally to all income shocks. If a change in income appears permanent (such as being promoted to a secure and high-paying job), people are likely to consume a large fraction of the increase in income. On the other hand, if the income change is clearly transitory (for example, if it arises from a one-time bonus or a good harvest), a significant fraction of the additional income may be saved.

The *life-cycle hypothesis* assumes that people save in order to smooth their consumption over their lifetime. One important objective is to have an adequate retirement income. Hence, people tend to save while working so as to build up a nest egg for retirement and then spend out of their accumulated savings in their twilight years. One implication of the life-cycle hypothesis is that a program like social security, which provides a generous income supplement for retirement, will reduce saving by middle-aged workers since they no longer need to save as much for retirement.

Wealth and Other Influences. A further important determinant of the amount of consumption is wealth. Consider two consumers, each earning $50,000 per year. One has $200,000 in the bank, while the other has no savings at all. The first person may consume part of wealth, while the second has no wealth to draw down. The fact that higher wealth leads to higher consumption is called the *wealth effect.*

Wealth usually changes slowly from year to year. However, when wealth rises or declines sharply, this

Eye Therapies Exhibit 2127, 440 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

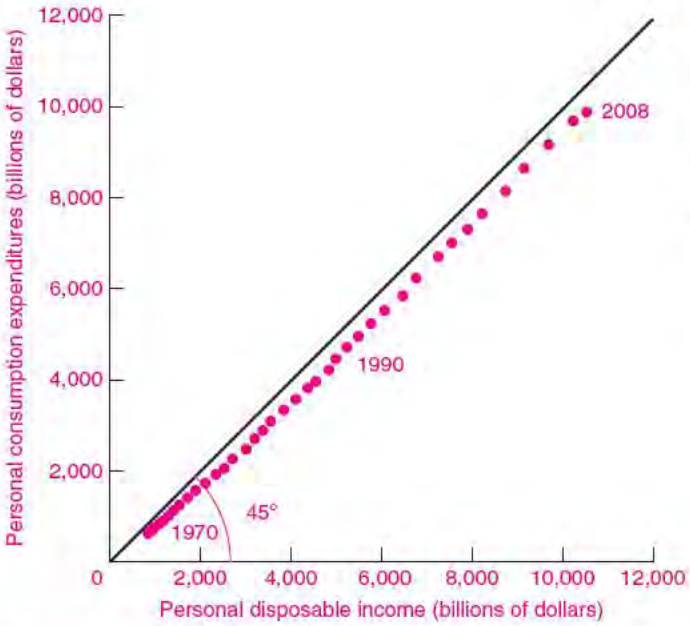


FIGURE 21-6. A Consumption Function for the United States, 1970–2008

The figure shows a scatter plot of personal disposable income and consumption. We have drawn a 45° line that shows where consumption exactly equals *DI*. Next, draw a consumption-function line through the points. Make sure you understand why the slope of the line you have drawn is the *MPC*. Can you verify that the *MPC* slope of the fitted line is close to 0.96?

Source: U.S. Bureau of Economic Analysis.

may lead to major changes in consumption spending. One important historical case was the stock market crash in 1929, when fortunes collapsed and paper-rich capitalists became paupers overnight. Economic historians believe that the sharp decline in wealth after the 1929 stock market crash reduced consumption spending and contributed to the depth of the Great Depression.

Over the last decade, the rise and decline of housing prices had a marked effect on consumption. From 2000 to 2006, the total value of household real estate rose over $7000 billion (about $70,000 per household). Many households refinanced their homes, took out home equity loans, or dipped into their savings. This is one of the reasons for the decline in the saving rate in recent years, as we will see shortly.

However, what went up then went down. By early 2009, the average price of residential houses had declined almost 30 percent from the peak in 2006. The wealth effect from declining housing values was a drag on consumer spending during this period.

The National Consumption Function

Having reviewed the theory of consumption behavior, we conclude that the determinants are complex, including disposable income, wealth, and expectations of future income. We can plot the simplest consumption function in Figure 21-6. The scatter diagram shows data for the period 1970–2008, with each point representing the level of consumption and disposable income for a given year.

In addition, you might draw a line in Figure 21-6 through the scatter points and label it "Fitted consumption function." This fitted consumption function shows how closely consumption has followed disposable income over the period shown. In fact, economic historians have found that a close relationship between disposable income and consumption holds back to the nineteenth century.



The Declining Personal Saving Rate

Although consumption behavior tends to be stable over time, the personal saving rate dropped sharply in the United States over the last three decades. The personal saving rate as measured in the national accounts averaged around 8 percent of personal disposable income over most of the twentieth century. Starting about 1980, however, it began to decline and is now close to zero. (See Figure 21-7.)

Eye Therapies Exhibit 2127, 441 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

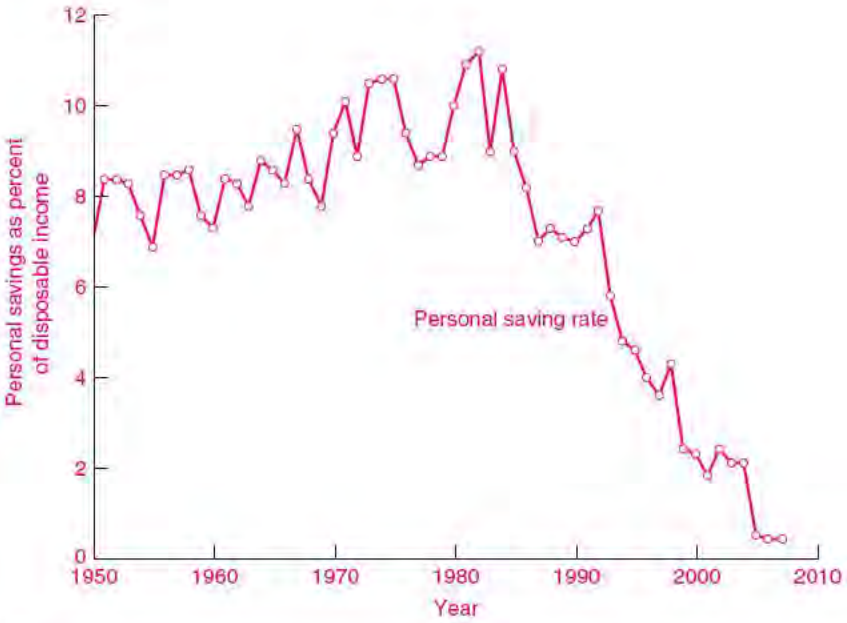


FIGURE 21-7. Personal Saving Rate Has Declined

After rising slowly over the postwar period, the personal saving rate took a sharp nosedive after 1980.

Source: U.S. Bureau of Economic Analysis.

This drop alarmed many economists because, over the long run, the growth in a nation's capital stock is largely determined by its national saving rate. National saving is composed of private and government saving. A high-saving nation has a rapidly growing capital stock and enjoys a rapid growth in its potential output. When a nation's saving rate is low, its equipment and factories become obsolete and its infrastructure begins to rot away. (This discussion abstracts away from borrowing abroad, but that cannot be a substantial fraction of income forever.)

What were the reasons for the sharp decline in the personal saving rate? This is a controversial question today, but economists point to the following potential causes:

- *Social security.* Some economists argued that the social security system has removed some of the need for private saving. In earlier times, as the life-cycle model of consumption suggests, a household would save during working years to build up a nest egg for retirement. When the government collects social security taxes and pays out social security benefits, people have less need to save for retirement. Other income-support systems have a similar effect, reducing the need to save for a rainy day. Disaster insurance for farmers, unemployment insurance for workers, and medical care for the poor and elderly all reduce the precautionary motive for people to save.
- *Financial markets.* For most of economic history, financial markets had numerous imperfections. People found it hard to borrow funds for worthwhile purposes, whether to buy a house, finance an education, or start a business. As financial markets developed, often with the help of the government, new loan instruments allowed people to borrow more easily. One example is the proliferation of credit cards, which encourage people to borrow (even though the interest rates are quite high). A generation ago, it would be difficult to borrow more than $1000 unless a person had substantial assets. Today, credit-card solicitations arrive daily in the mail. It is not unusual to receive multiple promotions offering credit lines of $5,000 or more in a single week!

  Perhaps the biggest and ultimately most troublesome source of finance was the "subprime" mortgages that proliferated in the early 2000s. These were loans at as much as 100 percent of the value of a house, sometimes to people with no documented income. When housing prices declined, literally hundreds of billions of dollars of these loans were in default, and investors worldwide took huge losses.
- *The rapid growth in paper wealth.* Part of the decline in personal saving in the 1990–2007 period was caused by the rapid increase in personal wealth. First, the

Eye Therapies Exhibit 2127, 442 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

stock market boomed, and then housing prices took off. Economists calculate that the wealth effect alone might have contributed to a decline in the personal saving rate of 3 percentage points by the late 2000s.

Alternative Measures of Saving

You might at this point ask, "If people are saving so little, why are there so many rich people?" This question raises an important point about measuring personal saving. Saving looks different to the household than to the nation as a whole. This is so because saving as measured in the national income and product accounts is not the same as that measured by accountants or in balance sheets. The *national-accounts measure of saving* is the difference between disposable income (excluding capital gains) and consumption. The *balance-sheet measure of saving* calculates the change in real net worth (that is, assets less liabilities, corrected for inflation) from one year to the next; this measure includes real capital gains.

If we examine the balance-sheet savings rate for the decade from 1997 to 2007—the viewpoint from the dining room table, so to speak—the savings rate was relatively high. Average household net worth over this period in 2007 prices rose from $157,000 to $191,000. The change in net worth was 17 percent of disposable income. So the balance-sheet saving rate was 17 percent, while the national-account saving rate shown in Figure 21-7 was 2 percent.

Does this alternative view mean that we can breathe a sigh of relief? Probably not. The reason is that the high saving over the last decade was largely an increase in "paper wealth." A rise in stock prices or the prices of existing assets like housing does not necessarily reflect the productivity or "real wealth" of the economy. Although people feel richer when asset prices rise in a speculative bubble, the economy cannot produce more cars, computers, food, or housing. Indeed, if everyone wanted to sell their houses, they would find that prices would fall and they could not convert their paper wealth into consumption.

Hence, economists are justified in worrying about the decline in the national-accounts saving rate. While consumers may *feel* richer because of a booming stock or housing market, an economy is *actually* richer only when its productive tangible and intangible assets increase.

B. INVESTMENT

The second major component of private spending, after consumption, is investment. Investment plays two roles in macroeconomics. First, because it is a large and volatile component of spending, investment often leads to changes in aggregate demand and affects the business cycle. In addition, investment leads to capital accumulation. Adding to the stock of buildings and equipment increases the nation's potential output and promotes economic growth in the long run.

Thus investment plays a dual role, affecting short-run output through its impact on aggregate demand and influencing long-run output growth through the impact of capital formation on potential output and aggregate supply.



The Meaning of "Investment" in Economics

Remember that macroeconomists use the term "investment" or "real investment" to mean additions to the stock of productive assets or capital goods like computers or trucks. When Amazon.com builds a new warehouse or when the Smiths build a new house, these activities represent investment.

Many people speak of "investing" when buying a piece of land, an old security, or any title to property. In economics, these purchases are really financial transactions or "financial investments," because what one person is buying, someone else is selling, and the net effect is zero. There is investment only when real capital is produced.

DETERMINANTS OF INVESTMENT

In this discussion, we focus on *gross private domestic investment*, or *I*. This is the domestic component of national investment. Recall, however, that *I* is but one component of total social investment, which also includes foreign investment, government investment, and intangible investments in human capital and improved knowledge.

The major types of gross private domestic investment are the building of residential structures; investment in business fixed equipment, software, and structures; and additions to inventory. In this discussion, we focus on business investment, but the principles apply to investments by other sectors as well.

Eye Therapies Exhibit 2127, 443 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Why do businesses invest? Ultimately, businesses buy capital goods when they expect that this action will earn them a profit—that is, will bring them revenues greater than the costs of the investment. This simple statement contains the three elements essential to understanding investment: revenues, costs, and expectations.

Revenues

An investment will bring the firm additional revenue if it helps the firm sell more product. This suggests that the overall level of output (or GDP) will be an important determinant of investment. When factories are lying idle, firms have relatively little need for new factories, so investment is low. More generally, investment depends upon the revenues that will be generated by the state of overall economic activity. Most studies find that investment is very sensitive to the business cycle.

Costs

A second important determinant of the level of investment is the costs of investing. Because investment goods last many years, reckoning the costs of investment is somewhat more complicated than doing so for other commodities like coal or wheat. For durable goods, the cost of capital includes not only the price of the capital good but also the interest rate that borrowers pay to finance the capital as well as the taxes that firms pay on their incomes.

To understand this point, note that investors often raise the funds for buying capital goods by borrowing (say, through a mortgage or in the bond market). What is the cost of borrowing? It is the *interest rate* on borrowed funds. Recall that the interest rate is the price paid for borrowing money for a period of time; for example, you might have to pay 8 percent to borrow $1000 for a year. In the case of a family buying a house, the interest rate is the mortgage interest rate.

Additionally, taxes can have a major effect on investment. One important tax is the federal corporation income tax. This tax takes up to 35 cents of the last dollar of corporate profits, thereby discouraging investment in the corporate sector. Sometimes, the government gives tax breaks to particular activities or sectors. For example, the government encourages home ownership by allowing homeowners to deduct real-estate taxes and mortgage interest from their taxable income.

Expectations

Additionally, profit expectations and business confidence are central to investment decisions. Investment is a gamble on the future. This means that business investments require a weighing of certain present costs with uncertain future profits. If businesses are concerned that political conditions in Russia are unstable, they will be reluctant to invest there. Conversely, if businesses believe that Internet commerce is the key to riches, they will invest heavily in that sector.

However, economists also realize that emotions weigh in the balance, that some investments are moved as much by intuition as by spreadsheets. This point was emphasized by J. M. Keynes as one of the reasons for the instability of a market economy:

> Even apart from the instability due to speculation, there is the instability due to the characteristic of human nature that a large proportion of our positive activities depend on spontaneous optimism rather than mathematical expectations, whether moral or hedonistic or economic. Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as the result of *animal spirits*—a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities.

Thus, investment decisions hang by a thread on expectations and forecasts. But accurate forecasting is difficult. Businesses spend much energy analyzing investments and trying to narrow the uncertainties about their investments.

We can sum up our review of the forces lying behind investment decisions as follows:

Businesses invest to earn profits. Because capital goods last many years, investment decisions depend on (1) the level of output produced by the new investments, (2) the interest rates and taxes that influence the costs of the investment, and (3) business expectations about the state of the economy.

THE INVESTMENT DEMAND CURVE

In analyzing the determinants of investment, we focus particularly on the relationship between interest rates and investment. This linkage is crucial because interest rates (influenced by central banks) are the

Eye Therapies Exhibit 2127, 444 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

major instrument by which governments influence investment. To show the relationship between interest rates and investment, economists use a schedule called the **investment demand curve.**

Consider a simplified economy where firms can invest in different projects: A, B, C, and so forth, up to H. These investments are so durable (like power plants or buildings) that we can ignore the need for replacement. Further, they yield a constant stream of net income each year, and there is no inflation. Table 21-5 shows the financial data on each of the investment projects.

Consider project A. This project costs $1 million. It has a very high return—$1500 per year of revenues per $1000 invested (this is a rate of return of 150 percent per year). Columns (4) and (5) show the cost of investment. For simplicity, assume that the investment is financed purely by borrowing at the market interest rate, here taken alternately as 10 percent per year in column (4) and 5 percent in column (5).

Thus at a 10 percent annual interest rate, the cost of borrowing $1000 is $100 a year, as is shown in all entries of column (4); at a 5 percent interest rate, the borrowing cost is $50 per $1000 borrowed per year.

Finally, the last two columns show the *annual net profit* from each investment. For lucrative project A, the net annual profit is $1400 a year per $1000 invested at a 10 percent interest rate. Project H loses money.

To review our findings: In choosing among investment projects, firms compare the annual revenues from an investment with the annual cost of capital, which depends upon the interest rate. The difference between annual revenue and annual cost is the annual net profit. When annual net profit is positive, the investment makes money, while a negative net profit denotes that the investment loses money.

Look again at Table 21-5 and examine the last column, showing annual net profit at a 5 percent interest rate. Note that at this interest rate, investment

(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Cost per $1,000 Borrowed at Annual Interest Rate of:		Annual Net Profit per $1,000 Borrowed at Annual Interest Rate of:	
Project	Total investment in project ($, million)	Annual revenues per $1,000 invested ($)	10% ($)	5% ($)	10% ($) (6) = (3) − (4)	5% ($) (7) = (3) − (5)
A	1	1,500	100	50	1,400	1,450
B	4	220	100	50	120	170
C	10	160	100	50	60	110
D	10	130	100	50	30	80
E	5	110	100	50	10	60
F	15	90	100	50	−10	40
G	10	60	100	50	−40	10
H	20	40	100	50	−60	−10

TABLE 21-5. The Profitability of Investment Depends on the Interest Rate

The economy has eight investment projects, ranked in order of return. Column (2) shows the investment in each project. Column (3) calculates the perpetual return each year per $1000 invested. Columns (4) and (5) then show the cost of the project, assuming all funds are borrowed, at interest rates of 10 and 5 percent; this is shown per $1000 borrowed.

The last two columns calculate the annual net profit per $1000 invested in the project. If net profit is positive, profit-maximizing firms will undertake the investment; if negative, the investment project will be rejected.

Note how the cutoff between profitable and unprofitable investments moves as the interest rate rises. (Where would the cutoff be if the interest rate rose to 15 percent per year?)

Eye Therapies Exhibit 2127, 445 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

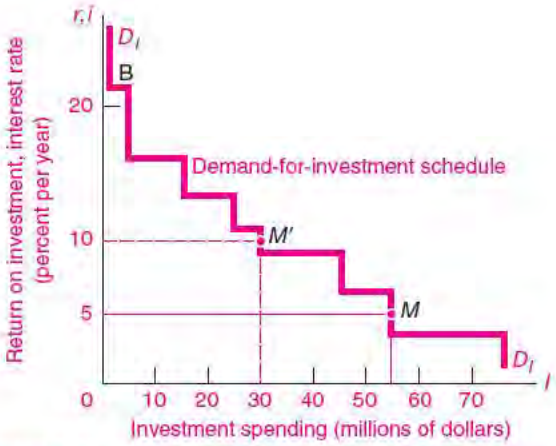


FIGURE 21-8. Investment Depends upon Interest Rate

The downward-stepping demand-for-investment schedule plots the amount that businesses would invest at each interest rate, as calculated from the data in Table 21-5. Each step represents a lump of investment: project A has such a high rate of return that it is off the figure; the highest visible step is project B, shown at the upper left. At each interest rate, all investments that have positive net profit will be undertaken.

projects A through G would be profitable. We would thus expect profit-maximizing firms to invest in all seven projects, which [from column (2)] total up to $55 million in investment. Thus at a 5 percent interest rate, investment demand would be $55 million.

However, suppose that the interest rate rises to 10 percent. Then the cost of financing these investments would double. We see from column (6) that investment projects F and G become unprofitable at an interest rate of 10 percent; investment demand would fall to $30 million.

We show the results of this analysis in Figure 21-8. This figure shows the *demand-for-investment schedule*, which is here a downward-sloping step function of the interest rate. This schedule shows the amount of investment that would be undertaken at each interest rate; it is obtained by adding up all the investments that would be profitable at each level of the interest rate.

Hence, if the market interest rate is 5 percent, the desired level of investment will occur at point *M*, which shows investment of $55 million. At this interest rate, projects A through G are undertaken. If interest rates were to rise to 10 percent, projects F and G would be squeezed out; in this situation, investment demand would lie at point *M'* with total investment of $30 million.[3]

Shifts in the Investment Demand Curve

We have seen how interest rates affect the level of investment. Investment is affected by other forces as well. For example, an increase in the GDP will shift the investment demand curve out, as shown in Figure 21-9(*a*) on the next page.

An increase in business taxation would depress investment. Say that the government taxes away half the net yield in column (3) of Table 21-5, with interest costs in columns (4) and (5) not being deductible. The net profits in columns (6) and (7) would therefore decline. [Verify that at a 10 percent interest rate, a 50 percent tax on column (3) would raise the cutoff to between projects B and C, and the demand for investment would decline to $5 million.] The case of a tax increase on investment income is shown in Figure 21-9(*b*).

We can also see how expectations enter the picture from a historical example. In the late 1990s, investors became infatuated with the Internet and the "new economy." They poured money into now-defunct companies on the basis of wild projections. Some seasoned investors even succumbed to the "animal spirits," as, for example, when Time Warner paid $180 billion for the online company AOL. Figure 21-9(*c*) illustrates how a bout of business optimism would shift out the investment demand schedule in the 1990s. When the technology-stock bubble burst in 2000, the demand for investment in software and equipment fell sharply as well, and the curve in Figure 21-9(*c*) shifted sharply back to the left. These are but two examples of how expectations can have powerful effects on investment.

After learning about the factors affecting investment, you will not be surprised to discover that investment is the most volatile component of spending. Investment behaves unpredictably because it depends on such uncertain factors as the success or failure of new and untried products, changes in tax rates and interest rates, political attitudes and

[3] We will later see that when prices are changing, it is appropriate to use a real interest rate, which represents the nominal or money interest rate corrected for inflation.

Eye Therapies Exhibit 2127, 446 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

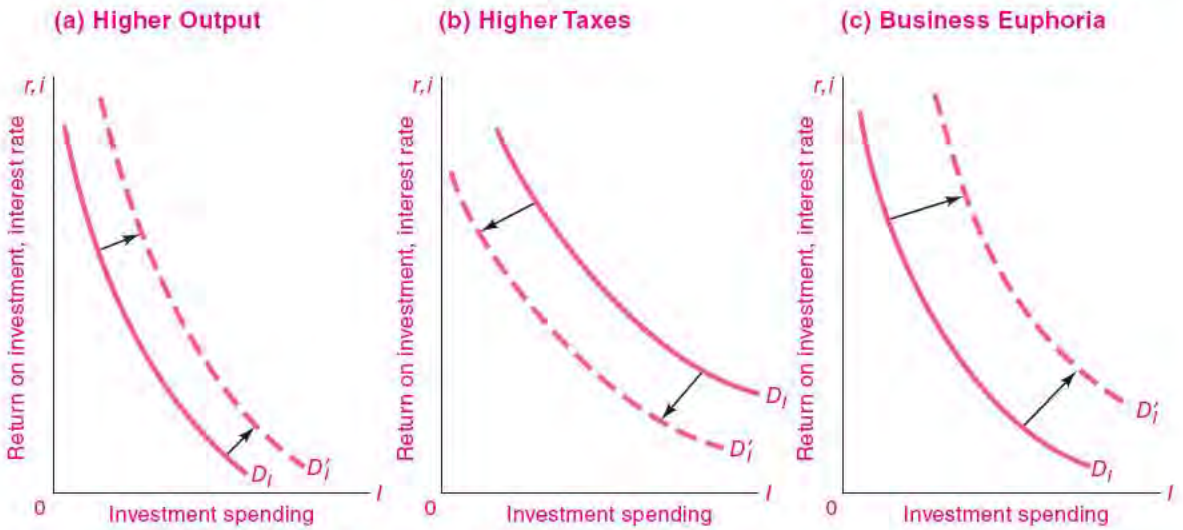


FIGURE 21-9. Shifts in Investment Demand Function

In the demand-for-investment (D_I) schedule, the arrows show the impact of **(a)** a higher level of GDP, **(b)** higher taxes on capital income, and **(c)** a burst of business euphoria.

approaches to stabilizing the economy, and similar changeable events of economic life. *In virtually every business cycle, investment fluctuations have been the driving force behind boom or bust.*

ON TO THE THEORY OF AGGREGATE DEMAND

We have now completed our introduction to the basic concepts of macroeconomics. We have examined the determinants of consumption and investment and seen how they can fluctuate from year to year, sometimes quite sharply.

At this point, macroeconomics branches into two major subjects—business cycles and economic growth. We begin our survey in the next chapter with business cycles, which concern the short-term fluctuations in output, employment, and prices. Modern business-cycle theories rely primarily on the Keynesian approach. This analysis shows the impact of financial shocks and changes in investment, government spending and taxation, and foreign trade. These shocks are amplified through induced consumption effects and determine aggregate demand. We will learn that the wise application of government fiscal and monetary policies can reduce the severity of recessions and inflation, but also that poor policies can amplify shocks. The theories of consumption and investment surveyed in this chapter will be the major players in our business-cycle drama.

SUMMARY

A. Consumption and Saving

1. Disposable income is an important determinant of consumption and saving. The consumption function is the schedule relating total consumption to total disposable income. Because each dollar of disposable income is either saved or consumed, the saving function is the other side or mirror image of the consumption function.

Eye Therapies Exhibit 2127, 447 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

2. Recall the major features of consumption and saving functions:
   a. The consumption (or saving) function relates the level of consumption (or saving) to the level of disposable income.
   b. The marginal propensity to consume (*MPC*) is the amount of extra consumption generated by an extra dollar of disposable income.
   c. The marginal propensity to save (*MPS*) is the extra saving generated by an extra dollar of disposable income.
   d. Graphically, the *MPC* and the *MPS* are the slopes of the consumption and saving schedules, respectively.
   e. $MPS \equiv 1 - MPC$.
3. Adding together individual consumption functions gives us the national consumption function. In simplest form, it shows total consumption expenditures as a function of disposable income. Other variables, such as permanent income or long-term income trends as well as wealth, also have a significant impact on consumption patterns.
4. The personal saving rate has declined sharply in the last three decades. To explain this decline, economists point to social security and government health programs, changes in financial markets, and wealth effects. Declining saving hurts the economy because personal saving is a major component of national saving and investment. While people feel richer because of the booming stock market, the nation's true wealth increases only when its productive tangible and intangible assets increase.

B. Investment

5. The second major component of spending is gross private domestic investment in housing, plant, software, and equipment. Firms invest to earn profits. The major economic forces that determine investment are therefore the revenues produced by investment (primarily influenced by the state of the business cycle), the cost of investment (determined by interest rates and tax policy), and the state of expectations about the future. Because it depends on highly unpredictable future events, investment is the most volatile component of aggregate spending.
6. An important relationship is the investment demand schedule, which connects the level of investment spending to the interest rate. Because the profitability of investment varies inversely with the interest rate, which affects the cost of capital, we can derive a downward-sloping investment demand curve. As the interest rate declines, more investment projects become profitable.

CONCEPTS FOR REVIEW

Consumption and Saving

disposable income, consumption, saving
consumption and saving functions
personal saving rates
marginal propensity to consume (*MPC*)
marginal propensity to save (*MPS*)
$MPC + MPS \equiv 1$
break-even point
45° line
determinants of consumption:
  current disposable income
  permanent income
  wealth
  life-cycle effect

Investment

determinants of investment:
  revenues
  costs
  expectations
role of interest rates in *I*
investment demand function
animal spirits

FURTHER READING AND INTERNET WEBSITES

Further Reading

Economists have studied consumer expenditure patterns in order to improve predictions and aid economic policy. One of the most influential studies is Milton Friedman, *The Theory of the Consumption Function* (University of Chicago Press, 1957). A historical overview by an economic historian is Stanley Lebergott, *Pursuing Happiness: American Consumers in the Twentieth Century* (Princeton University Press, Princeton, N.J., 1993).

Firms devote much management time to deciding about investment strategies. A good survey can be found in Richard A. Brealey, Stewart C. Myers, and Franklin Allen,

Eye Therapies Exhibit 2127, 448 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Principles of Corporate Finance (McGraw-Hill, New York, 2009).

Websites

Data on total personal consumption expenditures for the United States are provided at the website of the Bureau of Economic Analysis, *www.bea.gov*.

Data on family budgets are contained in Bureau of Labor Statistics, "Consumer Expenditures," available at *www.bls.gov*.

Data and analysis of investment for the U.S. economy are provided by the Bureau of Economic Analysis at *www.bea.gov*.

Milton Friedman and Franco Modigliani made major contributions to our understanding of the consumption function. Visit the Nobel website at *nobelprize.org/nobel_prizes/economics* to read about the importance of their contributions to macroeconomics.

QUESTIONS FOR DISCUSSION

1. Summarize the budget patterns for food, clothing, luxuries and saving.
2. In working with the consumption function and the investment demand schedule, we need to distinguish between shifts of and movements along these schedules.
   a. Define carefully for both curves changes that would lead to shifts of and those that would produce movements along the schedules.
   b. For the following, explain verbally and show in a diagram whether they are shifts of or movements along the consumption function: increase in disposable income, decrease in wealth, fall in stock prices.
   c. For the following, explain in words and show in a diagram whether they are shifts of or movements along the investment demand curve: expectation of a decline in output next year, rise of interest rates, increase in taxes on profits.
3. Exactly how were the *MPC* and *MPS* in Table 21-4 computed? Illustrate by calculating *MPC* and *MPS* between points *A* and *B*. Explain why it must always be true that $MPC + MPS \equiv 1$.
4. I consume all my income at every level of income. Draw my consumption and saving functions. What are my *MPC* and *MPS*?
5. Estimate your income, consumption, and saving for last year. If you dissaved (consumed more than your income), how did you finance your dissaving? Estimate the composition of your consumption in terms of each of the major categories listed in Table 21-1.
6. "Along the consumption function, income changes more than consumption." What does this imply for the *MPC* and *MPS*?
7. "Changes in disposable income lead to movements along the consumption function; changes in wealth or other factors lead to a shift of the consumption function." Explain this statement with an illustration of each case.
8. What would be the effects of the following on the investment demand function illustrated in Table 21-5 and Figure 21-8?
   a. A doubling of the annual revenues per $1000 invested shown in column (3)
   b. A rise in interest rates to 15 percent per year
   c. The addition of a ninth project with data in the first three columns of (J, 10, 70)
   d. A 50 percent tax on net profits shown in columns (6) and (7)
9. Using the augmented investment demand schedule from question 8(**c**) and assuming that the interest rate is 10 percent, calculate the level of investment for cases **a** through **d** in question 8.
10. **Advanced problem:** According to the life-cycle model, people consume each year an amount that depends upon their *lifetime* income rather than upon their current income. Assume that you expect to receive future income (in constant dollars) according to the schedule in Table 21-6.
    a. Assume that there is no interest paid on savings. You have no initial savings. Further assume that you want to "smooth" your consumption (enjoying equal consumption each year) because of diminishing extra satisfaction from extra consumption. Derive your best consumption trajectory for the 5 years, and write the figures in column (3). Then calculate your saving and enter the amounts in column (4); put your end-of-period wealth, or cumulative saving, for each year into column (5). What is your average saving rate in the first 4 years?
    b. Next, assume that a government social security program taxes you $2000 in each of your working

Eye Therapies Exhibit 2127, 449 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

(1) Year	(2) Income ($)	(3) Consumption ($)	(4) Saving ($)	(5) Cumulative saving (end of year) ($)
1	30,000	_____	_____	_____
2	30,000	_____	_____	_____
3	25,000	_____	_____	_____
4	15,000	_____	_____	_____
5*	0	_____	_____	0

*Retired.

TABLE 21-6.

years and provides you with an $8000 pension in year 5. If you still desire to smooth consumption, calculate your revised saving plan. How has the social security program affected your consumption? What is the effect on your average saving rate in the first 4 years? Can you see why some economists claim that social security can lower saving?

Eye Therapies Exhibit 2127, 450 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

22

Business Cycles and Aggregate Demand



The fault, dear Brutus, is not in our stars—but in ourselves.

William Shakespeare
Julius Caesar

The American economy has been subject to business cycles since the early days of the Republic. Sometimes, business conditions are healthy, with rapidly growing employment, factories working overtime, and robust profits. The "fabulous 1990s" was such a period for the American economy. The economy grew rapidly; employment and capacity utilization were exceptionally high, and unemployment was low. Yet, unlike the case in earlier long expansions, inflation remained low throughout the 1990s.

Such periods of prosperity often come to an unhappy end. In the nineteenth and early twentieth centuries, and again in 2007–2009, financial crises turned into waves of contagious pessimism, businesses failed, credit conditions tightened, and a downturn in the banking and financial sectors rippled through the rest of the economy. During business downturns, jobs are hard to find, factories are idle, and profits are low. These downturns are usually short and mild, as was the case in the recession that began in March 2001 and ended in November 2001. From time to time the contraction may persist for a decade and cause widespread economic hardships, as during the 1930s in the Great Depression of the 1930s or in Japan in the 1990s.

These short-term fluctuations in economic activity, known as *business cycles*, are the central topic of this chapter. Understanding business cycles has proved to be one of the most enduring issues in all of macroeconomics. What causes business fluctuations? How can government policies reduce their virulence? Economists were largely unable to answer these questions until the 1930s, when the revolutionary macroeconomic theories of John Maynard Keynes highlighted the importance of the forces of aggregate demand in determining business cycles. Keynesian economics emphasizes that *changes in aggregate demand can have powerful impacts on the overall levels of output, employment, and prices in the short run.*

This chapter describes the basic features of the business cycle and presents the simplest theories of output determination. The structure of this chapter is as follows:

- We begin with a description of the key elements of the business cycle.
- We then summarize the basics of aggregate demand and show how the modern business cycle fits into that framework.
- Next, we develop the multiplier model—the simplest Keynesian example of a model of aggregate demand.
- We close with an application of the multiplier model to the question of the impact of fiscal policy on output.

Eye Therapies Exhibit 2127, 451 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

A. WHAT ARE BUSINESS CYCLES?

Economic history shows that no economy grows in a smooth and even pattern. A country may enjoy several years of economic expansion and prosperity, with rapid increases in stock prices (as in the 1990s) or housing prices (as in the early 2000s). Then, the irrational exuberance may flip over to irrational pessimism as, during the 2007–2009 period, lenders stop issuing mortgages or car loans on favorable terms, banks slow their lending to businesses, and spending declines. Consequently, national output falls, unemployment rises, and profits and real incomes decline.

Eventually the bottom is reached and recovery begins. The recovery may be incomplete, or it may be so strong as to lead to a new boom. Prosperity may mean a long, sustained period of brisk demand, plentiful jobs, and rising living standards. Or it may be marked by a quick, inflationary flare-up in prices and speculation, followed by another slump.

Upward and downward movements in output, inflation, interest rates, and employment form the business cycle that characterizes all market economies.

FEATURES OF THE BUSINESS CYCLE

What exactly do we mean by "business cycles"?

Business cycles are economywide fluctuations in total national output, income, and employment, usually lasting for a period of 2 to 10 years, marked by widespread expansion or contraction in most sectors of the economy.

Economists typically divide business cycles into two main phases: *recession* and *expansion*. Peaks and troughs mark the turning points of the cycle. Figure 22-1 shows the successive phases of the business cycle. The downturn of a business cycle is called a recession. A **recession** is a recurring period of decline in total output, income, and employment, usually lasting from 6 to 12 months and marked by contractions in many sectors of the economy. A recession that is large in both scale and duration is called a **depression.**

The semiofficial judge of the timing of contractions and expansions is the National Bureau of Economic Research (NBER), a private research organization. The NBER defines a recession as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment,

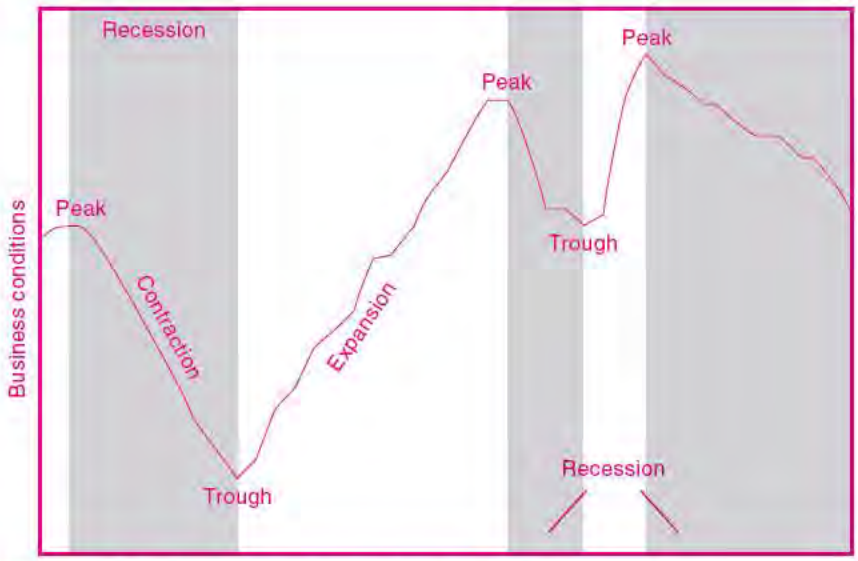


FIGURE 22-1. A Business Cycle, like the Year, Has Its Seasons

Business cycles are the irregular expansions and contractions in economic activity. (These are the actual monthly data on industrial production for a recent business-cycle period.)

Eye Therapies Exhibit 2127, 452 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

industrial production, and wholesale-retail sales." (See "Websites" at the end of this chapter for further information on dating of recessions.)

An alternative definition sometimes used is that a recession occurs when real GDP has declined for two consecutive calendar quarters. (Question 12 at the end of the chapter reviews the difference between the two definitions.)

Although we call these short-term fluctuations "cycles," the actual pattern is irregular. No two business cycles are quite the same. No exact formula, such as might apply to the revolutions of the planets or the swings of a pendulum, can be used to predict the duration and timing of business cycles. Rather, business cycles more closely resemble the irregular fluctuations of the weather. Figure 22-2 shows the American business cycles throughout recent history. Here you can see that business cycles are like mountain ranges, with some valleys that are deep and broad, as in the Great Depression, and others that are shallow and narrow, as in the recession of 1991.

While individual business cycles are not identical, they often share a family similarity. If a reliable economic forecaster announces that a recession is about to arrive, what are the typical phenomena that you should expect? The following are a few of the *customary characteristics* of a recession:

- Investment usually falls sharply in recessions. Housing has generally been the first to decline, either because of a financial crisis or because the Federal Reserve has raised interest rates to slow inflation. Consumer purchases often decline sharply as well. As businesses slow production lines, real GDP falls.
- Employment usually falls sharply in the early stages of a recession. It sometimes is slow to recover in what are often called "jobless recoveries."



FIGURE 22-2. Business Activity since 1919

Industrial production has fluctuated irregularly around its long-run trend. Can you detect a more stable economy in recent years?

Source: Federal Reserve Board, detrended by authors.

Eye Therapies Exhibit 2127, 453 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

- As output falls, inflation slows and the demand for crude materials declines, and materials' prices tumble. Wages and the prices of services are unlikely to face a similar decline, but they tend to rise less rapidly in economic downturns.
- Business profits fall sharply in recessions. In anticipation of this, common-stock prices usually fall as investors sniff the scent of a business downturn.
- Generally, as business conditions deteriorate and employment falls, the Federal Reserve begins to lower short-term interest rates to stimulate investment, and other interest rates decline as well.

BUSINESS-CYCLE THEORIES

Exogenous vs. Internal Cycles. Over the years, macroeconomists have engaged in vigorous debates about the reasons for business fluctuations. Some think they are caused by monetary fluctuations, others by productivity shocks, and still others by changes in exogenous spending.

There is certainly no end to possible explanations, but it is useful to classify the different theories into two categories: exogenous and internal. The *exogenous* theories find the sources of the business cycle in the fluctuations of factors outside the economic system—in wars, revolutions, and elections; in oil prices, gold discoveries, and population migrations; in discoveries of new lands and resources; in scientific breakthroughs and technological innovations; even in sunspots, climate change, and the weather.

An example of an exogenous cycle was the outbreak of World War II. When Germany and Japan launched wars on Europe and the United States, this led to a rapid military buildup, large increases in spending, and an increase in aggregate demand that propelled the United States out of the Great Depression. Here we saw an exogenous event—a major war—that led to a huge increase in military spending and to the biggest economic expansion of the twentieth century. (We will examine this episode later in this chapter.)

By contrast, the *internal* theories look for mechanisms within the economic system itself. In this approach, every expansion breeds recession and contraction, and every contraction breeds revival and expansion. Many business cycles in U.S. economic history were internal cycles that originated in the financial sector. It is for this reason that we devote much of our attention to monetary and financial economics.

Financial Crises and Business Cycles

One common feature of capitalism around the world is the speculative booms and busts that occurred frequently in the nineteenth century, produced the upheaval of the Great Depression, and reappeared in the United States several times over the last two decades. Below are some important examples.

Panics of Early Capitalism. The nineteenth century witnessed frenzies of investment speculation—notably in canals, land, and railroads. Inevitably, "animal spirits" would take over. Railroads would be overbuilt, land prices would rise too high, and people would take on too much debt. Bankruptcy would lead to bank failures, a run on the banks, and a banking crisis. Output and prices would fall sharply in the panic. Eventually, after the worst excesses were wrung out, the economy would begin to expand again.

Hyperinflation. Sometimes, an overheated economy leads to high inflation, or even hyperinflation. Hyperinflation occurs when prices rise at 100 percent or more *per month*. The most famous hyperinflation in history occurred in Germany in 1923. The government was unable to meet its financial obligations through taxing and borrowing, so it turned to the monetary printing press. By the end of 1923, currency was printed with more and more digits, and the largest banknote in circulation was for 25 billion marks! Central banks today are vigilant in their defense against even the most moderate inflation.

The New-Economy Bubble. The classic pattern of speculative boom was seen again in the late 1990s. The phenomenal pattern of growth and innovation in the "new-economy" sectors—including software, the Internet, and the newly invented dot.com companies—produced a speculative boom in new-economy stocks. Companies sold online dating services, gave away free electronic birthday cards, and issued stock for Flooz.com, which sold a worthless digital currency. College students dropped out of school to become instant millionaires (or so they dreamed). All of this spurred real investment in computers, software, and telecommunications. Investment in information-processing equipment rose by 70 percent from 1995 to 2000, representing one-fifth of the entire rise in real GDP during this period.

Eye Therapies Exhibit 2127, 454 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Eventually, investors became skeptical about the fundamental value of many of these firms. Losses piled up on top of losses. The urge to buy the stocks before prices rose higher was replaced by the panicky desire to sell before they collapsed. The stock price of a typical new-economy company fell from $100 per share to pennies by 2003. Many such companies went bankrupt. College dropouts went back to school wiser but seldom richer.

The changed expectations about the new economy and the resulting stock market decline contributed to the recession and slow growth in the 2000–2002 period. Investment in information-processing equipment fell by 10 percent, and investment in computers fell by twice as much. The impressive innovations of the new economy have become a staple feature of modern technology, but, with a few exceptions, investors have little or no profits to show for their efforts.

The Housing Bubble. Less than a decade later, another financial crisis erupted, and this was again the result of rapid innovation. But in this case, the innovation was the process of financial "securitization." This occurs when a financial instrument, such as a simple home mortgage, is sliced and diced, repackaged, and then sold on securities markets. While securitization itself was not a new phenomenon, the scope of packaging and repackaging grew sharply. Rating agencies failed to provide accurate ratings of the riskiness of these new securities, and many people bought them thinking they were as good as gold. The worst examples were "subprime mortgages," mortgages provided to people for the entire value of a house on the basis of little or no documentation of their income and job status. By early 2007, the total value of these new securities was over $1 trillion.

All went well as long as housing prices were rising, as they did starting in 1995. But then in 2006 the housing bubble burst—echoing the end of the speculative dot.com stock-market bubble from a decade earlier. Many of the new securities lost value. It turned out they were not top-grade AAA securities but junk bonds. As banks and other financial institutions suffered large losses, they began to tighten credit, reduce loans, and cut back sharply on new mortgages. Risk premiums rose sharply.

The Federal Reserve took steps to ease monetary conditions—lowering interest rates and extending credit—but it was flying against powerful headwinds. As the value of stocks fell more sharply than at any time in a century, many financial institutions were on the verge of bankruptcy. Many of the large investment banking firms disappeared. The Federal Reserve and U.S. Treasury loaned massive amounts of federal money and bailed out several financial firms. Yet, even with the strong countercyclical activities, the economy went into a deep recession at the end of 2007.

You begin to see the theme running through all these events. The next few chapters survey our economic theories to explain them.

B. AGGREGATE DEMAND AND BUSINESS CYCLES

We have now begun to understand the short-term changes in output, employment, and prices that characterize business fluctuations in market economies. Most explanations of business cycles rely upon the theory of aggregate demand. This section explains *AD* theory in greater detail.

THE THEORY OF AGGREGATE DEMAND

What are the major components of aggregate demand? How do they interact with aggregate supply to determine output and prices? Exactly how do short-run fluctuations in *AD* affect GDP? We first examine aggregate demand in more detail in order to get a better understanding of the forces driving the economy. Then, in the following sections, we derive the simplest model of aggregate demand: the multiplier model.

Aggregate demand (or *AD*) is the total or aggregate quantity of output that is willingly bought at a given level of prices, other things held constant. *AD* is the desired spending in all product sectors: consumption, private domestic investment, government purchases of goods and services, and net exports. It has four components:

1. *Consumption.* As we saw in the last chapter, consumption (*C*) is primarily determined by

Eye Therapies Exhibit 2127, 455 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

disposable income, which is personal income less taxes. Other factors affecting consumption are longer-term trends in income, household wealth, and the aggregate price level. Aggregate demand analysis focuses on the determinants of *real* consumption (that is, nominal or dollar consumption divided by the price index for consumption).

2. *Investment.* Investment (I) spending includes purchases of buildings, software, and equipment and accumulation of inventories. Our analysis in Chapter 21 showed that the major determinants of investment are the level of output, the cost of capital (as determined by tax policies along with interest rates and other financial conditions), and expectations about the future. The major channel by which economic policy can affect investment is monetary policy.
3. *Government purchases.* A third component of aggregate demand is government purchases of goods and services (G). This includes the purchases of goods like tanks and school books, as well as the services of judges and public-school teachers. Unlike private consumption and investment, this component of aggregate demand is determined directly by the government's spending decisions; when the Pentagon buys a new fighter aircraft, this output directly adds to the GDP.
4. *Net exports.* A final component of aggregate demand is net exports (X), which equal the value of exports minus the value of imports. Imports are determined by domestic income and output, by the ratio of domestic to foreign prices, and by the foreign exchange rate of the dollar. Exports (which are imports of other countries) are the mirror image of imports, and they are determined by foreign incomes and outputs, by relative prices, and by foreign exchange rates. Net exports, then, will be determined by domestic and foreign outputs, relative prices, and exchange rates.

Figure 22-3 shows the AD curve and its four major components. At price level P, we can read the levels of consumption, investment, government purchases, and net exports, which sum to GDP, or Q. The sum of the four spending streams at that price level is aggregate spending, or aggregate demand, at that price level.

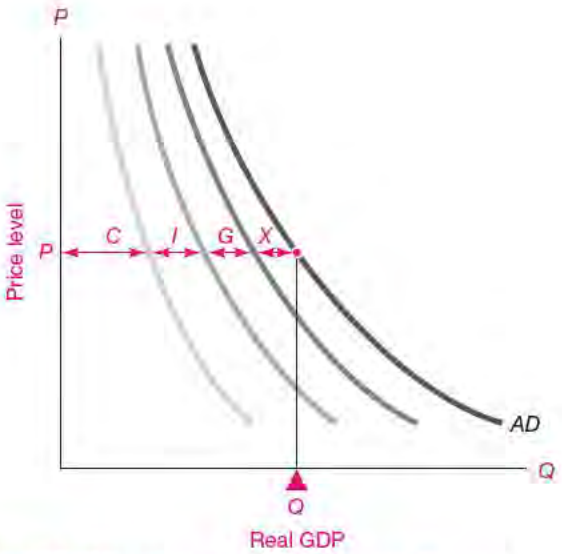


FIGURE 22-3. Components of Aggregate Demand

Aggregate demand (AD) consists of four components—consumption (C), domestic private investment (I), government spending on goods and services (G), and net exports (X).

Aggregate demand shifts when there are changes in macroeconomic policies (such as monetary-policy changes or changes in government expenditures or tax rates) or when exogenous events change spending (as would be the case with changes in foreign output, affecting X, or in business confidence, affecting I).

THE DOWNWARD-SLOPING AGGREGATE DEMAND CURVE

One important point you should notice is that the aggregate demand curve in Figure 22-3 slopes downward. This means that, holding other things constant, the level of real spending declines as the overall price level in the economy rises.

What is the reason for the downward slope? The basic reason is that there are some elements of income or wealth that do not rise when the price level rises. For example, some items of personal income might be set in nominal dollar terms—some government transfer payments, the minimum wage, and company pensions are examples. When the price level goes up, therefore, real disposable income falls, leading to a decline in real consumption expenditures.

Eye Therapies Exhibit 2127, 456 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

In addition, some elements of wealth may be fixed in nominal terms. Examples here would be holdings of money and bonds, which usually contain promises to pay a certain number of dollars in a given period. If the price level rises, therefore, the real value of wealth declines, and this would again lead to lower levels of real consumption.

We illustrate the impact of a higher price level graphically in Figure 22-4(*a*) on page 436. Say that the economy is in equilibrium at point *B*, with a price level of 100 and a real GDP of $3000 billion. Next assume that prices rise by 50 percent, so the price index *P* rises from 100 to 150. Suppose that at that higher price level, real spending declines because of lower real disposable income. Total real spending declines to $2000 billion, shown at point *C*. We see here how higher prices have reduced real spending.

To summarize:

The *AD* curve slopes downward. This downward slope implies that real spending declines as the price level rises, other things held constant. Real spending declines with a higher price level primarily because of the effect of higher prices on real incomes and real wealth.

Shifts in Aggregate Demand

We have seen that total spending in the economy tends to decline as the price level rises, holding other things constant. But those other things do in fact tend to change, thereby producing changes in aggregate demand. What are the key determinants of changes in aggregate demand?

We can separate the determinants of *AD* into two categories, as shown in Table 22-1. One set includes

Variable	Impact on aggregate demand
	Policy Variables
Monetary policy	Monetary expansion may lower interest rates and loosen credit conditions, inducing higher levels of investment and consumption of durable goods. In an open economy, monetary policy also affects the exchange rate and net exports.
Fiscal policy	Increases in government purchases of goods and services directly increase spending; tax reductions or increases in transfers raise disposable income and induce higher consumption. Tax incentives like an investment tax credit can induce higher spending in a particular sector.
	Exogenous Variables
Foreign output	Output growth abroad leads to an increase in net exports.
Asset values	Rise in stock market increases household wealth and thereby increases consumption; also, higher stock prices lower the cost of capital and thereby increase business investment.
Advances in technology	Technological advances can open up new opportunities for business investment. Important examples have been the railroad, the automobile, and computers.
Other	Defeat of a socialist government stimulates foreign investment; peace breaks out, with an increase in world oil production, and lowers oil prices; good weather leads to lower food prices.

TABLE 22-1. Many Factors Can Increase Aggregate Demand and Shift out the *AD* Curve

The aggregate demand curve relates total spending to the price level. But numerous other influences affect aggregate demand—some policy variables, others exogenous factors. The table lists changes that would tend to increase aggregate demand and shift out the *AD* curve.

Eye Therapies Exhibit 2127, 457 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the macroeconomic *policy variables*, which are under government control. These are monetary policy (steps by which the central bank can affect interest rates and other financial conditions) and fiscal policy (taxes and government expenditures). Table 22-1 illustrates how these government policies can affect different components of aggregate demand.

The second set includes *exogenous variables*, or variables that are determined outside the *AS-AD* framework. As Table 22-1 shows, some of these variables (such as wars or revolutions) are outside the scope of macroeconomic analysis proper, some (such as foreign economic activity) are outside the control of domestic policy, and others (such as the stock market) have significant independent movement.

What are the effects of changes in the variables lying behind the *AD* curve? Consider the economic effects of a sharp increase in military spending, such as took place in World War II. The additional costs of the war included pay for the troops, purchases of ammunition and equipment, and costs of transportation. The effect of these purchases was an increase in *G*. Unless some other component of spending decreased to offset the increase in *G*, the total *AD* curve would shift out and to the right as *G* increased. Similarly, a radical new innovation that increased the profitability of new investment, or an increase in consumer wealth because of higher housing prices, would lead to an increase in aggregate demand and an outward shift of the *AD* curve.

Figure 22-4(*b*) on page 436 shows how the changes in the variables listed in Table 22-1 would affect the *AD* curve. To test your understanding, construct a similar table showing forces that would tend to decrease aggregate demand (see question 2 at the end of the chapter).



Two Reminders

We pause for two important reminders.

1. We first emphasize the difference between macroeconomic and microeconomic demand curves. Recall from our study of supply and demand that the microeconomic demand curve has the price of an individual commodity on the vertical axis and production of that commodity on the horizontal axis, with all other prices and total consumer incomes held constant.

   In the aggregate demand curve, the general price level is on the vertical axis, while total output and incomes vary along the horizontal axis. By contrast, total incomes and output are held constant for the microeconomic demand curve.

   Finally, the negative slope of the microeconomic demand curve occurs because consumers substitute other goods for the good in question when its price rises. If the price of meat rises, the quantity demanded falls because consumers tend to substitute bread and potatoes for meat, using more of the relatively inexpensive commodities and less of the relatively expensive one.

   The aggregate demand curve is downward-sloping for completely different reasons: Total spending falls when the overall price level rises because consumer real incomes and real wealth fall, reducing consumption, and interest rates rise, reducing investment spending.

2. Remember also the important distinction between the *movement along* a curve and the *shift of* a curve. Figure 22-4(*a*) shows a case of movement along the aggregate demand curve. This might occur when higher oil prices reduce real disposable income. Figure 22-4(*b*) shows a shift of the aggregate demand curve. This might occur because of a sharp increase in war spending. Always keep this distinction in mind as you analyze a particular policy or shock.

Business Cycles and Aggregate Demand

One important source of business fluctuations is shocks to aggregate demand. A typical case is illustrated in Figure 22-5 on page 436, which shows how a decline in aggregate demand lowers output. Say that the economy begins in short-run equilibrium at point *B*. Then, perhaps because of a financial panic or a tax increase, the aggregate demand curve shifts leftward to *AD'*. If there is no change in aggregate supply, the economy will reach a new equilibrium at point *C*. Note that output declines from *Q* to *Q'*. In addition, prices are now lower than they were at the previous equilibrium, and the rate of inflation falls.

The case of an economic expansion is just the opposite. Suppose that a war leads to a sharp increase in government spending. As a result, the *AD* curve would shift to the right, output and employment would increase, and prices and inflation would rise.

Business-cycle fluctuations in output, employment, and prices are often caused by shifts in aggregate demand. These occur as consumers, businesses,

Eye Therapies Exhibit 2127, 458 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

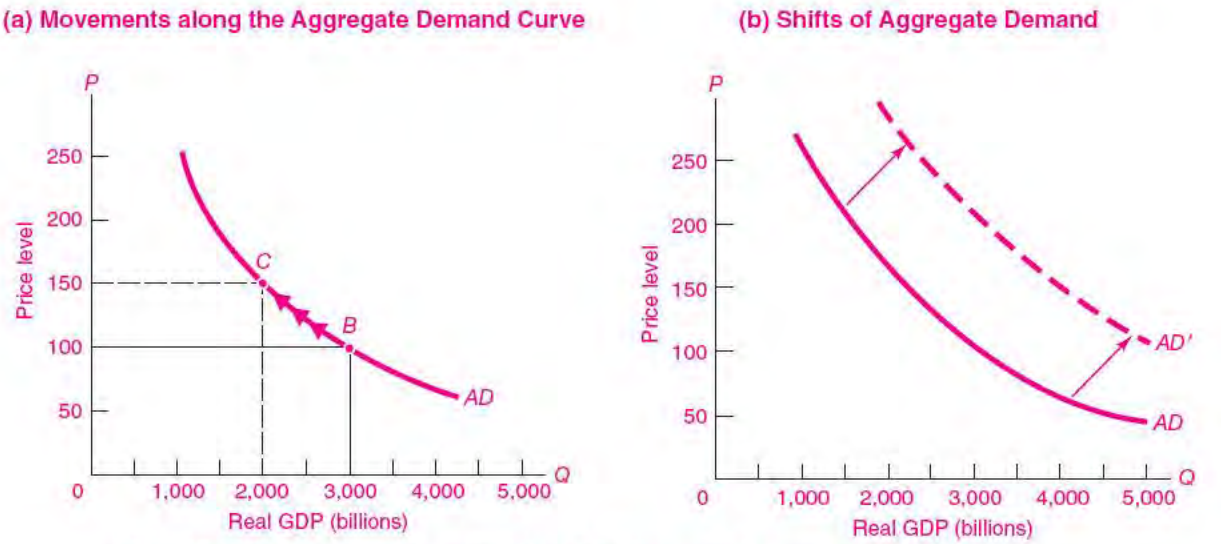


FIGURE 22-4. Movement along vs. Shifts of the Aggregate Demand Curve

In (**a**), a higher price level with given nominal money incomes lowers real disposable income; this leads to higher interest rates and declining spending on interest-sensitive investment and consumption. This illustrates a *movement along* the *AD* curve from *B* to *C* when other things are held constant.

In (**b**), other things are no longer constant. Changes in variables underlying *AD*—such as the money supply, tax policy, or military spending—lead to changes in total spending at a given price level. This leads to a *shift of* the *AD* curve.

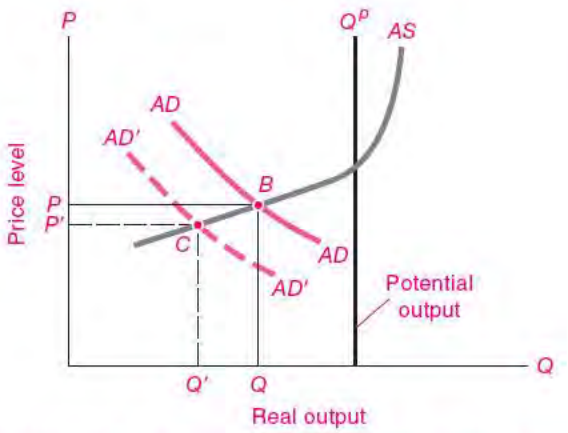


FIGURE 22-5. A Decline in Aggregate Demand Leads to an Economic Downturn

A downward shift in the *AD* curve along a relatively flat and unchanging *AS* curve leads to lower levels of output. Note that as a result of the leftward shift in the *AD* curve, actual output declines relative to potential output and makes a recession worse.

or governments change total spending relative to the economy's productive capacity. When these shifts in aggregate demand lead to sharp business downturns, the economy suffers recessions or even depressions. A sharp upturn in economic activity can lead to inflation.

Is the Business Cycle Avoidable?

The history of business cycles in the United States shows a remarkable trend toward greater stability in the last quarter-century (look back at Figure 22-2). The period through 1940 witnessed numerous crises and depressions—prolonged, cumulative slumps like those of the 1870s, 1890s, and 1930s. Since 1945, business cycles have become less frequent and milder, and many Americans have never witnessed a real Depression.

What were the sources of the Great Moderation? Some believe that capitalism is inherently more stable now than it was in earlier times. Some of that stability comes from a larger and more predictable government sector. Equally important is a better

Eye Therapies Exhibit 2127, 459 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

understanding of macroeconomics that now permits the government to conduct its monetary and fiscal policies so as to prevent shocks from turning into recessions and to keep recessions from snowballing into depressions.

During tranquil periods, people often declare that the business cycle has been vanquished. Is this a realistic possibility? While business cycles have moderated in America over the last quarter-century, they have actually become more prevalent in other economies. So take heed of the following prophetic words of the great macroeconomist Arthur Okun, which are particularly appropriate as the world economy heads into recession in 2007–2009:

> Recessions are now generally considered to be fundamentally preventable, like airplane crashes and unlike hurricanes. But we have not banished air crashes from the land, and it is not clear that we have the wisdom or the ability to eliminate recessions. The danger has not disappeared. The forces that produce recurrent recessions are still in the wings, merely waiting for their cue.

C. THE MULTIPLIER MODEL

The basic macroeconomic theory of business cycles holds that shifts in aggregate demand produce the frequent and unpredictable fluctuations in output, prices, and employment known as business cycles. Economists try to understand the *mechanism* by which changes in spending get translated into changes in output and employment. The simplest approach to understanding business cycles is known as the *Keynesian multiplier model.*

When economists attempt to understand why major increases in military spending led to rapid increases in GDP, or why the tax cuts of the 1960s or 1980s ushered in long periods of business-cycle expansions, or why the investment boom of the late 1990s produced America's longest expansion, they often turn to the Keynesian multiplier model for the simplest explanation.

What exactly is the **multiplier model?** It is a macroeconomic theory used to explain how output is determined in the short run. The name "multiplier" comes from the finding that each dollar change in exogenous expenditures (such as investment) leads to more than a dollar change (or a multiplied change) in GDP. The key assumptions underlying the multiplier model are that wages and prices are fixed and that there are unemployed resources in the economy. In addition, in this introductory chapter, we are ignoring the role of monetary policy and assuming that financial markets do not react to changes in the economy. Additionally, we are for now assuming that there is no international trade and finance. These further elaborations will be introduced in later chapters.

OUTPUT DETERMINED BY TOTAL EXPENDITURES

Our initial discussion of the multiplier model analyzes how investment and consumption spending interact with incomes to determine national output. This is called the *total expenditure approach* to determining national output.

Recall Chapter 21's picture of the national consumption function. We have drawn a reminder graph in Figure 22-6, where the consumption function is

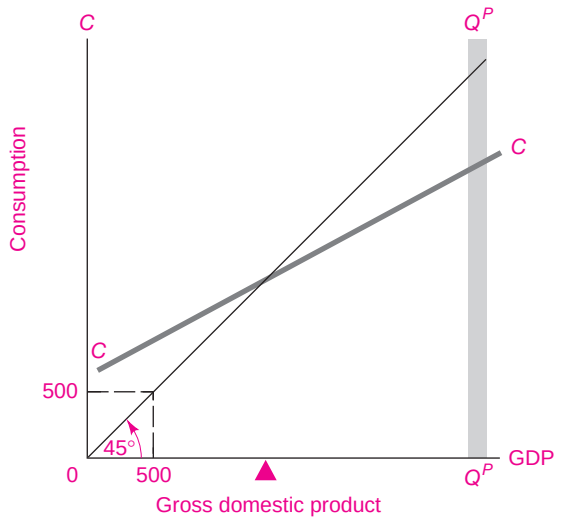


FIGURE 22-6. National Income Determines the Level of Consumption

Recall the consumption function, *CC*, that was described in Chapter 21. This shows the level of consumption expenditures corresponding to every level of income (where income equals GDP in this simple example). The two points marked "500" emphasize the important property of the 45° line. Any point on the 45° line depicts a vertical distance exactly equal to the horizontal distance. The blue band marked Q_PQ_P shows the level of potential GDP.

Eye Therapies Exhibit 2127, 460 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

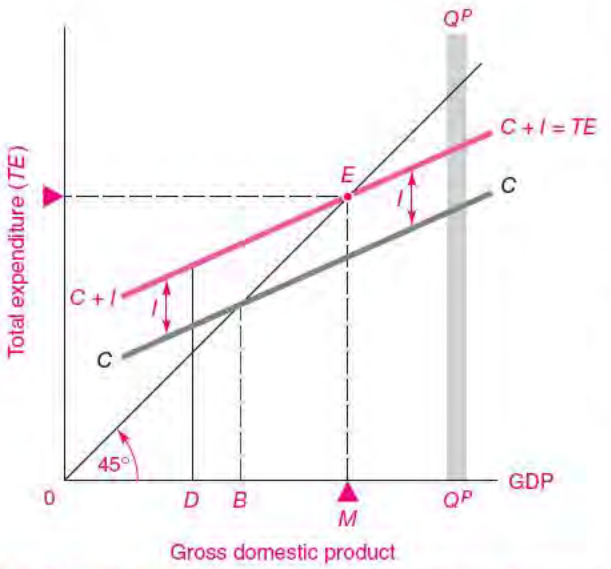


FIGURE 22-7. The Equilibrium Level of National Output Is Determined When Total Expenditure (*TE*) Equals Output

The blue *CC* line represents the consumption function (shown in Figure 22-6). The *II* arrows indicate constant investment. Adding *II* to *CC* gives the *TE* curve of total desired investment plus consumption spending. Along the 45° line, expenditures exactly equal GDP. Equilibrium GDP comes at point *E*, which is the intersection of the *TE* line and the 45° line. This is the only level of GDP at which the desired spending on $C + I$ exactly equals output.

the *CC* line. Recall that the consumption function shows the desired consumption corresponding to each level of income. We have omitted taxes, transfers, and other items, so that personal income equals national income, and national income equals GDP.

We now develop in Figure 22-7 an important new graph showing the total expenditure-output relationship. This graph is sometimes called the "Keynesian cross," because it shows how output equals expenditure when the expenditure curve crosses the 45° line. (If you are not sure about the significance of the 45° line, look back at Chapter 21's explanation.)

We begin by drawing the consumption function, *CC*. We then add total investment to consumption. Normally, investment depends on interest rates, tax policy, and business confidence. To simplify things, we treat investment as an *exogenous* variable, one whose level is determined outside the model. Say that investment opportunities are such that investment would be exactly $200 billion per year regardless of the level of GDP. The investment schedule is stacked on top of the consumption schedule in Figure 22-7. Note that the $C + I$ curve is higher than the *C* curve by exactly the constant amount of *I*. This parallel feature indicates that investment is constant.

This $C + I$ curve represents total expenditures (*TE*), which equals desired investment (which is at fixed level *I*) plus consumption. This is drawn in Figure 22-7 as the green $C + I$ or *TE* curve.

Finally, we draw in a 45° line along which expenditure on the vertical axis exactly equals output on the horizontal axis. At any point on the 45° line, total desired expenditure (measured vertically) exactly equals the total level of output (measured horizontally).

We can now calculate the equilibrium level of output in Figure 22-7. Where planned expenditure, represented by the *TE* curve, equals total output, the economy is in equilibrium.

The total expenditure curve (*TE*) shows the level of expenditure desired or planned by consumers and businesses corresponding to each level of output. The economy is in equilibrium at the point where the $TE = C + I$ curve crosses the 45° line—at point *E* in Figure 22-7. Point *E* is the macroeconomic equilibrium because at that point, the level of desired expenditure on consumption and investment exactly equals the level of total output.

Reminder on the Meaning of Equilibrium

We often look for a macroeconomic "equilibrium" when analyzing business cycles or economic growth. What exactly does this term mean? An **equilibrium** is a situation where the different forces at work are in balance. For example, if you see a ball rolling down a hill, the ball is not in equilibrium because the forces at work are pulling the ball down. This is therefore a **disequilibrium.** When the ball comes to rest in a valley at the bottom of the hill, the forces operating on the ball are in balance. This is therefore an equilibrium.

Similarly, in macroeconomics, an equilibrium level of output is one where the different forces of spending and output are in balance; in equilibrium, the level of output tends to persist until there are changes in the forces affecting the economy.

Eye Therapies Exhibit 2127, 461 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Applying the equilibrium concept to Figure 22-7, we see that point *E* is an equilibrium. At point *E,* and only at point *E,* does *desired spending on* C + I *equal actual output.* At any other level of production, desired spending would differ from production. At any level other than *E,* businesses would find themselves producing too little or too much and would want to change the level of production back toward the equilibrium level.

The Adjustment Mechanism

It is not enough to say that point *E* is an equilibrium. We need to understand *why* a certain output is an equilibrium and what would happen if output deviated from that equilibrium. Let's consider three cases: planned spending above output, planned spending below output, and planned spending equal to output.

In the first case, suppose that spending is above output. This is represented by point *D* in Figure 22-7. At this level of output, the $C + I$ spending line is above the 45° line, so planned $C + I$ spending would be greater than output. This means that consumers would be buying more goods than businesses had anticipated. Auto dealers would find their lots emptying, and the backlog for computers would be getting longer and longer.

In such a disequilibrium situation, auto dealers and computer stores would respond by increasing their orders. Automakers would recall workers from layoff and gear up their production lines, while computer makers would add additional shifts. As a result of this increased production, output would increase. *Therefore, a discrepancy between total planned expenditure and total output leads to an adjustment of output.*

You should also work through what happens in the second case, where output is below equilibrium.

Finally, take the third case, where planned expenditure exactly equals output. At equilibrium, firms will find that their sales are equal to their forecasts. Inventories will be at their planned levels. There will not be any unexpected orders. Firms cannot improve profits by changing output because planned consumption needs have been met. So production, employment, income, and spending will remain the same. In this case GDP stays at point *E,* and we can rightly call it an *equilibrium.*

The equilibrium level of GDP occurs at point *E,* where planned spending equals planned production. At any other output, the total desired spending on consumption and investment differs from the planned production. Any deviation of plans from actual levels will cause businesses to change their production and employment levels, thereby returning the system to the equilibrium GDP.

A Numerical Analysis

An example may help show why the equilibrium level of output occurs where planned spending and planned output are equal.

Table 22-2 shows a simple example of consumption, saving, and output. The break-even level of income, where consumption equals income, is $3000 billion ($3 trillion). Each $300 billion change of income is assumed to lead to a $100 billion change in saving and a $200 billion change in consumption. In other words, the *MPC* is assumed to be constant and equal to ⅔.

We assume that investment is exogenous and always sustainable at $200 billion, as shown in column (4) of Table 22-2.

Columns (5) and (6) are the crucial ones. Column (5) shows the total GDP. It is simply column (1) copied again into column (5). The figures in column (6) represent total planned expenditures at each level of GDP; that is, it equals the planned consumption spending plus planned investment. It is the $C + I$ schedule from Figure 22-7 in numbers.

When businesses as a whole are producing too much output (higher than the sum of what consumers and businesses want to purchase), inventories of unsold goods will be piling up.

Reading from the top row of Table 22-2, we see that if firms are initially producing $4200 billion of GDP, planned or desired spending [shown in column (6)] is only $4000 billion. In this situation, excess inventories will be accumulating. Firms will respond by reducing their production levels, and GDP will fall. In the opposite case, represented in the bottom row of Table 22-2, total spending is $3000 billion but output is only $2700 billion. Inventories are being depleted and firms will expand operations, raising output.

We see, then, that when businesses as a whole are temporarily producing more than they can profitably sell, they will reduce production and GDP will fall. When they are selling more than their current production, they will increase their output, and GDP will rise.

Eye Therapies Exhibit 2127, 462 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

GDP Determination Where Output Equals Planned Spending (billions of dollars)

(1) Levels of GDP and *DI*	(2) Planned consumption	(3) Planned saving (3) = (1) − (2)	(4) Planned investment	(5) Level of GDP (5) = (1)		(6) Total planned consumption and investment, *TE* (6) = (2) + (4)	(7) Resulting tendency of output
4,200	3,800	400	200	4,200	>	4,000	Contraction
3,900	3,600	300	200	3,900	>	3,800	Contraction
3,600	**3,400**	**200**	**200**	**3,600**	=	**3,600**	**Equilibrium**
3,300	3,200	100	200	3,300	<	3,400	Expansion
3,000	3,000	0	200	3,000	<	3,200	Expansion
2,700	2,800	−100	200	2,700	<	3,000	Expansion

TABLE 22-2. Equilibrium Output Can Be Found Arithmetically at the Level Where Planned Spending Equals GDP

The darker green row depicts the equilibrium GDP level, where the $3600 that is being produced is just matched by the $3600 that households plan to consume and that firms plan to invest. In upper rows, firms will be forced into unintended inventory investment and will respond by cutting back production until equilibrium GDP is reached. Interpret the lower rows' tendency toward expansion of GDP toward equilibrium.

Only when the level of actual output in column (5) exactly equals planned expenditure (*TE*) in column (6) will the economy be in equilibrium. In equilibrium, and only in equilibrium, business sales will be exactly sufficient to justify the current level of aggregate output. In equilibrium, GDP will neither expand nor contract.

THE MULTIPLIER

Where is the multiplier in all this? To answer this question, we need to examine how a change in exogenous investment spending affects GDP. It is logical that an increase in investment will raise the level of output and employment. But by how much? The multiplier model shows that an increase in investment will increase GDP by an amplified or multiplied amount—by an amount greater than itself.

The **multiplier** is the impact of a 1-dollar change in exogenous expenditures on total output. In the simple $C + I$ model, the multiplier is the ratio of the change in total output to the change in investment.

Note that the definition of the multiplier speaks of the change in output per unit change in *exogenous expenditures*. This indicates that we are taking certain components of spending as given outside the model. In the case in hand, the exogenous component is investment. Later, we will see that the same approach can be used to determine the effect of changes in government expenditures, exports, and other items on total output.

For example, suppose investment increases by $100 billion. If this causes an increase in output of $300 billion, the multiplier is 3. If, instead, the resulting increase in output is $400 billion, the multiplier is 4.

Woodsheds and Carpenters. Why is it that the multiplier is greater than 1? Let's suppose that I hire unemployed workers to build a $1000 woodshed. My carpenters and lumber producers will get an extra $1000 of income. But that is not the end of the story. If they all have a marginal propensity to consume of ⅔, they will now spend $666.67 on new consumption goods. The producers of these goods will now have extra incomes of $666.67. If their *MPC* is also ⅔, they in turn will spend $444.44, or ⅔ of $666.67 (or ⅔ of ⅔ of $1000). The process will go on, with each new round of spending being ⅔ of the previous round.

Eye Therapies Exhibit 2127, 463 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Thus an endless chain of *secondary consumption spending* is set in motion by my *primary* investment of $1000. But, although an endless chain, it is an ever-diminishing one. Eventually it adds up to a finite amount.

Using straightforward arithmetic, we can find the total increase in spending in the following manner:

$1000.00	=	$1 \times \$1000$
+		+
666.67		$\frac{2}{3} \times \$1000$
+		+
444.44		$(\frac{2}{3})^2 \times \$1000$
+		+
296.30		$(\frac{2}{3})^3 \times \$1000$
+		+
197.53		$(\frac{2}{3})^4 \times \$1000$
+		+
⋮		⋮
$3000.00		$\frac{1}{1 - \frac{2}{3}} \times \$1000$, or $3 \times \$1000$

This shows that, with a *MPC* of ⅔, the multiplier is 3; it consists of the 1 of primary investment plus 2 extra of secondary consumption respending.

The same arithmetic would give a multiplier of 4 for a *MPC* of ¾, because $1 + \frac{3}{4} + (\frac{3}{4})^2 + (\frac{3}{4})^3 + \ldots$ eventually adds up to 4. For a *MPC* of ½, the multiplier would be 2.[1]

The size of the multiplier thus depends upon how large the *MPC* is. It can also be expressed in terms of the twin concept, the *MPS*. For a *MPS* of ¼, the *MPC* is ¾ and the multiplier is 4. For a *MPS* of ⅓, the multiplier is 3. If the *MPS* were $1/x$, the multiplier would be x.

By this time it should be clear that the simple multiplier is always the inverse, or reciprocal, of the marginal propensity to save. It is thus equal to $1/(1 - MPC)$. Our simple multiplier formula is

$$\text{Change in output} = \frac{1}{MPS} \times \text{change in investment}$$

$$= \frac{1}{1 - MPC} \times \text{change in investment}$$

[1] The formula for an infinite geometric progression is

$$1 + r + r^2 + r^3 + \cdots + r^n + \cdots = \frac{1}{1 - r}$$

as long as *MPC* (r) is less than 1 in absolute value.

The Multiplier Model Compared with the AS-AD Model

As you study the multiplier model, you might begin to wonder how this model fits in with the *AS-AD* model of Chapter 19. These are not, in fact, different approaches. Rather, the multiplier model is a special case of the aggregate demand-and-supply model. It explains how *AD* is affected by consumption and investment spending under certain precise assumptions.

One of the key assumptions in the multiplier analysis is that prices and wages are fixed in the short run. This is an oversimplification, for many prices adjust quickly in the real world. But this assumption captures the point that if some wages and prices are sticky—which is most definitely the case—then some of the adjustment to *AD* shifts will come through output adjustments. We will return to this important point in later chapters.

We can show the relationship between the multiplier analysis and the *AS-AD* approach in Figure 22-8. Part (*b*) displays an *AS* curve that becomes completely vertical when output equals potential output. However, when there are unemployed resources—to the left of potential output in the graph—output will be determined primarily by the strength of aggregate demand. As investment increases, this increases *AD,* and equilibrium output rises.

The same economy can be described by the multiplier diagram in the top panel of Figure 22-8. The multiplier equilibrium gives the same level of output as the *AS-AD* equilibrium—both lead to a real GDP of *Q*. They simply stress different features of output determination.

This discussion again points to a crucial feature of the multiplier model. While it is a useful model for describing recessions or even depressions, it cannot apply to periods of full employment. Once factories are operating at full capacity and all workers are employed, the economy simply cannot produce more output.

D. FISCAL POLICY IN THE MULTIPLIER MODEL

For centuries, economists have understood the *allocational* role of fiscal policy (government tax and spending programs). It has long been known that

Eye Therapies Exhibit 2127, 464 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

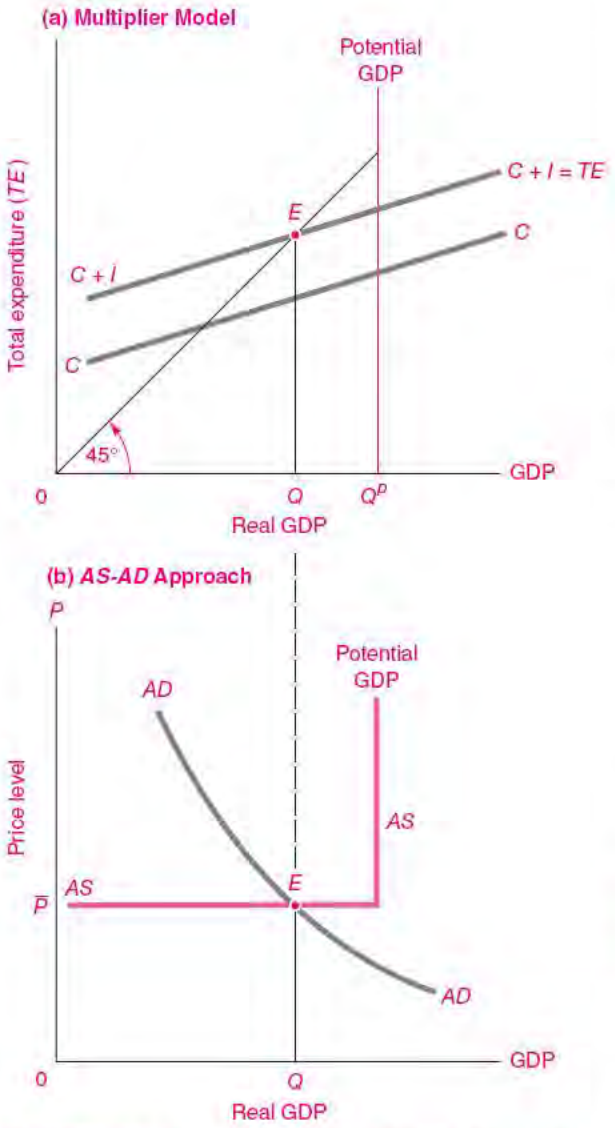


FIGURE 22-8. How the Multiplier Model Relates to the *AS-AD* Approach

The multiplier model is a way of understanding the workings of the *AS-AD* equilibrium.

(a) The top panel shows the output-expenditure equilibrium in the multiplier model. At point *E*, the spending line just cuts the 45° line, leading to equilibrium output of *Q*.

(b) The equilibrium can also be seen in the bottom panel, where the *AD* curve cuts the *AS* curve at point *E*. In this simplest business-cycle model wages and prices are assumed to be fixed, so the *AS* curve is horizontal until full employment is reached. Both approaches lead to exactly the same equilibrium output, *Q*.

fiscal programs are instrumental in deciding how the nation's output should be divided between collective and private consumption and how the burden of payment for collective goods should be divided among the population.

Only with the development of modern macroeconomic theory has a surprising fact been uncovered: Government fiscal powers also have a major *macroeconomic* impact upon the short-run movements of output, employment, and prices. The knowledge that fiscal policy has powerful effects upon economic activity led to the *Keynesian approach to macroeconomic policy*, which is the active use of government action to moderate business cycles. This approach was described by the Nobel Prize–winning macroeconomist James Tobin as follows:

> Keynesian policies are, first, the explicit dedication of macroeconomic policy instruments to real economic goals, in particular full employment and real growth of national income. Second, Keynesian demand management is activist. Third, Keynesians have wished to put both fiscal and monetary policies in consistent and coordinated harness in the pursuit of macroeconomic objectives.

In this section we use the multiplier model to show how government purchases affect output.

HOW GOVERNMENT FISCAL POLICIES AFFECT OUTPUT

To understand the role of government in economic activity, we need to look at government purchases and taxation, along with the effects of those activities on private-sector spending. We now modify our earlier analysis by adding G to $C + I$ to get a new total expenditure curve $TE = C + I + G$. This new schedule can describe the macroeconomic equilibrium when government, with its spending and taxing, is in the picture.

It will simplify our task in the beginning if we analyze the effects of government purchases with total taxes collected held constant (taxes that do not change with income or other economic variables are called *lump-sum taxes*). But even with a fixed dollar value of taxes, we can no longer ignore the distinction between disposable income and gross domestic product. Under simplified conditions (including no foreign trade, transfers, or depreciation), we know

Eye Therapies Exhibit 2127, 465 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

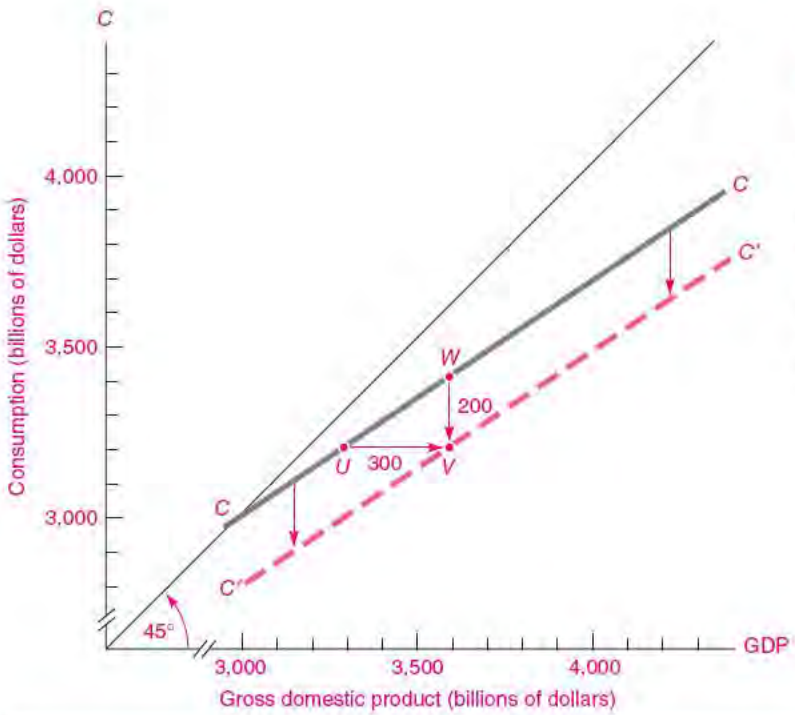


FIGURE 22-9. Taxes Reduce Disposable Income and Shift *CC* Schedule to the Right and Down

Each dollar of taxes paid shifts the *CC* schedule to the right by the amount of the tax. A rightward *CC* shift also means a downward *CC* shift, but the downward *CC* shift is less than the rightward shift. Why? Because the downward shift is equal to the rightward shift times the *MPC*. Thus, if the *MPC* is ⅔, the downward shift is ⅔ times \$300 billion = \$200 billion. Verify that $WV = \frac{2}{3}\ UV$.

from Chapter 20 that GDP equals disposable income plus taxes. But with tax revenues held constant, GDP and *DI* will always differ by the same amount; thus, after taking account of such taxes, we can still plot the *CC* consumption schedule against GDP rather than against *DI*.

Figure 22-9 shows how the consumption function changes when taxes are present. This figure draws the original no-tax consumption function as the blue *CC* line. In this case, GDP equals disposable income. We use the same consumption function as in Table 22-2 on page 440. Therefore, consumption is 3000 when GDP (and *DI*) is 3000, and so forth.

Now introduce taxes of 300. At a *DI* of 3000, GDP must equal 3300 = 300 + 3000. Consumption is still 3000 when GDP is 3300 because *DI* is 3000. We can therefore plot consumption as a function of GDP by shifting the consumption function rightward to the green *C'C'* curve. The amount of the rightward shift is *UV*, which is exactly equal to the amount of taxes, 300.

Alternatively, we can plot the new consumption function as a parallel *downward* shift by 200. As Figure 22-9 shows, 200 is the result of multiplying a decrease in income of 300 times the *MPC* of ⅔.

Turning next to the different components of aggregate demand, recall from Chapter 20 that GDP consists of four elements:

$$\begin{aligned}\text{GDP} = {} & \text{consumption expenditure} \\ & + \text{gross private domestic investment} \\ & + \text{government purchases of goods and services} \\ & + \text{net exports} \\ = {} & C + I + G + X\end{aligned}$$

For now, we consider a closed economy with no foreign trade, so our GDP consists of the first three components, $C + I + G$. (We add the final component, net exports, when we consider open-economy macroeconomics.)

Figure 22-10 shows the effect of including government purchases. This diagram is very similar to the one used earlier in this chapter (see Figure 22-7). Here, we have added a new expenditure stream, *G*, to the consumption and investment amounts. Diagrammatically, we place the new variable, *G* (government

Eye Therapies Exhibit 2127, 466 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

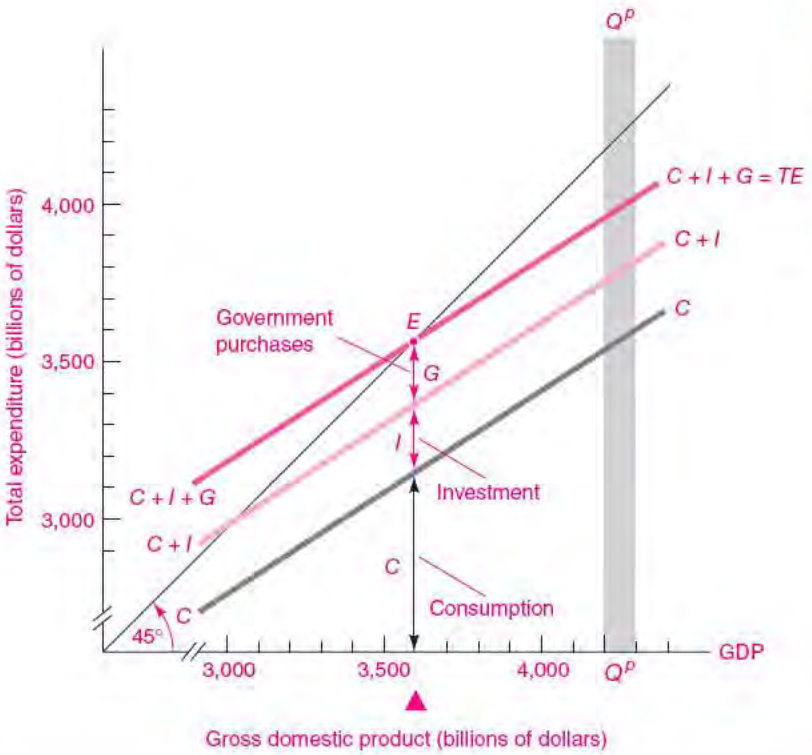


FIGURE 22-10. Government Purchases Add On Just like Investment to Determine Equilibrium GDP

We now add government purchases on top of consumption and investment spending. This gives us the new total planned expenditure schedule, $TE = C + I + G$. At E, where the TE schedule intersects the 45° line, we find the equilibrium level of GDP.

purchases of goods and services), on top of the consumption function and the fixed amount of investment. The vertical distance between the $C + I$ line and the new $TE = C + I + G$ line is just the quantity of G.

Why do we simply add G on the top? Because spending on government buildings (G) has the same macroeconomic impact as spending on private buildings (I); the collective expenditure involved in buying a government vehicle (G) has the same effect on jobs as private consumption expenditures on automobiles (C).

We end up with the three-layer cake of $TE = C + I + G$, calculating the amount of total spending forthcoming at each level of GDP. We now must locate the point of intersection of the TE line with the 45° line to find the equilibrium level of GDP. At this equilibrium GDP level, denoted by point E in Figure 22-10, total planned spending exactly equals total planned output. Point E thus indicates the equilibrium level of output when we add government purchases to the multiplier model.

Impact of Taxation on Aggregate Demand

How does government taxation tend to reduce aggregate demand and the level of GDP? Extra taxes lower our disposable incomes, and lower disposable incomes tend to reduce our consumption spending. Clearly, if investment and government purchases remain unchanged a reduction in consumption spending will then reduce GDP and employment. Thus, in the multiplier model, higher taxes without increases in government purchases will tend to reduce real GDP.[2]

A look back at Figure 22-9 confirms this reasoning. In this figure, the upper CC curve represents the level of the consumption function with no taxes. But the upper curve cannot be the consumption function because consumers definitely pay taxes on their incomes. Suppose that consumers pay $300 billion in taxes at every level of income; thus, DI is exactly $300 billion less than GDP at every level of output.

[2] Strictly speaking, by "taxes" in this chapter we mean net taxes, or taxes minus transfer payments.

Eye Therapies Exhibit 2127, 467 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

As shown in Figure 22-9, this level of taxes can be represented by a rightward shift in the consumption function of $300 billion. This rightward shift will also appear as a downward shift; if the *MPC* is ⅔, the rightward shift of $300 billion will be seen as a downward shift of $200 billion.

Without a doubt, taxes lower output in our multiplier model, and Figure 22-10 shows why. When taxes rise, $I + G$ does not change, but the increase in taxes will lower disposable income, thereby shifting the *CC* consumption schedule downward. Hence, the $C + I + G$ schedule shifts downward. You can pencil in a new, lower $C + I + G$ schedule in Figure 22-10. Confirm that its new intersection with the 45° line must be at a lower equilibrium level of GDP.

Keep in mind that G is government purchases of goods and services. It excludes spending on transfers such as unemployment insurance or social security payments. These transfers are treated as negative taxes, so the taxes (T) considered here can best be thought of as taxes less transfers. Therefore, if direct and indirect taxes total $400 billion, while all transfer payments are $100 billion, then net taxes, T, are $400 − $100 = $300 billion. (Can you see why an increase in social security benefits lowers T, raises *DI*, shifts the $C + I + G$ curve upward, and raises equilibrium GDP?)

A Numerical Example

The points made up to now are illustrated in Table 22-3. This table is very similar to Table 22-2, which illustrated output determination in the simplest multiplier model. The first column shows a reference level of GDP, while the second shows a fixed level of taxes, $300 billion. Disposable income in column (3) is GDP less taxes. Planned consumption, taken as a function of *DI*, is shown in column (4). Column (5) shows the fixed level of planned investment, while column (6) exhibits the level of government purchases. To find total planned expenditures, *TE*, in column (7), we add together the *C*, *I*, and *G* in columns (4) through (6).

Finally, we compare total desired expenditures *TE* in column (7) with the initial level of GDP in column (1). If desired spending is above GDP, firms raise production to meet the level of spending, and output consequently rises; if desired spending is below GDP, output falls. This tendency, shown in the last column, assures us that output will tend toward its equilibrium level at $3600 billion.

Output Determination with Government Spending (billions of dollars)

(1) Initial level of GDP	(2) Taxes *T*	(3) Disposable income *DI*	(4) Planned consumption *C*	(5) Planned investment *I*	(6) Government expenditure *G*	(7) Total planned expenditure, *TE* ($C + I + G$)		(8) Resulting tendency of economy
4,200	300	3,900	3,600	200	200	4,000	↓	Contraction
3,900	300	3,600	3,400	200	200	3,800	↓	Contraction
3,600	**300**	**3,300**	**3,200**	**200**	**200**	**3,600**		**Equilibrium**
3,300	300	3,000	3,000	200	200	3,400	↑	Expansion
3,000	300	2,700	2,800	200	200	3,200	↑	Expansion

TABLE 22-3. Government Purchases, Taxes, and Investment Also Determine Equilibrium GDP

This table shows how output is determined when government purchases of goods and services are added to the multiplier model. In this example, taxes are "lump-sum" or independent of the level of income. Disposable income is thus GDP minus $300 billion. Total spending is $I + G$ + the consumption determined by the consumption function.

At levels of output less than $3600 billion, planned spending is greater than output, so output expands. Levels of output greater than $3600 are unsustainable and lead to contraction. Only at output of $3600 is output in equilibrium—that is, planned spending equals output.

Eye Therapies Exhibit 2127, 468 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

FISCAL-POLICY MULTIPLIERS

The multiplier analysis shows that government fiscal policy is high-powered spending much like investment. The parallel suggests that fiscal policy should also have multiplier effects upon output. And this is exactly right.

The **government expenditure multiplier** is the increase in GDP resulting from an increase of $1 in government purchases of goods and services. An initial government purchase of a good or service will set in motion a chain of spending: if the government builds a road, the road-builders will spend some of their incomes on consumption goods, which in turn will generate additional incomes, some of which will be spent. In the simple model examined here, the ultimate effect on GDP of an extra dollar of *G* will be the same as the effect of an extra dollar of *I*: the multipliers are both equal to $1/(1 - MPC)$. Figure 22-11 shows how a change in *G* will result in a higher level of GDP, with the increase being a multiple of the increase in government purchases.

To show the effects of an extra $100 billion of *G*, the $C + I + G$ curve in Figure 22-11 has been shifted up by $100 billion. The ultimate increase in GDP is equal to the $100 billion of primary spending times the expenditure multiplier. In this case, because the *MPC* is ⅔, the multiplier is 3, so the equilibrium level of GDP rises by $300 billion.

This example, as well as common sense, tells us that the government expenditure multiplier is exactly the same number as the investment multiplier. They are both called **expenditure multipliers.**

Also, note that the multiplier horse can be ridden in both directions. If government purchases were to fall, with taxes and other influences held constant, GDP would decline by the change in *G* times the multiplier.

The effect of *G* on output can be seen as well in the numerical example of Table 22-3. You can pencil in a different level of *G*—say, $300 billion—and find the equilibrium level of GDP. It should give the same answer as Figure 22-11.

We can sum up:

Government purchases of goods and services (*G*) are an important force in determining output and employment. In the multiplier model, if *G* increases, output will rise by the increase in *G* times the expenditure multiplier. Government purchases therefore have the potential to increase or decrease output over the business cycle.

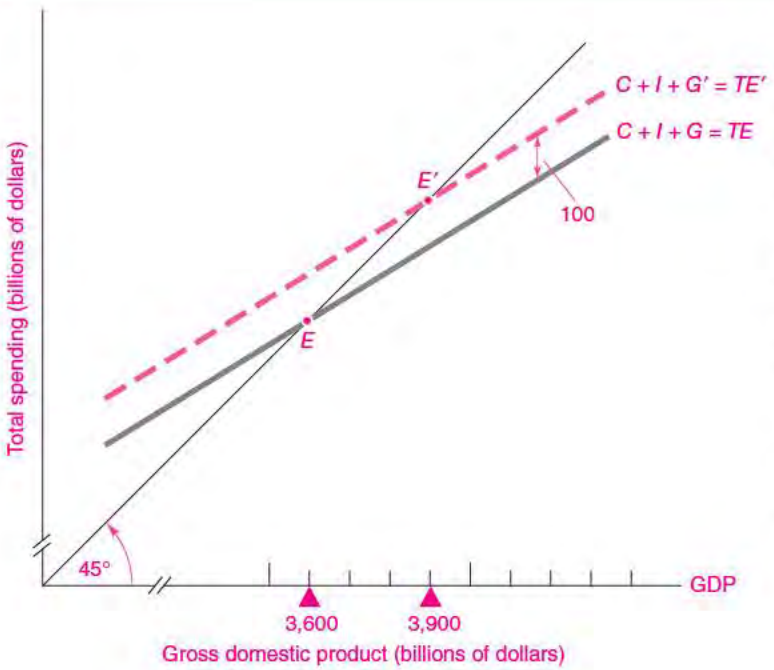


FIGURE 22-11. The Effect of Higher *G* on Output

Suppose that the government raises defense purchases by $100 billion in response to a threat to Mideast oil fields. This shifts upward the $C + I + G$ line by $100 billion to $C + I + G'$.

The new equilibrium level of GDP is thus read off the 45° line at E' rather than at E. Because the *MPC* is ⅔, the new level of output is $300 billion higher. That is, the government expenditure multiplier is

$$3 = \frac{1}{1 - \frac{2}{3}}$$

(What would the government expenditure multiplier be if the *MPC* were ¾? ⁹⁄₁₀?)

Eye Therapies Exhibit 2127, 469 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Economic Stimulus from Defense Spending

War	Period of war or buildup	Increase in defense spending as percent of GDP	Real GDP growth over buildup period (%)
World War I	1916–1918	10.2	13.0
World War II			
Before Pearl Harbor	1939–1941	9.7	26.7
All years	1939–1944	41.4	69.1
Korean War	1950:3–1951:3	8.0	10.5
Vietnam War	1965:3–1967:1	1.9	9.7
Persian Gulf War	1990:3–1991:1	0.3	−1.3
Iraq War	2003:1–2003:2	0.1	0.5

TABLE 22-4. Economic Booms Accompany Large Increases in Military Spending

This table shows the period of the war or buildup, the size of the military buildup, and the resulting increase in real GDP. Major wars have produced sustained economic booms, but the last two wars, with relatively little growth in military spending, had only a small impact on the economy.

Source: Department of Commerce, National Income and Product Accounts, available at *www.bea.gov*, and estimates by authors. The dates are year and quarter. Hence, 1950:3 is the third quarter of 1950.



Are Wars Necessary for Full Employment?

Historically, economic expansions were the constant companions of war. As can be seen in Table 22-4, major wars in the past were often accompanied by large increases in military spending. In World War II, for example, defense outlays rose by almost 10 percent of total GDP before Pearl Harbor was bombed in December 1941. Indeed, many scholars believe that the United States emerged from the Great Depression largely because of the buildup for World War II. Similar but smaller military buildups accompanied economic expansions in the Korean and Vietnam Wars.

By contrast, the Persian Gulf War of the early 1990s triggered a recession. The reason for this anomaly was that there was but a small increase in military spending and psychological factors triggered by the war more than offset the increase in *G*.

What were these psychological factors? After Iraq invaded Kuwait in August 1990, consumers and investors became frightened and reduced spending. Additionally, oil prices shot up, lowering real incomes. These factors then reversed after the U.S. victory in February 1991.

What was the impact of the war in Iraq in early 2003? This war resembled the Persian Gulf War more than it did major wars. There was little increase in defense spending, while cautious consumers and businesses, along with high oil prices, produced a strong headwind that slowed the economy.

The role of wartime spending in economic expansions is one of the most direct and persuasive examples of the functioning of the multiplier model. Make sure you understand the underlying mechanism as well as why the sizes of the economic expansions shown in Table 22-4 vary so much.

Impact of Taxes

Taxes also have an impact upon equilibrium GDP, although the size of tax multipliers is smaller than that of expenditure multipliers. Consider the following example: Suppose the economy is at its potential GDP and the nation raises defense spending by $200 billion. Such sudden increases have occurred at many points in the history of the United States—in the early 1940s for World War II, in 1951 for the Korean war, in the mid-1960s for the Vietnam war, and in the early 1980s during the Reagan administration's military buildup. Furthermore, say that economic planners wish to raise taxes just enough to offset the effect on GDP of the $200 billion increase in *G*. How much would taxes have to be raised?

Eye Therapies Exhibit 2127, 470 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

We are in for a surprise. To offset the $200 billion increase in *G*, we need to increase tax collections by more than $200 billion. In our numerical example, we can find the exact size of the tax, or *T*, increase from Figure 22-9. That figure shows that a $300 billion increase in *T* reduces disposable income by just enough to produce a consumption decline of $200 billion when the *MPC* is ⅔. Put differently, a tax increase of $300 billion will shift the *CC* curve down by $200 billion. Hence, while a $1 billion increase in defense spending shifts up the $C + I + G$ line by $1 billion, a $1 billion tax increase shifts down the $C + I + G$ line by only $⅔ billion (when the *MPC* is ⅔). Thus offsetting an increase in government purchases requires an increase in *T* larger than the increase in *G*.

Tax changes are a powerful weapon in affecting output. But the tax multiplier is smaller than the expenditure multiplier by a factor equal to the *MPC:*

Tax multiplier = *MPC* × expenditure multiplier

The reason the tax multiplier is smaller than the expenditure multiplier is straightforward. When government spends $1 on *G*, that $1 gets spent directly on GDP. On the other hand, when government cuts taxes by a dollar, only part of that dollar is spent on *C*, while a fraction of that $1 tax cut is saved. The difference in the responses to a dollar of *G* and to a dollar of *T* is enough to lower the tax multiplier below the expenditure multiplier.[3]

The Multiplier Model and the Business Cycle

The multiplier model is the simplest model of the business cycle. It can show how changes in investment due to innovation or pessimism, or fluctuations in government spending due to war, can lead to sharp changes in output. Suppose that war breaks out and the country increases military spending (as illustrated by the many cases in Table 22-4). *G* increases, and this leads to a multiplied increase in output, as seen in Figure 22-11. If you look back at Figure 22-2 on page 430, you can see how large wars were accompanied by large increases in output relative to potential output. Similarly, suppose that a burst of innovation leads to rapid growth in investment, as occurred with the new-economy boom of the 1990s. This would lead to an upward shift in the $C + I + G$ curve and to higher output. Again, you can see the results in Figure 22-2. Make sure you can graph each of these examples using the $C + I + G$ apparatus. Also, make sure you can explain why a revolution in a country that led to sharp decline in investment might lead to a recession.

Economists often combine the multiplier model with the accelerator principle of investment as an internal theory of the business cycle. In this approach, every expansion breeds recession and contraction, and every contraction breeds revival and expansion—in a quasi-regular, repeating chain. According to the accelerator principle, rapid output growth stimulates investment, which is amplified by the multiplier on investment. High investment, in turn, stimulates more output growth, and the process continues until the capacity of the economy is reached, at which point the economic growth rate slows. The slower growth, in turn, reduces investment spending, and this, working through the multiplier, tends to send the economy into a recession. The process then works in reverse until the trough is reached, and the economy then stabilizes and turns up again. This internal theory of the business cycle shows a mechanism, like the rise and fall of the tides in which an exogenous shock tends to propagate itself through the economy in a cyclical fashion. (See question 11 at the end of the chapter for a numerical example.)

The multiplier model, working together with the dynamics of investment, shows how alternating bouts of investment optimism and pessimism, along with changes in other exogenous expenditures, can lead to the fluctuations that we call business cycles.

[3] For simplicity, we take the absolute value of the tax multiplier (since the multiplier is actually negative). The different multipliers can be seen using the device of the "expenditure rounds" shown on page 441. Let the *MPC* be *r.* Then if *G* goes up by 1 unit, the total increase in spending is the sum of secondary respending rounds:

$$1 + r + r^2 + r^3 + \cdots = \frac{1}{1 - r}$$

Now, if taxes are reduced by $1, consumers save $(1 - r)$ of the increased disposable income and spend *r* dollars on the first round. With the further rounds, the total spending is thus

$$r + r^2 + r^3 + \cdots = \frac{r}{1 - r}$$

Thus the tax multiplier is *r* times the expenditure multiplier, where *r* is the *MPC.*

Eye Therapies Exhibit 2127, 471 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The Multiplier Model in Perspective

We have completed our introductory survey of the Keynesian multiplier model. It will be useful to put all this in perspective and see how the multiplier model fits into a broader view of the macroeconomy. Our goal is to understand what determines the level of national output in a country. In the long run, a country's production and living standards are largely determined by its potential output. But in the short run, business conditions will push the economy above or below its long-term trend. It is this deviation of output and employment from the long-term trend that we analyze with the multiplier model.

The multiplier model has been enormously influential in business-cycle theory over the last half-century. However, it gives an oversimplified picture of the economy. One of the most significant omissions is the impact of financial markets and monetary policy on the economy. Changes in output tend to affect interest rates, which in turn affect the economy. Additionally, the simplest multiplier model omits the interactions between the domestic economy and the rest of the world. Finally, the model omits the supply side of the economy as represented by the interaction of spending with aggregate supply and prices. All of these shortcomings will be remedied in later chapters, and it is useful to keep in mind that this first model is simply a stepping stone on the path to understanding the economy in all its complexity.

The multiplier analysis focuses primarily on spending changes as the factors behind short-run output movements. In this approach, fiscal policy is often used as a tool to stabilize the economy. But the government has another equally powerful weapon in monetary policy. Although monetary policy works quite differently, it has many advantages as a means of combating unemployment and inflation.

The next two chapters survey one of the most fascinating parts of all economics: money and financial markets. Once we understand how the central bank helps determine interest rates and credit conditions, we will have a fuller appreciation of how governments can tame the business cycles that have run wild through much of the history of capitalism.



SUMMARY

A. What are Business Cycles?

1. Business cycles or fluctuations are swings in total national output, income, and employment, marked by widespread expansion or contraction in many sectors of the economy. They occur in all advanced market economies. We distinguish the phases of expansion, peak, recession, and trough.
2. Most business cycles occur when shifts in aggregate demand cause changes in output, employment, and prices. Aggregate demand shifts when changes in spending by consumers, businesses, or governments change total spending relative to the economy's productive capacity. A decline in aggregate demand leads to recessions or even depressions. An upturn in economic activity can lead to inflation.
3. Business-cycle theories differ in their emphasis on exogenous and internal factors. Importance is often attached to fluctuations in such exogenous factors as technology, elections, wars, exchange-rate movements, and oil-price shocks. Most theories emphasize that these exogenous shocks interact with internal mechanisms, such as financial market bubbles and busts.

B. Aggregate Demand and Business Cycles

4. Ancient societies suffered when harvest failures produced famines. The modern market economy can suffer from poverty amidst plenty when insufficient aggregate demand leads to deteriorating business conditions and high unemployment. At other times, excessive government spending and reliance on the monetary printing press can lead to runaway inflation. Understanding the forces that affect aggregate demand, including government fiscal and monetary policies, can help economists and policymakers smooth out the cycle of boom and bust.
5. Aggregate demand represents the total quantity of output willingly bought at a given price level, other things held constant. Components of spending include (*a*) consumption, which depends primarily upon disposable income; (*b*) investment, which depends upon present and expected future output and upon interest rates and taxes; (*c*) government purchases of goods and services; and (*d*) net exports, which depend upon foreign and domestic outputs and prices and upon foreign exchange rates.

Eye Therapies Exhibit 2127, 472 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

6. Aggregate demand curves differ from demand curves used in microeconomic analysis. The *AD* curves relate overall spending on all components of output to the overall price level, with policy and exogenous variables held constant. The aggregate demand curve is downward-sloping because a higher price level reduces real income and real wealth.
7. Factors that change aggregate demand include (*a*) macroeconomic policies, such as fiscal and monetary policies, and (*b*) exogenous variables, such as foreign economic activity, technological advances, and shifts in asset markets. When these variables change, they shift the *AD* curve.

C. The Multiplier Model

8. The multiplier model provides a simple way to understand the impact of aggregate demand on the level of output. In the simplest approach, household consumption is a function of disposable income, while investment is fixed. People's desire to consume and the willingness of businesses to invest are brought into balance by adjustments in output. The equilibrium level of national output occurs when planned spending equals planned output. Using the expenditure-output approach, equilibrium output comes at the intersection of the total expenditure (*TE*) consumption-plus-investment schedule and the 45° line.
9. If output is temporarily above its equilibrium level, businesses find output higher than sales, with inventories piling up involuntarily and profits plummeting. Firms therefore cut production and employment back toward the equilibrium level. The only sustainable level of output comes when buyers desire to purchase exactly as much as businesses desire to produce. Thus, for the simplified Keynesian multiplier model, investment calls the tune and consumption dances to the music.
10. Investment has a *multiplied effect* on output. When investment changes, output will initially rise by an equal amount. But that output increase is also an income increase for consumers. As consumers spend a part of their additional income, this sets in motion a whole chain of additional consumption spending and employment.
11. If people always spend *r* of each extra dollar of income on consumption, the total of the multiplier chain will be

$$1 + r + r^2 + \cdots = \frac{1}{1 - r} = \frac{1}{1 - MPC} = \frac{1}{MPS}$$

The simplest multiplier is numerically equal to $1/(1 - MPC)$.
12. Key points to remember are (*a*) the basic multiplier model emphasizes the importance of shifts in aggregate demand in affecting output and income and (*b*) it is primarily applicable for situations with unemployed resources.

D. Fiscal Policy in the Multiplier Model

13. The analysis of fiscal policy elaborates the Keynesian multiplier model. It shows that an increase in government purchases—taken by itself, with taxes and investment unchanged—has an expansionary effect on national output much like that of investment. The total expenditure $TE = C + I + G$ schedule shifts upward to a higher equilibrium intersection with the 45° line.
14. A decrease in taxes—taken by itself, with investment and government purchases unchanged—raises the equilibrium level of national output. The *CC* schedule of consumption plotted against GDP is shifted upward and leftward by a tax cut. But since the extra dollars of disposable income go partly into saving, the dollar increase in consumption will not be quite as great as the increase in new disposable income. Therefore, the tax multiplier is smaller than the government-expenditure multiplier.

CONCEPTS FOR REVIEW

Business Fluctuations or Cycles

business cycle or business fluctuation
business-cycle phases: peak, trough, expansion, contraction
recession
exogenous and internal cycle theories

Aggregate Demand

aggregate demand shifts and business fluctuations
aggregate demand, *AD* curve
major components of aggregate demand: *C*, *I*, *G*, *X*
downward-sloping *AD* curve
factors underlying and shifting the *AD* curve

The Basic Multiplier Model

$TE = C + I + G$ schedule
output and spending: planned vs. actual levels
multiplier effect of investment

Eye Therapies Exhibit 2127, 473 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

multiplier

$$= 1 + MPC + (MPC)^2 + \cdots$$
$$= \frac{1}{1 - MPC} = \frac{1}{MPS}$$

Government Purchases and Taxation

fiscal policy:
G effect on equilibrium GDP
T effect on *CC* and on GDP
multiplier effects of government purchases (*G*) and taxes (*T*)
$C + I + G$ curve

FURTHER READING AND INTERNET WEBSITES

Further Reading

The quotation from Okun is Arthur M. Okun, *The Political Economy of Prosperity* (Norton, New York, 1970), pp. 33 ff. This is a fascinating book on the economic history of the 1960s written by one of America's great macroeconomists.

The classic study of business cycles by leading scholars at the National Bureau of Economic Research (NBER) is Arthur F. Burns and Wesley Clair Mitchell, *Measuring Business Cycles* (Columbia University Press, New York, 1946). This is available from the NBER at *www.nber.org/books/burn46-1*. The multiplier model was developed by John Maynard Keynes in *The General Theory of Employment, Interest and Money* (Harcourt, New York, first published in 1935). Advanced treatments can be found in the intermediate textbooks listed in the Further Reading section in Chapter 19. One of Keynes's most influential books, *The Economic Consequences of the Peace* (1919), predicted with uncanny accuracy that the Treaty of Versailles would lead to disastrous consequences for Europe.

Websites

A consortium of macroeconomists participates in the NBER program on economic fluctuations and growth. You can sample the writings and data at *www.nber.org/programs/efg/efg.html*. The NBER also dates business cycles for the United States. You can see the recessions and expansions along with a discussion at *www.nber.org/cycles.html*.

Business-cycle data and discussion can be found at the site of the Bureau of Economic Analysis, *www.bea.gov*. The first few pages of the *Survey of Current Business,* available at *www.bea.gov/bea/pubs.htm,* contain a discussion of recent business-cycle developments.

QUESTIONS FOR DISCUSSION

1. Define carefully the difference between movements along the *AD* curve and shifts of the *AD* curve. Explain why an increase in potential output would shift out the *AS* curve and lead to a movement along the *AD* curve. Explain why a tax cut would shift the *AD* curve outward (increase aggregate demand).
2. Construct a table parallel to Table 22-1, listing events that would lead to a *decrease* in aggregate demand. (Your table should provide different examples rather than simply changing the direction of the factors mentioned in Table 22-1.)
3. In recent years, a new theory of real business cycles (or RBCs) has been proposed (this approach is further analyzed in Chapter 31). RBC theory suggests that business fluctuations are caused by shocks to productivity, which then propagate through the economy.
   a. Show the RBC theory in the *AS-AD* framework.
   b. Discuss whether the RBC theory can explain the customary characteristics of business fluctuations described on pages 430–431.
4. In the simple multiplier model, assume that investment is always zero. Show that equilibrium output in this special case would come at the break-even point of the consumption function. Why would equilibrium output come *above* the break-even point when investment is positive?
5. Define carefully what is meant by equilibrium in the multiplier model. For each of the following, state why the situation is *not* an equilibrium. Also describe how the economy would react to each of the situations to restore equilibrium.
   a. In Table 22-2, GDP is $3300 billion.
   b. In Figure 22-7, actual investment is zero and output is at *M*.
   c. Car dealers find that their inventories of new cars are rising unexpectedly.
6. Reconstruct Table 22-2 assuming that planned investment is equal to (*a*) $300 billion and (*b*) $400 billion. What is the resulting difference in GDP? Is this difference greater or smaller than the change in *I*? Why?

Eye Therapies Exhibit 2127, 474 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

When I drops from $200 billion to $100 billion, how much must GDP drop?

7. Give (*a*) the common sense, (*b*) the arithmetic, and (*c*) the geometry of the multiplier. What are the multipliers for $MPC = 0.9?\ 0.8?\ 0.5?$
8. Explain in words and using the notion of expenditure rounds why the tax multiplier is smaller than the expenditure multiplier.
9. "Even if the government spends billions on wasteful military armaments, this action can create jobs in a recession." Discuss.
10. **Advanced problem:** The growth of nations depends crucially on saving and investment. And from youth we are taught that thrift is important and that "a penny saved is a penny earned." But will higher saving necessarily benefit the economy? In a striking argument called *the paradox of thrift,* Keynes pointed out that when people attempt to save more, this will not necessarily result in more saving for the nation as a whole.

    To see this point, assume that people decide to save more. Higher desired saving means lower desired consumption, or a downward shift in the consumption function. Illustrate how an increase in desired saving shifts down the *TE* curve in the multiplier model of Figure 22-7. Explain why this will *decrease output with no increase in saving!* Provide the intuition here that if people try to increase their saving and lower their consumption for a given level of business investment, sales will fall and businesses will cut back on production. Explain how far output will fall.

    Here then is the paradox of thrift: When the community desires to save more, the effect may actually be a lowering of income and output with no increase of saving.

11. **Advanced problem illustrating the multiplier-accelerator mechanism:** Find two dice and use the following technique to see if you can generate something that looks like a business cycle: Record the numbers from 20 or more rolls of the dice. Take five-period moving averages of the successive numbers. Then plot these averages. They will look very much like movements in GDP, unemployment, or inflation.

    One sequence thus obtained was 7, 4, 10, 3, 7, 11, 7, 2, 9, 10, . . . The averages were $(7 + 4 + 10 + 3 + 7)/5 = 6.2$; $(11 + 7 + 2 + 9 + 10)/5 = 7$, and so forth. Why does this look like a business cycle?

    [*Hint:* The random numbers generated by the dice are like exogenous shocks of investment or wars. The moving average is like the economic system's (or a rocking chair's) internal multiplier or smoothing mechanism. Taken together, they produce what looks like a cycle.]

12. **Data problem:** Some economists prefer an objective, quantitative definition of a recession to the more subjective approach used by the NBER. These economists define a recession as any period during which real GDP declined for at least two quarters in a row. Note from the text that this is *not* the way the NBER defines a recession.
    a. Get quarterly data on real GDP for the United States for the period since 1948. This can be obtained from the website of the Bureau of Economic Analysis, *www.bea.gov.* Put the data in a column of a spreadsheet, along with the corresponding date in another column.
    b. Calculate in a spreadsheet the percent growth rate of real GDP for each quarter at an annual rate. This is calculated as follows:

$$g_t = 400 \times \frac{x_t - x_{t-1}}{x_{t-1}}$$

    c. Under this alternative definition, which periods would you identify as recessions? For which years does this alternative objective procedure reach a conclusion different from that of the NBER?

Eye Therapies Exhibit 2127, 475 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

Money and the Financial System

23



Over all history, money has oppressed people in one of two ways: either it has been abundant and very unreliable, or reliable and very scarce.

John Kenneth Galbraith
The Age of Uncertainty (1977)

The financial system is one of the most important and innovative sectors of a modern economy. It forms the vital circulatory system that channels resources from savers to investors. Whereas finance in an earlier era consisted of banks and the country store, finance today involves a vast, worldwide banking system, securities markets, pension funds, and a wide array of financial instruments. When the financial system functions smoothly, as was the case for most of the period since World War II, it contributes greatly to healthy economic growth. However, when banks fail and people lose confidence in the financial system, as happened in the world financial crisis of 2007–2009, credit becomes scarce, investment is curbed, and economic growth slows.

Overview of the Monetary Transmission Mechanism

One of the most important topics in macroeconomics is the *monetary transmission mechanism*. This refers to the process by which monetary policy undertaken by the central bank (in the case of the U.S., the Federal Reserve), interacts with banks and the rest of the economy to determine interest rates, financial conditions, aggregate demand, output, and inflation.

We can provide an overview of the monetary transmission mechanism as a series of five logical steps:

1. The central bank announces a target short-term interest rate that depends upon its objectives and the state of the economy.
2. The central bank undertakes daily open-market operations to meet its interest-rate target.
3. The central bank's new interest-rate target and market expectations about future financial conditions help determine the entire spectrum of short- and long-term interest rates, asset prices, and exchange rates.
4. The changes in interest rates, credit conditions, asset prices, and exchange rates affect investment, consumption, and net exports.
5. Changes in investment, consumption, and net exports affect the path of output and inflation through the *AS-AD* mechanism.

We survey the different elements of this mechanism in the three chapters on money, finance, and central banking. Chapter 15 examined the major elements of interest rates and capital. The present chapter focuses on the private financial sector, including the structure of the financial system (Section A), the

Eye Therapies Exhibit 2127, 476 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

demand for money (Section B), banks (Section C), and the stock market (Section D). The next chapter surveys central banking as well as the way in which financial markets interact with the real economy to determine output and inflation. When you have completed these chapters, you will understand the different steps in the monetary transmission mechanism. It is one of the most important parts of all of macroeconomics.

A. THE MODERN FINANCIAL SYSTEM

The Role of the Financial System

The financial sector of an economy is the circulatory system that links together goods, services, and finance in domestic and international markets. It is through money and finance that households and firms borrow from and lend to each other in order to consume and invest. People may borrow or lend because their cash incomes do not match their desired spending. For example, students generally have spending needs for tuition and living expenses that exceed their current incomes. They often finance their excess spending with student loans. Similarly, working couples will generally save some of their current incomes for retirement, perhaps by buying stocks or bonds. They are thereby financing their retirement.

The activities involved in finance take place in the **financial system.** This encompasses the markets, firms, and other institutions which carry out the financial decisions of households, businesses, and governments. Important parts of the financial system include the money market (discussed later in this chapter), markets for fixed-interest assets like bonds or mortgages, stock markets for the ownership of firms, and foreign exchange markets which trade the monies of different countries. Most of the financial system in the United States is composed of for-profit entities, but government institutions such as the Federal Reserve System and other regulatory bodies are particularly important for ensuring an efficient and stable financial system.

Borrowing and lending take place in financial markets and through financial intermediaries. **Financial markets** are like other markets except that their products and services consist of financial instruments like stocks and bonds. Important financial markets are stock markets, bond markets, and foreign exchange markets.

Institutions which provide financial services and products are called **financial intermediaries.** Financial institutions differ from other businesses because their assets are largely financial, rather than real assets like plant and equipment. Many retail financial transactions (such as banking or purchase of insurance) take place through financial intermediaries rather than directly in financial markets.

The most important financial intermediaries are commercial banks, which take deposits of funds from households and other groups and lend these funds to businesses and others who need funds; banks also "create" the special product known as money. Other important financial intermediaries are insurance companies and pension funds; these firms provide specialized services such as insurance policies and investments held until people retire.

Yet another group of intermediaries pools and subdivides securities. These intermediaries include mutual funds (which hold bonds and corporate stocks on behalf of small investors), government-sponsored mortgage buyers (which buy mortgages from banks and sell them to other financial institutions), and "derivative" firms (which buy assets and then subdivide them into various parts).

Table 23-1 shows the growth and composition of the assets of financial institutions in the United States. There has been substantial growth and innovation in this area, such that the ratio of all assets to GDP grew from 1.5 in 1965 to 4.5 in 2007. This growth took place because of increased *financial intermediation*, which is a process in which assets are bought, repackaged, and resold several times. The purpose of financial intermediation is to transform illiquid assets into liquid assets that small investors can buy. By the end of 2007, financial intermediaries had total assets of $61 trillion, or around $530,000 per American household. Clearly, given the investments people have in this sector, a careful study is important not only for good policy but also for wise household financial decision making.

The Functions of the Financial System

Because the financial system is such a critical part of a modern economy, let's consider its major functions:

Eye Therapies Exhibit 2127, 477 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

	1965		2007	
	Total assets ($, billion)	Percent of total	Total assets ($, billion)	Percent of total
Federal Reserve	112	11	2,863	5
Commercial banks	342	33	11,195	18
Other credit institutions	198	19	2,575	4
Insurance and pension funds	325	31	16,557	27
Money market and mutual funds	43	4	11,509	19
Government-sponsored mortgage firms	20	2	9,322	15
Asset-backed securities	0	0	4,221	7
Security brokers, dealers, and miscellaneous	10	1	3,095	5
Total	1050	100	61,337	100
Percent of GDP	146%		450%	

TABLE 23-1. Assets of Major Financial Institutions in the United States

The financial sector has evolved rapidly over the last four decades. The table shows the total assets of all financial institutions, the grand total of which increased from 146 to 450 percent of GDP. Banks and other credit institutions declined in importance as secondary institutions like mutual funds and government-sponsored mortgage guarantors expanded sharply. Some important new areas, such as asset-backed securities, did not even exist in the 1960s.

Source: Federal Reserve Board, Flow of Funds, available at *www.federalreserve.gov/releases/z1/*, level tables.

- The financial system *transfers resources* across time, sectors, and regions. This function allows investments to be devoted to their most productive uses rather than being bottled up where they are least needed. We provided the examples above of student loans and retirement saving. Another example is found in international finance. Japan, which has a high saving rate, transfers resources to China, which has robust investment opportunities; this transfer occurs through both loans and direct foreign investments in China.
- The financial system *manages risks* for the economy. In one sense, risk management is like resource transfer: it moves risks from those people or sectors that most need to reduce their risks and transfers or spreads the risks to others who are better able to weather them. For example, fire insurance on your house takes a risk that you may lose a $200,000 investment and spreads that risk among hundreds or thousands of stockholders of the insurance company.
- The financial system *pools and subdivides funds* depending upon the need of the individual saver or investor. As an investor, you might want to invest $10,000 in a diversified portfolio of common stocks. To buy efficiently a portfolio of 100 companies might require $10 million of funds. Here is where a stock mutual fund comes in: by having 1000 investors, it can buy the portfolio, subdivide it, and manage it for you. In return, a well-run mutual fund might charge $30 per year on your $10,000 portfolio. Additionally, a modern economy requires large-scale firms which have billions of dollars of invested plant and equipment. No single person is likely to be able to afford that—and if someone could, that person would not want all his or her eggs in one basket. The modern corporation can and does undertake this task because of its ability to sell shares of stock to many people and pool these funds to make large and risky investments.
- The financial system performs an important *clearinghouse function,* which facilitates transactions between payers (purchasers) and payees (sellers). For example, when you write a check to buy a new computer, a clearinghouse will debit your bank and credit the bank of the company selling the computer. This function allows rapid transfers of funds around the world.

Eye Therapies Exhibit 2127, 478 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



FIGURE 23-1. The Flow of Funds Tracks Financial Flows in the Economy

Savers and investors transfer funds across time, space, and sectors through financial markets and financial intermediaries. Some flows (such as buying 100 shares of XYZ) go directly through financial markets, while others (such as purchasing shares of mutual funds or depositing money in your checking account) go through financial intermediaries.

The Flow of Funds

We can illustrate a simplified account of financial markets through a picture of the **flow of funds,** shown in Figure 23-1. This shows two sets of economic agents—savers and investors—and representative examples of saving and investing through financial markets and financial intermediaries.

This picture is simplified, for there are many different kinds of financial assets or instruments, as we will see in the next section.

A MENU OF FINANCIAL ASSETS

Financial assets are claims by one party against another party. In the United States, they consist primarily of *dollar-denominated assets* (whose payments are fixed in dollar terms) and *equities* (which are claims on residual flows such as profits or on real assets). Table 23-2 shows the major financial instruments for the United States at the end of 2007. The total value of financial assets was $142 trillion, which totals an enormous $1.2 million per American household. Of course, many of these assets are offseting items, but these huge numbers show how vast the financial system has become.

Here are the major financial instruments or assets:

- *Money* and its two components are very special assets, and they will be defined carefully later in this chapter.
- *Savings accounts* are deposits with banks or credit institutions, usually guaranteed by governments, that have a fixed-dollar principal value and interest rates determined by short-term market interest rates.

Eye Therapies Exhibit 2127, 479 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Financial instrument	Total ($, billion)	Percent of total
Money (M_1)		
Currency	774	0.5
Checking deposits	745	0.5
Savings deposits	7,605	5.4
Money market and mutual funds	10,852	7.6
Credit market instruments		
Government and government-sponsored	12,475	8.8
Private	38,660	27.2
Corporate and noncorporate equity	29,355	20.7
Insurance and pension reserves	13,984	9.9
Miscellaneous credit and other	27,470	19.4
Total, all financial instruments	**141,921**	**100.0**

TABLE 23-2. Major Financial Instruments in the United States, 2007

This table shows the wide range of financial assets owned by households, firms, and businesses in the United States. The total value is larger than the amount issued by financial institutions alone because many assets are issued by other entities, such as governments.

Source: Federal Reserve Board, Flow of Funds, available at *www.federalreserve.gov/releases/z1/*, level tables.

- *Credit market instruments* are dollar-denominated obligations of governments or private entities. Federal securities are generally thought to be risk-free assets. Other credit market instruments, which have varying degrees of risk, are mortgages, corporate securities, and junk bonds.
- *Common stocks* (which are a kind of equity) are ownership rights to companies. They yield dividends, which are payments drawn from company profits. Publicly traded stocks, which are priced on stock markets, are discussed later in this chapter. Noncorporate equities are the values of partnerships, farms, and small businesses.
- *Money market funds* and *mutual funds* are funds that hold millions or billions of dollars in either short-term assets or stocks and can be subdivided into fractional shares to be bought by small investors.
- *Pension funds* represent ownership in the assets that are held by companies or pension plans. Workers and companies contribute to these funds during working years. These funds are then drawn down to support people during their retirement years.
- *Financial derivatives* are included in the credit market instruments. These are new forms of financial instruments whose values are based on or derived from the values of other assets. One important example is a stock option, whose value depends upon the value of the stock to which it is benchmarked.

Note that this list of financial assets excludes the single most important asset owned by most people—their houses, which are tangible as opposed to financial assets.

Review of Interest Rates

Chapter 15 presented a full survey of rates of return, present value, and interest rates. You should review these concepts carefully. Below are the main points.

The interest rate is the price paid for borrowing money. We usually calculate interest as percent per year on the amount of borrowed funds. There are many interest rates, depending upon the maturity, risk, tax status, and other attributes of the loan.

Some examples will illustrate how interest works:

- When you graduate from college, you have only $500. You decide to keep it in the form of currency in a jar. If you don't spend any, you will still have $500 at the end of 1 year because currency has a zero interest rate.

Eye Therapies Exhibit 2127, 480 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

- A little later, you deposit $2000 in a savings account at your local bank, where the interest rate on savings accounts is 4 percent per year. At the end of 1 year, the bank will have paid $80 in interest into your account, so the account will now be worth $2080.
- You start your first job and decide to buy a small house that costs $100,000. You go to your local bank and find that a 30-year, fixed-rate mortgage has an interest rate of 5 percent per year. Each month you must make a mortgage payment of $536.83. Note that this payment is a little bit more than the pro-rated monthly interest charge of 0.417 (= 5/12) percent per month. Why? Because the monthly payment includes not only interest but also *amortization* (the repayment of principal, the amount borrowed). By the time you have made your 360 monthly payments, you will have completely paid off the loan.

B. THE SPECIAL CASE OF MONEY

Let's now turn to the special case of money. If you think about it for a moment, you will realize that money is a strange thing. We study for years so that we can earn a good living, yet each dollar bill is just paper, with minimal intrinsic value. Money is useless until we get rid of it.

However, money is anything but useless from a macroeconomic point of view. Monetary policy is today one of the two important tools (along with fiscal policy) the government has to stabilize the business cycle. The central bank uses its control over money, credit, and interest rates to encourage growth when the economy slows and to slow growth when inflationary pressures rise.

When the financial system is well managed, output grows smoothly and prices are stable. But an unstable financial system, as seen in many countries torn apart by war or revolution, can lead to inflation or depression. Many of the world's major macroeconomic traumas of the twentieth century can be traced to mismanaged monetary systems.

We now turn to a careful analysis of the definition of and demand for money.

THE EVOLUTION OF MONEY

The History of Money

What is money? **Money** *is anything that serves as a commonly accepted medium of exchange.* Because money has a long and fascinating history, we will begin with a description of money's evolution.

Barter. In an early textbook on money, when Stanley Jevons wanted to illustrate the tremendous leap forward that occurred as societies introduced money, he used the following experience:

> Some years since, Mademoiselle Zélie, a singer of the Théâtre Lyrique at Paris, . . . gave a concert in the Society Islands. In exchange for an air from Norma and a few other songs, she was to receive a third part of the receipts.
>
> When counted, her share was found to consist of three pigs, twenty-three turkeys, forty-four chickens, five thousand cocoa-nuts, besides considerable quantities of bananas, lemons, and oranges. . . . [I]n Paris . . . this amount of live stock and vegetables might have brought four thousand francs, which would have been good remuneration for five songs. In the Society Islands, however, pieces of money were scarce; and as Mademoiselle could not consume any considerable portion of the receipts herself, it became necessary in the mean time to feed the pigs and poultry with the fruit.

This example describes **barter,** which consists of the exchange of goods for other goods. Exchange through barter contrasts with exchange through money because pigs, turkeys, and lemons are not generally acceptable monies that we or Mademoiselle Zélie can use for buying things. Although barter is better than no trade at all, it operates under grave disadvantages because an elaborate division of labor would be unthinkable without the introduction of the great social invention of money.

As economies develop, people no longer barter one good for another. Instead, they sell goods for money and then use money to buy other goods they wish to have. At first glance this seems to complicate rather than simplify matters, as it replaces one transaction with two. If you have apples and want nuts, would it not be simpler to trade one for the other rather than to sell the apples for money and then use the money to buy nuts?

Eye Therapies Exhibit 2127, 481 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Actually, the reverse is true: two monetary transactions are simpler than one barter transaction. For example, some people may want to buy apples, and some may want to sell nuts. But it would be a most unusual circumstance to find a person whose desires exactly complement your own—eager to sell nuts and buy apples. To use a classic economics phrase, instead of there being a "double coincidence of wants," there is likely to be a "want of coincidence." So, unless a hungry tailor happens to find an unclothed farmer who has both food and a desire for a pair of pants, under barter neither can make a direct trade.

Societies that want to trade extensively simply cannot overcome the overwhelming handicaps of barter. The use of a commonly accepted medium of exchange, money, permits the farmer to buy pants from the tailor, who buys shoes from the cobbler, who buys leather from the farmer.

Commodity Money. Money as a medium of exchange first came into human history in the form of commodities. A great variety of items have served as money at one time or another: cattle, olive oil, beer or wine, copper, iron, gold, silver, rings, diamonds, and cigarettes.

Each of the above has advantages and disadvantages. Cattle are not divisible into small change. Beer does not improve with keeping, although wine may. Olive oil provides a nice liquid currency that is as minutely divisible as one wishes, but it is rather messy to handle. And so forth.

By the eighteenth century, commodity money was almost exclusively limited to metals like silver and gold. These forms of money had *intrinsic value,* meaning that they had use value in themselves. Because money had intrinsic value, there was no need for the government to guarantee its value, and the quantity of money was regulated by the market through the supply and demand for gold or silver. But metallic money has shortcomings because scarce resources are required to dig it out of the ground; moreover, it might become abundant simply because of accidental discoveries of ore deposits.

The advent of monetary control by central banks has led to a much more stable currency system. The intrinsic value of money is now its least important feature.

Modern Money. The age of commodity money gave way to the age of *paper money*. The essence of money is now laid bare. Money is wanted not for its own sake but for the things it will buy. We do not wish to consume money directly; rather, we use it by getting rid of it. Even when we choose to keep money, it is valuable only because we can spend it later on.

The use of paper currency has become widespread because it is a convenient medium of exchange. Paper currency is easily carried and stored. The value of money can be protected from counterfeiting by careful engraving. The fact that private individuals cannot legally create money keeps it scarce. Given this limitation on supply, currency has value. It can buy things. As long as people can pay their bills with currency, as long as it is accepted as a means of payment, it serves the function of money.

Paper money issued by governments was gradually overtaken by *bank money*—the checking accounts that we will discuss shortly.

A few years ago, many people predicted that we would soon move to a cashless society. They foresaw that cash and checking accounts would be replaced by electronic money, such as the stored-value cards found in many stores today. But, in fact, consumers have been reluctant to adopt electronic money in substantial amounts. They trust and prefer government money and checks. To some extent electronic transfers, debit cards, and e-banking have replaced paper checks, but these should be seen as different ways of *using* a checking account rather than as different *kinds* of money.

Components of the Money Supply

Let us now look more carefully at the different kinds of money, focusing on the United States. The main *monetary aggregate* studied in macroeconomics is known as M_1. This is also called *transactions money*. In earlier times, economists examined other concepts of money, such as M_2. These concepts included further assets and were often useful for looking at broad trends, but they are little used in monetary policy today. The following are the components of M_1:

- *Currency.* Currency is defined as coins and paper money held outside the banking system. Most of us know little more about a $1 or $5 bill than that each is inscribed with the picture of an American

Eye Therapies Exhibit 2127, 482 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

statesman, bears some official signatures, and has a number showing its face value. Examine a $10 bill or some other paper bill. You will find that it says "Federal Reserve Note." But what "backs" our paper currency? Many years ago, paper money was backed by gold or silver. There is no such pretense today. Today, all U.S. coins and paper currency are *fiat money*. This term signifies something declared to be money by the government even if it has no intrinsic value. Paper currency and coins are *legal tender*, which must be accepted for all debts, public and private. Currency is approximately one-half of total M_1.

- *Checking deposits.* The other component of M_1 is bank money. This consists of funds, deposited in banks and other financial institutions, on which you can write checks and withdraw your money on demand. The technical name for this component of the money supply is "demand deposits and other checkable deposits." If I have $1000 in my checking account at the Albuquerque National Bank, that deposit can be regarded as money. Why? For the simple reason that I can pay for purchases with checks drawn on it. The funds in my account are a medium of exchange, and it is therefore counted as money.

Students often wonder if credit cards are money. Actually, they are not. The reason is that a credit card is actually an easy (but not cheap!) way to *borrow* money. When paying with a credit card, you are promising to pay the credit card company—with money—at a later date.

Figure 23-2 shows the trend in the ratio of M_1 to GDP. This ratio has declined by a factor of 3 over the last half-century. At the same time, all other financial assets have grown sharply.

Money is anything that serves as a commonly accepted medium of exchange. Today, we define transactions money as M_1, which is the sum of currency held by the public and checking deposits.

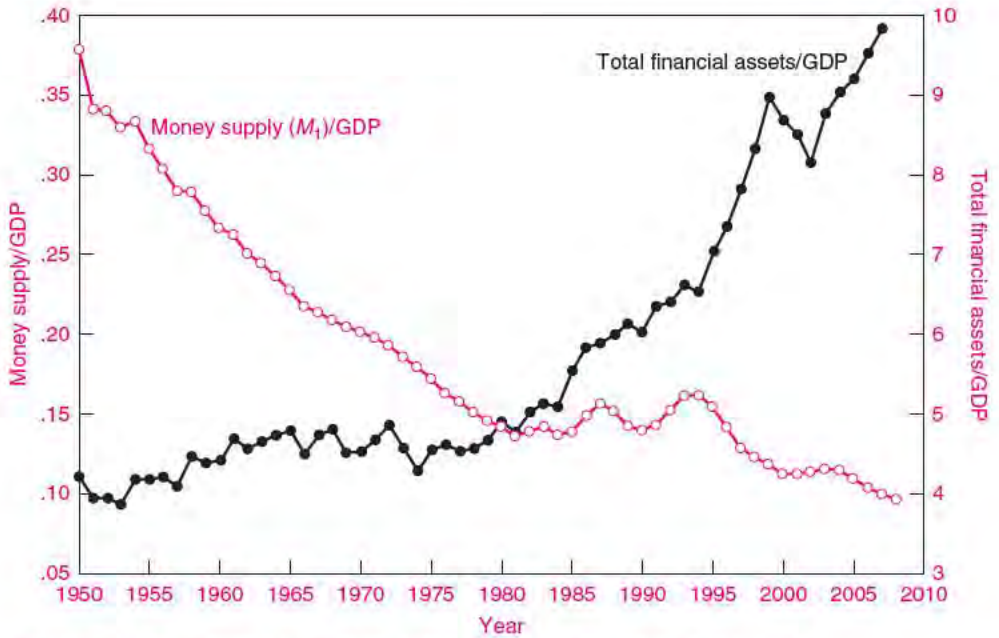


FIGURE 23-2. Money Holdings and Total Financial Assets per Unit of GDP

Total financial assets have risen sharply relative to GDP, while the ratio of the money supply to GDP has gradually declined. Note the vast difference in scale. Total financial assets are defined similarly here as in Table 23-1.

Source: Financial data from the Federal Reserve Board; GDP from the Bureau of Economic Analysis.

Eye Therapies Exhibit 2127, 483 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

THE DEMAND FOR MONEY

The demand for money is different from the demand for ice cream or movies. Money is not desired for its own sake; you cannot eat nickels, and we seldom hang $100 bills on the wall for the artistic quality of their engraving. Rather, we demand money because it serves us indirectly as a lubricant to trade and exchange.

Money's Functions

Before we analyze the demand for money, let's note money's functions:

- The central function emphasized here is that money serves as a *medium of exchange*. Without money, we would be constantly roving around looking for someone to barter with. Money's value is often shown when the monetary system malfunctions. After Russia abandoned its central-planning system in the early 1990s, for example, people spent hours waiting in line for goods and tried to get dollars or other foreign currencies because the ruble had ceased to function as an acceptable means of exchange.
- Money is also used as the *unit of account*, the unit by which we measure the value of things. Just as we measure weight in kilograms, we measure value in money. The use of a common unit of account simplifies economic life enormously.
- Money is sometimes used as a *store of value*. In comparison with risky assets like stocks or real estate or gold, money is relatively riskless. In earlier days, people held currency as a safe form of wealth. Today, when people seek a safe haven for their wealth, the vast preponderance of their wealth is held in nonmonetary assets, such as savings accounts, stocks, bonds, and real estate.

The Costs of Holding Money

What is the *cost* of holding money? Money is costly because it has a lower yield than do other safe assets. Currency has a nominal interest rate of exactly zero percent per year. Checking deposits sometimes have a small interest rate, but that rate is usually well below the rate on savings accounts or money market mutual funds. For example, over the period 2000–2007, currency had a yield of 0 percent per year, checking accounts had an average yield of around 0.2 percent per year, and short-term money funds had a yield of around 4.6 percent per year. If the weighted yield on money (currency and checking accounts) was 0.1 percent per year, then the *cost of holding money* was 4.5 = 4.6 − 0.1 percent per year. Figure 23-3 on page 462 shows the interest rate on money as compared to that on safe short-term assets.

The cost of holding money is the interest forgone from not holding other assets. That cost is usually very close to the short-term interest rate.

Two Sources of Money Demand

Transactions Demand for Money. People need money primarily because their incomes and expenditures do not come at the same time. For example, I might be paid on the last day of the month, but I buy food, newspapers, gasoline, and clothing throughout the month. The need to have money to pay for purchases, or transactions, of goods, services, and other items constitutes the *transactions demand for money*.

For example, suppose that a family earns $3000 per month, keeps it in money, and spends it evenly throughout the month. A calculation will show that the family holds $1500 on average in money balances.

This example can help us see how the demand for money responds to different economic influences. If all prices and incomes double, the nominal demand for M doubles. Thus the transactions demand for money doubles if nominal GDP doubles with no change in real GDP or other real variables.

How does the demand for money vary with interest rates? As interest rates rise, the family might say, "Let's put only half of our money in the checking account at the beginning of the month and put the other half in a savings account earning 8 percent per year. Then on day 15, we'll take that $1500 out of the savings account and put it into our checking account to pay the next 2 weeks' bills."

This means that as interest rates rose and the family decided to put half its earnings in a savings account, the average money balance of our family fell from $1500 to $750. This shows how money holdings (or the demand for money) may be sensitive to interest rates: other things equal, as interest rates rise, the quantity of money demanded declines.

Eye Therapies Exhibit 2127, 484 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

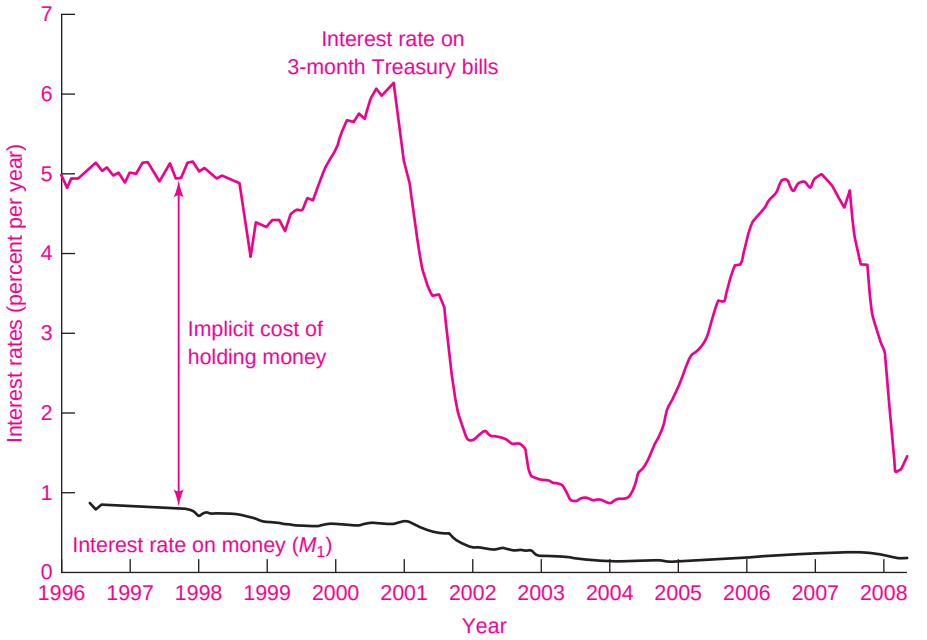


FIGURE 23-3. Interest Rates on Money and Safe Short-Term Assets

This figure shows the interest rate on money (which is the average of zero on currency and the rate on checking accounts) as compared to the interest rate on short-term Treasury securities. The difference between these two interest rates is the implicit cost of holding money.

Source: Treasury interest rate from Federal Reserve; interest rate on checking accounts from Informa Research Services, Inc.

Asset Demand. In addition to its use for transaction needs, you might wonder if money itself would ever be used as a store of value. The answer today is, not often. In a modern economy in normal times, people prefer to keep their nontransaction assets in safe, interest-bearing assets such as savings accounts or money funds. Suppose you need $2000 a month in your checking account for your transactions, and you have another $50,000 in savings. Surely, you would be better off putting the $50,000 in a money market fund earning 4.6 percent per year than in a checking account earning 0.2 percent per year. After a decade, the latter would be worth only $51,009 while the former would be worth $78,394. (Make sure you can reproduce these numbers.)

There are some important exceptions, however, where money itself might be used as a store of value. Money might be an attractive asset in primitive financial systems where there are no other reliable assets. U.S. currency is widely held abroad as a safe asset in countries where hyperinflation occurs, or where a currency might be devalued, or where the financial system is unreliable. Additionally, in advanced countries, people might hold money as an asset when interest rates are near zero. This situation, known as a liquidity trap, terrifies central bankers because they lose the ability to affect interest rates. We will review this syndrome in the next chapter.

The main reason people hold money (M_1) is to meet their transactions demand. This means that money is an acceptable medium of exchange that we can use to buy our goods and pay our bills. As our incomes rise, the dollar value of the goods we buy tends to go up as well, and we therefore need more money for transactions, raising our demand for money. In a modern financial system, there is generally little or no asset demand for M_1.

Eye Therapies Exhibit 2127, 485 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

C. BANKS AND THE SUPPLY OF MONEY

Now that we have described the basic structure of the financial system, we turn to commercial banks and the supply of money. If you look back at the description of the monetary transmission mechanism at the beginning of this chapter, you will see that the activities of banks are the critical third step. While money constitutes a relatively small fraction of all financial assets, the interaction between the central bank and commercial banks turns out to play a central role in the setting of interest rates, and ultimately in influencing macroeconomic behavior.

Banks are fundamentally businesses organized to earn profits for their owners. A commercial bank provides certain services for its customers and in return receives payments from them.

Table 23-3 shows the consolidated balance sheet of all U.S. commercial banks. A *balance sheet* is a statement of a firm's financial position at a point in time. It lists *assets* (items that the firm owns) and *liabilities* (items that the firm owes). Each entry in a balance sheet is valued at its actual market value or its historical cost.[1] The difference between the total value of assets and total liabilities is called *net worth.*

Except for the details, a bank balance sheet looks much like a balance sheet for any other business. The unique feature of a bank balance sheet is an asset called **reserves.** This is a technical term used in banking to refer to a special category of bank assets that are regulated by the central bank. Reserves equal currency held by the bank ("vault cash") plus deposits with Federal Reserve Banks. In earlier days, reserves were held to pay depositors, but today they serve primarily to meet legal reserve requirements. We will discuss reserves in detail in the next chapter.

How Banks Developed from Goldsmith Establishments

Commercial banking began in England with the goldsmiths, who developed the practice of storing people's gold and valuables for safekeeping. At first, such establishments simply functioned as secure warehouses. Depositors left their gold for safekeeping and were given a receipt. Later they presented their receipt, paid a fee, and got back their gold.

What would the balance sheet of a typical goldsmith establishment look like? Perhaps like Table 23-4. A total of $1 million has been deposited in its vaults, and this whole sum is held as a cash asset (this is the item "Reserves" in the balance sheet). To balance this

[1] Balance sheets, assets, and liabilities are extensively discussed in Chapter 7 of the full textbook.

Balance Sheet of All Commercial Banking Institutions, 2008 (billions of dollars)

Assets		Liabilities and Net Worth	
Reserves	43	Checking deposits	629
Loans	6,250	Savings and time deposits	5,634
Investments and securities	2,265	Other liabilities	2,643
Other assets	1,404	Net worth (capital)	1,056
Total	9,961	Total	9,961

TABLE 23-3. Balance Sheet of All U.S. Commercial Banks

Commercial banks are diversified financial institutions and are the major providers of checking deposits, which is an important component of M_1. Checking accounts are payable on demand and thus can be used as a medium of exchange. Reserves are held primarily to meet legal requirements, rather than to provide against possible unexpected withdrawals. (Note that banks have a small amount of net worth or capital relative to their total assets and liabilities. The ratio of liabilities to net worth is called the "leverage ratio." Highly leveraged financial institutions produce systemic risk if the values of their assets all deteriorate at the same time, as occurred in 2007–2009.)

Source: Federal Reserve Board, available at *www.federalreserve.gov/releases/.*

Eye Therapies Exhibit 2127, 486 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Goldsmith Balance Sheet with 100% Reserves

Assets		Liabilities	
Reserves	1,000,000	Demand deposits	1,000,000
Total	1,000,000	Total	1,000,000

TABLE 23-4. First Goldsmith Bank Held 100 Percent Cash Reserves against Demand Deposits

In a primitive banking system, with 100 percent backing of deposits, no creation of money out of reserves is possible.

asset, there is a demand deposit of the same amount. Reserves are therefore 100 percent of deposits.

In today's language, the goldsmiths' demand deposits would be part of the money supply; they would be "bank money." However, the bank money just offsets the amount of ordinary money (gold or currency) placed in the bank's vaults and withdrawn from active circulation. No money creation has taken place. The process is of no more interest than if the public decided to convert nickels into dimes. *A 100 percent-reserve banking system has a neutral effect on money and the macroeconomy because it has no effect on the money supply.*

We can go a step further and ask what would happen if there were paper money issued under a gold standard with 100 percent backing by gold. In this case, you can create a new Table 23-4 by writing "gold notes" instead of "demand deposits." The gold notes would be currency and part of M_1. Again, the money supply would be unchanged because the currency has 100 percent backing.

Fractional-Reserve Banking

Let's take another step toward today's banking system by introducing *fractional-reserve banking*. Banks soon learned that they did not need to keep 100 percent of their gold or silver as reserves against their notes and deposits. People did not all come to redeem their notes at the same time. A bank might be safe if it kept only fractional reserves to back its notes and deposits. This was a tiny first step on the road to today's vast financial system.

We explore the implications of fractional-reserve banking starting with a situation where a system of banks operates with a customary or legal requirement that it keep reserves equal to at least 10 percent

Goldsmith Balance Sheet with Fractional Reserves

Assets		Liabilities	
Reserves	100,000	Demand deposits	
Investments	900,000	and gold notes	1,000,000
Total	1,000,000	Total	1,000,000

TABLE 23-5. Goldsmith Bank Keeps 10 Percent Reserves against Deposits and Gold Notes

Later, Goldsmith Bank learns that it does not need to keep 100 percent reserves. Here, it has decided to invest 90 percent and keep only 10 percent in reserves against deposits and notes.

of deposits. Suppose that the president of Goldsmith Bank wakes up and says, "We do not need to keep all this sterile gold as reserves. In fact, we can lend out 90 percent of it and still have sufficient gold to meet the demands of depositors."

So Goldsmith Bank lends out $900,000 and keeps the remaining $100,000 as gold reserves. The initial result is shown in Table 23-5. The bank has invested $900,000—perhaps lending money to Duck.com, which is building a toy factory.

But that is not the end of the process. Duck.com will take the $900,000 loan and deposit it in its own checking account to pay the bills for the factory. Suppose, for simplicity, that the firm has a checking account in Goldsmith Bank. The interesting result here, shown in Table 23-6, is that Goldsmith Bank

Goldsmith Balance Sheet after Deposit of Loan by Duck.com

Assets		Liabilities	
Reserves	1,000,000	Demand deposits	
Investments	900,000	and gold notes	1,900,000
Total	1,900,000	Total	1,900,000

TABLE 23-6. After the Firm Deposits Its Loan, the Banking System Has Excess Reserves to Lend Out Again

The Duck firm deposits its $900,000 loan into its account. This increases Goldsmith Bank's reserves of gold back to $1,000,000. Soon the excess will be lent out again.

Eye Therapies Exhibit 2127, 487 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

has recovered the $900,000 of reserves. In essence, Duck.com took the loan of gold and then lent it back to the bank. (The process would be exactly the same if Duck.com went to another bank: that bank would have excess reserves of $900,000.)

But now the bank needs to keep only 10 percent × $1.9 million = $190,000 for reserves, so it can lend out the excess $810,000. Soon the $810,000 will show up in a bank deposit. This process of deposit, relending, and redeposit continues in a chain of dwindling expansions.

Final System Equilibrium

Now let's sum up the total of all deposits. We started with $1,000,000 in deposits, then added $900,000, then $810,000 and so on. The total is given by the sum:

$$\begin{aligned}\text{Total deposits} &= 1{,}000{,}000 + 1{,}000{,}000 \times 0.9 + 1{,}000{,}000 \times 0.9^2 + \cdots \\ &= 1{,}000{,}000[1 + 0.9 + 0.9^2 + \cdots + (0.9)^n + \cdots] \\ &= 1{,}000{,}000\left(\frac{1}{1 - 0.9}\right) = 1{,}000{,}000\left(\frac{1}{0.1}\right) = 10{,}000{,}000\end{aligned}$$

At the end of the process, the total amount of deposits and money is $10 million, which is 10 times the total amount of reserves. Assuming that Goldsmith is the only bank, or that we are looking at the consolidated banking system, we can show the final balance sheet in Table 23-7. The point here is that once banks require only fractional reserves, the total money supply is a multiple of the reserves.

This can be seen intuitively. The cumulative process just described must come to an end when every bank in the system has reserves equal to 10 percent of deposits. In other words, the final equilibrium of the banking system will be the point at which 10 percent of deposits (D) equals total reserves. What level of D satisfies this condition? The answer is D = $10 million.

When banks hold fractional reserves against their deposits, they actually create money. The total bank money is generally equal to total reserves multiplied by the inverse of the reserve ratio:

$$\text{Bank money} = \text{total reserves} \times \left(\frac{1}{\text{reserve ratio}}\right)$$

A Modern Banking System

It is time to put our fable of goldsmiths behind us. How does all this relate to the actual banking system today? The surprising answer is that with some additional details, the process we just described fits today's banking system exactly. Here are the key elements of the modern banking system:

- Banks are required to hold at least 10 percent of their checking deposits as reserves, in the form of either currency or deposits with the Federal Reserve (more on this in the next chapter).
- The Federal Reserve buys and sells reserves at a target interest rate set by the Fed (again, more on this in the next chapter).
- The checking-deposit component of M_1 is therefore determined by the amount of reserves along with the required reserve ratio.

A few qualifications need to be mentioned before closing this section. First, commercial banks do much more than simply provide checking accounts, as we saw in Table 23-3. This fact may complicate the task of the regulatory authorities, but it does not change the basic operation of monetary policy.

A second complication arises if nominal interest rates approach zero. This is referred to as the liquidity trap. We will discuss this syndrome in the next chapter.

Consolidated Balance Sheet of All Banks in Equilibrium

Assets		Liabilities	
Reserves	1,000,000	Demand deposits	
Investments	9,000,000	and gold notes	10,000,000
Total	10,000,000	Total	10,000,000

TABLE 23-7. Final Equilibrium Balance Sheet When Banking System Has No Excess Reserves

We aggregate the banking system together assuming that there are $1,000,000 of total reserves. When banks have lent out all excess reserves, so reserves are just 10 percent of deposits and notes, total money is 1/0.1 = 10 times reserves.

D. THE STOCK MARKET

We close this chapter with a tour through one of the most exciting parts of a capitalist system: the stock market. A **stock market** is a place where shares

Eye Therapies Exhibit 2127, 488 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

in publicly owned companies—the titles to business firms—are bought and sold. In 2008, the value of corporate equities in the United States was estimated at $21 trillion. The stock market is the hub of our corporate economy.

The New York Stock Exchange is America's main stock market, listing more than a thousand securities. Another important market is the NASDAQ, which had a meteoric rise and subsequent collapse in stock prices after 2000. Every large financial center has a stock exchange. Major ones are located in Tokyo, London, Frankfurt, Shanghai, and, of course, New York.

Risk and Return on Different Assets

Before discussing major issues in stock market analysis, we need to introduce some basic concepts in financial economics. We noted earlier in this chapter that different assets have different characteristics. Two important characteristics are the rate of return and the risk.

The *rate of return* is the total dollar gain from a security (measured as a percent of the price at the beginning of the period). For savings accounts and short-term bonds, the return would simply be the interest rate. For most other assets, the return combines an income item (such as dividends) with a *capital gain* or *loss,* which represents the increase or decrease in the value of the asset between two periods.

We can illustrate the rate of return using data on stocks. (For this example, we ignore taxes and commissions.) Say that you bought a representative portfolio of $10,000 worth of stocks in U.S. companies at the end of 1996. Over the next 3 years, your fund would have had a total real return (including dividends plus capital gains and correcting for inflation) of 32 percent per year.

However, before you get too excited about these fantastic gains, be forewarned that the stock market also goes down. In the 3 years after 1999, real stock prices declined by 19 percent per year. An even worse experience came in 2008, when stock prices declined 38 percent during the year.

The fact that some assets have predictable rates of return while others are quite risky leads to the next important characteristic of investments. **Risk** refers to the variability of the returns on an investment. If I buy a 1-year Treasury bond with a 6 percent return, the bond is a riskless investment because I am sure to get my expected dollar return. On the other hand, if I buy $10,000 worth of stocks, I am uncertain about their year-end value.

Economists often measure risk as the standard deviation of returns; this is a measure of dispersion whose range encompasses about two-thirds of the variation.[2] For example, from 1908 to 2008, common stocks had an average annual real return of 6 percent per year with an annual standard deviation of return of 16 percent. This implies that the real return was between 22(= 6 + 16) percent and −10(= 6 − 16) percent about two-thirds of the time.

Individuals generally prefer higher return, but they also prefer lower risk because they are *risk-averse.* This means that they must be rewarded by higher returns to induce them to hold investments with higher risks. We would not be surprised, therefore, to learn that over the long run safe investments like bonds have lower average returns than risky investments like stocks.

Table 15-1 on page 289 showed the historical returns or interest rates on a number of important investments. We show the most important assets in the *risk-return diagram* in Figure 23-4. This diagram shows the average real (or inflation-corrected) return on the vertical axis and the historical risk (measured as a standard deviation) on the horizontal axis. Note the positive relationship between risk and return.

Bubbles and Crashes

The history of finance is one of the most exciting parts of economics. Sometimes, sound judgments get put aside as markets engage in frenzies of speculation, often followed by moods of pessimism and falling prices.

Investors are sometimes divided into those who invest on firm foundations and those who try to

[2] The standard deviation is a measure of variability that can be found in any elementary statistics textbook. It is roughly equal to the average deviation of a series from its mean. The precise definition of standard deviation is the square root of the squared deviations of a variable from its mean. As an example, if a variable takes the values of 1, 3, 1, 3, the mean or expected value is 2 while the standard deviation is 1.

Eye Therapies Exhibit 2127, 489 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

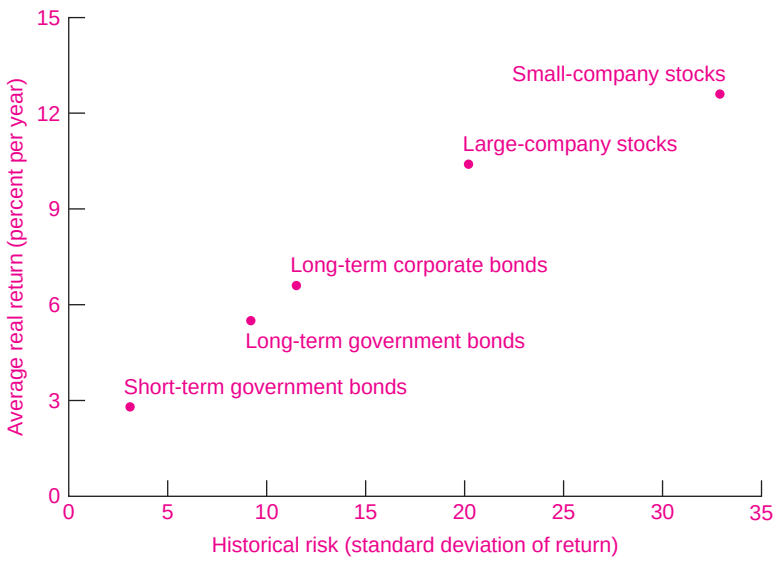


FIGURE 23-4. Risk and Return on Major Investments, 1926–2005

Investments vary in their average returns and riskiness. Bonds tend to be safe with low returns, while stocks have much higher returns but face higher risks. This diagram shows the *historical* risk and return on different financial assets. Depending upon market sentiments, the *expected* risk and return may differ markedly from the historical experience.

Source: Ibbotson Associates, 2006.

outguess the market psychology. The firm-foundation approach holds that assets should be valued on the basis of their intrinsic value. For common stocks, the intrinsic value is the expected present value of the dividends. If a stock has a constant dividend of $2 per year and the appropriate interest rate with which to discount dividends is 5 percent per year, the intrinsic value would be $2/.05 = $40 per share. The firm-foundation approach is the slow but safe way of getting rich.

Impatient souls might share the view of Keynes, who argued that investors are more likely to worry about market psychology and to speculate on the future value of assets rather than wait patiently for stocks to prove their intrinsic value. He argued, "It is not sensible to pay 25 for an investment which is worth 30, if you also believe that the market will value it at 20 three months hence." The market psychologist tries to guess what the average investor thinks, which requires considering what the average investor thinks about the average investor, and so on, ad infinitum.

When a psychological frenzy seizes the market, it can result in speculative bubbles and crashes. A *speculative bubble* occurs when prices rise because people think they are going to rise even further in the future—it is the reverse of Keynes's just-cited dictum. A piece of land may be worth only $1000, but if you see a land-price boom driving prices up 50 percent each year, you might buy it for $2000 hoping you can sell it to someone else next year for $3000.

A speculative bubble fulfills its own promises for a while. If people buy because they think stocks will rise, their act of buying sends up the price of stocks. This causes other people to buy even more and sends the dizzy dance off on another round. But, unlike people who play cards or dice, no one apparently loses what the winners gain. Of course, the prizes are all on paper and would disappear if everyone tried to cash them in. But why should anyone want to sell such lucrative securities? Prices rise because of hopes and dreams, not because the profits and dividends of companies are soaring.

History is marked by bubbles in which speculative prices were driven up far beyond the intrinsic value of the asset. In seventeenth-century Holland, a tulip mania drove tulip prices to levels higher than the price of a house. In the eighteenth century, the stock of the South Sea Company rose to fantastic levels on empty promises that the firm would enrich its stockholders. In more recent times, similar bubbles have been found in biotechnology, Japanese land, "emerging markets," and a vacuum-cleaning company called

Eye Therapies Exhibit 2127, 490 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

ZZZZ Best, whose business was laundering money for the Mafia.

The most famous bubble of them all occurred in the American stock market in the 1920s. The "roaring twenties" saw a fabulous stock market boom, when everyone bought and sold stocks. Most purchases in this wild bull market were on margin. This means that a buyer of $10,000 worth of stocks put up only part of the price in cash and borrowed the difference, pledging the newly bought stocks as collateral for the loan. What did it matter that you had to pay the broker 6, 10, or 15 percent per year on the loan when Auburn Motors or Bethlehem Steel might jump 10 percent in value overnight?

Speculative bubbles always produce crashes and sometimes lead to economic panics. The speculation of the 1920s was soon followed by the 1929 panic and crash. This event ushered in the long and painful Great Depression of the 1930s. By the trough of the Depression in 1933, the market had declined 85 percent.

Trends in the stock market are tracked using *stock-price indexes,* which are weighted averages of the prices of a basket of company stocks. Commonly followed averages include the Dow-Jones Industrial Average (DJIA) of 30 large companies; Standard and Poor's index of 500 companies (the S&P 500), which is a weighted average of the stock prices of 500 large American corporations; and the NASDAQ Composite Index, which includes more than 3000 stocks listed on that market.

Figure 23-5 shows the history of the Standard and Poor's 500 price index over the last century. The lower curve shows the nominal stock-price average, which records the actual average during a particular month. The upper line shows the real price of stocks;

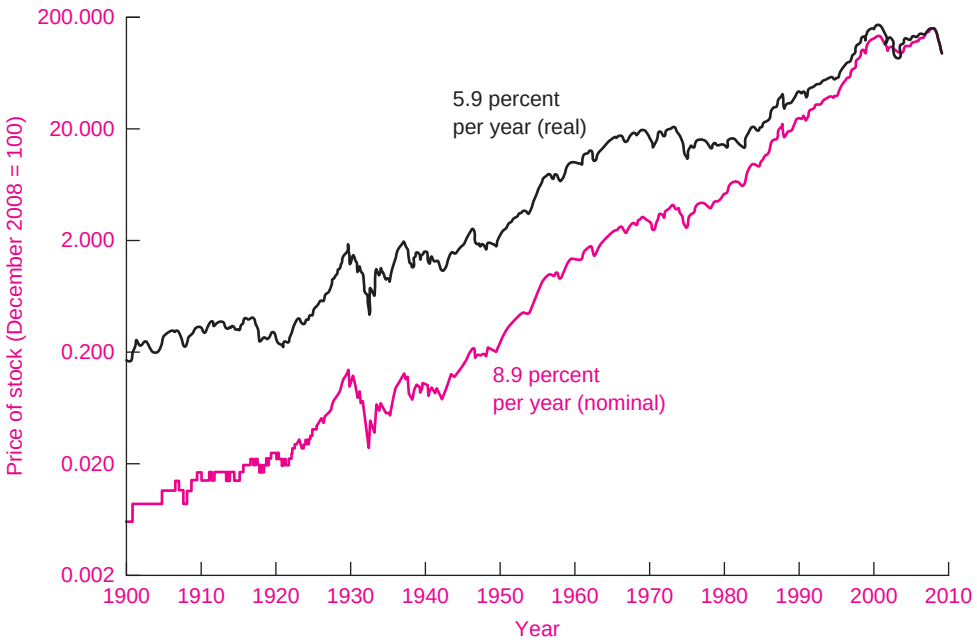


FIGURE 23-5. The Only Guarantee about Stock Prices Is That They Will Fluctuate

The Standard and Poor's index (the S&P 500) tracks the value-weighted average of the stock prices of 500 large companies traded in the U.S. It is shown here including reinvested dividends. Stock prices in nominal terms are shown by the bottom line; these averaged a growth of 8.9 percent per year from 1900 to 2008. The top line shows the "real" S&P 500, which is the S&P 500 corrected for movements in the consumer price index. It rose 5.9 percent per year on average.

Source: Standard and Poor, Bureau of Labor Statistics.

Eye Therapies Exhibit 2127, 491 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

this equals the nominal price divided by an index of consumer prices. Both curves are indexed to equal 100 in December 2008. The average growth rate of stocks over the period was 8.9 percent per year in dollar terms but only 5.9 percent per year after correcting for inflation.

Stocks have proven to be a good investment over the long term. But they are also extremely risky in the short run, as people learned when stock prices declined 52 percent from the peak in October 2007 to the trough in November 2008. Is there a crystal ball that can foretell the movement of stock prices? This is the subject of modern finance theory.

Efficient Markets and the Random Walk

Economists and finance professors have long studied prices in speculative markets such as the stock market and the foreign exchange market. One important hypothesis is that speculative markets tend to be "efficient." This finding has stirred great controversy in the economics profession and with financial analysts.

What is the essence of the **efficient-market theory?** A summary statement is the following:

> Securities markets are extremely efficient in absorbing information about individual stocks and about the stock market as a whole. When new information arrives, the news is quickly incorporated into stock prices. Systems which attempt to forecast prices on the basis of the past or of fundamentals cannot produce returns greater than those that could be obtained by holding a randomly selected portfolio of individual stocks of comparable risk.[3]

A colorful story illustrates the basic message. A finance professor and a student are walking across the campus when they see what looks like a $100 bill lying on the ground. The professor tells the student, "Don't bother to pick it up. If it were really a $100 bill, it wouldn't be there." In other words, you can't get rich simply by bending down on a public thoroughfare!

This paradoxical view has been generally confirmed in hundreds of studies over the last half-century. Their lesson is not that you will never become rich by following a rule or formula but that, on average, such rules do not outperform a diversified portfolio of stocks.

Rationale for the Efficient-Market View. Finance theorists have spent many years analyzing stock and bond markets in order to understand why well-functioning financial markets rule out persistent excess profits. The theory of efficient markets explains this.

An **efficient financial market** is one where all new information is quickly understood by market participants and becomes immediately incorporated into market prices. For example, say that Lazy-T Oil Company has just struck oil in the Gulf of Alaska. This event is announced at 11:30 A.M. on Tuesday. When will the price of Lazy-T's shares rise? The efficient-market theory holds that market participants will react at once, bidding the price of Lazy-T up by the correct amount. In short, at every point in time, markets have already digested and included all available information in asset prices.

The theory of efficient markets holds that market prices contain all available information. It is not possible to make profits by acting on old information or at patterns of past price changes. Returns on stocks will be primarily determined by their riskiness relative to the market.

A Random Walk. The efficient-market view provides an important way of analyzing price movements in organized markets. Under this approach, the price movements of stocks should look highly erratic, like a random walk, when charted over a period of time.

A price follows a **random walk** when its movements over time are completely unpredictable. For example, toss a coin for heads or tails. Call a head "plus 1" and a tail "minus 1." Then keep track of the running score of 100 coin tosses. Draw it on graph paper. This curve is a random walk. Now, for comparison, also graph 100 days' movement of Microsoft stock and of Standard and Poor's 500 index. Note how similar all three figures appear.

Why do speculative prices resemble a random walk? Economists, on reflection, have arrived at the following truths: In an efficient market all predictable things have already been built into the prices. It

[3] This definition is adopted from Malkiel's 2003 article; see Further Readings. Note that "efficiency" is used differently in finance theory than in other parts of economics. Here, "efficiency" means that information is quickly absorbed, not that resources produce the maximal outputs.

Eye Therapies Exhibit 2127, 492 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

is the arrival of *new* information that affects stock or commodity prices. Moreover, the news must be random and unpredictable (or else it would be predictable and therefore not truly news).

To summarize:

The efficient-market theory explains why movements in stock prices look so erratic. Prices respond to news, to surprises. But surprises are unpredictable events—like the flip of a coin or next month's rainstorm—that may move in any direction. Because stock prices move in response to erratic events, stock prices themselves move erratically, like a random walk.

Qualifications to the Efficient-Market View. Although the efficient-market view has been the canon of finance in economics and business, many believe that it is oversimplified and misleading. Here are some of the reservations:

1. Researchers have uncovered many "anomalies" in stock-price movements that lead to some predictability. For example, stocks with high dividends or earnings relative to prices appear to perform better in subsequent periods. Similarly, sharp upward or downward movements tend to be followed by "reversals" in movements. To some, these anomalies are persuasive indicators of market inefficiencies; to others, they simply reflect the tendency of analysts to mine the data looking for patterns that are in fact spurious correlations.
2. Economists who look at the historical record ask whether it is plausible that sharp movements in stock prices could actually reflect new information. Consider the 30 percent drop in stock prices that occurred from October 15 to October 19, 1987. Efficient-market theories imply that this drop was caused by economic events that depressed the expected present value of future corporate earnings. Critics of the efficient-market view argue that there was no news that could make a 30 percent difference in the value of stock prices over those 4 days. Efficient-market theorists fall silent before this criticism.
3. Finally, the efficient-market view applies to individual stocks but not necessarily to the market as a whole. There is persuasive evidence of long, self-reversing swings in stock market prices. These swings tend to reflect changes in the general mood of the financial community. Periods like the 1920s and 1990s saw investor optimism and rising stock prices, while the 1930s and 2007–2008 were periods of investor pessimism when stock prices declined sharply. However, say that we believed that the market reflected an "irrational exuberance" and was overvalued. What could we do? We could not individually buy or sell enough stocks to overcome the entire national mood. In addition, we might get wiped out if we bet against the market a year or two before the peak. So, from a macroeconomic perspective, speculative markets can exhibit waves of pessimism and optimism without powerful economic forces moving in to correct these mood swings.

PERSONAL FINANCIAL STRATEGIES

While taking a course in economics is no guarantee of great wealth, the principles of modern finance can definitely help you invest your nest egg wisely and avoid the worst financial blunders. What lessons does economics teach about personal investment decisions? We have culled the following five rules from the wisdom of the best brains on the street:

Lesson 1: Know thy investments. The absolute bedrock of a sound investment strategy is to be realistic and prudent in your investment decisions. For important investments, study the materials and get expert advice. Be skeptical of approaches that claim to have found the quick route to success. You can't get rich by listening to your barber or consulting the stars (although, unbelievably, some financial advisers push astrology to their clients). Hunches work out to nothing in the long run. Moreover, the best brains on Wall Street do not, on average, beat the averages (Dow-Jones, Standard and Poor's, etc.).

Lesson 2: Diversify, diversify—that is the law of the prophets of finance. One of the major lessons of finance is the advantage of diversifying your investments. "Don't put all your eggs in one basket" is one way of expressing this rule. By putting funds in a number of different investments, you can continue to average a high yield while reducing the risk. Calculations show that by diversifying their wealth among a broad array of investments—different

Eye Therapies Exhibit 2127, 493 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

common stocks, conventional and inflation-indexed bonds, real estate, domestic and foreign securities—people can attain a good return while minimizing the downside risk on their investments.

Lesson 3: Consider common-stock index funds. Investors who want to invest in the stock market can achieve a good return with the least possible risk by holding a broadly diversified portfolio of common stocks. A good vehicle for diversifying is an *index fund*. This is a portfolio of the stocks of many companies, weighting each company in proportion to its market value and often tracking a major stock index like the S&P 500. One major advantage of index funds is that they have low expenses and low turnover-induced taxes.

Lesson 4: Minimize unnecessary expenses and taxes. People often find that a substantial amount of their investment earnings is nibbled away by taxes and expenses. For example, some mutual funds charge a high initial fee when you purchase the fund. Others might charge a management fee of 1 or even 2 percent of assets each year. Additionally, heavily "managed" funds have high turnover and may lead to large taxes on capital gains. Day traders may find great enjoyment in lightning movements in and out, and they may strike it rich, but they *definitely* will pay heavy brokerage and investment charges. By choosing your investments carefully, you can avoid these unnecessary drains on your investment income.

Lesson 5: Match your investments with your risk preference. You can increase your expected return by picking riskier investments (see Figure 23-4). But always consider how much risk you can afford—financially *and psychologically*. As one sage put it, investments are a tradeoff between eating well and sleeping well. If you get insomnia worrying about the ups and downs of the market, you can maximize your sleep by keeping your assets in inflation-indexed U.S. Treasury bonds. But in the long run, you might be snoozing soundly on a cot! If you want to eat well and can tolerate disappointments, you might invest more heavily in stocks, including ones in foreign countries and emerging markets, and incorporate more volatile small companies into your portfolio—rather than concentrating on short-term bonds and bank deposits.

Such are the lessons of history and economics. If, after reading all this, you still want to try your hand in the stock market, do not be daunted. But take to heart the caution of one of America's great financiers, Bernard Baruch:

> If you are ready to give up everything else—to study the whole history and background of the market and all the principal companies whose stocks are on the board as carefully as a medical student studies anatomy—if you can do all that, and, in addition, you have the cool nerves of a great gambler, the sixth sense of a kind of clairvoyant, and the courage of a lion, you have a ghost of a chance.



SUMMARY

A. The Modern Financial System

1. Financial systems in a modern economy transfer resources over space, time, and sectors. The flow of funds in financial systems occurs through financial markets and financial intermediaries. The major functions of a financial system are to transfer resources, to manage risk, to subdivide and pool funds, and to clear transactions.
2. Interest rates are the prices paid for borrowing funds; they are measured in dollars paid back per year per dollar borrowed. The standard way we quote interest rates is in percent per year. People willingly pay interest because borrowed funds allow them to buy goods and services to satisfy current consumption needs or make profitable investments.
3. Recall the menu of financial assets, especially money, bonds, and equities.
4. Study the *monetary transmission mechanism*. This refers to the process by which monetary policy undertaken by the central bank, our Federal Reserve, interacts with banks and the rest of the economy to determine interest rates, other financial conditions, aggregate

Eye Therapies Exhibit 2127, 494 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

demand, output, and inflation. Make sure you understand each of the five steps (page 453).

B. The Special Case of Money

5. Money is anything that serves as a commonly accepted medium of exchange, or a means of payment. Money also functions as a unit of account. Unlike other economic goods, money is valued because of social convention. We value money indirectly for what it buys, rather than for its direct utility. Money today is composed of currency and checking deposits and is denoted M_1.
6. People hold money primarily because they need it to pay their bills or buy goods; this is known as the transactions demand. But people keep only a small fraction of their assets in money because money has an opportunity cost: we sacrifice interest earnings when we hold money. Therefore, the asset demand for money is limited.

C. Banks and the Supply of Money

7. Banks are commercial enterprises that seek to earn profits for their owners. One major function of banks is to provide checking accounts to their customers. Banks are legally required to keep reserves on their checking deposits. These can be in the form of either vault cash or deposits at the Federal Reserve.
8. Under 100 percent reserves, banks cannot create money, as seen in the simplest goldsmith bank example. For illustrative purposes, we then examined a required reserve ratio of 10 percent. In this case, the banking system as a whole creates bank money in a ratio of 10 to 1 for each dollar of reserves. With fractional-reserve banking, the total value of checking deposits is a multiple of reserves. Remember the formula

$$\text{Bank money} = \text{total reserves} \times \left(\frac{1}{\text{reserve ratio}}\right)$$

D. The Stock Market

9. The most important factors about assets are the rate of return and the risk. The rate of return is the total dollar gain from a security over a specified period of time. Risk refers to the variability of the returns on an investment, often measured by the statistical standard deviation. Because people are risk-averse, they require higher returns to induce them to buy riskier assets.
10. Stock markets, of which the New York Stock Exchange is the most important, are places where titles of ownership to the largest companies are bought and sold. The history of stock prices is filled with violent gyrations, such as the Great Crash of 1929 or the sharp bear market of 2008. Trends are tracked using stock-price indexes, such as the Standard and Poor's 500 and the familiar Dow-Jones Industrial Average.
11. Modern economic theories of stock prices generally focus on the efficient-market theory. An "efficient" financial market is one in which all information is immediately absorbed by speculators and built into market prices. In efficient markets, there are no easy profits; looking at yesterday's news or at past patterns of prices or business cycles will not help predict future price movements. Thus, in efficient markets, prices respond to surprises. Because surprises are inherently random, stock prices and other speculative prices move erratically, as in a random walk.
12. Plant the five rules of personal finance firmly in your long-term memory: (*a*) Know thy investments. (*b*) Diversify, diversify—that is the law of the prophets of finance. (*c*) Consider common-stock index funds. (*d*) Minimize unnecessary expenses and taxes. And (*e*) Match your investments with your risk preference.

CONCEPTS FOR REVIEW

The Modern Financial System

financial system, financial markets, financial intermediaries
functions of the financial system
major financial assets or instruments
interest forgone as the cost of holding money

The Special Case of Money

Money (M_1) = currency outside the banks plus checking deposits
commodity *M*, paper *M*, bank *M*
motives for money demand: transactions demand (today) asset demand (in a fragile financial system)

Banking and the Money Supply

bank reserves = vault cash plus deposits with the Fed
fractional-reserve banking
bank money = reserves/required reserve ratio

The Stock Market

common stocks (corporate equities)
efficient market, random walk of stock prices
index fund
five rules for personal investing

Eye Therapies Exhibit 2127, 495 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

FURTHER READING AND INTERNET WEBSITES

Further Reading

There are many fine histories of money. A good one is John Kenneth Galbraith, *Money, Whence It Came, Where It Went* (Houghton, Boston, 1975). There are many good textbooks on monetary economics. The standard reference on U.S. monetary history is Milton Friedman and Anna Jacobson Schwartz, *Monetary History of the United States 1867–1960* (Princeton University Press, Princeton, N.J., 1963).

Modern capital and finance theory are very popular subjects often covered in the macroeconomics part of an introductory course or in special courses. Good books on the subject are Burton Malkiel, *A Random Walk down Wall Street,* 9th ed. (Norton, New York, 2007). A recent book surveying financial history and theory and arguing that the stock market was extraordinarily overvalued in the bull market of 1981–2000 is Robert Shiller, *Irrational Exuberance*, 2d ed. (Princeton University Press, Princeton, N.J., 2005). A recent summary of evidence on the efficient-market theory by Burton Malkiel and Robert Shiller is found in the *Journal of Economic Perspectives,* Winter 2003.

Websites

Review our list of good blogs in Chapter 19.

Basic data on money, interest rates, and monetary policy can be found at the website of the Federal Reserve, *www.federalreserve.gov.* Interesting articles on monetary policy can be found in the *Federal Reserve Bulletin* at *www.federalreserve.gov/publications.htm.* The best comprehensive data on finance are from the Federal Reserve flow of funds at *www.federalreserve.gov/releases/z1/.*

A good source for data on financial markets is *finance.yahoo.com.* If you are interested in the latest buzz on stocks, you might visit the Motley Fool at *www.fool.com.*

QUESTIONS FOR DISCUSSION

1. Suppose that banks hold 20 percent of deposits as reserves rather than 10 percent. Assuming that reserves are unchanged, redo the balance sheet in Table 23-7. What is the new ratio of bank deposits to reserves?
2. What would be the effect of each of the following on the money demand, M_1 (with other things held equal)?
   a. An increase in real GDP
   b. An increase in the price level
   c. A rise in the interest rate on savings accounts and Treasury securities
   d. A doubling of all prices, wages, and incomes (Calculate the exact effect on the money demand.)
   e. An increase in the interest rate banks pay on checking accounts
3. The implicit cost of checking accounts is equal to the difference between the yield on safe short-term assets (such as Treasury bills) and the interest rate on checking accounts. What are the impacts of the following on the opportunity cost of holding money in checking deposits?
   a. Before 1980 (when checking deposits had a zero interest rate under law), market interest rates increased from 8 to 9 percent.
   b. In 2007 (when interest rates on money were one-quarter of market interest rates), interest rates declined from 4 to 2 percent.
   c. How would you expect the demand for checking deposits to respond to the change in market interest rates under **a** and **b** if the elasticity of demand for money with respect to the implicit cost of money is -1?
4. Explain whether you think that each of the following should be counted as part of the money supply (M_1) of the United States: savings accounts, subway tokens, postage stamps, credit cards, debit cards, Starbucks cash cards, and $20 bills used by Russians in Moscow.
5. Explain why the best portfolio should not contain any money (use information from Section D of this chapter). How does the notion of the cost of holding money fit into your answer? Would your answer change if your checking account earned a return equal to that of risk-free investments?
6. According to the efficient-market theory, what effect would the following events have on the price of GM's stock?
   a. A surprise announcement that the government is going to lower business taxes next July 1
   b. A decrease in business taxes on July 1, 6 months after Congress passed the legislation

Eye Therapies Exhibit 2127, 496 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

c. An announcement, unexpected by experts, that the United States will impose quotas on imports of Chinese cars during the coming year

d. Implementation of **c** by issuing regulations on December 31

7. The Federal Reserve is scheduled to pay interest on bank reserves.

a. Suppose that the interest rate on reserves is 1 percentage point below market rates. Would banks still desire to minimize excess reserves? Would this affect the bank money equation in Summary point 8 above?

b. Suppose that the interest rate on reserves is equal to the market rate. How would your answer to **a** change?

c. Using your answer to **b,** can you see why the relationship between reserves and bank money becomes very loose when market interest rates are zero (the "liquidity trap")?

8. Suppose that one giant bank, the Humongous Bank of America, held all the checking deposits of all the people, subject to a 10 percent legal reserve requirement. If reserves increased by $1 billion, could the Humongous Bank expect to lend out more than 90 percent of the reserve increase, knowing that the new deposit must come back to it? Would this change the ultimate money-supply multiplier? Explain both answers.

9. **Advanced problem:** An *option* is the right to buy or sell an asset (stocks, bonds, foreign exchange, land, etc.) for a specified price on or before a specific date. A *call option* is the right to buy the stock, while a *put option* is the right to sell the stock. Suppose you have a call option to buy 100 shares in a highly volatile stock, Fantasia.com, at any time in the next 3 months at $10 per share. Fantasia currently sells at $9 per share.

a. Explain why the value of the option is more than $1 per share.

b. Suppose the option were to expire tomorrow and the price of Fantasia.com had an even chance of rising $5 or falling $5 before then. What would be the value of the option today?

c. Replace the figure "$5" with "$10" in **b**. What would happen to the value of the option? Explain why an increase in volatility *increases* the value of an option (other things unchanged).

10. This problem will illustrate the point that the prices of many speculative financial assets look like a random walk.

a. Flip a coin 100 times. Count a head as "plus 1" and a tail as "minus 1." Keep a running score of the total. Plot your results. This is a random walk. (This is easily accomplished on a computer with a program such as Excel, which contains a random-number generator and a graphics function.)

b. Next, keep track of the closing price of the stock of your favorite company for a few weeks, or get it online. Plot the price against time for each day. Compare the random numbers in **a** with your stock prices, or show them to a friend and ask the friend to spot the difference. If they look the same, this illustrates that stocks behave like a random walk.

Eye Therapies Exhibit 2127, 497 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

24

Monetary Policy and the Economy



There have been three great inventions since the beginning of time: fire, the wheel, and central banking.

Will Rogers

Where would you look to find the most important macroeconomic policymakers today? In the White House? In Congress? Perhaps in the United Nations or the World Bank? Surprisingly, the answer is that you would look in an obscure marble building in Washington that houses the Federal Reserve System. It is here that you will find the Federal Reserve (or "the Fed," as it is often called). The Fed determines the level of short-term interest rates and lends money to financial institutions, thereby profoundly affecting financial markets, wealth, output, employment, and prices. Indeed, the Fed's influence spreads not only throughout the 50 states but to virtually every corner of the world through financial and trade linkages.

The Federal Reserve's central goals are to ensure low inflation, steady growth in national output, low unemployment, and orderly financial markets. If output is growing rapidly and inflation is rising, the Federal Reserve Board is likely to raise interest rates, putting a brake on the economy and reducing price pressures.

The period 2007–2009 was a particularly challenging time for the Federal Reserve and other central banks. During this period, unsound investments and excessive leverage led to the deteriorating financial health of banks and other financial institutions. This in turn produced huge declines in stock and bond prices, "bank runs," and the failures of several large banks. The Federal Reserve, the European Central Bank, and U.S. and foreign governments provided *trillions* of dollars of loans, loan guarantees, nationalizations, and bailouts. All of these were designed to prevent the seizing up of financial markets and to reduce the severity of the ensuing recession.

Every country has a central bank that is responsible for managing the country's monetary affairs. This chapter begins by explaining the objectives and organization of central banks, focusing on the U.S. Federal Reserve System. It explains how the Fed operates and describes the monetary transmission mechanism. The second section of the chapter then surveys some of the major issues in monetary policy.

A. CENTRAL BANKING AND THE FEDERAL RESERVE SYSTEM

We begin this section by providing an overview of central banking. The next section provides the details about the different tools employed by the central bank and explains how they can be used to affect short-term interest rates.

Eye Therapies Exhibit 2127, 498 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

THE ESSENTIAL ELEMENTS OF CENTRAL BANKING

A central bank is a government organization that is primarily responsible for the monetary affairs of a country. In this section, we focus on the U.S. Federal Reserve System. We describe its history, objectives, and functions.

History

During the nineteenth century, the United States was plagued by banking panics. These occurred when large numbers of people attempted to convert their bank deposits into currency all at the same time. When people arrived at the banks, they found that there was insufficient currency to cover everybody's deposits because of the system of fractional reserves. Bank failures and economic downturns often ensued. After the severe panic of 1907, agitation and discussion led to the Federal Reserve Act of 1913, whose purpose was "to provide for the establishment of Federal reserve banks, to furnish an elastic currency, to afford means of rediscounting commercial paper, to establish a more effective supervision of banking in the United States, and for other purposes." That was the beginning of the Fed.

Structure

As currently constituted, the **Federal Reserve System** consists of the Board of Governors in Washington, D.C., and the regional Reserve Banks. The core of the Federal Reserve is the *Board of Governors,* which consists of seven members nominated by the president and confirmed by the Senate to serve overlapping terms of 14 years. Members of the board are generally economists or bankers who work full time at the job.

Additionally, there are 12 regional Federal Reserve Banks, located in New York, Chicago, Richmond, Dallas, San Francisco, and other major cities. The regional structure was originally designed in the populist age to ensure that different areas of the country would have an equal voice in banking matters and to avoid a great concentration of central-banking powers in Washington or in the hands of the Eastern bankers. Today, the Federal Reserve Banks supervise banks in their districts, operate the national payments system, and participate in the making of national monetary policy.

The key decision-making body in the Federal Reserve System is the *Federal Open Market Committee* (FOMC). The 12 voting members of the FOMC include the seven governors plus five of the presidents of the regional Federal Reserve Banks who serve as voting members on a rotating basis. This key group controls the most important tool used in monetary policy: the setting of the short-term interest rate.

At the pinnacle of the entire system is the *chair of the Board of Governors.* The chair is nominated by the president and confirmed by the Senate for renewable four-year terms. The chair presides over the Board of Governors and the FOMC, acts as the public spokesperson for the Fed, and exercises enormous power over monetary policy. The current chair is Ben Bernanke, who was a distinguished academic economist, a professor of economics at Princeton University, as well as a former Fed governor before he was appointed chair in 2006. Bernanke succeeded Alan Greenspan, a conservative business economist who became an iconic figure in American economic affairs during his long term as Fed chair (1987–2006).

In spite of the geographically dispersed structure of the Fed, the Fed's power is actually quite centralized. The Federal Reserve Board, joined at meetings by the presidents of the 12 regional Federal Reserve Banks, operates under the Fed chair to formulate and carry out monetary policy. The structure of the Federal Reserve System is shown in Figure 24-1.

Goals of Central Banks

Before focusing primarily on the U.S. system, we discuss briefly the goals of central banks around the world. We can distinguish three different general approaches of central banks:

- *Multiple objectives.* Many central banks have general goals, such as to maintain economic stability. Among the specific objectives pursued might be low and stable inflation, low unemployment, rapid economic growth, coordination with fiscal policy, and a stable exchange rate.
- *Inflation targeting.* In recent years, many countries have adopted explicit inflation targets. Under such a mandate, the central bank is directed to undertake its policies so as to ensure that inflation stays within a range that is generally low but positive. For example, the Bank of England has

Eye Therapies Exhibit 2127, 499 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

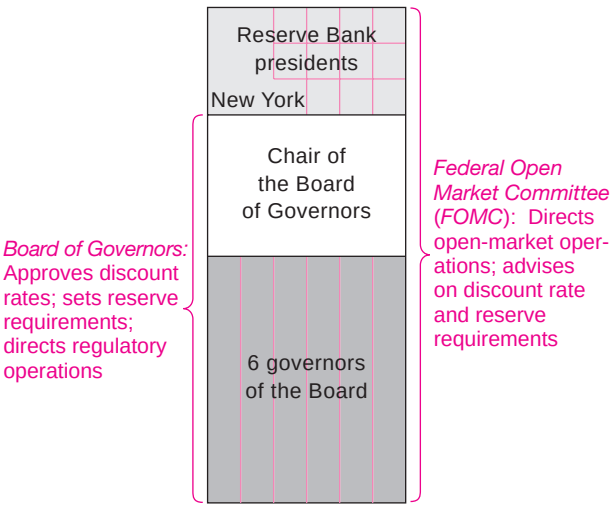


FIGURE 24-1. The Major Players in Monetary Policy

Two important committees are at the center of monetary policy. The seven-member Board of Governors approves changes in discount rates and sets reserve requirements. The FOMC directs the setting of bank reserves. The chair of the Board of Governors heads both committees. The size of each box indicates that person's or group's relative power; note the size of the chair's box.

been directed to set monetary policy to maintain a 2 percent annual inflation rate.

- *Exchange-rate targeting.* In a situation where a country has a fixed exchange rate and open financial markets, it can no longer conduct an independent monetary policy, as we will see in our chapters on open-economy macroeconomics. In such a case, the central bank can be described as setting its monetary policy to attain an exchange-rate target.

The Federal Reserve falls into the first category, that of "multiple objectives." Under the Federal Reserve Act, the Fed is directed "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Today this is interpreted as a dual mandate to maintain low and stable inflation along with a healthy real economy. This is how the Fed sees its role today:

> [The Federal Reserve's] objectives include economic growth in line with the economy's potential to expand; a high level of employment; stable prices (that is, stability in the purchasing power of the dollar); and moderate long-term interest rates.[1]

Functions of the Federal Reserve

The Federal Reserve has four major functions:

- Conducting monetary policy by setting short-term interest rates
- Maintaining the stability of the financial system and containing systemic risk as the lender of last resort
- Supervising and regulating banking institutions
- Providing financial services to banks and the government

We will primarily examine the first two of these functions because they have the most important impact on macroeconomic activity.

Central-Bank Independence

On examining the structure of the Fed, you might naturally ask, "In which of the three branches of government does the Fed lie?" The answer is interesting. Although nominally a corporation owned by the commercial banks that are members of the Federal Reserve System, the Federal Reserve is in practice a public agency. It is directly responsible to Congress; it attends to the advice of the president; and whenever any conflict arises between making a profit and promoting the public interest, it acts unswervingly in the public interest.

Above all, the Federal Reserve is an *independent* agency. While it consults with Congress and the president, in the end the Fed decides monetary policy according to its own views about the nation's economic interests. As a result, the Fed sometimes comes into conflict with the executive branch. Almost every president has words of advice for the Fed. When Fed policies clash with the administration's goals, presidents occasionally use harsh words. The Fed listens politely but generally chooses the path it deems best for the country, for its decisions do not have to be approved by anybody.

From time to time, critics argue that the Fed is too independent—that it is undemocratic for a small group of unelected people to govern the nation's

[1] See *The Federal Reserve System: Purposes and Functions*, p. 2, under "Websites" in this chapter's Further Reading section.

Eye Therapies Exhibit 2127, 500 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

financial markets. This is a sobering thought, for unelected bodies sometimes lose touch with social and economic realities.

Defenders of the Fed's independence respond that an independent central bank is the guardian of a nation's currency and the best protector against rampant inflation. Moreover, independence ensures that monetary policy is not subverted for partisan political objectives, as sometimes happens in countries where the executive branch controls the central bank. Historical studies show that countries with independent central banks have generally been more successful in keeping inflation down than have those whose central banks are under the control of elected officials.

To summarize:

Every modern country has a central bank. The U.S. central bank is composed of the Federal Reserve Board in Washington, together with the 12 regional Federal Reserve Banks. The Fed's primary mission is to conduct the nation's monetary policy by influencing monetary and credit conditions in pursuit of low inflation, high employment, and stable financial markets.

HOW THE CENTRAL BANK DETERMINES SHORT-TERM INTEREST RATES

Central banks are at the center stage of macroeconomics because they largely determine short-term interest rates. We now turn to an explanation of this function.

Overview of the Fed's Operations

The Federal Reserve conducts its policy through changes in an important short-term interest rate called the **federal funds rate.** This is the interest rate that banks charge each other to trade reserve balances at the Fed. It is a short-term (overnight) risk-free interest rate in U.S. dollars. The Fed controls the federal funds rate by exercising control over the following important instruments of monetary policy:

- *Open-market operations*—buying or selling U.S. government securities in the open market to influence the level of bank reserves
- *Discount-window lending*—setting the interest rate, called the *discount rate,* and the collateral requirements with which commercial banks, other depository institutions, and, more recently, primary dealers can borrow from the Fed
- *Reserve-requirements policy*—setting and changing the legal reserve-ratio requirements on deposits with banks and other financial institutions

The basic description of monetary policy is this: When economic conditions change, the Fed determines whether the economy is departing from the desired path of inflation, output, and other goals. If so, the Fed announces a change in its target interest rate, the federal funds rate. To implement this change, the Fed undertakes open-market operations and changes the discount rate. These changes then cascade through the entire spectrum of interest rates and asset prices, and eventually change the overall direction of the economy.

Balance Sheet of the Federal Reserve Banks

To understand how the Fed conducts monetary policy, we first need to describe the consolidated balance sheet of the Federal Reserve System, shown in Table 24-1. U.S. government securities (e.g., bonds) have historically been the bulk of the Fed's assets. Starting in 2007, the Fed extended its operations to include term auctions, dealer credit, and loan guarantees, which by 2008 constituted a substantial fraction of its assets. The exact composition of the balance sheet is not essential for our understanding of how the Fed normally determines interest rates.

There are two unique items among the Fed's liabilities: currency and reserves. *Currency* is the Fed's principal liability. This item comprises the coins and the paper bills we use every day. The other major liability is reserve balances of banks, which are balances kept on deposit by commercial banks. These deposits, along with the banks' vault cash, are designated as **bank reserves.**

The following is our plan for the remainder of this section: First, we explain in more detail the three instruments that the Fed uses to conduct monetary policy. We will show how the supply of reserves is determined through a combination of announcements, open-market operations, and

Eye Therapies Exhibit 2127, 501 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Combined Balance Sheet of 12 Federal Reserve Banks, September 2008 (billions of dollars)

Assets		Liabilities and Net Worth	
U.S. government securities	$479.8	Federal Reserve currency	$832.4
Loans, auction credits, and repurchase agreements	322.5	Deposits:	
		Reserve balances of banks	**47.0**
Miscellaneous other assets	181.0	Other deposits	14.4
		Miscellaneous liabilities	89.5
Total	$983.3	Total	$983.3

TABLE 24-1. By Changing Its Balance Sheet, the Fed Determines Short-Term Interest Rates and Credit Conditions

By buying and selling its assets (government securities and repurchase agreements), the Fed controls its liabilities (bank deposits and Federal Reserve notes). The Fed determines the federal funds interest rate by changing the volume of reserves and thereby affects GDP, unemployment, and inflation.

Source: Federal Reserve Board, at *www.federalreserve.gov/releases/h41.*

discount-window policy. Then, we show how short-term interest rates are determined, with the most important factor being the Fed's control over the supply of reserves.

Operating Procedures

The FOMC meets eight times a year to decide upon monetary policy and give operating instructions to the Federal Reserve Bank of New York, which conducts open-market operations on a day-to-day basis.

Today, the Fed operates primarily by setting a short-term target for the *federal funds rate,* which is the interest rate that banks pay each other for the overnight use of bank reserves. Figure 24-2 shows the federal funds rate for recent years along with shaded areas for recessions. You can see how the Fed tends to lower interest rates before recessions and raise them as the economy enters expansions. If you look back to Figure 15-2 on p. 289, you can see how other interest rates tend to move along with the federal funds rate. The linkage is not a tight one, however. While the Fed sets the general level and trend in interest rates, there are many other factors at work in determining interest rates and financial conditions, as evidenced by the fact that interest rates sometime move in different directions.

HOW THE FEDERAL RESERVE AFFECTS BANK RESERVES

The most important element of monetary policy is the determination of bank reserves through Fed policy. This is an intricate process and requires careful study. Through the combination of reserve requirements, open-market operations, and discount-window policy, the Fed can normally determine the quantity of bank reserves within very narrow limits. We start with a review of the nuts and bolts of these major policy instruments.

Open-Market Operations

Open-market operations are a central bank's primary tool for implementing monetary policy. These are activities whereby the Fed affects bank reserves by buying or selling government securities on the open market.

How does the Fed decide how much to buy or sell? The Fed looks at the factors underlying reserve demand and supply and determines whether those trends are consistent with its target for the federal funds rate. On the basis of this forecast, the Fed will buy or sell a quantity of government securities that will help keep the funds rate near the target.

Suppose that, on the basis of its forecasts, the Fed desires to sell $1 billion worth of securities. The Fed

Eye Therapies Exhibit 2127, 502 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

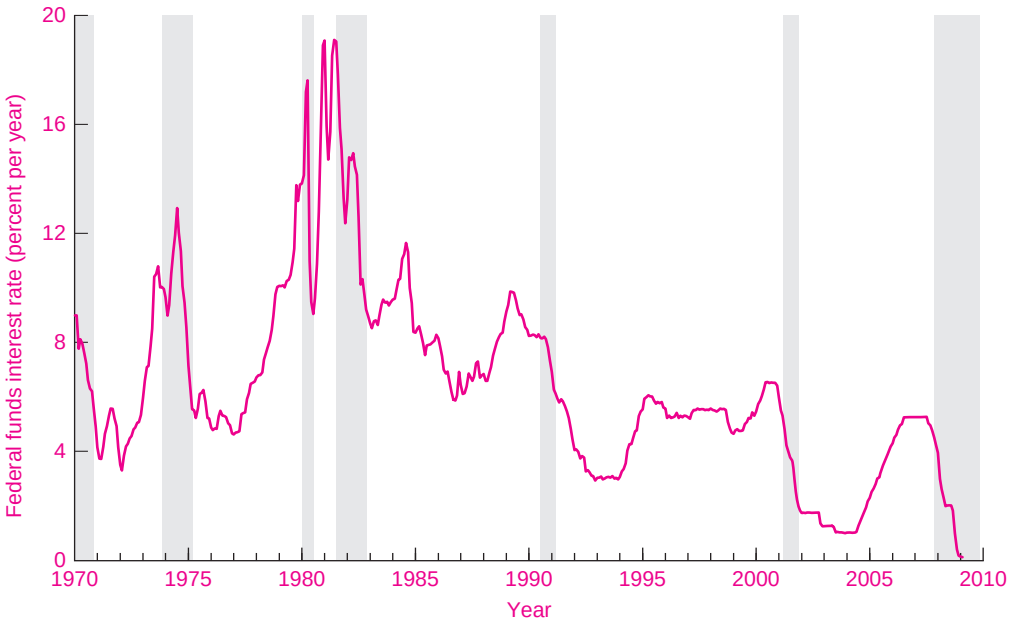


FIGURE 24-2. Federal Reserve Determines the Federal Funds Rate

The Fed sets a target for the federal funds rate, which is the interest rate charged by banks for lending reserves to each other. This rate then affects all other interest rates, although the linkage is variable and is affected by expectations of future interest rates as well as by overall financial conditions. (Look at Figure 15-2 for a graph of other major interest rates.) Note how the federal funds rate approached zero at the end of 2008 as the economy entered a liquidity trap.

Source: Federal Reserve Board.

conducts open-market operations with primary dealers, which include about 20 large banks and securities broker-dealers such as Goldman-Sachs and J.P. Morgan. The dealers would buy the securities, drawing upon accounts at the Federal Reserve. After the sale, the total deposits at the Fed would decline by $1 billion. *The net effect would be that the banking system loses $1 billion in reserves.*

Table 24-2(*a*) shows the effect of a $1 billion open-market sale on a hypothetical Federal Reserve balance sheet. The blue entries show the Fed balance sheet before the open-market operation. The green entries show the effect of the open-market sale. The net effect is a $1 billion reduction in both assets and liabilities. The Fed's assets decreased with the $1 billion sale of government bonds, and its liabilities decreased by exactly the same amount, with the corresponding $1 billion decrease in bank reserves.

Now focus on the impact this has on commercial banks, whose consolidated balance sheet is shown in Table 24-2(*b*). We assume that commercial banks hold 10 percent of their deposits as reserves with the central bank. After the open-market operation, banks see that they are short of reserves because they have lost $1 billion of reserves but only lost $1 billion of deposits. The banks must then sell some of their investments and call in some short-term loans to meet the legal reserve requirement. This sets off a multiple contraction of deposits. When the entire chain of impacts has unfolded, deposits are down by $10 billion, with corresponding changes on the asset

Eye Therapies Exhibit 2127, 503 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Federal Reserve Balance Sheet (billions of dollars)

Assets		Liabilities	
Securities	500 –1	Currency held by public	410
Loans	10	Bank reserves	100 –1
Total assets	**510 –1**	**Total liabilities**	**510 –1**

TABLE 24-2(a). Open-Market Sale by Fed Cuts Bank Reserves

Balance Sheet of Commercial Banks (billions of dollars)

Assets		Liabilities	
Reserves	100 –1	Demand deposits	1000 –10
Loans and investments	900 –9		
Total assets	**1000 –10**	**Total liabilities**	**1000 –10**

TABLE 24-2(b). Decline in Reserves Leads Banks to Reduce Loans and Investments until Money Supply Is Cut by 10-to-1 Ratio

The central bank sells securities to reduce reserves in order to raise interest rates toward its target.

In **(a),** the Fed sells $1 billion worth of securities on the open market. When dealers pay for the securities, this reduces reserves by $1 billion.

Then, in **(b),** we see the effect of the open-market operation on the balance sheet of the commercial banks. With a reserve-requirement ratio of 10 percent of deposits, banks must reduce loans and investments. The net effect will be to tighten money and raise interest rates.

side of the banks' balance sheet [look carefully at the green entries in Table 24-2(*b*)].

This contraction of loans and investments will tend to raise interest rates. If the Fed has forecast correctly, the interest rate will move to the Fed's new target.

But if it has forecast incorrectly, what should the Fed do? Simply make another adjustment by buying or selling reserves the next day!

Discount-Window Policy: A Backstop for Open-Market Operations

The Fed has a second set of instruments that it can use to meet its targets. The discount window is a facility from which banks, and more recently primary dealers, can borrow when they need additional funds. The Fed charges a "discount rate" on borrowed funds, although the discount rate will vary slightly among different uses and institutions. Generally, the primary discount rate is ¼ to ½ of a percentage point above the target federal funds rate.

The discount window serves two purposes. It complements open-market operations by making reserves available when they are needed on short notice. It also serves as a backstop source of liquidity for institutions when credit conditions may suddenly become tight.

Until very recently, the discount window was seldom used. In the credit crisis of 2007–2009, the Federal Reserve opened the discount window so that banks could borrow when their customers became nervous and demanded immediate withdrawals. During this period, in order to provide more liquidity to a nervous financial market, the Fed enlarged the scope of its lending capacities in several ways. The Fed broadened its definition of allowable collateral, added primary dealers to the list of institutions eligible to borrow at the discount window, put guarantees on shaky securities to help prop up failing banks, and purchased private commercial paper from nonbank entities. All these steps were intended to reduce fears that financial institutions would be unable to pay off their obligations and that the financial system would freeze up and credit would become unavailable to businesses and households.

Lender of Last Resort. Financial intermediaries like banks are inherently unstable because, as we have seen, their liabilities are short-term and subject to

Eye Therapies Exhibit 2127, 504 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

rapid withdrawal while their assets are often long-term and even illiquid. From time to time, banks and other financial institutions cannot meet their obligations to their customers. Perhaps there are seasonal needs for cash, or perhaps, even more ominously, depositors may lose faith in their banks and withdraw their deposits all at once. In this situation, when the bank has run out of liquid assets and lines of credit, a central bank may step in to be the *lender of last resort*. This function was well described by former Fed chair Alan Greenspan:

> [If] we choose to enjoy the advantages of a system of leveraged financial intermediaries, the burden of managing risk in the financial system will not lie with the private sector alone. Leveraging always carries with it the remote possibility of a chain reaction, a cascading sequence of defaults that will culminate in financial implosion if it proceeds unchecked. Only a central bank, with its unlimited power to create money, can with a high probability thwart such a process before it becomes destructive. Hence, central banks have, of necessity, been drawn into becoming lenders of last resort.

Today the discount window is used primarily to ensure that money markets are operating smoothly. It provides additional liquidity, and it is also the place to which banks can turn when they need a lender of last resort.

The Role of Reserve Requirements

The Nature of Reserves. The previous chapter showed the relationship between bank reserves and bank money. In a free-market banking system, prudent bankers would always need to hold some reserves on hand. They would need to keep a small fraction of their deposits in cash to pay out to depositors who desired to convert their deposits to currency or who wrote checks drawn on their accounts.

Many years ago, bankers recognized that, although deposits are payable on demand, they are seldom all withdrawn together. It would be necessary to hold reserves equal to total deposits if all depositors suddenly wanted to be paid off in full at the same time, but this almost never occurred. On any given day, some people made withdrawals while others made deposits. These two kinds of transactions generally canceled each other out.

Early bankers did not need to keep 100 percent of deposits as sterile reserves; reserves earned no interest when they were sitting in a vault. Banks quickly hit upon the idea of finding profitable investments for their excess deposits. By putting most of the money deposited with them into interest-bearing assets and keeping only fractional cash reserves, banks could maximize their profits.

The transformation into fractional-reserve banks—holding fractional rather than 100 percent reserves against deposits—was in fact revolutionary. It led to the leveraged financial institutions that dominate our financial system today.

Legal Reserve Requirements. In the nineteenth century, banks sometimes had insufficient reserves to meet depositors' demands, and these occasionally spiraled into bank crises. Therefore, beginning at that time, and currently formalized under Federal Reserve regulations, banks were required to keep a certain fraction of their checking deposits (the Fed uses the technical term "checkable deposits") as reserves. In an earlier period, reserve requirements were an important part of controlling the quantity of money (as discussed later in this chapter). In today's environment, where the Fed primarily targets interest rates, reserve requirements are a relatively unimportant instrument of monetary policy.

Reserve requirements apply to all types of checking deposits. Under Federal Reserve regulations, banks are required to hold a fixed fraction of their checking deposits as reserves. This fraction is called the **required reserve ratio.** Bank reserves take the form of vault cash (bank holdings of currency) and deposits by banks with the Federal Reserve System.

Table 24-3 shows current reserve requirements along with the Fed's discretionary power to change these requirements. The key concept is the level of required reserve ratios. They currently range from 10 percent against checking deposits down to zero for personal savings accounts. For convenience in our numerical examples, we use 10 percent reserve ratios, with the understanding that the actual ratio may differ from time to time.

In normal times, the level of required reserves is generally higher than what banks would voluntarily hold. These high requirements serve primarily to ensure that the demand for reserves is relatively

Eye Therapies Exhibit 2127, 505 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Type of deposit	Reserve ratio (%)	Range in which Fed can vary (%)
Checking (transactions) accounts:		
$0–$44 million	3	No change allowed
Above $44 million	10	8–14
Time and savings deposits:		
Personal	0	
Nonpersonal:		
Up to 1½ years' maturity	0	0–9
More than 1½ years' maturity	0	0–9

TABLE 24-3. Required Reserves for Financial Institutions

Reserve requirements are governed by law and regulation. The reserve-ratio column shows the percent of deposits in each category that must be held in non-interest-bearing deposits at the Fed or as cash on hand. Checking accounts in large banks face a required reserve ratio of 10 percent, while other major deposits have no reserve requirements. The Fed has power to alter the reserve ratio within a given range but does so only on the rare occasion when economic conditions warrant a sharp change in monetary policy.

Source: *Federal Reserve Bulletin*, March 2008.

predictable so that the Fed can have more precise control over the federal funds rate.

The Fed began to pay interest on bank reserves in 2008. The idea was that the interest rate on reserves would serve as a floor under the federal funds rate, thereby allowing better control over the federal funds rate. For example, if the target federal funds rate is 3½ percent, while the interest rate on reserves is 3 percent and the discount rate is 4 percent, then the federal funds rate will effectively be constrained between 3 and 4 percent, and the Fed can more easily attain its target. The financial environment took an unusual turn during the financial crisis of 2007–2009 as the economy entered a "liquidity trap." We return to this point briefly later in this chapter.

Determination of the Federal Funds Rate

Now that we have surveyed the basic instruments, we can analyze how the Fed determines short-term interest rates. The basic operation is shown in Figure 24-3. This shows the demand for and supply of bank reserves.

First, consider the demand for bank reserves. As we saw in the last chapter, banks are required to hold reserves as determined by the total value of their checking deposits and the required reserve ratio. Because the demand for checking deposits is an inverse function of the interest rate, this implies that the demand for bank reserves will also decline as interest rates rise. This is what lies behind the downward-sloping D_RD_R curve in Figure 24-3.

Next, we need to consider the supply of reserves. This is determined by open-market operations. By purchasing and selling securities, the Fed controls the level of reserves in the system. A purchase of securities by the Fed increases the supply of bank reserves, while a sale does the opposite.

The equilibrium federal funds interest rate is determined where desired supply and demand are equal. The important insight here is that the Fed can achieve its target through the judicious purchase and sale of securities—that is, through open-market operations.

But Figure 24-3 shows only the very short run supply and demand. Because the Fed intervenes in the market daily, and because market participants know the Fed's interest-rate target, the Fed can keep the federal funds rate close to its target. Figure 24-4 shows supply and demand over the period of a month or more. The central bank in essence provides a perfectly elastic supply of reserves at the target federal funds rate. This shows how the Fed achieves its funds target on a week-to-week and month-to-month basis.

Eye Therapies Exhibit 2127, 506 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

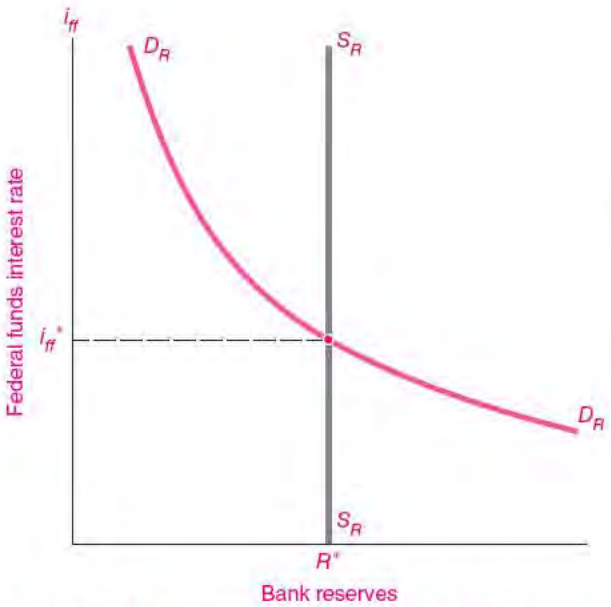


FIGURE 24-3. Supply of and Demand for Bank Reserves Determine the Federal Funds Rate

The demand for bank reserves declines as interest rates rise, reflecting that checking deposits decline as lower interest rates increase money demand. The Fed has a target interest rate at i_{ff}^*. By supplying the appropriate quantity of reserves at R^* through open-market operations, the Fed achieves its target.

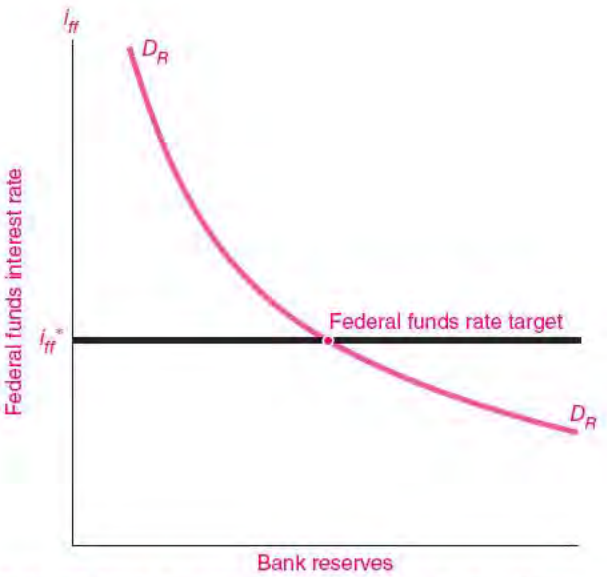


FIGURE 24-4. By Constant Intervention the Fed Can Achieve Its Interest-Rate Target

Because the Fed intervenes daily, undertaking open-market operations as illustrated in Figure 24-3, it can achieve its target with a narrow margin.

The federal funds rate, which is the most important short-term interest rate in the market, is determined by the supply of and demand for bank reserves. By constantly monitoring the market and providing or removing reserves as needed through open-market operations, the Federal Reserve can ensure that short-term interest rates stay very close to its target.

B. THE MONETARY TRANSMISSION MECHANISM

A Summary Statement

Having examined the building blocks of monetary theory, we now describe the **monetary transmission mechanism,** the route by which monetary policy affects output, employment, prices, and inflation. We sketched the mechanism at the beginning of the previous chapter, and now we describe the mechanism in greater detail.

1. *The central bank raises the interest-rate target.* The central bank announces a target short-term interest rate chosen in light of its objectives and the state of the economy. The Fed may also change the discount rate and the terms of its lending facilities. These decisions are based on current economic conditions, particularly inflation, output growth, employment, and financial conditions.
2. *The central bank undertakes open-market operations.* The central bank undertakes daily open-market operations to meet its federal funds target. If the Fed wished to slow the economy, it would sell securities, thereby reducing reserves and raising short-term interest rates; if a recession threatened, the Fed would buy securities, increasing the supply of reserves and lowering short-term interest rates. Through open-market operations,

Eye Therapies Exhibit 2127, 507 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the Fed keeps the short-term interest rate close to its target on average.

3. *Asset markets react to the policy changes.* As the short-term interest rate changes, given expectations about future financial conditions, banks adjust their loans and investments, as well as their interest rates and credit terms. Changes in current and expected future short-term interest rates, along with other financial and macroeconomic influences, determine the entire spectrum of longer-term interest rates. Higher interest rates tend to reduce asset prices (such as those of stocks, bonds, and houses). Higher interest rates also tend to raise foreign-exchange rates in a flexible-exchange-rate system.
4. *Investment and other spending react to interest-rate changes.* Suppose the Fed has raised interest rates to reduce inflation. The combination of higher interest rates, tighter credit, lower wealth, and a higher exchange rate tends to reduce investment, consumption, and net exports. Businesses scale down their investment plans. Similarly, when mortgage interest rates rise, people may postpone buying a house, lowering housing investment. In addition, in an open economy, the higher foreign-exchange rate of the dollar will depress net exports. Hence, tight money will reduce spending on interest-sensitive components of aggregate demand.
5. *Monetary policy will ultimately affect output and price inflation.* The aggregate supply-and-demand analysis (or, equivalently, the multiplier analysis) showed how changes in investment and other autonomous spending affect output and employment. If the Fed tightens money and credit, the decline in *AD* will lower output and cause prices to rise less rapidly, thereby curbing inflationary forces.

We can summarize the steps as follows:

Change in monetary policy
→ change in interest rates, asset prices, exchange rates
→ impact on *I, C, X*
→ effect on *AD*
→ effect on *Q, P*

Make sure you understand this important sequence from the central bank's change in its interest-rate target to the ultimate effect on output and prices. We have discussed the first steps of the sequence in depth, and we now follow through by exploring the effect on the overall economy.

The Effect of Changes in Monetary Policy on Output

We close with a graphical analysis of the monetary transmission mechanism.

Interest Rates and the Demand for Investment. We can track the first part of the mechanism in Figure 24-5. This diagram puts together two diagrams we have met before: the supply of and demand for reserves in (*a*) and the demand for investment in (*b*). We have simplified our analysis by assuming that there is no inflation, no taxes, and no risk, with the result that the federal funds interest rate in (*a*) is the same as the cost of capital paid by business and residential investors in (*b*). In this simplified situation, the real interest rate (r) equals the central bank's interest rate (i_{ff}). Monetary policy leads to interest rate r^*, which then leads to the corresponding level of investment I^*.

Next, consider what happens when economic conditions change. Suppose that economic conditions deteriorate. This could be the result of a decline in military spending after a war, or the result of a decline in investment due to the burst of a bubble, or the result of a collapse in consumer confidence after a terrorist attack. The Fed would examine economic conditions and determine that it should lower short-term interest rates through open-market purchases. This would lead to the downward shift in interest rates from r^* to r^{**} shown in Figure 24-6(*a*).

The next step in the sequence would be the reaction of investment, shown in Figure 24-6(*b*). As interest rates decline *and holding other things constant,* the demand for investment would increase from I^* to I^{**}. (We emphasize the point about holding other things constant because this diagram shows the shift relative to what would otherwise occur. Taking into account that other things *are* changing, we might see a fall in *actual* investment. However, the monetary shift indicates that investment would fall less with the policy than without it.)

Changes in Investment and Output. The final link in the mechanism is the impact on aggregate demand,

Eye Therapies Exhibit 2127, 508 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

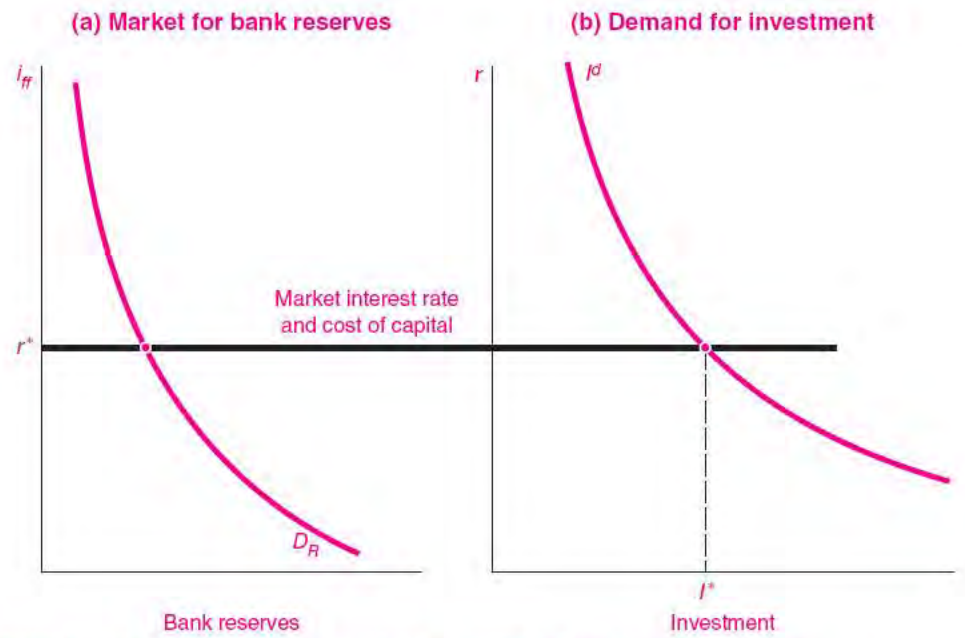


FIGURE 24-5. Interest Rate Determines Business and Residential Investment

This figure shows the linkage between monetary policy and the real economy. (**a**) The Fed uses open-market operations to determine short-term interest rates. (**b**) Assuming no inflation or risk, the interest rate determines the cost of business and residential investment; that is, $r = i_{ff}$. Total investment, which is the most interest-sensitive component of *AD*, can be found at I^*.

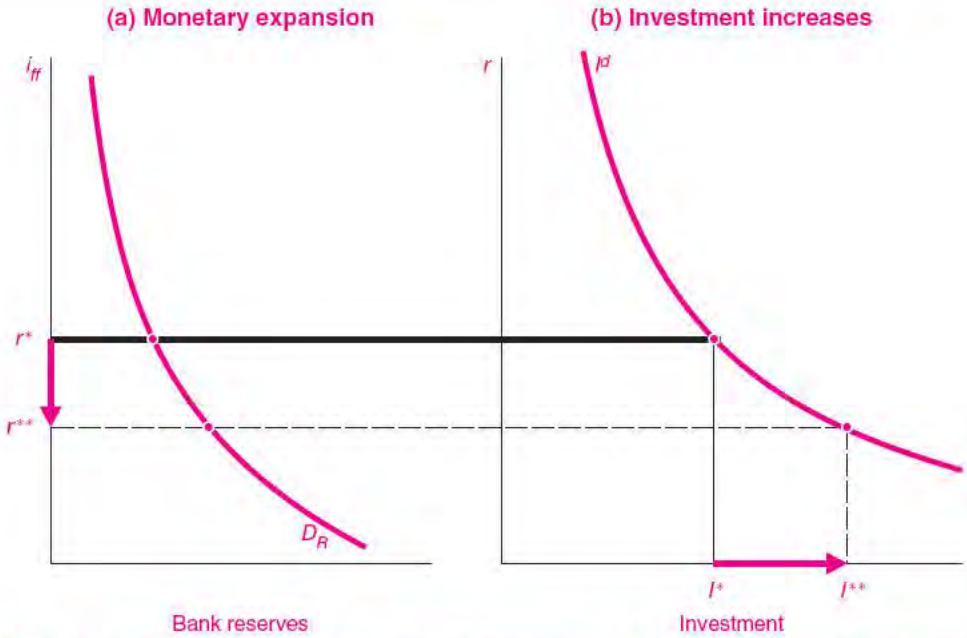


FIGURE 24-6. Monetary Expansion Leads to Lower Interest Rates and Increased Investment

Suppose that the economy weakens, as happened in 2007–2008. (**a**) The Fed buys securities and increases reserves, lowering the interest rate. (**b**) The effect (other things held constant) is that the lower interest rate raises asset prices and stimulates business and residential investment. See how investment rises from I^* to I^{**}.

Eye Therapies Exhibit 2127, 509 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

as shown in Figure 24-7. This is the same diagram we used to illustrate the multiplier mechanism in Chapter 22. We have shown the $C + I + G$ curve of total expenditure as a function of total output on the horizontal axis. With the original interest rate r^*, output is at the depressed level Q^* before the central bank undertakes its expansionary policy.

Next, assume that the Fed takes steps to lower market interest rates, as shown in Figure 24-6. The lower interest rates increase investment from I^* to I^{**}. This is illustrated in Figure 24-7 as an upward shift in the total expenditure line to $C + I(r^{**}) + G$. The result is a higher total output at Q^{**}. This diagram shows how the sequence of monetary steps has led to higher output, just as the Fed desired in the face of deteriorating economic conditions.

This graphical device is oversimplified. It omits many other contributions to changes in aggregate demand, such as the impact of monetary policy on wealth and consequently on consumption, the effect of exchange rates on foreign trade, and the direct effect of credit conditions on spending. Additionally, we have not yet fully described how monetary policy affects inflation. Nevertheless, this simple graph illustrates the essence of the monetary transmission mechanism.

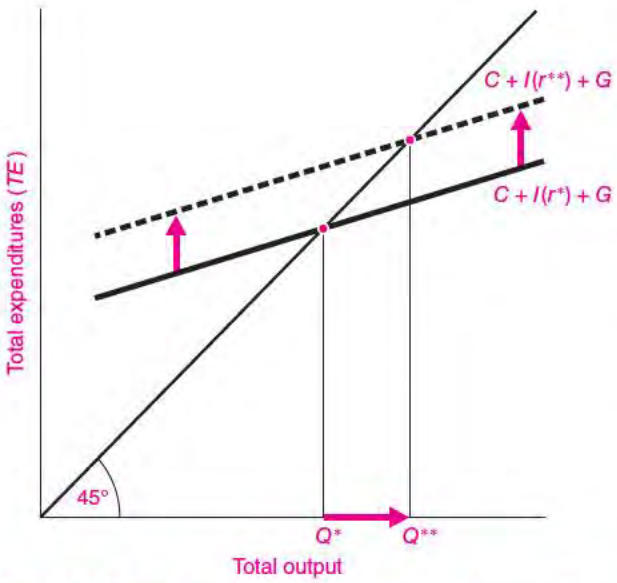


FIGURE 24-7. Monetary Expansion Lowers Interest Rate and Increases Output

As interest rates decline from r^* to r^{**}, then (other things held constant) investment increases from $I(r^*)$ to $I(r^{**})$. This increase shifts up the aggregate demand $C + I + G$ curve of total expenditure, and output increases from Q^* to Q^{**}. This completes the monetary transmission mechanism.

Monetary policy uses open-market operations and other instruments to affect short-term interest rates. These short-term interest rates then interact with other economic influences to affect other interest rates and asset prices. By affecting interest-sensitive spending, such as business and residential investment, monetary policy helps control output, employment, and price inflation.

The Challenge of a Liquidity Trap

One of the greatest challenges for a central bank arises as nominal interest rates approach zero. This is referred to as the **liquidity trap.** Such a situation occurred in the Great Depression of the 1930s and then again in 2008–2009 in the United States.

When short-term safe interest rates are zero, short-term safe securities are equivalent to money. The demand for money becomes infinitely elastic with respect to the interest rate. In this situation, banks have no reason to economize on their reserve holdings; they get essentially the same interest rates on reserves as on riskless short-term investments. For example, in early 2009, banks could earn 0.10 percent annually on reserves and 0.12 percent on Treasury bills.

Central bank open-market operations therefore have little or no impact upon interest rates and financial markets. Instead, when the Fed purchases securities, the banks just increase their excess reserves. This syndrome appeared with a vengeance in 2008–2009 as excess reserves rose from a normal level of $1 billion to over $900 billion. In essence, banks were using the Fed as a safe deposit box for their funds! (Make sure you understand why open-market operations are ineffective in a liquidity trap.) Because the Fed cannot lower short-term interest rates, it is unable to use the normal monetary transmission mechanism to stimulate the economy in a liquidity trap.

If the central bank cannot lower short-term interest rates below zero, what other steps can it take to stimulate a depressed economy? This was

Eye Therapies Exhibit 2127, 510 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the dilemma that the Fed faced in early 2009. One step would be to attempt to lower *long-term interest rates*. This would require that the central bank purchase long-term bonds instead of focusing on short-term securities, which is its usual practice. A second step would be to *reduce the risk premium on risky securities*. Acting with the U.S. Treasury, the Fed has been taking forceful steps in this direction since the early stages of the 2007–2009 credit crisis. The steps included buying distressed assets, opening the discount window to non-bank financial institutions, buying commercial paper, and lending against a wide range of private financial assets. The purpose of these steps was to improve liquidity and increase the availability of credit in financial markets. An excellent review of the Fed's activities during this period is contained in a 2009 speech by Fed chair Bernanke cited in the Further Readings section at the end of this chapter.

Monetary Policy in the AS-AD Framework

Figures 24-5, 24-6, and 24-7 illustrate how a change in monetary policy could lead to an increase in aggregate demand. We can now show the effect of such an increase on the overall macroeconomic equilibrium by using aggregate supply and aggregate demand curves.

The increase in aggregate demand produced by a monetary expansion is shown as a rightward shift of the *AD* curve, as drawn in Figure 24-8. This shift illustrates a monetary expansion in the presence of unemployed resources, with a relatively flat *AS* curve. The monetary expansion shifts aggregate demand from *AD* to *AD′*, moving the equilibrium from *E* to *E′*. This example demonstrates how monetary expansion can increase aggregate demand and have a powerful impact on real output.

The complete sequence of impacts from expansionary monetary policy is therefore as follows: Open-market operations lower market interest rates. Lower interest rates stimulate interest-sensitive spending on business investment, housing, net exports, and the like. Aggregate demand increases via the multiplier mechanism, raising output and prices above the levels they would otherwise attain. Therefore, the basic sequence is

$$r \text{ down} \rightarrow I,\ C,\ X \text{ up} \rightarrow AD \text{ up} \rightarrow Q \text{ and } P \text{ up}$$

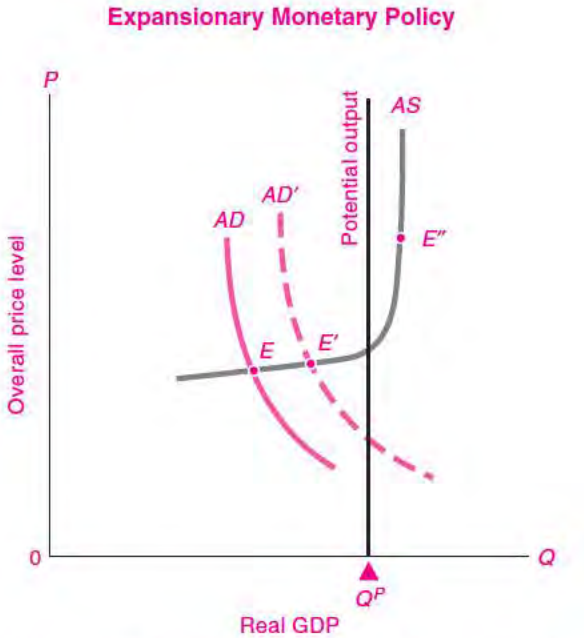


FIGURE 24-8. Expansionary Monetary Policy Shifts Out the *AD* Curve, Increasing Output and Prices

Figures 24-5 to 24-7 showed how a monetary expansion would lead to an increase in investment and thereby to a multiplied increase in output. This results in a rightward shift of the *AD* curve.

In the Keynesian region where the *AS* curve is relatively flat, a monetary expansion has its primary effect on real output, with only a small effect on prices. In a fully employed economy, the *AS* curve is near-vertical (shown at point *E″*), and a monetary expansion will primarily raise prices and nominal GDP, with little effect on real GDP. Can you see why in the long run monetary policy would have no impact on real output if the *AS* curve is vertical?

To clinch your understanding of this vital sequence, work through the opposite case of a monetary contraction. Say that the Federal Reserve decides to raise interest rates, slow the economy, and reduce inflation. You can trace this sequence in Figures 24-5 through 24-7 by reversing the direction of the initial change in monetary policy, thereby seeing how money, interest rates, investment, and aggregate demand react when monetary policy is tightened. Then see how a corresponding leftward shift of the *AD* curve in Figure 24-8 would reduce both output and prices.

Eye Therapies Exhibit 2127, 511 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Monetary Policy in the Long Run

The analysis in this chapter focuses primarily on monetary policy and business cycles. That is, it considers how monetary policy and interest rates affect output in the short run.

Be aware, however, that a different set of forces will operate in the long run. Monetary policies to stimulate the economy cannot keep increasing output beyond its potential for long. If the central bank holds interest rates too low for long periods of time, the economy will overheat and inflationary forces will take hold. With low real interest rates, speculation may arise, and animal spirits may overtake rational calculations. Some analysts believe that interest rates were too low for too long in the 1990s, causing the stock market bubble; some people think that the same mechanism was behind the housing market bubble of the 2000s.

In the long run, therefore, monetary expansion mainly affects the price level with little or no impact upon real output. As shown in Figure 24-8, monetary changes will affect aggregate demand and real GDP in the short run when there are unemployed resources in the economy and the *AS* curve is relatively flat. However, in our analysis of aggregate supply in the following chapters, we will see that the *AS* curve tends to be vertical or near-vertical in the long run as wages and prices adjust. Because of such price-wage adjustments and a near-vertical *AS* curve, the effects of *AD* shifts on output will diminish in the long run, and the effects on prices will tend to dominate. *This means that, as prices and wages become more flexible in the long run, monetary-policy changes tend to have a relatively small impact on output and a relatively large impact on prices.*

What is the intuition behind this difference between the short run and the long run? Suppose that monetary policy lowers interest rates. In the beginning, real output rises smartly and prices rise modestly. As time passes, however, wages and prices adjust more completely to the higher price and output levels. Higher demand in both labor and product markets raises wages and prices; wages are adjusted to reflect the higher cost of living. In the end, the expansionary monetary policy would produce an economy with unchanged real output and higher prices. All dollar variables (including the money supply, reserves, government debt, wages, prices, exchange rates, etc.) would be higher, while all real variables would be unchanged. In such a case, we say that *money is neutral*, meaning that changes in monetary policy have no effect on real variables.

This discussion of monetary policy has taken place without reference to fiscal policy. In reality, whatever the philosophical predilections of the government, every advanced economy simultaneously conducts both fiscal and monetary policies. Each type of policy has both strengths and weaknesses. In the chapters that follow, we return to an integrated consideration of the roles of monetary and fiscal policies in combating the business cycle and promoting economic growth.

C. APPLICATIONS OF MONETARY ECONOMICS

Having examined the basic elements of monetary economics and central banking, we now turn to two important applications of money to macroeconomics. We begin with a review of the influential monetarist approach, and then we examine the implications of globalization for monetary policy.

MONETARISM AND THE QUANTITY THEORY OF MONEY AND PRICES

Financial and monetary systems cannot manage themselves. The government, including the central bank, must make fundamental decisions about the monetary standard, the money supply, and the ease or tightness of money and credit. Today, there are many different philosophies about the best way to manage monetary affairs. Many believe in an active policy that "leans against the wind" by raising interest rates when inflation threatens and lowering them in recessions. Others are skeptical about the ability of policymakers to use monetary policy to "fine-tune" the economy to attain the desired levels of inflation and unemployment; they would rather limit monetary policy to targeting inflation. Then there are the monetarists, who believe that discretionary monetary policy should be replaced by a fixed rule relating to the growth of the money supply.

Eye Therapies Exhibit 2127, 512 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Having reviewed the basics of mainstream monetary theory, this section analyzes monetarism and traces the history of its development from the older quantity theory of money and prices. We will also see that monetarism is closely related to modern macroeconomic theory.

The Roots of Monetarism

Monetarism holds that the money supply is the primary determinant of both short-run movements in nominal GDP and long-run movements in prices. Of course, Keynesian macroeconomics also recognizes the key role of money in determining aggregate demand. The main difference between monetarists and Keynesians lies in the importance assigned to the role of money in the determination of aggregate demand. While Keynesian theories hold that many other forces besides money also affect aggregate demand, monetarists believe that changes in the money supply are the primary factor that determines movement in output and prices.

In order to understand monetarism, we need to understand the concept of the *velocity of money*.

The Equation of Exchange and the Velocity of Money

Money sometimes turns over very slowly; it may sit under a mattress or in a bank account for long periods of time between transactions. At other times, particularly during periods of rapid inflation, money circulates quickly from hand to hand. The speed of the turnover of money is described by the concept of the velocity of money, introduced by Cambridge University's Alfred Marshall and Yale University's Irving Fisher. The velocity of money measures the number of times per year that the average dollar in the money supply is spent for goods and services. When the quantity of money is large relative to the flow of expenditures, the velocity of circulation is low; when money turns over rapidly, its velocity is high.

The concept of velocity is formally introduced in the **equation of exchange.** This equation states[2]

$$MV \equiv PQ \equiv (p_1q_1 + p_2q_2 + \cdots)$$

where M is the money supply, V is the velocity of money, P is the overall price level, and Q is total real output. This can be restated as the definition of the **velocity of money** by dividing both sides by M:

$$V \equiv \frac{PQ}{M}$$

We generally measure PQ as total income or output (nominal GDP); the associated velocity concept is the *income velocity of money.*

Velocity is the rate at which money circulates through the economy. The **income velocity of money** is measured as the ratio of nominal GDP to the stock of money.

As a simple example, assume that the economy produces only bread. GDP consists of 48 million loaves of bread, each selling at a price of \$1, so GDP = PQ = \$48 million per year. If the money supply is \$4 million, then by definition V = \$48/\$4 = 12 per year. This means that money turns over 12 times per year or once a month as incomes are used to buy the monthly bread.

The Quantity Theory of Prices

Having defined an interesting variable called velocity, we now describe how early monetary economists used velocity to explain movements in the overall price level. The key assumption here is that *the velocity of money is stable and predictable.* The reason for stability, according to monetarists, is that velocity mainly reflects underlying patterns in the timing of earning and spending. If people are paid once a month and tend to spend their income evenly over the course of the month, income velocity will be 12 per year. Suppose that all prices, wages, and incomes double. With unchanged spending patterns, the income velocity of money would remain unchanged and the demand for money would double. Only if people and businesses modify their spending patterns or the way in which they pay their bills would the income velocity of money change.

On the basis of this insight about the stability of velocity, some early writers used velocity to explain changes in the price level. This approach, called the **quantity theory of money and prices,** rewrites the definition of velocity as follows:

$$P \equiv \frac{MV}{Q} \equiv \left(\frac{V}{Q}\right)M \approx kM$$

[2] The definitional equations have been written with the three-bar identity symbol rather than with the more common two-bar equality symbol. This usage emphasizes that they are "identities"—statements which hold true by definition.

Eye Therapies Exhibit 2127, 513 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

This equation is obtained from the earlier definition of velocity by substituting the variable k as a shorthand for V/Q and solving for P. We write the equation in this way because many classical economists believed that if transaction patterns were stable, k would be constant or stable. In addition, they generally assumed full employment, which meant that real output would grow smoothly. Putting these two assumptions together, $k \approx (V/Q)$ would be near-constant in the short run and decline smoothly in the long run.

What are the implications of the quantity theory? As we can see from the equation, if k were constant, the price level would then move proportionally with the supply of money. A stable money supply would produce stable prices; if the money supply grew rapidly, so would prices. Similarly, if the money supply were growing a hundredfold or a millionfold each year, the economy would experience galloping inflation or hyperinflation. Indeed, the most vivid demonstrations of the quantity theory can be seen in periods of hyperinflation. Look at Figure 30-4 (on page 613). Note how prices rose a billionfold in Weimar Germany after the central bank unleashed the power of the monetary printing presses. This is the quantity theory of money with a vengeance.

To understand the quantity theory of money, it is essential to recall that money differs fundamentally from ordinary goods such as bread and cars. We want bread to eat and cars to drive. But we want money only because it buys us bread and cars. If prices in Zimbabwe today are 100 million times what they were a few years ago, it is natural that people will need about 100 million times as much money to buy things as they did before. Here lies the core of the quantity theory of money: the demand for money rises proportionally with the price level as long as other things are held constant.

In reality, velocity has tended to increase slowly over time, so the k ratio might also change slowly over time. Moreover, in normal times, the quantity theory is only a rough approximation to the facts. Figure 24-9 shows a scatter plot of money growth and inflation over the last half-century. While periods of faster U.S. money growth are also periods of higher inflation, other factors are clearly at work as well, as evidenced by the imperfect correlation between money supply and prices.

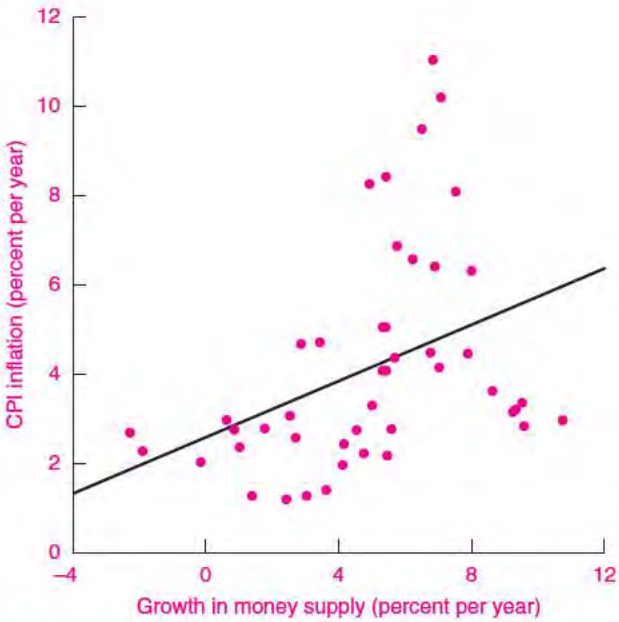


FIGURE 24-9. The Quantity Theory in the United States, 1962–2007

The quantity theory states that prices should change 1 percent for each 1 percent change in the money supply. The scatter plot and the line of best fit show how the simple quantity theory holds for data from the last half-century. Inflation is indeed correlated with money growth, but the relationship is a loose fit. As we will see in our chapters on inflation, other variables such as unemployment and commodity prices influence inflation as well. Query: Assuming velocity is constant and output grows at 3 percent per year, what scatter plot would be produced if money were neutral?

Source: Money supply from the Federal Reserve Board, and the consumer price index from the Bureau of Labor Statistics. Data are 3-year moving averages.

The quantity theory of money and prices holds that prices move proportionally with the supply of money. Although the quantity theory is only a rough approximation, it does help to explain why countries with low money growth have moderate inflation while those with rapid money growth find their prices galloping along.

Modern Monetarism

Modern monetary economics was developed after World War II by Chicago's Milton Friedman and his numerous colleagues and followers. Under

Eye Therapies Exhibit 2127, 514 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Friedman's leadership, monetarists challenged Keynesian macroeconomics and emphasized the importance of monetary policy in macroeconomic stabilization. In the 1970s, the monetarist approach branched into two separate schools of thought. One continued the monetarist tradition, which we will now describe. The younger offshoot became the influential "new classical school," which is analyzed in Chapter 31.

Strict monetarists hold that "only money matters." This means that prices and output are determined solely by the money supply and that other factors affecting aggregate demand, such as fiscal policy, have no effect on total output or prices. Moreover, while monetary changes may affect real output in the short run, in the long run output is determined by supply factors of labor, capital, and technology. This theory predicts that in the long run, *money is neutral*. This proposition means that in the long run, after expectations have been corrected and business-cycle movements have damped out, (1) nominal output moves proportionally with the money supply and (2) all real variables (output, employment, and unemployment) are independent of the money supply.

The Monetarist Platform: Constant Money Growth

Monetarism played a significant role in shaping macroeconomic policy in the period after World War II. Monetarists hold that money has no effect on real output in the long run, while it does affect output in the short run with long and variable lags. These views lead to the central monetarist tenet of a **fixed-money-growth rule:** The central bank should set the growth of the money supply at a fixed rate and hold firmly to that rate.

Monetarists believe that a fixed growth rate of money would eliminate the major source of instability in a modern economy—the capricious and unreliable shifts of monetary policy. They argue that we should, in effect, replace the Federal Reserve with a computer that produces a fixed-money-growth rate. Such a computerized policy would ensure that there would be no bursts in money growth. With stable velocity, nominal GDP would grow at a stable rate. With suitably low money growth, the economy would soon achieve price stability. So argue the monetarists.

The Monetarist Experiment

When U.S. inflation moved into the double-digit range in the late 1970s, many economists and policymakers believed that monetary policy was the only hope for an effective anti-inflation policy. In October 1979, Federal Reserve chair Paul Volcker launched a fierce attack against inflation in what has been called the *monetarist experiment*. In a dramatic shift from its normal operating procedures, the Fed attempted to stabilize the growth of bank reserves and the money supply rather than targeting interest rates.

The Fed hoped that the quantitative approach to monetary management would lower the growth rate of nominal GDP and thereby lower inflation. In addition, some economists believed that a disciplined monetary policy would quickly reduce inflationary expectations. Once people's expectations were reduced, the economy could experience a relatively painless reduction in the underlying rate of inflation.

The experiment succeeded in slowing the growth of nominal GDP and reducing inflation. With tight money, interest rates rose sharply. Inflation slowed from 13 percent per year in 1980 to 4 percent per year in 1982. Any lingering doubts about the efficacy of monetary policy were killed by the monetarist experiment. Money works. Money matters. Tight money can wring inflation out of the economy. However, the decline in inflation came at the cost of a deep recession and high unemployment during the 1980–1983 period.

The Decline of Monetarism

Paradoxically, just as the monetarist experiment succeeded in rooting inflation out of the American economy, changes in financial markets undermined the monetarist approach. During and after the monetarist experiment, velocity became extremely unstable. Careful economic studies have shown that velocity is positively affected by interest rates and cannot be considered to be a constant that is independent of monetary policy.

Figure 24-10 shows trends in velocity over the 1960–2007 period. M_1 velocity growth was relatively stable in the 1960–1979 period, leading many economists to believe that velocity was predictable. Velocity became much more unstable after 1980 as the high interest rates of the 1979–1982 period spurred financial innovations, including money market

Eye Therapies Exhibit 2127, 515 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

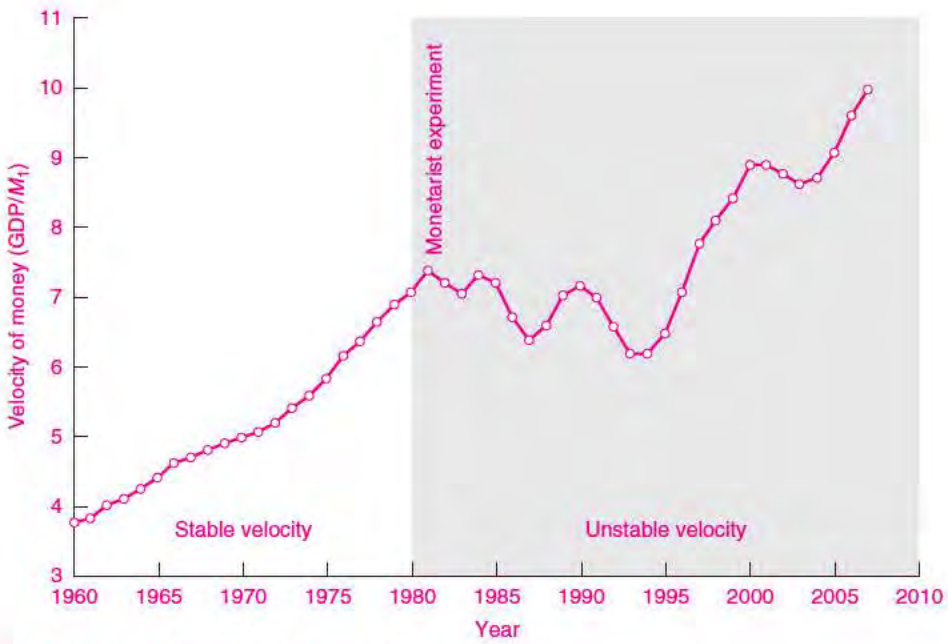


FIGURE 24-10. Income Velocity of M_1

Monetarists assume that the velocity of money is stable and thereby argue for a constant money-supply growth rate. The velocity of money grew at a steady and predictable rate until around 1979. Beginning in 1980 (the shaded area of the graph), an active monetary policy, more-volatile interest rates, and financial innovations led to the extreme instability of velocity.

Source: Velocity defined as the ratio of nominal GDP to M_1; money supply from the Federal Reserve Board, and GDP from the Commerce Department.

accounts and interest-bearing checking accounts. Some economists believe that the instability of velocity was actually *produced* by the heavy reliance on targeting monetary aggregates during this period.

As the velocity of money became increasingly unstable, the Federal Reserve gradually stopped using it as a guide for monetary policy. By the early 1990s, the Fed began to rely on macroeconomic indicators such as inflation, output, and employment to diagnose the state of the economy. Interest rates, not the money supply, became the major instrument of policy.

For most central banks today, monetarism is no longer a useful macroeconomic theory. Indeed, during the recession of 2007–2009, the Federal Reserve did not include monetary quantities among its objectives. But this did not diminish the importance of monetary policy, which continues to be a central partner in macroeconomic policy around the world.

Monetarism holds that "only money matters" in the determination of output and prices and that money is neutral in the long run. Although monetarism is no longer a dominant branch of macroeconomics, monetary policy continues to be a central tool of stabilization policy in large market economies today.

MONETARY POLICY IN AN OPEN ECONOMY[3]

Central banks are particularly important in open economies, where they manage reserve flows and the exchange rate and monitor international financial developments. As economies become increasingly

[3] This section is relatively advanced and can usefully be studied after the chapters on open-economy macroeconomics (Chapters 27 and 28) have been covered.

Eye Therapies Exhibit 2127, 516 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

integrated (a process often called *globalization*), central banks must learn to manage external flows as well as internal targets. This section discusses some of the major issues concerning the monetary management of an open economy.

International Linkages

No country is an island, isolated from the world economy. All economies are linked through international trade in goods and services and through flows of capital and financial assets.

An important element in the international financial linkage between two countries is the exchange rate. As we will see again in later chapters, international trade and finance involve the use of different national currencies, all of which are linked by relative prices called foreign exchange rates. Hence, the relative price of Euros to U.S. dollars is the exchange rate between those two currencies.

One important exchange-rate system is floating exchange rates, in which a country's foreign exchange rate is determined by market forces of supply and demand. Today, the United States, Europe, and Japan all operate floating-exchange-rate systems. These three regions can pursue their monetary policies independently from other countries. This chapter's analysis mainly concerns the operation of monetary policy under floating exchange rates.

Some economies—such as Hong Kong and China today, as well as virtually all countries in earlier periods—maintain fixed exchange rates. They "peg" their currencies to one or more external currencies. When a country has a fixed exchange rate, it must align its monetary policy with that of the country to which its currency is pegged. For example, if Hong Kong has open financial markets and an exchange rate pegged to the U.S. dollar, then it must have the same interest rates as the United States.

The Federal Reserve acts as the government's operating arm in the international financial system. Under a floating-exchange-rate system, the main aim of the central bank is to prevent disorderly conditions, such as might occur during a political crisis. The Fed might buy or sell dollars or work with foreign central banks to ensure that exchange rates do not move erratically. However, unlike in the earlier era of fixed exchange rates, the Fed does not "intervene" to maintain a particular exchange rate.

In addition, the Federal Reserve often takes the lead in working with foreign countries and international agencies when international financial crises erupt. The Fed played an important role in the Mexican loan package in 1994–1995, worked with other countries to help calm markets during the East Asian crisis in 1997 and the global liquidity crisis in 1998, and helped calm markets during the Argentine crisis of 2001–2002. When financial institutions in many countries began to incur large losses in 2007–2008, the Federal Reserve joined forces with other central banks to provide liquidity and prevent investor panics in one country from spilling over into other countries.

MONETARY TRANSMISSION IN THE OPEN ECONOMY

The monetary transmission mechanism in the United States has evolved over the last three decades as the economy has become more open and changes have occurred in the exchange-rate system. The relationship between monetary policy and foreign trade has always been a major concern for smaller and more open economies like Canada and Great Britain. However, after the introduction of flexible exchange rates in 1973 and with the rapid growth of cross-border linkages, international trade and finance have come to play a new and central role in U.S. macroeconomic policy.

Let's see how monetary policy affects the economy through international trade with a flexible exchange rate. Suppose the Federal Reserve decides to tighten money. This raises interest rates on assets denominated in U.S. dollars. Attracted by higher-dollar interest rates, investors buy dollar securities, driving up the foreign exchange rate on the dollar. The higher exchange rate on the dollar encourages imports into the United States and reduces U.S. exports. As a result, net exports fall, reducing aggregate demand. This will lower real GDP and reduce the rate of inflation. We will study the international aspects of macroeconomics in more detail in Chapters 27 and 28.

Foreign trade opens up another link in the monetary transmission mechanism. Monetary policy has the same impact on international trade as it has on domestic investment: tight money lowers net exports,

Eye Therapies Exhibit 2127, 517 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

thereby depressing output and prices. The international-trade impact of monetary policy reinforces its domestic-economy impact.

FROM AGGREGATE DEMAND TO AGGREGATE SUPPLY

We have completed our introductory analysis of the determinants of aggregate demand. We examined the foundations and saw that aggregate demand is determined by exogenous factors, such as investment and net exports, along with monetary and fiscal government policies. In the short run, changes in these factors lead to changes in spending and changes in both output and prices.

In today's volatile and globalized world, economies are exposed to shocks from both the inside and the outside of their borders. Wars, revolutions, stock market collapses, housing-price bubbles, financial and currency crises, oil-price shocks, and government miscalculations have led to periods of high inflation or high unemployment or both. No market mechanism provides an automatic pilot that can eliminate macroeconomic fluctuations. Governments must therefore take responsibility for moderating the swings of the business cycle.

While the United States experienced recessions in 1990, 2001, and 2008, it has up to now been fortunate to avoid deep and prolonged downturns. Other countries over the last quarter-century have not been so lucky. Japan, much of Europe, Latin America, Russia, and the East Asian countries have all occasionally been caught in the turbulent storms of rapid inflation, high unemployment, currency crises, or sharp declines in living standards. These events serve as a reminder that there is no universal cure for unemployment and inflation in the face of all the shocks to a modern economy.

We have now concluded our introductory chapters on short-run macroeconomics. The next part of the book turns to issues of economic growth, the open economy, and economic policy.



SUMMARY

A. Central Banking and the Federal Reserve System

1. Every modern country has a central bank. The U.S. central bank is made up of the Federal Reserve Board in Washington, together with the 12 regional Federal Reserve Banks. Its primary mission is to conduct the nation's monetary policy by influencing financial conditions in pursuit of low inflation, high employment, and stable financial markets.
2. The Federal Reserve System (or "the Fed") was created in 1913 to control the nation's money and credit and to act as the "lender of last resort." It is run by the Board of Governors and the Federal Open Market Committee (FOMC). The Fed acts as an independent government agency and has great discretion in determining monetary policy.
3. The Federal Reserve has four major functions: conducting monetary policy by setting short-term interest rates, maintaining the stability of the financial system and containing systemic risk as the lender of last resort, supervising and regulating banking institutions, and providing financial services to banks and the government.
4. The Fed has three major policy instruments: (*a*) open-market operations, (*b*) the discount window for borrowing by banks and, more recently, primary dealers, and (*c*) legal reserve requirements for depository institutions.
5. The Federal Reserve conducts its policy through changes in an important short-term interest rate called the federal funds rate. This is the short-term interest rate that banks charge each other to trade reserve balances at the Fed. The Fed controls the federal funds rate by exercising control over its instruments, primarily through open-market operations.

B. The Monetary Transmission Mechanism

6. Remember the important monetary transmission mechanism, the route by which monetary policy is translated into changes in output, employment, and inflation:
   a. The central bank announces a target short-term interest rate chosen in light of its objectives and the state of the economy.

Eye Therapies Exhibit 2127, 518 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

b. The central bank undertakes daily open-market operations to meet its interest-rate target.
c. The central bank's interest-rate target and expectations about future financial conditions determine the entire spectrum of short- and long-term interest rates, asset prices, and exchange rates.
d. The level of interest rates, credit conditions, asset prices, and exchange rates affect investment, consumption, and net exports.
e. Investment, consumption, and net exports affect the path of output and inflation through the *AS-AD* mechanism.

We can write the operation of a monetary policy change as follows:

Change in monetary policy
→ change in interest rates, asset prices, exchange rates
→ impact on *I, X, C*
→ effect on *AD*
→ effect on *Q, P*

7. Although the monetary transmission mechanism is often described simply in terms of "the interest rate" and "investment," this mechanism is in fact an extremely rich and complex process whereby changes in all kinds of financial conditions influence a wide variety of spending. The affected sectors include: housing, affected by mortgage interest rates and housing prices; business investment, affected by interest rates and stock prices; spending on consumer durables, influenced by interest rates and credit availability; state and local capital spending, affected by interest rates; and net exports, determined by the effects of interest rates upon foreign exchange rates.

C. Applications of Monetary Economics

8. Monetarism holds that the money supply is the primary determinant of short-run movements in both real and nominal GDP as well as the primary determinant of long-run movements in nominal GDP. The income velocity of money (V) is defined as the ratio of the dollar-GDP flow (PQ) to the stock of money (M): $V \equiv PQ/M$. With constant velocity, prices move proportionally to the money supply. Monetarists propose that the money supply should grow at a low fixed rate. Statistical studies indicate that velocity tends to be positively correlated with interest rates, a finding that undermines the monetarist policy prescription.
9. In an open economy, the international-trade linkage reinforces the domestic impacts of monetary policy. In a regime of flexible exchange rates, changes in monetary policy affect the exchange rate and net exports, adding yet another facet to the monetary mechanism. The trade link tends to reinforce the impact of monetary policy, which operates in the same direction on net exports as it does on domestic investment.

CONCEPTS FOR REVIEW

Central Banking

bank reserves
federal funds interest rate
Federal Reserve balance sheet
open-market purchases and sales
discount rate, borrowing from the Fed
legal reserve requirements
FOMC, Board of Governors

The Monetary Transmission Mechanism and Applications

demand for and supply of reserves
monetary transmission mechanism
interest-sensitive components of spending
monetary policy in the *AS-AD* framework
"neutrality" of money
second route by which *M* affects output

Eye Therapies Exhibit 2127, 519 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

FURTHER READING AND INTERNET WEBSITES

Further Reading

Alan Greenspan's memoir, *The Age of Turbulence* (Penguin, New York, 2007) is a valuable history of the last half-decade as well as of his stewardship of the Federal Reserve.

The *Federal Reserve Bulletin* contains monthly reports on Federal Reserve activities and other important financial developments. The *Bulletin* is available on the Internet at *www.federalreserve.gov/pubs/bulletin/default.htm.*

The quotation on the lender of last resort is from Alan Greenspan, "Remarks," Lancaster House, London, U.K., September 25, 2002, available at *www.federalreserve.gov/boarddocs/speeches/2002/200209253/default.htm.*

The governors of the Fed often bring informed economic expertise to monetary and other issues. See speeches at *www.federalreserve.gov/newsevents/*. A particularly influential speech by current Fed chair Ben Bernanke on the "global savings glut" is at *www.federalreserve.gov/boarddocs/speeches/2005/200503102/default.htm.*

Websites

The Federal Reserve System: Purposes and Functions, 9th ed. (Board of Governors of the Federal Reserve System, Washington, D.C., 2005), available online at *www.federalreserve.gov/pf/pf.htm*, provides a useful description of the operations of the Fed. Also, see the Further Reading and Websites sections in Chapter 25 for a more detailed list of sites on monetary policy. An excellent review of the Federal Reserve's response to the credit crisis of 2007–2009 is contained in a speech by Fed chair Ben Bernanke, "The Crisis and the Policy Response," January 2009, available at http://www.federalreserve.gov/newsevents/speech/bernanke20090113a.htm.

If you want to know which Reserve Bank region you live in, see *www.federalreserve.gov/otherfrb.htm.* Why are the eastern regions so small?

Biographies of the members of the Board of Governors can be found at *www.federalreserve.gov/bios/*. Particularly interesting are the transcripts and minutes of Fed meetings, at *www.federalreserve.gov/fomc/*.

QUESTIONS FOR DISCUSSION

1. Using Figures 24-5 through 24-7, work through each of the following:
   a. As in 2007–2008, the Federal Reserve is concerned about a decline in housing prices that is reducing investment. What steps might the Fed take to stimulate the economy? What will be the impact on bank reserves? What will be the impact on interest rates? What will be the impact on investment (other things held constant)?
   b. As in 1979, the Fed is concerned about rising inflation and wishes to reduce output. Answer the same questions as in **a**.
2. Suppose you are the chair of the Fed's Board of Governors at a time when the economy is heading into a recession and you are called to testify before a congressional committee. Write your explanation to an interrogating senator outlining what monetary steps you would take to prevent the recession.
3. Consider the balance sheet of the Fed in Table 24-1. Construct a corresponding balance sheet for banks (like the one in Table 23-3 in the previous chapter) assuming that reserve requirements are 10 percent on checking accounts and zero on everything else.
   a. Construct a new set of balance sheets, assuming that the Fed sells $1 billion worth of government securities through open-market operations.
   b. Construct another set of balance sheets, assuming that the Fed increases reserve requirements from 10 to 20 percent.
   c. Assume that banks borrow $1 billion worth of reserves from the Fed. How will this action change the balance sheets?
4. Assume that commercial banks have $100 billion of checking deposits and $4 billion of vault cash. Further assume that reserve requirements are 10 percent of checking deposits. Lastly, assume that the public holds $200 billion of currency, which is always fixed. Central-bank assets include only government securities.
   a. Construct the balance sheets for the central bank and the banking system. Make sure you include banks' deposits with the central bank.
   b. Now assume that the central bank decides to engage in an open-market operation, selling

Eye Therapies Exhibit 2127, 520 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

$1 billion worth of government securities to the public. Show the new balance sheets. What has happened to M_1?

c. Finally, using the graphical apparatus of the monetary transmission mechanism, show the qualitative impact of the policy on interest rates, investment, and output.

5. In his memoirs, Alan Greenspan wrote, "I regret to say that Federal Reserve independence is not set in stone. FOMC discretion is granted by statute and can be withdrawn by statute." (*The Age of Turbulence*, p. 478 f.) Explain why the independence of a central bank might affect the way in which monetary policy is conducted. If a central bank is not independent, how might its monetary policies change in response to electoral pressures? Would you recommend that a new country have an independent central bank? Explain.

6. One of the nightmares of central bankers is the liquidity trap. This occurs when nominal interest rates approach or even equal zero. Once the interest rate has declined to zero, monetary expansion is ineffective because interest rates on securities cannot go below zero.

a. Explain why the nominal interest rate on government bonds cannot be negative. (*Hint:* What is the nominal interest rate on currency? Why would you hold a bond whose interest rate is below the interest rate on currency?)

b. A liquidity trap is particularly serious when a country simultaneously experiences falling prices, also called deflation. For example, in the early 2000s, consumer prices in Japan were falling at 2 percent per year. What were Japanese real interest rates during this period if the nominal interest rate was 0? What was the *lowest* real interest rate that the Bank of Japan could have produced during this period?

c. Explain on the basis of **b** why the liquidity trap poses such a serious problem for monetary policy during periods of deflation and depression.

7. After the reunification of Germany in 1990, payments to rebuild the East led to a major expansion of aggregate demand in Germany. The German central bank responded by slowing money growth and raising German real interest rates. Trace through why this German monetary tightening would be expected to lead to a depreciation of the dollar. Explain why such a depreciation would stimulate economic activity in the United States. Also explain why European countries that had pegged their currencies to the German mark would find themselves plunged into recessions as German interest rates rose and pulled other European rates up with them.

8. In December 2007, the Federal Open Market Committee made the following statement: "The Federal Open Market Committee seeks monetary and financial conditions that will foster price stability and promote sustainable growth in output. To further its long-run objectives, the Committee [will reduce] the federal funds rate [from 4½ percent to] 4¼ percent." Your assignment is to explain the macroeconomic rationale behind this monetary expansion. It will help to review the minutes of the FOMC meeting at *www.federalreserve.gov/monetarypolicy/files/fomcminutes20071211.pdf*.

Eye Therapies Exhibit 2127, 521 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

PART SIX

Growth, Development, and the Global Economy

CHAPTER

Economic Growth

25



The Industrial Revolution was not an episode with a beginning and an end. . . . It is still going on.

E. J. Hobsbawm
The Age of Revolution (1962)

If you look at photographs of an earlier era, you will quickly recognize how dramatically the living standards of the average household have changed over past decades and centuries. Today's homes are stocked with goods that could hardly be imagined a century ago. Just think of entertainment before the era of plasma televisions, high-definition DVDs, and portable media devices. Similarly, the Internet has opened up a vast array of information that could be obtained only by going to the library, and even then only a small fraction of published knowledge was available in most libraries. Or consider the health care available today as compared to periods such as the U.S. Civil War, when soldiers died simply because they got an infection.

These changes in the array, quality, and quantity of goods and services available to the average household are the human face of economic growth. In macroeconomics, economic growth designates the process by which economies accumulate larger quantities of capital equipment, push out the frontiers of technological knowledge, and become steadily more productive. Over the long run of decades and generations, living standards, as measured by output per capita or consumption per household, are primarily determined by aggregate supply and the level of productivity of a country.

This chapter begins with a survey of the theory of economic growth and then reviews the historical trends in economic activity with particular application to wealthy countries like the United States. The next chapter looks at the other end of the income spectrum by examining the plight of the developing countries, struggling to reach the level of affluence enjoyed in the West. The two chapters that follow examine the role of international trade and finance in macroeconomics.

The Long-Term Significance of Growth

A careful analysis of the economic history of the United States reveals that real GDP has grown by a factor of 35 since 1900 and by a factor of over 1000 since 1800. Rapid growth of output is the distinguishing feature of modern times and contrasts sharply with human history going back to its origins millions of years ago. This is perhaps the central economic fact of the century. Continuing rapid economic growth enables advanced industrial countries to provide more of everything to their citizens—better food and bigger homes, more resources for medical care and pollution control, universal education for children, better equipment for the military, and public pensions for retirees.

Eye Therapies Exhibit 2127, 524 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Because economic growth is so important for living standards, it is a central objective of policy. Countries that run swiftly in the economic-growth race, such as Britain in the nineteenth century and the United States in the twentieth century, serve as role models for other countries seeking the path to affluence. At the other extreme, countries in economic decline often experience political and social turmoil. The revolutions in Eastern Europe and the Soviet Union in 1989–1991 were sparked when those nations' residents compared their economic stagnation under socialism with the rapid growth experienced by their Western, market-oriented neighbors. Economic growth is the single most important factor in the success of nations in the long run.

A. THEORIES OF ECONOMIC GROWTH

Let's begin with a careful definition of exactly what we mean by economic growth: **Economic growth** represents the expansion of a country's potential GDP or national output. Put differently, economic growth occurs when a nation's production-possibility frontier (*PPF*) shifts outward.

A closely related concept is the growth rate of *output per person*. This determines the rate at which the country's living standards are rising. Countries are primarily concerned with the growth in per capita output because this leads to rising average incomes.

What are the long-term patterns of economic growth in high-income countries? Table 25-1 shows the history of economic growth since 1870 for high-income countries including the major countries of North America and Western Europe, Japan, and Australia. We see the steady growth of output over this period. Even more important for living standards is the growth in output per hour worked, which moves closely with the increase in living standards. Over the entire period, output per hour worked grew by an average annual rate of 2.3 percent. If we compound this rate over the 136 years, output per person at the end was 22 times higher than at the beginning (make sure you can reproduce this number).

What were the major forces behind this growth? What can nations do to speed up their economic growth rate? And what are the prospects for the twenty-first century? These are the issues that must be confronted by economic-growth analysis.

Economic growth involves the growth of potential output over the long run. The growth in output per capita is an important objective of government because it is associated with rising average real incomes and rising living standards.

THE FOUR WHEELS OF GROWTH

What is the recipe for economic growth? To begin with, many roads lead to Rome. There are many successful strategies on the road to self-sustained economic growth. Britain, for example, became the

Period	Average Annual Growth Rate (percent per year)			
	GDP	GDP per hour worked	Total hours worked	Labor force
1870–1913	2.5	1.6	0.9	1.2
1913–1950	1.9	1.8	0.1	0.8
1950–1973	4.8	4.5	0.3	1.0
1973–2006	2.6	2.2	0.4	1.0
Total period	**2.8**	**2.3**	**0.5**	**1.0**

TABLE 25-1. Patterns of Growth in Advanced Countries

Over the last century-plus, major high-income countries like the United States, Germany, France, and Japan have grown rapidly. Output has grown faster than inputs of labor, reflecting increases in capital and technological advance.

Source: Angus Maddison, *Phases of Capitalist Development* (Oxford University Press, Oxford, 1982), updated by authors. The data cover 16 major countries starting in 1870, while more recent data cover 31 advanced economies.

Eye Therapies Exhibit 2127, 525 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

world economic leader in the 1800s by pioneering the Industrial Revolution, inventing steam engines and railroads, and emphasizing free trade. Japan, by contrast, came to the economic-growth race later. It made its mark by first imitating foreign technologies and protecting domestic industries from imports and then developing tremendous expertise in manufacturing and electronics.

Even though their individual paths may differ, all rapidly growing countries share certain common traits. The same fundamental process of economic growth and development that helped shape Britain and Japan is at work today in developing countries like China and India. Indeed, economists who have studied growth have found that the engine of economic progress must ride on the same four wheels, no matter how rich or poor the country. These four wheels, or factors of growth, are:

- Human resources (labor supply, education, skills, discipline, motivation)
- Natural resources (land, minerals, fuels, environmental quality)
- Capital (factories, machinery, roads, intellectual property)
- Technological change and innovation (science, engineering, management, entrepreneurship)

Often, economists write the relationship in terms of an *aggregate production function* (or *APF*), which relates total national output to inputs and technology. Algebraically, the *APF* is

$$Q = AF(K, L, R)$$

where Q = output, K = productive services of capital, L = labor inputs, R = natural-resource inputs, A represents the level of technology in the economy, and F is the production function. As the inputs of capital, labor, or resources rise, we would expect that output would increase, although output will probably show diminishing returns to additional inputs of production factors. We can think of the role of technology as augmenting the productivity of inputs. **Productivity** denotes the ratio of output to a weighted average of inputs. As technology (A) improves through new inventions or the adoption of technologies from abroad, this advance allows a country to produce more output with the same level of inputs.

Let's now see how each of the four factors contributes to growth.

Human Resources

Labor inputs consist of quantities of workers and of the skills of the workforce. Many economists believe that the quality of labor inputs—the skills, knowledge, and discipline of the labor force—is the single most important element in economic growth. A country might buy fast computers, modern telecommunications devices, sophisticated electricity-generating equipment, and hypersonic fighter aircraft. However, these capital goods can be effectively used and maintained only by skilled and trained workers. Improvements in literacy, health, and discipline, and most recently the ability to use computers, add greatly to the productivity of labor.

Natural Resources

The second classic factor of production is natural resources. The important resources here are arable land, oil, gas, forests, water, and mineral deposits. Some high-income countries like Canada and Norway have grown primarily on the basis of their ample resource base, with large output in oil, gas, agriculture, fisheries, and forestry. Similarly, the United States, with its fertile farmlands, is the world's largest producer and exporter of grains.

But the possession of natural resources is not necessary for economic success in the modern world. New York City prospers primarily on its high-density service industries. Many countries, such as Japan, had virtually no natural resources but thrived by concentrating on sectors that depend more on labor and capital than on indigenous resources. Indeed, tiny Hong Kong, with but a tiny fraction of the land and natural resources of Nigeria, actually has a larger GDP than does that giant country.

Capital

Capital includes tangible capital goods like roads, power plants, and equipment like trucks and computers, as well as intangible items such as patents, trademarks, and computer software. The most dramatic stories in economic history often involve the accumulation of capital. In the nineteenth century, the transcontinental railroads of North America brought commerce to the American heartland, which had been living in isolation. In the twentieth century, waves of investment in automobiles, roads, and power plants increased productivity and provided the infrastructure which created entire new industries. Many

Eye Therapies Exhibit 2127, 526 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

believe that computers and information technology will do for the twenty-first century what railroads and highways did in earlier times.

Accumulating capital, as we have seen, requires a sacrifice of current consumption over many years. Countries that grow rapidly tend to invest heavily in new capital goods; in the most rapidly growing countries, 10 to 20 percent of output may go into net capital formation. The United States shows a stark contrast with high-saving countries. The U.S. net national saving rate, after averaging around 7 percent during the first four decades after World War II, began to decline and actually fell to near-zero in 2008. The low saving rate was the result of low personal saving and large government fiscal deficits. The low saving was seen primarily in the large external (trade) deficit. Economists worry that the low saving rate will retard investment and economic growth in the decades to come and that the large foreign indebtedness may require major adverse changes in exchange rates and real wages.

When we think of capital, we must not concentrate only on computers and factories. Many investments that are necessary for the efficient functioning of the private sector will be undertaken only by governments. These investments are called **social overhead capital** and consist of the large-scale projects that precede trade and commerce. Roads, irrigation and water projects, and public-health measures are important examples. All these involve large investments that tend to be "indivisible," or lumpy, and sometimes have increasing returns to scale. These projects generally involve external economies, or spillovers that private firms cannot capture, so the government must step in to ensure that these social overhead or infrastructure investments are effectively undertaken. Some investments, such as transportation and communication systems, involve "network" externalities in which productivity depends upon the fraction of the population which uses or has access to the network.

Technological Change and Innovation

In addition to the three classic factors discussed above, technological advance has been a vital fourth ingredient in the rapid growth of living standards. Historically, growth has definitely not been a process of simple replication, adding rows of steel mills or power plants next to each other. Rather, a never-ending stream of inventions and technological advances led to a vast improvement in the production possibilities of Europe, North America, and Japan.

We are today witnessing an explosion of new technologies, particularly in computation, communication (such as the Internet), and the life sciences. But this is not the first time that American society has been shaken by fundamental inventions. Electricity, radio, the automobile, and television also diffused rapidly through the American economy in an earlier age. Figure 25-1 shows the diffusion of major inventions of the twentieth century. This S-shaped pattern is typical of the diffusion of new technologies.

Technological change denotes changes in the processes of production or introduction of new products or services. Process inventions that have greatly increased productivity were the steam engine, the generation of electricity, antibiotics, the internal-combustion engine, the wide-body jet, the microprocessor, and the fax machine. Fundamental product inventions include the telephone, the radio, the airplane, the phonograph, the television, the computer, and the DVR.

The most dramatic developments of the modern era are occurring in information technology. Here, tiny notebook computers can outperform the fastest computer of the 1960s, while fiber-optic lines can carry 200,000 simultaneous conversations that required 200,000 paired copper-wire lines in an earlier period. These inventions provide the most spectacular examples of technological change. Nonetheless, technological advance is in fact a continuous process of small and large improvements, as witnessed by the fact that the United States issues over 100,000 new patents annually and that millions of other small refinements are routine activities in a modern economy.

Economists have long pondered how to encourage technological progress because of its importance in raising living standards. Technological progress is a complex and multifaceted process, and no single formula for success has been found.

Here are some historical examples: Toyota succeeded in instilling a workplace ethic of making continuous quality improvements from the bottom up; this propelled Toyota to the top of the automobile industry. Quite a different pattern arose in Silicon Valley's computer business. Here, technological change was fostered by an entrepreneurial spirit of free inquiry, light government regulation, free international trade in intellectual property products, and the lure of lucrative stock options. Economists

Eye Therapies Exhibit 2127, 527 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

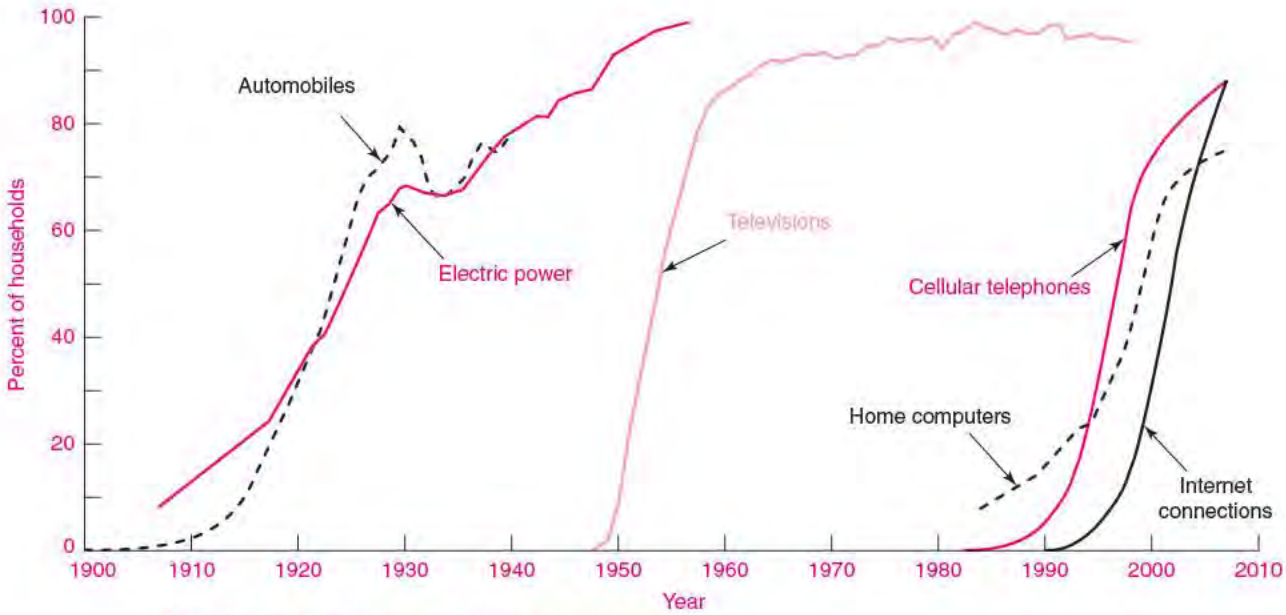


FIGURE 25-1. Diffusion of Major Technologies

Today's information technologies such as cellular telephones, computers, and the Internet are spreading rapidly through American society. Similar diffusion patterns were seen with other fundamental inventions in the past.

Source: *Economic Report of the President, 2000,* updated by authors.

Factor in economic growth	Examples
Human resources	Size of labor force Quality of workers (education, skills, discipline)
Natural resources	Oil and gas Soils and climate
Capital stock	Homes and factories Machinery Intellectual property Social overhead capital
Technology and entrepreneurship	Quality of scientific and engineering knowledge Managerial know-how Rewards for innovation

TABLE 25-2. The Four Wheels of Progress

Economic growth inevitably rides on the four wheels of labor, natural resources, capital, and technology. But the wheels may differ greatly among countries, and some countries combine them more effectively than others.

recognize that some approaches seem to kill the spirit of innovation. Many sectors of the Soviet Union under central planning saw technological stagnation because of the heavy hand of state regulation, lack of profit motivation, an inefficient pricing mechanism, and widespread corruption.

Table 25-2 summarizes the four wheels of economic growth.

Eye Therapies Exhibit 2127, 528 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



Institutions, Incentives, and Innovation

In the very long run, the growth in the world's output and wealth has come primarily because of improvements in knowledge. Yet institutions to promote the creation and spread of knowledge, along with incentives to devote our human effort to that task, were developed late in human history—slowly in Western Europe over the last 500 years. This point was eloquently argued by William Baumol:

> The museum at Alexandria was the center of technological innovation in the Roman Empire. By the first century B.C., that city knew of virtually every form of machine gearing that is used today, including a working steam engine. But these seemed to be used only to make what amounted to elaborate toys. The steam engine was used to open and close the doors of a temple.[1]

Baumol and economic historian Joel Mokyr argue that innovation depends crucially on the development of incentives and institutions. They particularly point to the role of private ownership, the patent system, and a rule-based system of adjudicating disputes as devices for fostering innovation.

THEORIES OF ECONOMIC GROWTH

Virtually everyone is in favor of economic growth. But there are strong disagreements about the best way to accomplish this goal. Some economists and policymakers stress the need to increase capital investment. Others advocate measures to stimulate research and development and technological change. Still a third group emphasizes the role of a better-educated workforce.

Economists have long studied the question of the relative importance of different factors in determining growth. In the discussion below, we look at different theories of economic growth, which offer some clues about the driving forces behind growth. Then, in the final part of this section, we see what can be learned about growth from its historical patterns over the last century.

[1] See Baumol in the Further Reading section at the end of this chapter.

The Classical Dynamics of Smith and Malthus

Early economists like Adam Smith and T. R. Malthus stressed the critical role of land in economic growth. In *The Wealth of Nations* (1776), Adam Smith provided a handbook of economic development. He began with a hypothetical idyllic age: "that original state of things, which precedes both the appropriation of land and the accumulation of [capital] stock." This was a time when land was freely available to all, and before capital accumulation had begun to matter.

What would be the dynamics of economic growth in such a "golden age"? Because land is freely available, people would simply spread out onto more acres as the population increases, just as the settlers did in the American West. Because there is no capital, national output would exactly double as population doubles. What about real wages? The entire national income would go to wages because there is no subtraction for land rent or interest on capital. Output expands in step with population, so the real wage rate per worker would be constant over time.

But this golden age cannot continue forever. Eventually, as population growth continues, all the land will be occupied. Once the frontier disappears, balanced growth of land, labor, and output is no longer possible. New laborers begin to crowd onto already-worked soils. Land becomes scarce, and rents rise to ration it among different uses.

Population still grows, and so does the national product. But output must grow more slowly than does population. Why? With new laborers added to fixed land, each worker now has less land to work with, and the law of diminishing returns comes into operation. The increasing labor-land ratio leads to a declining marginal product of labor and hence to declining real wage rates.[2]

How bad could things get? The dour Reverend T. R. Malthus thought that population pressures would

[2] The theory in this chapter relies on an important finding from microeconomics. In analysis of the determination of wages under simplified conditions, including perfect competition, it is shown that the wage rate of labor will be equal to the extra or marginal product of the last worker hired. For example, if the last worker contributes goods worth $12.50 per hour to the firm's output, then under competitive conditions the firm will be willing to pay up to $12.50 per hour in wages to that worker. Similarly, the rent on land is the marginal product of the last unit of land, and the real interest rate will be determined by the marginal product of the least productive piece of capital.

Eye Therapies Exhibit 2127, 529 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

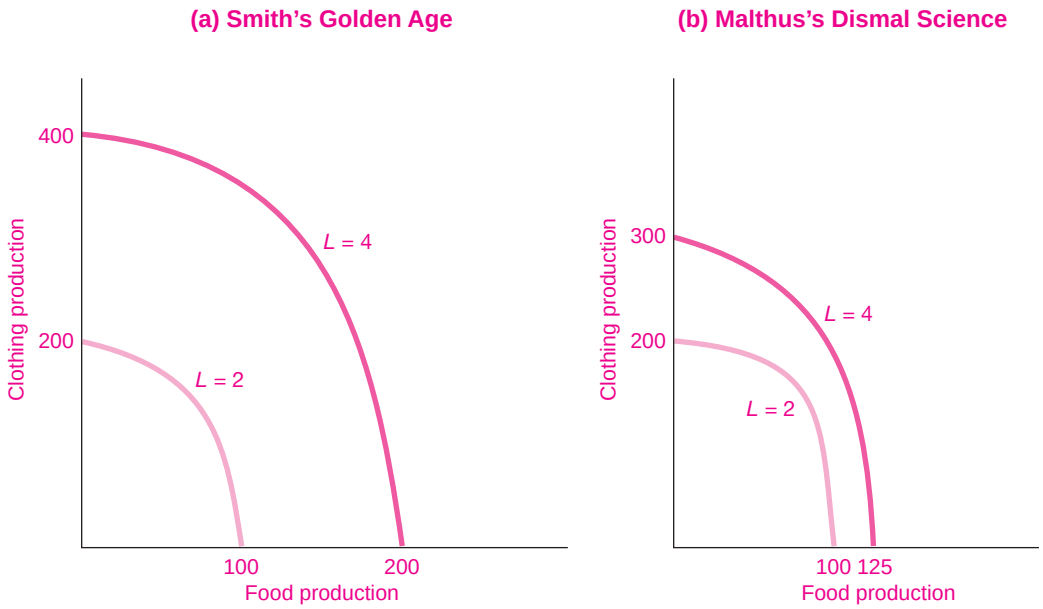


FIGURE 25-2. The Classical Dynamics of Smith and Malthus

In (**a**), unlimited land on the frontier means that when population doubles, labor can simply spread out and produce twice the quantity of any food and clothing combination. In (**b**), limited land means that increasing population from 2 million to 4 million triggers diminishing returns. Note that potential food production rises by only 25 percent with a doubling of labor inputs.

drive the economy to a point where workers were at the minimum level of subsistence. Malthus reasoned that whenever wages were above the subsistence level, population would expand; below-subsistence wages would lead to high mortality and population decline. Only at subsistence wages could there be a stable equilibrium of population. He believed the working classes were destined to a life that is brutish, nasty, and short. This gloomy picture led Thomas Carlyle to criticize economics as "the dismal science."

Figure 25-2(*a*) shows the process of economic growth in Smith's golden age. Here, as population doubles, the production-possibility frontier (*PPF*) shifts out by a factor of 2 in each direction, showing that there are no constraints on growth from land or resources. Figure 25-2(*b*) shows the pessimistic Malthusian case, where a doubling of population leads to a less-than-doubling of food and clothing, lowering per capita output, as more people crowd onto limited land and diminishing returns drive down output per person.

Economic Growth with Capital Accumulation: The Neoclassical Growth Model

Malthus's forecast was dramatically wide of the mark because he did not recognize that technological innovation and capital investment could overcome the law of diminishing returns. Land did not become the limiting factor in production. Instead, the first Industrial Revolution brought forth power-driven machinery that increased production, factories that gathered teams of workers into giant firms, railroads and steamships that linked together the far points of the world, and iron and steel that made possible stronger machines and faster locomotives. As market economies entered the twentieth century, a second Industrial Revolution grew up around the telephone, automobile, and electricity industries. Capital accumulation and new technologies became the dominant forces affecting economic development.

What will be the driving forces of economic growth in the twenty-first century? Perhaps advances

Eye Therapies Exhibit 2127, 530 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

in computation, software, and artificial intelligence will spark yet another industrial revolution. Perhaps, as some ecological pessimists warn, a present-day Malthusian specter haunts rich countries as climate change, sea-level rise, and drought-induced migrations lead to social unrest and economic decline.

To understand how capital accumulation and technological change affect the economy, we must introduce the **neoclassical model of economic growth.** This approach was pioneered by Robert Solow of MIT, who was awarded the 1987 Nobel Prize for this and other contributions to economic-growth theory. The neoclassical growth model serves as the basic tool for understanding the growth process in advanced countries and has been applied in empirical studies of the sources of economic growth.



Apostle of Economic Growth

Robert M. Solow was born in Brooklyn and educated at Harvard and then moved to the MIT Economics Department in 1950. Over the next few years he developed the neoclassical growth model and applied it in the growth-accounting framework discussed later in this chapter.

One of Solow's major studies was "A Contribution to the Theory of Economic Growth" in 1956. This was a mathematical version of the neoclassical growth model surveyed in this chapter. The importance of this study was highlighted as follows in Solow's Nobel Prize citation:

> Solow's theoretical model had an enormous impact on economic analysis. From simply being a tool for the analysis of the growth process, the model has been generalized in several different directions. It has been extended by the introduction of other types of production factors and it has been reformulated to include stochastic features. The design of dynamic links in certain "numerical" models employed in general equilibrium analysis has also been based on Solow's model. But, above all, Solow's growth model constitutes a framework within which modern macroeconomic theory can be structured.
>
> The increased interest of government to expand education and research and development was inspired by these studies. Every long-term report . . . for any country has used a Solow-type analysis.[3]

Solow has also contributed to empirical studies of economic growth, to natural-resource economics, and to the development of capital theory. In addition, Solow served as a macroeconomic adviser for the Kennedy administration.

Solow is known for his enthusiasm for economics as well as for his humor. He believed that the hunger for publicity has led some economists to exaggerate their knowledge. He criticized economists for "an apparently irresistible urge to push their science further than it will go, to answer questions more delicate than our limited understanding of a complicated question will allow. Nobody likes to say 'I don't know.'"

A lively writer, Solow worries that economics is terrifically difficult to explain to the public. At his news conference after winning the Nobel Prize, Solow quipped, "The attention span of the people you write for is shorter than the length of one true sentence." Nonetheless, Solow continues to labor for his brand of economics, and the world listens carefully to the apostle of economic growth from MIT.

[3] The citations of the committees for the Nobel Prizes in economics can be found on the Internet at *www.nobel.se/laureates.*

Basic Assumptions. The neoclassical growth model describes an economy in which a single homogeneous output is produced by two types of inputs—capital and labor. In contrast to the Malthusian analysis, labor growth is assumed to be a given. In addition, we assume that the economy is competitive and always operates at full employment, so we can analyze the growth of potential output.

The major new ingredients in the neoclassical growth model are capital and technological change. For the moment, assume that technology remains constant. Capital consists of durable produced goods that are used to make other goods. Capital goods include structures like factories and houses, equipment like computers and machine tools, and inventories of finished goods and goods in process.

For convenience, we will assume that there is a single kind of capital good (call it K). We then measure the aggregate stock of capital as the total quantity of capital goods. In our real-world calculations, we approximate the universal capital good as the total dollar value of capital goods (i.e., the constant-dollar value of equipment, structures, and inventories). If L is the number of workers, then (K/L) is equal to the quantity of capital per worker, or the *capital-labor ratio.* We can write our aggregate production function for the neoclassical growth model without technological change as $Q = F(K, L)$.

Turning now to the economic-growth process, economists stress the need for **capital deepening,** which is the process by which the quantity of capital

Eye Therapies Exhibit 2127, 531 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

per worker increases over time. Here are some examples of capital deepening: A farmer uses a mechanical orange picker instead of unskilled manual labor; a road builder uses a backhoe instead of a worker with a pick and shovel; a bank substitutes hundreds of ATM machines for human tellers. These are all examples of how the economy increases the amount of capital per worker. As a result, the output per worker has grown enormously in agriculture, road building, and banking.

What happens to the return on capital in the process of capital deepening? For a given state of technology, a rapid rate of investment in plant and equipment tends to depress the rate of return on capital.[4] This occurs because the most worthwhile investment projects get undertaken first, after which later investments become less and less valuable. Once a full railroad network or telephone system has been constructed, new investments will branch into more sparsely populated regions or duplicate existing lines. The rates of return on these later investments will be lower than the high returns on the first lines between densely populated regions.

In addition, the wage rate paid to workers will tend to rise as capital deepening takes place. Why? Each worker has more capital to work with and his or her marginal product therefore rises. As a result, the competitive wage rate rises along with the marginal product of labor.

We can summarize the impact of capital deepening in the neoclassical growth model as follows:

Capital deepening occurs when the stock of capital grows more rapidly than the labor force. In the absence of technological change, capital deepening will produce a growth of output per worker, of the marginal product of labor, and of real wages; it also will lead to diminishing returns on capital and therefore to a decline in the rate of return on capital.

Geometrical Analysis of the Neoclassical Model

We can analyze the effects of capital accumulation by using Figure 25-3. This figure shows the aggregate production function graphically by depicting output per worker on the vertical axis and capital per worker on the horizontal axis. In the background, *and held constant for the moment,* are all the other variables that were discussed at the start of this section—the amount of land, the endowment of natural resources, and, most important of all, the technology used by the economy.

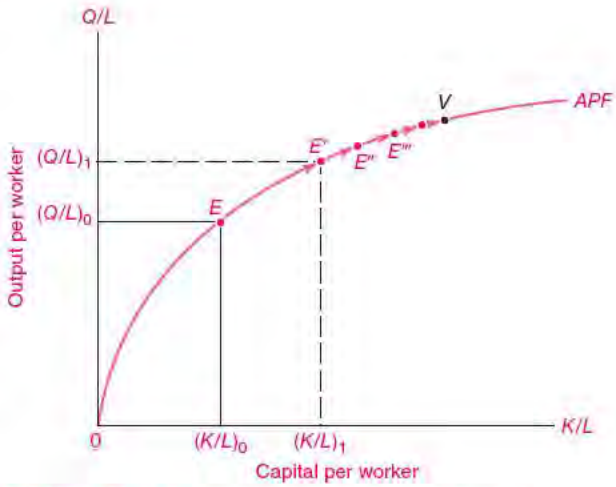


FIGURE 25-3. Economic Growth through Capital Deepening

As the amount of capital per worker increases, output per worker also increases. This graph shows the importance of "capital deepening," or increasing the amount of capital each worker has on hand. Remember, however, that other factors are held constant, such as technology, quality of the labor force, and natural resources.

What happens as the society accumulates capital? As each worker has more and more capital to work with, the economy moves up and to the right on the aggregate production function. Say that the capital-labor ratio increases, from $(K/L)_0$ to $(K/L)_1$. Then the amount of output per worker increases, from $(Q/L)_0$ to $(Q/L)_1$.

What happens to the factor prices of labor and capital? As capital deepens, diminishing returns to capital set in, so the rate of return on capital and the real interest rate fall. (The slope of the curve in Figure 25-3 is the marginal product of capital, which is seen to fall as capital deepening occurs.) Also, because each worker can work with more capital, workers' marginal productivities rise and the real wage rate consequently also rises.

[4] Under perfect competition and without risk, taxes, or inflation, the rate of return on capital is equal to the real interest rate on bonds and other financial assets.

Eye Therapies Exhibit 2127, 532 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The reverse would happen if the amount of capital per worker were to fall for some reason. For example, wars tend to reduce much of a nation's capital to rubble and lower the capital-labor ratio; after wars, therefore, we see a scarcity of capital and high returns on capital. Hence, our earlier verbal summary of the impact of capital deepening is verified by the analysis in Figure 25-3.

Long-Run Steady State. What is the long-run equilibrium in the neoclassical growth model without technological change? Eventually, the capital-labor ratio will stop rising. *In the long run, the economy will enter a steady state in which capital deepening ceases, real wages stop growing, and capital returns and real interest rates are constant.*

We can show how the economy moves toward the steady state in Figure 25-3. As capital continues to accumulate, the capital-labor ratio increases as shown by the arrows from E' to E'' to E''' until finally the capital-labor ratio stops growing at V. At that point, output per worker (Q/L) is constant, and real wages stop growing.

Without technological change, output per worker and the wage rate stagnate. This is certainly a far better outcome than the world of subsistence wages predicted by Malthus. But the long-run equilibrium of the neoclassical growth model makes it clear that if economic growth consists only of accumulating capital through replicating factories with existing methods of production, then the standard of living will eventually stop rising.

The Central Role of Technological Change

While the capital-accumulation model is a first step on the road to understanding economic growth, it leaves some major questions unanswered. To begin with, the model predicts that real wages will eventually stagnate if there is no improvement in technology. However, real wages have definitely not stagnated over the last century. Peek ahead at Figure 25-5(*c*) on page 513. This figure shows that real wages have grown by a factor of more than 8 over the last century. The simple capital-accumulation model cannot explain the tremendous growth in productivity over time, nor does it account for the tremendous differences in per capita income among countries.

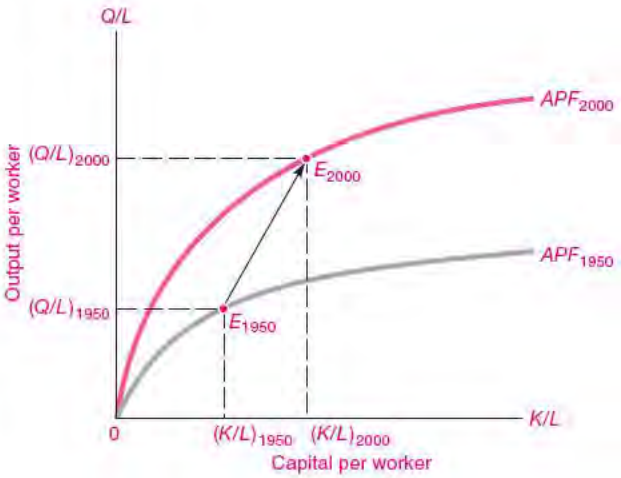


FIGURE 25-4. Technological Advance Shifts Up the Production Function

As a result of improvements in technology, the aggregate production function shifts *upward over time.* Hence improvements in technology combine with capital deepening to raise output per worker and real wages.

What is missing is technological change. We can depict technological change in our growth diagram as an upward shift in the aggregate production function, as illustrated in Figure 25-4. In this diagram, we show the aggregate production function for both 1950 and 2000. Because of technological change, the aggregate production function has shifted upward from APF_{1950} to APF_{2000}. This upward shift shows the advances in productivity that are generated by the vast array of new processes and products like electronics, Internet commerce, advances in metallurgy, improved medical technologies, and so forth.

Therefore, in addition to considering the capital deepening described above, we must also take into account advances in technology. The sum of capital deepening and technological change is the arrow in Figure 25-4, which indicates an increase in output per worker from $(Q/L)_{1950}$ to $(Q/L)_{2000}$. Instead of settling into a steady state, the economy enjoys rising output per worker, rising wages, and increasing living standards.

Of particular interest is the impact of changing technologies on rates of profit and real interest

Eye Therapies Exhibit 2127, 533 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

rates. As a result of technological progress, the real interest rate need not fall. Invention increases the productivity of capital and offsets the tendency for a falling rate of profit.

Technological Change as an Economic Output

Up to now we have treated technological change as something that floats mysteriously down from scientists and inventors like manna from heaven. Recent research on economic growth has begun to focus on the *sources of technological change*. This research, sometimes called *new growth theory* or the "theory of endogenous technological change," seeks to uncover the processes by which private market forces, public-policy decisions, and alternative institutions lead to different patterns of technological change.

One important point is that technological change is an output of the economic system. Edison's lightbulb was the result of years of research into different lightbulb designs; the transistor resulted from the efforts of scientists in Bell Labs to find a process that would improve telephone switching devices; pharmaceutical companies spend hundreds of millions of dollars developing and testing new drugs. Those who are talented and lucky may earn supernormal profits, or even become billionaires like Bill Gates of Microsoft, but many are the disappointed inventors or companies that end up with empty pockets.

The other unusual feature of technologies is that they are public goods, or "nonrival" goods in technical language. This means that they can be used by many people at the same time without being used up. A new computer language, a new miracle drug, a design for a new steelmaking process—I can use each of these without reducing its productivity for you and the British and the Japanese and everyone else. In addition, inventions are expensive to produce but inexpensive to reproduce. These features of technological change can produce severe market failures, which means that inventors sometimes have great difficulty profiting from their inventions because other people can copy them.

The market failures are largest for the most basic and fundamental forms of research. Public policy has an important role to play here. First, governments generally support basic science through government grants and research facilities. Without government and not-for-profit support, basic research in mathematics, the natural sciences, and the social sciences would wither away. Additionally, governments must be careful to ensure that profit-oriented inventors have adequate incentives to engage in research and development. Governments increasingly pay attention to *intellectual property rights,* such as patents and copyrights, to provide adequate market rewards for creative activities.

What is the major contribution of new growth theory? It has changed the way we think about the growth process and public policies. If technological differences are the major reason for differences in living standards among nations, and if technology is a produced factor, then economic-growth policy should focus much more sharply on how nations can improve their technological performance. This is just the lesson drawn by Stanford's Paul Romer, one of the leaders of new growth theory:

> Economists can once again make progress toward a complete understanding of the determinants of long-run economic success. Ultimately, this will put us in position to offer policymakers something more insightful than the standard neoclassical prescription—more saving and more schooling. We will be able to rejoin the ongoing policy debates about tax subsidies for private research, antitrust exemptions for research joint ventures, the activities of multinational firms, the effects of government procurement, the feedback between trade policy and innovation, the scope of protection for intellectual property rights, the links between private firms and universities, the mechanisms for selecting the research areas that receive public support, and the costs and benefits of an explicit government-led technology policy.[5]

To summarize:

Technological change—which increases output produced for a given bundle of inputs—is a crucial ingredient in the growth of nations. The new growth theory seeks to uncover the processes which generate technological change. This approach emphasizes that technological change is an output that is subject to severe market failures because technology is a public good that is expensive to produce but cheap to reproduce. Governments increasingly seek to provide strong intellectual property rights for those who develop new technologies.

[5] See Paul Romer in this chapter's Further Reading section.

Eye Therapies Exhibit 2127, 534 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

B. THE PATTERNS OF GROWTH IN THE UNITED STATES

The Facts of Economic Growth

The first part of this chapter described the basic theories of economic growth. But economists have not been content to rest with theory. A major research area all around the world has been measuring the different components of the economic-growth process and applying them to the important theories. An understanding of the patterns of economic growth will help sort out the reasons that some nations prosper while others decline.

Figure 25-5 depicts the key trends of economic development for the United States since the start of the twentieth century. Similar patterns have been found in most of the major industrial countries.

Figure 25-5(*a*) shows the trends in real GDP, the capital stock, and population. Population and employment have more than tripled since 1900. At the same time, the stock of physical capital has risen by a factor of 14. Thus, the amount of capital per worker (the K/L ratio) has increased by a factor of more than 4. Clearly, capital deepening has been an important feature of twentieth- and early-twenty-first-century American capitalism.

What about the growth in output? In a world without technological change, output growth would be somewhere between labor growth and capital growth. In fact, the output curve in Figure 25-5(*a*) is not in between the two factor curves, but actually lies above both curves. This indicates that technological progress must have increased the productivity of capital and labor.

For most people, an economy's performance is measured by their wages, salaries, and fringe benefits. This is shown in Figure 25-5(*c*) in terms of real hourly compensation (or wages and fringe benefits corrected for inflation). Hourly earnings have grown impressively for most of the post-1900 period, as we would expect from the growth in the capital-labor ratio and from steady technological advance.

The real interest rate (which is calculated as the interest rate on long-term Treasury securities corrected for inflation) is shown in Figure 25-5(*d*). The rate of profit on capital is larger than this risk-free interest rate to reflect risk and taxes, but it shows a similar pattern. Real interest rates and profit rates fluctuated greatly in business cycles and wars but have displayed no strong upward or downward trend over the whole period. Either by coincidence or because of an economic mechanism inducing this pattern, technological change has largely offset diminishing returns to capital.

Output per worker-hour is the solid blue curve in Figure 25-5(*c*). As could be expected from the deepening of capital and from technological advance, output per worker has risen steadily.

The fact that wages rise at the same rate as output per worker does not mean that labor has captured all the fruits of productivity advance. Rather, it means that labor has kept about the same *share* of total product, with capital also earning about the same relative share throughout the period. A close look at Figure 25-5(*c*) shows that real wages have grown at about the same rate as output per worker since 1900. More precisely, the average growth rate of real wages was 1.8 percent per year, while that of output per worker was 2.2 percent per year. These figures imply that labor's share of national income (and therefore also property's share) was near-constant over the last century.



Seven Basic Trends of Economic Growth

Economists studying the economic history of advanced nations have found that the following trends apply in most countries:

1. The capital stock has grown more rapidly than population and employment, resulting from capital deepening.
2. For most of the period since 1900, there has been a strong upward trend in real average hourly earnings.
3. The share of labor compensation in national income has been remarkably stable over the last century.
4. There were major oscillations in real interest rates and the rate of profit, particularly during business cycles, but there has been no strong upward or downward trend over the post-1900 period.
5. Instead of steadily rising, which would be predicted by the law of diminishing returns with unchanging technology, the capital-output ratio has actually declined since the start of the twentieth century.
6. For most of the period since 1900, the ratios of national saving and of investment to GDP were stable. Since

Eye Therapies Exhibit 2127, 535 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

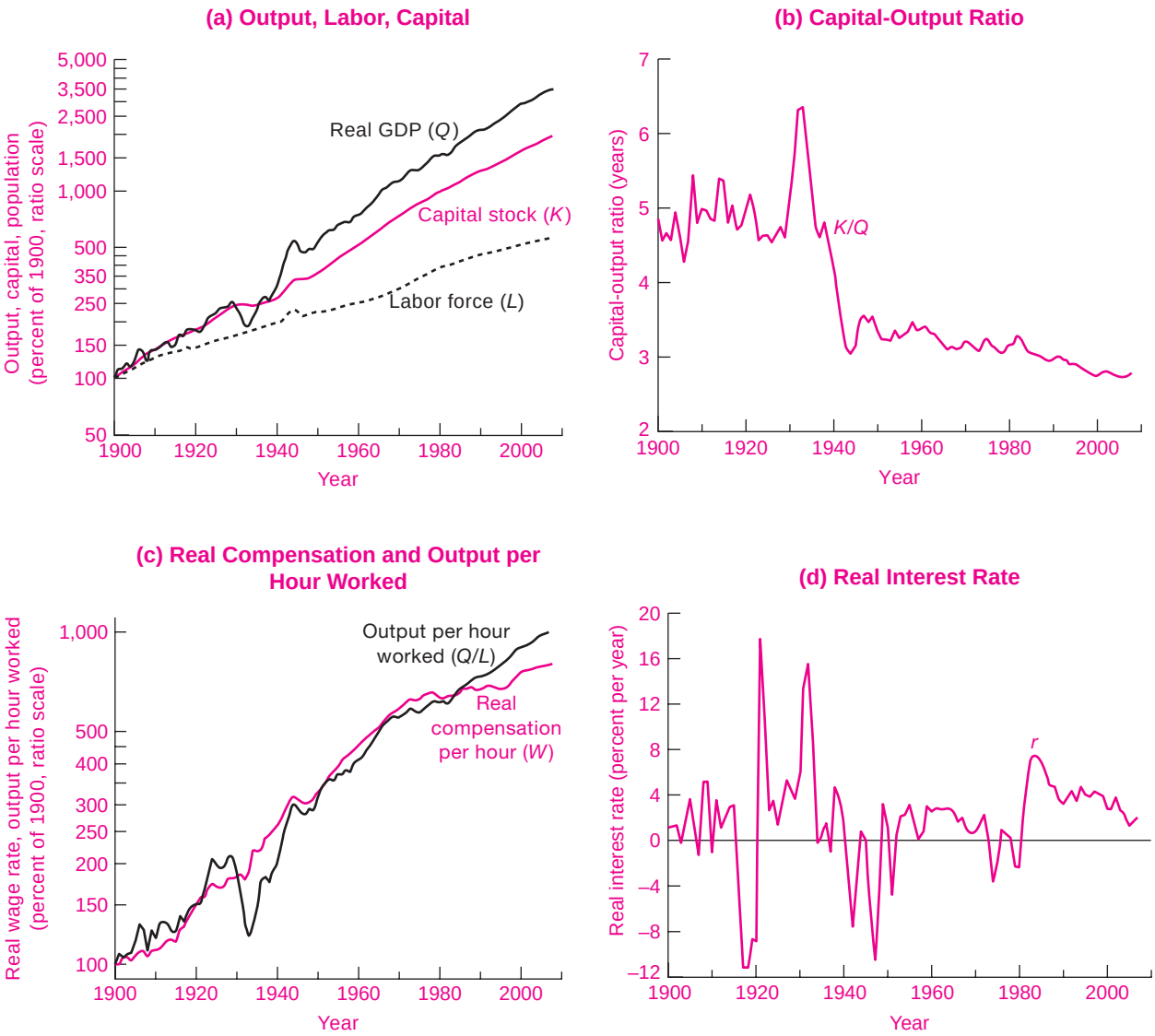


FIGURE 25-5. Economic Growth Displays Striking Regularities

(a) The capital stock has grown faster than population and labor supply. Nonetheless, total output has grown even more rapidly than capital because of improving technology. **(b)** The capital-output ratio dropped sharply during the first half of the twentieth century and has declined slowly since then. **(c)** Real earnings have grown steadily and at almost the same rate as average product per worker-hour over the entire period. **(d)** The real interest rate has been trendless since 1900, suggesting that technological change has offset diminishing returns to capital accumulation.

Source: U.S. Departments of Commerce and Labor, Federal Reserve Board, U.S. Bureau of the Census, and Susan Carter et al., *Historical Statistics of the United States: Millennial Edition* (Cambridge University Press, Cambridge, U.K., 2006), available online.

Eye Therapies Exhibit 2127, 536 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

1980, the national saving rate has declined sharply in the United States.

7. After effects of the business cycle are removed, national product has grown at an average rate of 3.3 percent per year. Output growth has been much higher than a weighted average of the growth of capital, labor, and resource inputs, suggesting that technological innovation must be playing a key role in economic growth.

Relationship of the Seven Trends to Economic-Growth Theories

While the seven trends of economic history are not like the immutable laws of physics, they do portray fundamental facts about growth in the modern era. How do they fit into our economic-growth theories?

Trends 2 and 1—higher wage rates when capital deepens—fit nicely into our neoclassical growth model shown in Figure 25-3. Trend 3—that the wage share has been remarkably stable—is an interesting coincidence that is consistent with a wide variety of production functions relating Q to L and K.

Trends 4 and 5, however, show us that technological change must be playing a role here, so Figure 25-4, with its picture of advancing technology, is more realistic than the steady state depicted in Figure 25-3. A steady profit rate and a declining, or steady, capital-output ratio cannot hold if the K/L ratio rises in a world with unchanging technology; taken together, they contradict the basic law of diminishing returns under deepening of capital. We must therefore recognize the key role of technological progress in explaining the seven trends of modern economic growth. Our models confirm what our intuition suggests.

The Sources of Economic Growth

We have seen that advanced market economies grow through increases in labor and capital and by technological change as well. But what are the relative contributions of labor, capital, and technology? To answer this question, we turn to an analysis of the quantitative aspects of growth and of the useful approach known as growth accounting. This approach is the first step in the quantitative analysis of economic growth for any country.

The Growth-Accounting Approach. Detailed studies of economic growth rely on what is called **growth accounting.** This technique is not a balance sheet or national product account of the kind we met in earlier chapters. Rather, it is a way of separating out the contributions of the different ingredients driving observed growth trends.

Growth accounting usually begins with the aggregate production function we met earlier in this chapter, $Q = AF(K, L, R)$. Often resources are omitted because land is constant. Using elementary calculus and some simplifying assumptions, we can express the growth of output in terms of the growth of the inputs plus the contribution of technological change. Growth in output (Q) can be decomposed into three separate terms: growth in labor (L) times its weight, growth in capital (K) times its weight, and technological change itself (T.C.).

Momentarily ignoring technological change, an assumption of constant returns to scale means that a 1 percent growth in L together with a 1 percent growth in K will lead to a 1 percent growth in output. But suppose L grows at 1 percent and K at 5 percent. It is tempting, but wrong, to guess that Q will then grow at 3 percent, the simple average of 1 and 5. Why is this wrong? Because the two factors do not necessarily contribute equally to output. Rather, the fact that three-fourths of national income goes to labor while only one-fourth goes to capital suggests that labor growth will contribute more to output than will capital growth.

If labor's growth rate gets 3 times the weight of capital's growth, we can calculate the answer as follows: Q will grow at 2 percent per year (= ¾ of 1 percent + ¼ of 5 percent). To growth of inputs, we add technological change and thereby obtain all the sources of growth.

Hence, output growth per year follows the *fundamental equation of growth accounting:*

$$\%\ Q\ \text{growth} = \tfrac{3}{4}\ (\%\ L\ \text{growth}) + \tfrac{1}{4}\ (\%\ K\ \text{growth}) + \text{T.C.} \qquad (1)$$

where "T.C." represents technological change (or total factor productivity) that raises productivity and where ¾ and ¼ are the relative contributions of each input to economic growth. Under conditions of perfect competition, these fractions are equal to the shares of national income of the two factors; naturally, these fractions would be replaced by new fractions if the relative shares of the factors were to change or if other factors were added.

Eye Therapies Exhibit 2127, 537 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

To explain per capita growth, we can eliminate L as a separate growth source. Now, using the fact that capital gets one-fourth of output, we have from equation (1)

$$\%\frac{Q}{L}\text{ growth} = \%\ Q\text{ growth} - \%\ L\text{ growth} = \tfrac{1}{4}\left(\%\frac{K}{L}\text{growth}\right) + \text{T.C.} \quad (2)$$

This relation shows clearly how capital deepening would affect per capita output if technological advance were zero. Output per worker would grow only one-fourth as fast as capital per worker, reflecting diminishing returns.

One final point remains: We can measure Q growth, K growth, and L growth, as well as the shares of K and L. But how can we measure T.C. (technological change)? We cannot. Rather, we must *infer* T.C. as the residual or leftover after the other components of output and inputs are calculated. We can therefore calculate technological change (or total factor productivity) by rearranging the terms in equation (1) as follows:

$$\text{T.C.} = \%\ Q\text{ growth} - \tfrac{1}{4}\ (\%\ L\text{ growth}) - \tfrac{1}{4}\ (\%\ K\text{ growth}) \quad (3)$$

This equation allows us to answer critically important questions about economic growth. What part of per capita output growth is due to capital deepening, and what part is due to technological advance? Does society progress chiefly by dint of thrift and the foregoing of current consumption? Or is our rising living standard the reward for the ingenuity of inventors and the daring of innovator-entrepreneurs?

Numerical Example. To determine the contributions of labor, capital, and other factors to output growth, we substitute representative numbers for the period 1900–2008 into equation (2) for the growth of Q/L. Since 1900, hours worked have grown 1.4 percent per year, and K has grown 2.6 percent per year, while Q has grown 3.3 percent per year. Thus, by arithmetic, we find that

$$\%\frac{Q}{L}\text{growth} = \tfrac{1}{4}\left(\%\frac{K}{L}\text{growth}\right) + \text{T.C.}$$

becomes

$$1.9 = \tfrac{1}{4}\,(1.2) + \text{T.C.} = 0.3 + 1.6$$

Thus of the 1.9 percent-per-year increase in output per hour worked, about 0.3 percentage point is due to capital deepening, while the largest portion, 1.6 percent per year, stems from T.C. (technological change).

Detailed Studies. More thorough studies refine the simple calculation but show quite similar conclusions. Table 25-3 presents the results of studies by

Contribution of Different Elements to Growth in Real GDP, United States, 1948–2007

	In percent per year	As percent of total
Real GDP growth (private business sector)	**3.52**	**100**
Sources of growth:		
Contribution of inputs	**2.14**	**61**
Capital	1.21	34
Labor	0.94	27
Total factor productivity growth (research and development, education, advances in knowledge, and other sources)	**1.39**	**39**

TABLE 25-3. Advances in Knowledge Outweigh Capital in Contributing to Economic Growth

Using the techniques of growth accounting, studies break down the growth of GDP in the private business sector into contributing factors. Recent comprehensive studies find that capital growth accounted for 34 percent of output growth. Education, research and development, and other advances in knowledge made up 39 percent of total output growth and more than half of the growth of output per unit of labor.

Source: U.S. Department of Labor, "Historical Multifactor Productivity Measures (SIC 1948–87 Linked to NAICS 1987–2007)," at *www.bls.gov/mfp/home.htm.*

Eye Therapies Exhibit 2127, 538 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the Department of Labor for the 1948–2007 period. During this time, output (measured as gross output of the private business sector) grew at an average rate of 3.5 percent per year, while input growth (of capital, labor, and land) contributed 2.1 percentage points per year. Hence **total factor productivity**—the growth of output less the growth of the weighted sum of all inputs, or what we have called T.C.—averaged 1.4 percent annually.

About 60 percent of the growth in output in the United States can be accounted for by the growth in labor and capital. The remaining 40 percent is a residual factor that can be attributed to education, research and development, innovation, economies of scale, advances in knowledge, and other factors.

Other countries show different patterns of growth. For example, scholars have used growth accounting to study the Soviet Union, which grew rapidly during the period from 1930 until the mid-1960s. It appears, however, that the high growth rate came primarily from forced-draft increases in capital and labor inputs. For the last few years of the U.S.S.R.'s existence, productivity actually *declined* as the central-planning apparatus became more dysfunctional, as corruption deepened, and as incentives worsened. The estimated growth of total factor productivity for the Soviet Union over the half-century before its collapse was slower than that for the United States and other major market economies. Only the ability of the central government to divert output into investment (and away from consumption) offset the system's inefficiency.

RECENT TRENDS IN PRODUCTIVITY

A careful look at productivity trends indicates that there are sharp movements from year to year as well as long swings. The growth of labor productivity is shown in Figure 25-6. Productivity grew briskly from World War II until the late 1960s.

Then, beginning around 1973, there were several years of poor performance, and even decline. Surveys of this period indicate that the poor productivity record stemmed from the sharp increases in



FIGURE 25-6. Labor Productivity Growth in U.S. Business, 1948–2008

Labor productivity grew rapidly until the troubled 1970s and then declined. Bolstered by impressive gains in information technology, especially computers, productivity growth has rebounded over the last decade.

Source: Bureau of Labor Statistics. Data were downloaded from the St. Louis Fed database at *research.stlouisfed.org/fred2*.

Eye Therapies Exhibit 2127, 539 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Productivity and Real Wages

Period	Average Annual Percentage Growth in: Labor productivity	Real wages
1948–1973	3.1	3.3
1973–1995	1.3	1.5
1995–2008	2.6	2.6

TABLE 25-4. Real Wages Mirror Productivity Growth

Over the long run, real wages tend to move with trends in labor productivity. After the productivity slowdown in 1973, real wage growth slowed sharply.

Source: U.S. Department of Labor. Productivity is for the U.S. business sector; nominal compensation is deflated using the price index for private business.

oil prices, increasing stringency of regulations, and impacts of price and wage controls and pervasive regulation of the energy industries, as well as a slowdown in research and development spending.

Economists worry about productivity because of its close association with growth in real wages and living standards. Figure 25-5(*c*) showed how growth in real wages has tracked productivity per hour worked since 1900. This point is presented quantitatively in Table 25-4. Some elementary arithmetic shows that if labor's share of national income is constant, this implies that real wages will grow at the rate of growth of labor productivity.[6]

The Productivity Rebound

Economists have been waiting for an upturn in productivity growth, hoping that the revolution in information technology would spur rapid growth throughout the economy. Indeed, innovations in information technology (computer hardware, software, and communications) have produced astonishing improvements in every corner of the economy. The prices of computers have fallen more than a thousandfold in the last three decades. Electronic mail and the Internet are changing the face of retailing. Computers are the nerve system of business—running airline pricing and reservation systems, scanning price and quantity data in stores, dispatching electricity, clearing checks, dunning taxpayers, and sending students their tuition bills. Some economists think that computers are like a new fourth factor of production.

The impact of the computer revolution became apparent in the productivity statistics beginning around 1995. Having grown slowly during the 1973–1995 period, labor productivity then surged ahead at 2.6 percent per year from 1995 to 2008.

As is predicted by the model with constant income shares, real compensation moved in parallel with labor productivity (see Table 25-4). Real wages grew at an average rate of 3.3 percent from 1948 to 1973, slowed to 1.5 percent per year from 1973 to 1995, and then increased sharply to 2.6 percent from 1995 to 2008.

Enthusiasts spoke of a "new era" and a "brave new world of American capitalism." Fed chair Alan Greenspan, known for his Delphic pronouncements, joined the technological enthusiasts, arguing, "A perceptible quickening in the pace at which technological innovations are applied argues for the hypothesis that the recent acceleration in labor productivity is not just a cyclical phenomenon or a statistical aberration, but reflects, at least in part, a more deep-seated, still developing, shift in our economic landscape."

Economists who have looked at the numbers under a statistical microscope have uncovered some interesting facts about the productivity rebound. Among the important factors are the following:

- *Productivity explosion in computers.* The productivity explosion (and consequent price decline) in computers has been extraordinary. Economists who have studied computer technology estimate that the growth of productivity in this sector has been between 20 and 30 percent per year. This became economically important as computers penetrated ever deeper into the U.S. economy. By the late 1990s, production of information technology was contributing almost half of all productivity growth, although that slowed sharply after the bursting of the technology bubble in 2000.

[6] To see this relationship, write labor's share as $W \times L = s \times P \times Q$, where s = labor's share, W = money wage rate, L = hours of work, P = price index, and Q = output. Dividing both sides by L and P yields $(W/P) = s \times (Q/L)$, which signifies that the real wage equals labor's share times labor productivity. Hence, if the share of labor of national income is constant, real wages will grow at the same rate as labor productivity.

Eye Therapies Exhibit 2127, 540 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

- *Capital deepening.* There has been a very sharp increase in investment since 1995. Companies invested heavily in computers and software to take advantage of their falling prices and the increasing power of new software.
- *Unmeasured outputs.* Many of the advances of the new economy have not been captured by the productivity statistics. The phenomenal advances of the Internet, e-mail, and cellular phones are largely missed in the productivity statistics. Some economists have found that productivity is significantly underestimated for software and communications equipment (see the discussion of price measurement in Chapter 20). Or consider, the time that consumers save by shopping on the Internet, the saving of time and postage involved in the switch from snail-mail to e-mail, and the convenience of cellular telephones—none of these shows up in measured productivity. Others think the true gains from computers lie in the future. Stanford economic historian Paul David, who has studied past inventions, believes that it takes decades for the economy to reap the full benefits of fundamental inventions.

Whether or not the more rapid productivity growth is a permanent feature of our economy, it is clear that computers continue to shape our economy and our lives in surprising ways.

This concludes our introduction to the principles of economic growth. The next chapter applies these principles to the struggle of poor countries to improve their living standards. In the remaining chapters in this part, we open our inquiry to international trade and finance.



SUMMARY

A. Theories of Economic Growth

1. The analysis of economic growth examines the factors that lead to the growth of potential output over the long run. The growth in output per capita is an important objective of government because it is associated with rising average real incomes and living standards.
2. Reviewing the experience of nations over space and time, we see that the economy rides on the four wheels of economic growth: (*a*) the quantity and quality of its labor force; (*b*) the abundance of its land and other natural resources; (*c*) the stock of accumulated capital; and, perhaps most important, (*d*) the technological change and innovation that allow greater output to be produced with the same inputs. There is no unique combination of these four ingredients, however; the United States, Europe, and Asian countries have followed different paths to economic success.
3. The classical models of Smith and Malthus describe economic development in terms of land and population. In the absence of technological change, increasing population ultimately exhausts the supply of free land. The resulting increase in population density triggers the law of diminishing returns, so growth produces higher land rents with lower competitive wages. The Malthusian equilibrium is attained when the wage rate has fallen to the subsistence level, below which population cannot sustain itself. In reality, however, technological change has allowed long-term growth in real wages and productivity per worker in most countries by continually shifting the productivity curve of labor upward.
4. Capital accumulation with complementary labor forms the core of modern growth theory in the neoclassical growth model. This approach uses a tool known as the aggregate production function, which relates inputs and technology to total potential GDP. In the absence of technological change and innovation, an increase in capital per worker (capital deepening) would not be matched by a proportional increase in output per worker because of diminishing returns to capital. Hence, capital deepening would lower the rate of return on capital (equal to the real interest rate under risk-free competition) while raising real wages.
5. Technological change increases the output producible with a given bundle of inputs. This pushes upward the aggregate production function, making more output available with the same inputs of labor and capital. Recent analysis in the "new growth theory" seeks to uncover the processes which generate technological change. This approach emphasizes (*a*) that technological change is an output of the economic system, (*b*) that technology is a public or nonrival good that can be used simultaneously by many people, and (*c*) that new inventions are expensive to produce but

Eye Therapies Exhibit 2127, 541 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

inexpensive to reproduce. These features mean that governments must pay careful attention to ensuring that inventors have adequate incentives, through strong intellectual property rights, to engage in research and development.

B. The Patterns of Growth in the United States

6. Numerous trends of economic growth are seen in data for the twentieth and early twenty-first centuries. Among the key findings are that real wages and output per hour worked have risen steadily; that the real interest rate has shown no major trend; and that the capital-output ratio has declined. The major trends are consistent with the neoclassical growth model augmented by technological advance. Thus economic theory confirms what economic history tells us—that technological advance increases the productivity of inputs and improves wages and living standards.
7. The last trend, continual growth in potential output since 1900, raises the important question of the sources of economic growth. Applying quantitative techniques, economists have used growth accounting to determine that "residual" sources—such as technological change and education—outweigh capital deepening in their impact on GDP growth and labor productivity.
8. After 1970, productivity growth slowed under the weight of energy-price increases, increasing environmental regulation, and other structural changes. In the late 1990s, however, the explosion of productivity and the investment in computers and other information technologies have led to a sharp upturn in measured productivity growth.

CONCEPTS FOR REVIEW

four wheels of growth:
- labor
- resources
- capital
- technology

aggregate production function
Smith's golden age
capital-labor ratio
Malthus's subsistence wage
neoclassical growth model
K/L rise as capital deepens
new growth theory
technology as a produced good
seven trends of economic growth
growth accounting:
- % Q growth = ¾ (% L growth) + 1/4 (% K growth) + T.C.
- % Q/L growth = ¼ (% K/L growth) + T.C.

FURTHER READING AND INTERNET WEBSITES

Further Reading

One of the best surveys of economic growth is Robert Solow, *Economic Growth* (Oxford University Press, Oxford, U.K., 1970). See his pathbreaking article, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics,* 1956. The text reference is William Baumol, "Entrepreneurship: Productive, Unproductive, and Destructive," *Journal of Political Economy,* October 1990, pp. 893–921.

You may want to read some excellent books on economic growth. David N. Weil, *Economic Growth* (Pearson, Addison-Wesley, New York, 2006) is an advanced survey of the subject. David Warsh is an excellent economic journalist; his *Knowledge and the Wealth of Nations* (Norton, New York, 2006) explores the origins of the new growth theory. Benjamin Friedman, *The Moral Consequences of Economic Growth* (Knopf, New York, 2006) explores the moral and historical dimensions of economic growth, with some surprising conclusions.

Websites

A website devoted to economic growth is maintained by Jonathan Temple of Oxford, *www.bristol.ac.uk/Depts/Economics/Growth/*, and contains many references and links, as well as access to growth data. The articles by Solow and Baumol are available at *www.jstor.org*.

Technological change is often associated with particular inventions. The lives and patents of great inventors can be found at *www.invent.org/hall_of_fame/1_0_0_hall_of_fame.asp*.

Eye Therapies Exhibit 2127, 542 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

QUESTIONS FOR DISCUSSION

1. **Reminder on compound growth:** Like financial economics, economic growth theory and measurement rely on calculations of growth rates. The one-period growth rate in percent per year is

$$g_t = 100 \times \left(\frac{x_t}{x_{t-1}} - 1 \right)$$

Similarly, the n-period growth rate in percent per year is calculated as

$$g_t^{(n)} = 100 \times \left[\left(\frac{x_t}{x_{t-n}} \right)^{1/n} - 1 \right]$$

   a. Now look back to the table of macroeconomic data in the Appendix to Chapter 19. Calculate the annual growth rate of real GDP for 1980–1981 and 1980–1982.
   b. Next, calculate the growth of labor productivity from 1995 to 2000, assuming the following shows indexes of real output and labor inputs.

Year	Labor inputs	Output
1995	100.00	100.00
2000	110.29	126.16

2. "If the government strengthens intellectual property rights, subsidizes basic science, and controls business cycles, we will see economic growth that would astound the classical economists." Explain what the writer meant by this statement.
3. "With zero population growth and no technological change, persistent capital accumulation would ultimately destroy the capitalist class." Explain why such a scenario might lead to a zero real interest rate and to a disappearance of profits.
4. Recall the growth-accounting equation [equation (1) on page 514]. Calculate the growth of output if labor grows at 1 percent per year, capital grows at 4 percent per year, and technological change is 1½ percent per year.
   How would your answer change if:
   a. Labor growth slowed to 0 percent per year?
   b. Capital growth increased to 5 percent per year?
   c. Labor and capital had equal shares in GDP?
   Also, calculate for each of these conditions the rate of growth of output per hour worked.
5. Use the *PPF* to illustrate the Malthusian prediction and why it is flawed. Put per capita food production on one axis and per capita manufactures on the other. Assume that there are diminishing returns to labor in food production but that manufactures have constant returns to labor.
6. **Advanced problem for those who know calculus:** Those who understand calculus can easily grasp the essentials of the growth-accounting framework of this chapter. We rely for this problem on the important Cobb-Douglas production function. This is a specific algebraic formula that is written as $Q_t = A_t K_t^{\alpha} L_t^{(1-\alpha)}$. It is widely used in empirical studies.
   a. Show that the growth rate of output is given by

$$g(Q_t) = g(A_t) + \alpha g(K_t) + (1 - \alpha)\, g(L_t)$$

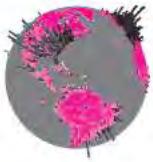
   where $g(x_t)$ is the growth rate of that variable.
   b. Advanced courses will show that under perfect competition, α = the share of capital in national income and $(1 - \alpha)$ = labor's share. If the share of labor in national income is 75 percent, derive the growth-accounting equation in the text.
7. **Advanced problem:** Many fear that computers will do to humans what tractors and cars did to horses—the horse population declined precipitously early in this century after technological change made horses obsolete. If we treat computers as a particularly productive kind of K, what would their introduction do to the capital-labor ratio in Figure 25-3? Can total output go down with a fixed labor force? Under what conditions would the real wage decline? Can you see why the horse analogy might not apply?

Eye Therapies Exhibit 2127, 543 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

26

The Challenge of Economic Development



I believe in materialism. I believe in all the proceeds of a healthy materialism—good cooking, dry houses, dry feet, sewers, drain pipes, hot water, baths, electric lights, automobiles, good roads, bright streets, long vacations away from the village pump, new ideas, fast horses, swift conversation, theaters, operas, orchestras, bands—I believe in them all for everybody. The man who dies without knowing these things may be as exquisite as a saint, and as rich as a poet; but it is in spite of, not because of, his deprivation.

Francis Hackett

Planet Earth today contains people at vastly different living standards. At one end are the affluent of North America and Western Europe, where the richest 1 percent of the people enjoy about 20 percent of world income and consumption. At the other extreme are the destitute of Africa and Asia—1 billion people living in absolute poverty, with few comforts, seldom knowing where the next meal will come from.

What causes the great differences in the wealth of nations? Can the world peacefully survive with such poverty in the midst of plenty? What steps can poorer nations take to improve their living standards? What are the responsibilities of affluent countries?

These questions concerning the obstacles facing developing countries are among the greatest challenges facing modern economics. It is here that the tools of economics can make the greatest difference in people's daily lives. It is here that economics can literally make the difference between life and death. We begin with an analysis of population and then describe the characteristics of developing countries. The second part of this chapter examines alternative approaches to economic growth in developing countries, particularly the more successful models in Asia along with the failed communist experiment in Russia.

A. POPULATION GROWTH AND DEVELOPMENT

MALTHUS AND THE DISMAL SCIENCE

Can technology keep pace with population growth in poor countries? Is Africa doomed to live on the ragged edge of subsistence because of its high birth rate and the burden of diseases like AIDS? These

Eye Therapies Exhibit 2127, 544 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

questions have been a prominent part of economics for almost two centuries.

Economic analysis of population dates back to the Reverend T. R. Malthus, whom we met in the context of the analysis of economic growth in the last chapter. Malthus developed his views while arguing against his father's perfectionist opinion that the human race was always improving. Finally, the son became so agitated that he wrote *An Essay on the Principle of Population* (1798), which was a best-seller and has since influenced the thinking of people all over the world about population and economic growth.

Malthus began with the observation of Benjamin Franklin that in the American colonies, where resources were abundant, population tended to double every 25 years or so. He then postulated a universal tendency for population—unless checked by limited food supply—to grow exponentially, or by a geometric progression. Eventually, a population which doubles every generation—1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, . . .—becomes so large that there is not enough space in the world for all the people to stand.

After invoking exponential growth, Malthus had one further argument. At this point he unleashed the devil of diminishing returns. He argued that, because land is fixed, the supply of food would tend to grow only at an arithmetic progression. It could not keep pace with the exponential growth (or geometric progression) of labor. (Compare 1, 2, 3, 4, . . . , with 1, 2, 4, 8, . . .). We paraphrase Malthus's gloomy conclusions as follows:

> As population doubles and redoubles, it is as if the globe were halving and halving again in size—until finally it has shrunk so much that food production is below the level necessary to support the population.

When the law of diminishing returns is applied to a fixed supply of land, food production tends not to keep up with a population's geometric-progression rate of growth.

Actually, Malthus did not say that population would *necessarily* increase at a geometric rate. This was only its tendency if unchecked. He described the checks that operate, in all times and places, to hold population down. In his first edition, he stressed the "positive" checks that increase the death rate: pestilence, famine, and war. Later, he held out hope that population growth could be slowed by "moral restraint" such as abstinence and postponed marriages.

This important application of diminishing returns illustrates the profound effects that a simple theory can have. Malthus's ideas had wide repercussions. His book was used to support a stern revision of the English poor laws. Under the influence of Malthus's writings, people argued that poverty should be made as uncomfortable as possible. In this view, the government cannot improve the welfare of the poor population because any increase in the incomes of the poor would only cause workers to reproduce until all were reduced to a bare subsistence.



Compound Interest and Exponential Growth

Let us pause for a reminder on exponential growth and compound interest, which are important tools in economics. Exponential (or geometric) growth occurs when a variable increases at a constant proportional rate from period to period. Thus, if a population of 200 is growing at 3 percent per year, it would equal 200 in year 0, 200×1.03 in year 1, $200 \times 1.03 \times 1.03$ in year 2, . . . , $200 \times (1.03)^{10}$ in year 10, and so on.

When money is invested continuously, it earns compound interest, meaning that interest is earned on past interest. Money earning compound interest grows geometrically. An intriguing calculation is to determine how much the $26 received by the Indians for Manhattan Island would, if deposited at compound interest, be worth today. Say that this fund was placed in an endowment that earned 6 percent each year from 1626. It would be worth $136 billion in 2010.

A useful rule about compound interest is the **rule of 70,** which states that a magnitude growing at a rate of g per year will double in $(70/g)$ years. For example, a human population growing at 2 percent per year will double in 35 years, whereas if you invest your funds at 7 percent per year, the funds will double in value every 10 years.

Flawed Prophecies of Malthus. Despite Malthus's careful statistical studies, demographers today think that his views were oversimplified. In his discussion of diminishing returns, Malthus did not anticipate the technological miracle of the Industrial Revolution; nor did he understand that the birth-control movement and new technologies would provide families with the capability to reduce the birth rate. In fact, population growth in most Western nations began to

Eye Therapies Exhibit 2127, 545 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

decline after 1870 just as living standards and real wages grew most rapidly.

In the century following Malthus, technological advance shifted out the production-possibility frontiers of countries in Europe and North America. Technological change outpaced population, resulting in a rapid rise in real wages. Nevertheless, the germs of truth in Malthus's doctrines are still important for understanding population trends in some poor countries where the race between population and food supply continues today.

Population Implosion? Before we turn to issues facing poor countries, it is important to recognize that the problem facing many rich countries is *declining population growth,* not population explosion. Virtually every rich country in the world today has zero or negative native population growth, meaning that the average number of adult children per woman is 2 or less. Population in most advanced countries is today growing only because of immigration. Stable or declining population with increasing life expectancy puts great stress on countries' fiscal conditions because of the need to fund health care and public pensions.

Limits to Growth and Neo-Malthusianism

Often, earlier ideas reemerge in light of new social trends or scientific findings. Again and again, neo-Malthusian ideas have surfaced as many antigrowth advocates and environmentalists argue that economic growth is limited due to the finiteness of our natural resources and because of environmental constraints.

Worries about the viability of growth emerged prominently in the early 1970s with a series of studies by an ominous-sounding group called the "Club of Rome." The analysis of this school appeared in a famous computer study called *The Limits to Growth* and its 1992 sequel *Beyond the Limits.* The predictions of the neo-Malthusians were even more dismal than those of Malthus himself:

> If present growth trends in world population, industrialization, pollution, food problems, and resource depletion continue unchanged, the limits to growth on this planet will be reached within the next one hundred years. The most probable results will be a rather sudden and uncontrollable decline in both population and industrial capacity.

These growth critics found a receptive audience because of mounting alarm about rapid population growth in developing countries and, in the 1970s, an upward spiral in oil prices and the sharp decline in the growth of productivity. A second wave of growth pessimism emerged over the last decade because of concerns about environmental constraints on long-term economic growth. Among today's concerns are global warming, in which the use of fossil fuels is warming the climate; widespread evidence of acid rain; the appearance of the Antarctic "ozone hole," along with ozone depletion in temperate regions; deforestation, especially of the tropical rain forests, which may upset the global ecological balance; soil erosion, which threatens the long-term viability of agriculture; ocean acidification from increased atmospheric carbon dioxide; and species extinction, which threatens many ecosystems and precious biological resources.

The economic analysis underlying the neo-Malthusian analysis is closely related to the Malthusian theory. Whereas Malthus held that production would be limited by diminishing returns in food production, today's growth pessimists argue that growth will be limited by the absorptive capacity of our environment. We can, some say, burn only a finite amount of fossil fuel before we face the threat of dangerous climate change. The need to reduce the use of fossil fuels might well slow our long-term economic growth.

There is a key difference, however. The earlier analysis related to *market commodities* such as land, food, and oil. Many of today's concerns relate to *externalities* and *public goods,* where unregulated market prices provide distorted signals.

What is the empirical evidence on the effects of resource exhaustion and environmental limits on economic growth? The facts are that the prices of most basic commodities such as grains, energy, and timber have risen *more slowly* than the general price level. However, many economists are concerned about externalities, particularly global public goods such as global warming. Nations have not found it easy to negotiate cooperative agreements to slow global warming. We can look to the troubled history of nuclear proliferation as another example where global cooperation has been difficult to achieve. The future of the global economy may depend upon finding solutions to these new Malthusian dilemmas.

Eye Therapies Exhibit 2127, 546 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

B. ECONOMIC GROWTH IN POOR COUNTRIES

ASPECTS OF A DEVELOPING COUNTRY

Exactly what is a **developing country?** The most important characteristic of a developing country is that it has low per capita income. In addition, people in developing countries usually have poor health, low levels of literacy, extensive malnutrition, and little capital to work with. Many poor countries have weak market and government institutions, corruption, and civil strife. These countries often have high native population growth, but they also suffer from out-migration, particularly among skilled workers.

Table 26-1 is a key source of data for understanding the major players in the world economy, as well as important indicators of underdevelopment. Low- and middle-income countries are grouped into six major regions.

A number of interesting features emerge from the table. Clearly, low-income countries are much poorer than advanced countries like the United States. People in the poorest countries earn only about one-twentieth as much as people in high-income countries. For the table's data, *purchasing-power-parity* (PPP) calculations were used to measure incomes. Market exchange rates tend to understate the incomes of low-wage countries. (The use of purchasing-power-parity exchange rates to evaluate living standards is discussed in Chapter 27.) Note also that the early 2000s were a period of strong

	Population			Per capita GDP		Education	Net Migration
Region	Total number, 2006 (millions)	Growth rate, 2000–2006 (% per year)	Life expectancy at birth (years)	2006 ($)	Growth, 2000–2006 (% per year)	Adult illiteracy (%, ages 15 and older)	Migration Rate (per 1,000 persons)
East Asia and Pacific (China, Indonesia, . . .)	1,900	0.9	71	6,820	7.6	9	−2.0
Eastern Europe and Central Asia (Russia, Poland, . . .)	460	0.0	69	9,660	5.7	2	−0.4
Latin America and Caribbean (Brazil, Mexico, . . .)	556	1.3	73	8,800	1.8	10	−1.2
Middle East and North Africa (Egypt, Iran, . . .)	311	1.8	70	6,450	2.3	27	−0.9
South Asia (India, Pakistan, . . .)	1,493	1.7	63	3,440	5.1	42	−0.2
Sub-Saharan Africa (Nigeria, Ethiopia, . . .)	770	2.3	47	2,030	2.3	41	−0.1

TABLE 26-1. Important Indicators for Different Country Groups

The World Bank groups developing countries into six regions. For each, a number of important indicators of economic development are shown. Note that low-income countries tend to have high illiteracy and out-migration. Some low-income countries have life expectancies close to those of rich countries.

Source: World Bank, *World Development Report,* and data at *www.worldbank.org.*

Eye Therapies Exhibit 2127, 547 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

growth in the world economy, and that spilled over to most poor regions as well.

In addition, many social and health indicators show the effects of poverty on low-income nations. Life expectancy is lower than in high-income countries, and educational attainment and literacy are often minimal.

There is a great diversity among developing countries. Some remain at the ragged edge of starvation—these are the poorest countries like Congo, Ethiopia, and Liberia. Other countries that were in that category two or three decades ago have moved to the rank of middle-income countries. The more successful ones—Slovenia, Singapore, and South Korea—have graduated from the developing group, and the most successful of these have per capita incomes that have reached the ranks of high-income countries. Yesterday's successful developing countries will be tomorrow's high-income countries.



Life in Low-Income Countries

To bring out the contrasts between advanced and developing economies, imagine that you are a typical 21-year-old in a low-income country such as Mali, India, or Bangladesh. You are poor. Even after making allowance for the goods that you produce and consume, your annual income barely averages $2000. Your counterpart in North America might have more than $30,000 in average earnings. Perhaps you can find cold comfort in the thought that only 1 person in 4 in the world averages more than $5000 in annual income.

For each of your fellow citizens who can read, there is one like you who is illiterate. Your life expectancy is four-fifths that of the average person in an advanced country; already, two of your brothers and sisters have died before reaching adulthood. Birth rates are high, particularly for families where women receive no education, but mortality rates are also much higher here than in countries with good health-care systems.

Most people in your country work on farms. Few can be spared from food production to work in factories. You work with but one-sixtieth the horsepower of a prosperous North American worker. You know little about science, but much about your village traditions.

You are often hungry, and the food you eat is mainly roughage or rice. While you were among those who got some primary schooling, like most of your friends, you did not go on to high school, and only the wealthiest go to a university. You work long hours in the fields without the benefit of machinery. At night, you sleep on a mat. You have little household furniture, perhaps a table and a radio. Your only mode of transportation is an old pair of boots.

Human Development

This review of life in the poorest countries of the world reminds us of the importance of adequate incomes in meeting basic needs as well as the fact that life involves more than market incomes. Thoughtful economists such as Nobel Prize recipient Amartya Sen and Yale's Gustav Ranis emphasize that other factors should be considered in appraising a country's progress: Factors such as health and life expectancy, school enrollment, adult literacy, and independence of women are important goals for developing countries along with increasing per capita market consumption.

Figure 26-1 shows a plot of life expectancy and per capita GDP. The correlation is strong, but there are exceptions to the general positive relationship. Some countries, such as Botswana, Equatorial Guinea, and South Africa, have low life expectancies relative to income because of the scourge of AIDS. No poor countries have high life expectancies, but countries like Greece and Costa Rica have life expectancies as high as or higher than those in the United States because of the poorly designed health-care system in the United States.

THE FOUR ELEMENTS IN DEVELOPMENT

Having seen what it means to be a developing country, we now turn to an analysis of the process by which low-income countries improve their living standards. We saw in Chapter 25 that economic growth in the United States—growth in its potential output—rides on four wheels. These are (1) human resources, (2) natural resources, (3) capital, and (4) technology. These four wheels operate in rich and poor countries, although the mix and strategy for combining them will differ depending on the state of development. Let's see how each of the four wheels operates in developing countries and consider how public policy can steer the growth process in favorable directions.

Eye Therapies Exhibit 2127, 548 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

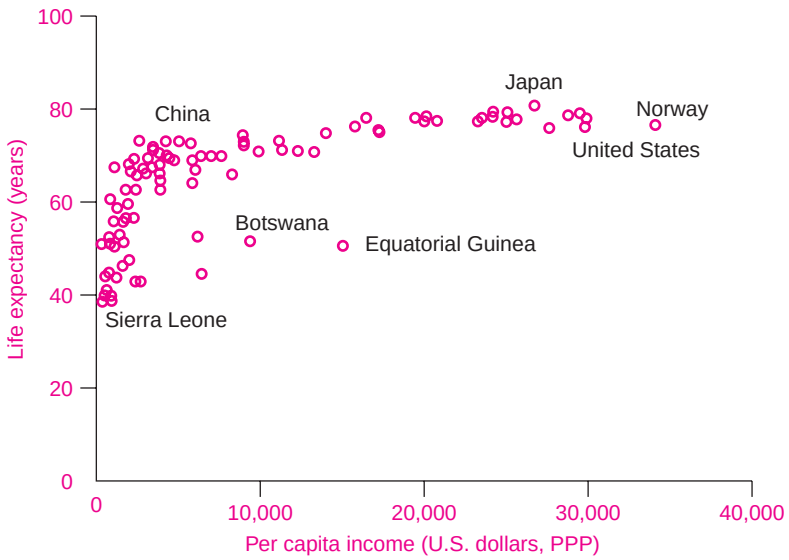


FIGURE 26-1. Life Expectancy and Incomes, 2000

Life expectancies are highly correlated with per capita incomes. Higher incomes allow greater investments in health care, but a healthier population is also more productive. Note that some middle-income African countries have been hard hit by the AIDS epidemic, threatening both health and economic development.

Source: United Nations Development Programme, *Human Development Report,* 2002.

Human Resources

Population Explosion: The Legacy of Malthus. Many poor countries are forever running hard just to stay in place. Even as a poor nation's GDP rises, so does its population. Recall our discussion of the Malthusian population trap, where population grows so rapidly that incomes remain at subsistence levels. While the high-income countries left Malthus behind long ago, Africa is still caught in the Malthusian bind of high birth rates and stagnant incomes. And the population expansion has not stopped—demographers project that the poor countries will add about 1 billion people over the next 25 years.

It's hard for poor countries to overcome poverty with birth rates so high. But there are escape routes from overpopulation. One strategy is to take an active role in curbing population growth, even when such actions run against prevailing religious norms. Many countries have introduced educational campaigns and subsidized birth control.

And for countries which manage to boost their per capita incomes, there is the prospect of making the *demographic transition,* which occurs when a population stabilizes with low birth rates and low death rates. Once countries get rich enough, and infant mortality drops, people voluntarily reduce their birth rates. When women are educated and emerge from subservience, they usually decide to spend less of their lives in childbearing. Families substitute quality for quantity—devoting time and incomes to a better education for fewer children. Mexico, Korea, and Taiwan have all seen their birth rates drop sharply as their incomes have risen and their populations have received more education.

Slowly, the results of economic development and birth control are being felt. The birth rate in poor countries has declined from 44 per 1000 per year in 1960 to 27 per 1000 in 2005, but that is still far higher than the birth rate of 11 per 1000 in the high-income countries. The struggle against poverty induced by excessive population growth continues.

However, the demographic transition has not been reached in every corner of the world. Fertility continues at a high rate in much of tropical Africa even as the AIDS epidemic rages through the population and lowers life expectancies in a way not experienced

Eye Therapies Exhibit 2127, 549 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

since the great plagues of earlier centuries. The specter of Malthus hangs over much of central Africa.

Human Capital. In addition to dealing with excessive population growth, developing countries must also be concerned with the quality of their human resources. Economic planners in developing countries emphasize the following strategies:

1. *Control disease and improve health and nutrition.* Raising the population's health standards not only makes people happier but also makes them more productive workers. Health-care clinics and provision of safe drinking water are vitally useful social capital.
2. *Improve education, reduce illiteracy, and train workers.* Educated people are more productive workers because they can use capital more effectively, adopt new technologies, and learn from their mistakes. For advanced learning in science, engineering, medicine, and management, countries will benefit by sending their best minds abroad to bring back the newest advances. But countries must beware of the brain drain, in which the most able people get drawn off to high-wage countries.
3. *Above all, do not underestimate the importance of human resources.* Most other factors can be bought in the international marketplace. Most labor is home-grown, although labor can sometimes be augmented through immigration. The crucial role of skilled labor has been shown again and again when sophisticated mining, defense, or manufacturing machinery fell into disrepair and disuse because the labor force of developing countries had not acquired the necessary skills for its operation and maintenance.

Natural Resources

Some poor countries of Africa and Asia have meager endowments of natural resources, and such land and minerals that they do possess must be divided among large populations. Perhaps the most valuable natural resource of developing countries is arable land. Much of the labor force in developing countries is employed in farming. Hence, the productive use of land—with appropriate conservation, fertilizers, and tillage—will go far in increasing a poor nation's output.

Moreover, land ownership patterns are a key to providing farmers with strong incentives to invest in capital and technologies that will increase their land's yield. When farmers own their own land, they have better incentives to make improvements, such as in irrigation systems, and undertake appropriate conservation practices.

Some economists believe that natural wealth from oil or minerals is not an unalloyed blessing. Countries like the United States, Canada, and Norway have used their natural wealth to form the solid base of industrial expansion. In other countries, the wealth has been subject to plunder and *rent seeking* by corrupt leaders and military cliques. Countries like Nigeria and Congo (formerly Zaire), which are fabulously wealthy in terms of mineral resources, failed to convert their underground assets into productive human or tangible capital because of venal rulers who drained that wealth into their own bank accounts and conspicuous consumption.

Capital

A modern economy requires a vast array of capital. Countries must abstain from current consumption to engage in fruitful roundabout production. But there's the rub, for the poorest countries are near a subsistence standard of living. When you are poor to begin with, reducing current consumption to provide for future consumption seems impossible.

The leaders in the growth race invest at least 20 percent of output in capital formation. By contrast, the poorest agrarian countries are often able to save only 5 percent of national income. Moreover, much of the low level of saving goes to provide the growing population with housing and simple tools. Little is left over for development.

But let's say a country has succeeded in hiking up its rate of saving. Even so, it takes many decades to accumulate the highways, telecommunications systems, hospitals, electricity-generating plants, and other capital goods that underpin a productive economic structure.

Even before acquiring the most sophisticated capital, however, developing countries must first build up their *infrastructure,* or social overhead capital, which consists of the large-scale projects upon which a market economy depends. For example, a regional agricultural adviser helps farmers in an area learn of new seeds or crops; a road system links up the different markets; a public-health program inoculates people against typhoid or diphtheria and protects the population beyond those inoculated. In each of these cases it would be impossible for an enterprising firm to capture the social benefits involved, because the firm cannot collect fees from the thousands or even millions of

Eye Therapies Exhibit 2127, 550 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

beneficiaries. Because of the large indivisibilities and external effects of infrastructure, the government must step in to make or ensure the necessary investments.

In many developing countries, the single most pressing problem is too little saving. Particularly in the poorest regions, urgent current consumption competes with investment for scarce resources. The result is too little investment in the productive capital so indispensable for rapid economic progress.



Foreign Borrowing and Debt Crises

If there are so many obstacles to finding domestic saving for capital formation, why not borrow abroad? Economic theory tells us that a rich country, which has tapped its own high-yield investment projects, can benefit both itself and the recipient by investing in high-yield projects abroad.

However, risks are the necessary companion of reward in foreign lending. The history of lending from rich to poor regions shows a cycle of opportunity, lending, profits, overexpansion, speculation, crisis, and drying-up of funds, followed by a new round of lending by yet another group of starry-eyed investors. No sooner has one crisis been forgotten than another one erupts.

It is instructive to review the saga of *emerging markets*, which is the name often given to rapidly growing low- and middle-income countries that are promising areas for foreign investment. In the 1990s, investors in wealthy countries sent their funds abroad in search of higher returns; poor countries, hungry for capital, welcomed this flow of foreign funds. From Thailand to South Africa, both loans and equity investments grew rapidly during the 1990s.

Figure 26-2 shows the interest-rate spread on emerging market securities. This represents the risk premium that borrowers from emerging-market countries would need to pay to attract funds. When the perceived risk is

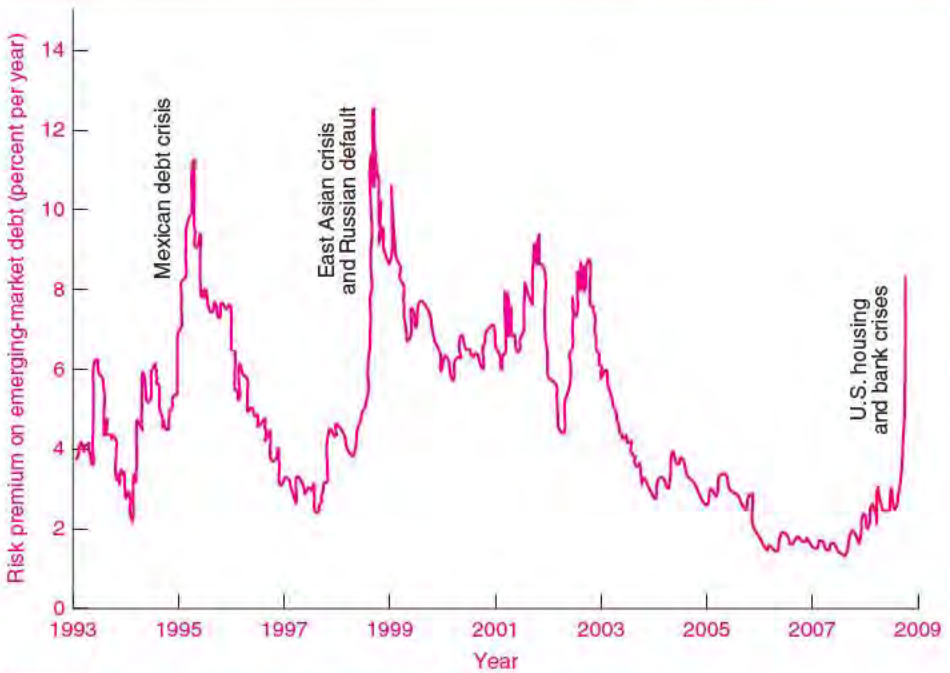


FIGURE 26-2. Spread on Emerging-Market Bonds, 1993–2008

The spread shows the risk premium that borrowers from emerging-market countries paid. It is the premium over safe U.S. dollar securities. Note how the premium shot up during the Mexican crisis in 1995 and the emerging-market crisis and Russian default in 1998. Then market participants became optimistic during the long market boom of the 2000s. All this came to an end with the credit crisis of 2007–2009 as the spread increased.

Source: International Monetary Fund.

Eye Therapies Exhibit 2127, 551 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

low, the spread is low. When investors become concerned that countries will not pay back their loans, or during periods when the price of risk rises, the spreads skyrocket.

As long as the growth in emerging markets continued, all was quiet and returns were solid. But a slowdown in growth, combined with a series of banking crises, led to massive outflows of short-term funds from Thailand, Indonesia, and South Korea. Bankers who had invested heavily called in their loans. This led to a sharp increase in the supply of the currencies of these countries. Most countries were on fixed-exchange-rate systems, and the selling overwhelmed the countries' foreign exchange reserves. One after another, the currencies of the East Asian countries depreciated sharply. Many called upon the International Monetary Fund (IMF) to provide short-term funds, but the IMF required contractionary monetary and fiscal policies. All these factors together produced sharp business recessions throughout East Asia. When Russia defaulted on its debt in 1998, the emerging-country market panicked and credit spreads shot up.

Within 3 years, most of these countries had recovered from the crisis after a period of *adjustment*—slow output growth, declining real wages, debt reschedulings, and trade surpluses. Economic growth had resumed. The world had survived another financial crisis. As Figure 26-2 shows, the spread or risk premium declined gradually over the next decade—until the next crisis erupted in the U.S. financial system in 2007.

Technological Change and Innovations

The final and most important wheel is technological advance. Here, developing countries have one major advantage: They can hope to benefit by relying on the technological progress of more advanced nations.

Imitating Technology. Poor countries need not find modern Newtons to discover the law of gravity; they can read about it in any physics book. They don't have to repeat the slow, meandering route to the Industrial Revolution; they can buy tractors, computers, and power looms undreamed of by the great merchants of the past.

Japan and the United States clearly illustrate this in their historical developments. The United States provides a hopeful example to the rest of the world. The key inventions involved in the automobile originated almost exclusively abroad. Nevertheless, Ford and General Motors applied foreign inventions and rapidly became the world leaders in the automotive industry.

Japan joined the industrial race late, and only at the end of the nineteenth century did it send students abroad to study Western technology. The Japanese government took an active role in stimulating the pace of development and in building railroads and utilities. By adopting productive foreign technologies, Japan moved into its position today as the world's second-largest industrial economy. The examples of the United States and Japan show how countries can thrive by adapting foreign science and technology to local market conditions.

Entrepreneurship and Innovation. From the histories of the United States and Japan, it might appear that adaptation of foreign technology is an easy recipe for development. You might say: "Just go abroad; copy more-efficient methods; put them into effect at home; then sit back and wait for the extra output to roll in."

Alas, implementing technological change is not that simple. You can send a textbook on chemical engineering to Poorovia, but without skilled scientists, engineers, entrepreneurs, and adequate capital, Poorovia couldn't even think about building a working petrochemical plant. The advanced technology was itself developed to meet the special conditions of the advanced countries—including ample skilled engineers and workers, reliable electrical service, and quickly available spare parts and repair services. These conditions do not prevail in poor countries.

One of the key tasks of economic development is promoting an entrepreneurial spirit. A country cannot thrive without a group of owners or managers willing to undertake risks, open new businesses, adopt new technologies, and import new ways of doing business. At the most fundamental level, innovation and entrepreneurship thrive when property rights are clear and complete and taxes and other drains on profits (such as corruption) are low and predictable. Government can also foster entrepreneurship through specific investments: by setting up extension services for farmers, by educating and training the workforce, and by establishing management schools.

Poor countries often suffer from pervasive corruption. The following discussion by economic

Eye Therapies Exhibit 2127, 552 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

development specialist Robert Klitgaard explains how corruption undermines economic development:

> At the broadest level, corruption is the misuse of office for unofficial ends. The catalogue of corrupt acts includes bribery, extortion, influence-peddling, nepotism, fraud, speed money, embezzlement, and more.
>
> Corruption that undercuts the rules of the game—for example, the justice system or property rights or banking and credit—devastates economic and political development. Corruption that allows polluters to foul rivers or hospitals to extort patients can be environmentally and socially corrosive. When corruption becomes the norm, its effects are crippling. So, although every country has corruption, the varieties and extent differ. The killer is systematic corruption that destroys the rules of the game. It is one of the principal reasons why the most underdeveloped parts of our planet stay that way.

Battling corruption is particularly difficult because the state, which is the instrument of justice, is often itself corrupt.

Vicious Cycles to Virtuous Circles

We have emphasized that poor countries face great obstacles in combining the four elements of progress—labor, capital, resources, and innovation. In addition, countries find that the difficulties reinforce each other in a *vicious cycle of poverty.*

Figure 26-3 illustrates how one hurdle raises yet other hurdles. Low incomes lead to low saving; low saving retards the growth of capital; inadequate capital prevents introduction of new machinery and rapid growth in productivity; low productivity leads to low incomes. Other elements in poverty are also self-reinforcing. Poverty is accompanied by low levels of education, literacy, and skill; these in turn prevent the adoption of new and improved technologies and lead to rapid population growth, which eats away at improvements in output and food production.

Countries that suffer from a vicious cycle can get caught in a *poverty trap.* This syndrome arises when there are multiple equilibria, and one of the equilibria may be particularly pernicious. Low-level traps are found in many areas of the social and natural sciences and are illustrated in Figure 26-4. This graph shows average income in period t on the horizontal axis and average income in period $(t + 1)$ on the

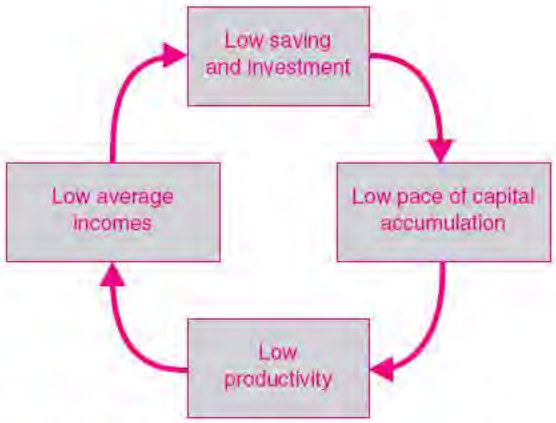


FIGURE 26-3. The Vicious Cycle of Poverty

Many obstacles to development are self-reinforcing. Low levels of income prevent saving, retard capital growth, hinder productivity growth, and keep income low. Successful development may require taking steps to break the chain at many points.

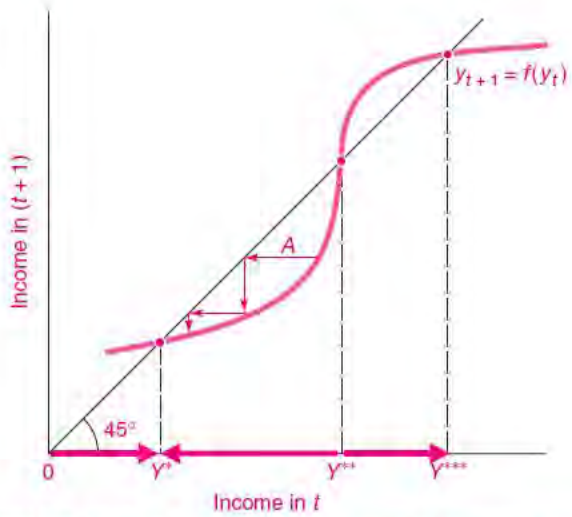


FIGURE 26-4. Countries Can Get Caught in Poverty Traps

When vicious cycles lead to downward spirals, countries can get caught in low-level traps such as Y^*. Note how a country that starts out between 0 and Y^{**} will gravitate back to the low-level trap. Follow the arrows starting at A and see how they lead to Y^*. However, if a country can make a big push to get out of the trap by pushing beyond Y^{**}, then the country enjoys a virtuous cycle of growth to the high-level of income at Y^{***}. Low-level traps can arise because of the interaction of low income, poor health, low saving, low investment, and low productivity.

Eye Therapies Exhibit 2127, 553 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

vertical axis. The nonlinear growth curve $y_{t+1} = f(y_t)$ shows how income moves over time. The 45° line shows the dividing line between positive growth and decline. When a point on the growth curve is above the 45° line, income in $(t + 1)$ is greater than income in t, so income is growing. When the growth curve intersects the 45° line, income is constant and we have an economic equilibrium.

The unusual feature of the *S*-shaped growth curve is that it leads to multiple equilibria. The lower crossing represents a nasty low-level equilibrium trap at Y^*, while the upper one is a benign high-level equilibrium at Y^{***}. Modern economic-development theory points to low-level traps coming from rapid population growth, low productivity, or low "connectivity."

Overcoming the poverty trap may require a concerted effort on many fronts, and some development economists recommend a "big push" forward to break the vicious cycle. If a country is fortunate, simultaneous steps to invest more, improve health and education, develop skills, and curb population growth can break the vicious cycle of poverty and stimulate a virtuous circle of rapid economic development. If the country can push itself to the right of Y^{**} in Figure 26-4, then it will take off into sustained economic growth.

STRATEGIES OF ECONOMIC DEVELOPMENT

We see how countries must combine labor, resources, capital, and technology in order to grow rapidly. But this is no real formula; it is the equivalent of saying that an Olympic sprinter must run like the wind. Why do some countries succeed in running faster than others? How do poor countries ever get started down the road of economic development?

Historians and social scientists have long been fascinated by the differences in the pace of economic growth among nations. Some early theories stressed climate, noting that all advanced countries lie in the earth's temperate zone. Others have pointed to custom, culture, or religion as a key factor. Max Weber emphasized the "Protestant ethic" as a driving force behind capitalism. More recently, Mancur Olson has argued that nations begin to decline when their decision structures become brittle and interest groups or oligarchies prevent social and economic change.

No doubt each of these theories has some validity for a particular time and place. But they do not hold up as universal explanations of economic development. Weber's theory leaves unexplained why the cradle of civilization appeared in the Near East and Greece while the later-dominant Europeans lived in caves, worshiped trolls, and wore bearskins. Where do we find the Protestant ethic in bustling China? How can we explain that a country like Japan, with a rigid social structure and powerful lobbies, has become one of the world's most productive economies?

Even in the modern era, people become attached to simple, holistic explanations of economic development. People once considered import substitution (the replacement of imports with domestically produced goods) to be the most secure development strategy. Then, in the 1970s, reliance on labor-intensive techniques was thought advantageous. Today, as we will see, economists tend to emphasize reliance on market forces with an outward orientation. This history should serve as a warning to be wary of oversimplified approaches to complex processes.

Nonetheless, historians and development economists have learned much from the study of the varieties of economic growth. What are some of the lessons? The following account represents a montage of important ideas developed in recent years. Each approach describes how countries might break out of the vicious cycle of poverty and begin to mobilize the four wheels of economic development.

The Backwardness Hypothesis

One view emphasizes the international context of development. We saw above that poorer countries have important advantages that the first pioneers along the path of industrialization did not. Developing nations can now draw upon the capital, skills, and technology of more-advanced countries. A hypothesis advanced by Alexander Gerschenkron of Harvard suggests that *relative backwardness* itself may aid development. Countries can buy modern textile machinery, efficient pumps, miracle seeds, chemical fertilizers, and medical supplies. Because they can lean on the technologies of advanced countries, today's developing countries can grow more rapidly than did Britain or Western Europe in the period 1780–1850. As low-income countries draw upon the

Eye Therapies Exhibit 2127, 554 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

more productive technologies of the leaders, we would expect to see *convergence* of countries toward the technological frontier. Convergence occurs when those countries or regions that have initially low incomes tend to grow more rapidly than ones with high incomes.

Industrialization vs. Agriculture

In most countries, incomes in urban areas are almost double those in rural areas. And in affluent nations, much of the economy is in industry and services. Hence, many nations jump to the conclusion that industrialization is the cause rather than the effect of affluence.

We must be wary of such inferences, which confuse the association of two characteristics with causality. Some people say, "Rich people drive BMWs, but driving a BMW will not make you a rich person." Similarly, there is no economic justification for a poor country to insist upon having its own national airline and large steel mill. These are not the fundamental necessities of economic growth.

The lesson of decades of attempts to accelerate industrialization at the expense of agriculture has led many analysts to rethink the role of farming. Industrialization is capital-intensive, attracts workers into crowded cities, and often produces high levels of unemployment. Raising productivity on farms may require less capital, while providing productive employment for surplus labor. Indeed, if Bangladesh could increase the productivity of its farming by 20 percent, that advance would do more to release resources for the production of comforts than would trying to construct a domestic steel industry to displace imports.

State vs. Market

The cultures of many developing countries are hostile to the operation of markets. Often, competition among firms or profit-seeking behavior is contrary to traditional practices, religious beliefs, or vested interests. Yet decades of experience suggest that extensive reliance on markets provides the most effective way of managing an economy and promoting rapid economic growth.

What are the important elements of a market-oriented policy? The important elements include the predominance of private property and ownership, an outward orientation in trade policy, low tariffs and few quantitative trade restrictions, the promotion of small business, and the fostering of competition. Moreover, markets work best in a stable macroeconomic environment—one in which taxes are predictable and inflation is low.

Growth and Outward Orientation

A fundamental issue of economic development concerns a country's stance toward international trade. Should developing countries attempt to be self-sufficient, to replace most imports with domestic production? (This is known as a strategy of *import substitution*.) Or should a country strive to pay for the imports it needs by improving efficiency and competitiveness, developing foreign markets, and keeping trade barriers low? (This is called a strategy of *outward orientation* or *openness*.)

Policies of import substitution were often popular in Latin America until the 1980s. The policy most frequently used toward this end was to build high tariff walls around domestic manufacturing industries so that local firms could produce and sell goods that would otherwise be imported.

A policy of openness keeps trade barriers as low as practical, relying primarily on tariffs rather than quotas and other nontariff barriers. It minimizes the interference with financial flows and allows supply and demand to operate in financial markets. It avoids a state monopoly on exports and imports. It keeps government regulation to the minimum necessary for an orderly market economy. Above all, it relies primarily on a private market system of profits and losses to guide production, rather than depending on public ownership and control or the commands of a government planning system.

The success of outward-oriented policies is best illustrated by the successful East Asian countries. A generation ago, countries like Taiwan, South Korea, and Singapore had per capita incomes one-quarter to one-third of those in the wealthiest Latin American countries. Yet, by saving large fractions of their national incomes and channeling these to high-return export industries, the East Asian countries overtook every Latin American country by the late 1980s. The secret to success was not a doctrinaire laissez-faire policy, for the governments in

Eye Therapies Exhibit 2127, 555 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

fact engaged in selective planning and intervention. Rather, the openness and outward orientation allowed the countries to reap economies of scale and the benefits of international specialization and thus to increase employment, use domestic resources effectively, enjoy rapid productivity growth, and provide enormous gains in living standards.

While openness provides many benefits, excessive openness, particularly to short-term financial flows, is an invitation to speculative attack. What investors lendeth, investors can taketh back. This syndrome can cause financial and banking crises, as we noted for the East Asian economies in our discussion earlier in this chapter.

Summary Judgment

Decades of experience in dozens of countries have led many development economists to the following summary view of the way government can best promote rapid economic development:

The government has a vital role in establishing and maintaining a healthy economic environment. It must ensure respect for the rule of law, enforce contracts, fight corruption, and orient its policies toward competition and innovation. Government must play a leading role in investments in social overhead capital—in education, health, communications, energy, and transportation—but it should look to the private sector where it has no comparative advantage. Government should resist the temptation to produce everything at home. A firm commitment to openness to trade and foreign investment will help ensure that a country moves quickly toward the best world practices in different sectors.

C. ALTERNATIVE MODELS FOR DEVELOPMENT

People continually look for ways to improve their living standards. Economic betterment is particularly compelling for poor countries seeking a path to the riches they see around them. This textbook has surveyed in depth the mixed market economy of the United States, which combines fundamentally free markets with a sizable government sector. What other alternatives are available?

A BOUQUET OF "ISMS"

At one extreme is *free-market absolutism,* which holds that the best government is the least government. At the other extreme is complete communism, with the government operating a collectivized economic order in which the first-person singular hardly exists. Between the extremes of laissez-faire and communism lie mixed capitalism, managed markets, socialism, and many combinations of these models. In this section, we describe briefly some of the influential alternative strategies for growth and development:

1. *The Asian managed-market approach.* South Korea, Taiwan, Singapore, and other countries of East Asia have devised their own brands of economics that combine strong government oversight with powerful market forces.
2. *Socialism.* Socialist thinking encompasses a wide variety of different approaches. In Western Europe after World War II, socialist governments operating in a democratic framework expanded the welfare state, nationalized industries, and planned their economies. In recent years, however, these countries moved back toward a free-market framework with extensive deregulation and privatization.
3. *Soviet-style communism.* For many years, the clearest alternative to the market economy existed in the Soviet Union. Under the Soviet model, the state owned all the land and most of the capital, set wages and most prices, and directed the microeconomic operation of the economy.

The Central Dilemma: Market vs. Command

A survey of alternative economic systems may seem like a bewildering array of economic "isms." And indeed, there is a great variety in the way countries organize their economies.

One central issue runs through all the great debates about alternative economic systems: Should economic decisions be taken primarily by the *private market* or by *government command?*

Eye Therapies Exhibit 2127, 556 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

At one end of the spectrum is the *market economy*. In a market system, people act voluntarily and primarily for financial gain or personal satisfaction. Firms buy factors and produce outputs, selecting inputs and outputs in a way that will maximize their profits. Consumers supply factors and buy consumer goods to maximize their satisfactions. Agreements on production and consumption are made voluntarily and with the use of money, at prices determined in free markets, and on the basis of arrangements between buyers and sellers. Although individuals differ greatly in terms of economic power, the relationships between individuals and firms are horizontal in nature, essentially voluntary, and nonhierarchical.

At the other end of the spectrum is the *command economy*, where decisions are made by government bureaucracy. In this approach, people are linked by a vertical relationship, and control is exercised by a multilevel hierarchy. The planning bureaucracy determines *what* goods are produced, *how* they are produced, and *for whom* output is produced. The highest level of the pyramid makes the major decisions and develops the elements of the plan for the economy. The plan is subdivided and transmitted down the bureaucratic ladder, with the lower levels of the hierarchy executing the plan with increasing attention to detail. Individuals are motivated by coercion and legal sanctions; organizations compel individuals to accept orders from above. Transactions and commands may or may not use money; trades may or may not take place at established prices.

In between are the socialist and the managed-market economies. In both cases government plays an important role in guiding and directing the economy, though much less so than in a command economy. The tension between markets and command runs through all discussions about alternative economic systems. Let us look in more detail at some of the alternatives to the mixed market economies.

THE ASIAN MODELS

Asian Dragons

Development specialists sometimes look to the countries of East Asia as examples of successful development strategies. The rapid economic growth over the last half-century in South Korea, Singapore, and Taiwan is sometimes called the *East Asian miracle*. Table 26-2 compares the performance of the "Asian dragons" with those of other major areas over recent years. Latin America and sub-Saharan Africa have been growing at a positive rate. However, look at the East Asian and Pacific region, and especially China. Countries in this region have had a phenomenal rate of growth, particularly in the last three decades.

A World Bank study analyzed the economic policies of different regions to see whether any patterns emerged.[1] The results confirmed common

[1] See this chapter's Further Reading section for the World Bank study on the East Asian miracle.

	Average Growth of Real per Capita GDP		
Region	**1962–1973**	**1973–1995**	**1995–2006**
East Asia and Pacific	3.6	4.8	6.4
China	4.0	4.7	8.2
South Asia	2.0	2.5	4.4
India	2.2	2.3	4.9
Latin America and Caribbean	4.0	1.7	1.5
Sub-Saharan Africa	2.8	0.7	1.7

TABLE 26-2. Attention to Fundamentals Spurred Growth for the Asian Dragons

Source: *World Development Indicators* (2008), available at *www.worldbank.org/*.

Eye Therapies Exhibit 2127, 557 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

views but also found a few surprises. Here are the high points:

- *Investment rates.* The Asian dragons followed the classic recipe of high investment rates to ensure that their economies benefited from the latest technology and could build up the necessary infrastructure. Investment rates among the Asian dragons were almost 20 percentage points higher than those of other regions.
- *Macroeconomic fundamentals.* Successful countries had a steady hand on macroeconomic policies, keeping inflation low and saving rates high. They invested heavily in human capital as well as in physical capital and did more to promote education than any other developing region. The financial systems were managed to ensure monetary stability and a sound currency.
- *Outward orientation.* The Asian dragons were outward-oriented, often keeping their exchange rates undervalued to promote exports, encouraging exports with fiscal incentives, and pursuing technological advance by adopting best-practice techniques of high-income countries.

The Rise of China

One of the major surprises in economic development during the last three decades was the rapid growth of the Chinese economy. After the Chinese revolution of 1949, China initially adopted a Soviet-style central-planning system. The high-water mark of centralization came with the Cultural Revolution of 1966–1969, which led to an economic slowdown in China. After the death of the revolutionary leader Mao Tse-tung, a new generation concluded that economic reform was necessary if the Communist party was to survive. Under Deng Xiaoping's leadership from 1977 to 1997, China decentralized a great deal of economic power and promoted competition. Economic reform was, however, not accompanied by political reform; the democracy movement was ruthlessly repressed in Tiananmen Square in 1989, and the Communist party has continued to monopolize the political process.

To spur economic growth, the Chinese leadership has taken dramatic steps such as setting up "special economic zones" which allowed capitalist and foreign enterprises to operate. The most rapidly growing parts of China have been the coastal regions, such as the southern region near Hong Kong and in greater Shanghai. These areas have become closely integrated with countries outside China and have attracted considerable foreign investment. In addition, China has allowed private and foreign firms, free from government planning or control, to operate alongside state-owned firms. These innovative forms of ownership have grown rapidly and by the 2000s were producing more than half of China's GDP.

The continued rapid growth of the Chinese economy has surprised observers almost as much as did the collapse of the Soviet economy. As shown in Table 26-2, the growth in per capita GDP accelerated from 4.0 percent per year in 1962–1973 to 8.2 percent per year in 1995–2006. Exports from China to the United States grew over 17 percent per year during the last decade. By 2008, China had annual exports of almost $2 trillion and had accumulated $1½ trillion in foreign exchange reserves.

The future of the Chinese economic model is being watched closely around the world. The undoubted success of outward orientation, particularly to foreign investment, is an especially striking feature of Chinese economic policy.

SOCIALISM

As a doctrine, socialism developed from the ideas of Karl Marx and other radical thinkers of the nineteenth century. Socialism is a middle ground between laissez-faire capitalism and the central-planning model, which we discuss in the next subsection. A few common elements characterize most socialist philosophies:

- *Government ownership of productive resources.* Socialists traditionally believed that the role of private property should be reduced. Key industries such as railroads and banking should be nationalized (that is, owned and operated by the state). In recent years, because of the poor performance of many state-owned enterprises, enthusiasm for nationalization has ebbed in most advanced democracies.
- *Planning.* Socialists are suspicious of the "chaos" of the marketplace and question the allocational efficiency of the invisible hand. They insist that a planning mechanism is needed to coordinate different sectors. In recent years, planners have

Eye Therapies Exhibit 2127, 558 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

emphasized subsidies to promote the rapid development of high-technology industries, such as microelectronics, aircraft manufacturing, and biotechnology; these policies are sometimes called "industrial policies."

- *Redistribution of income.* Inherited wealth and the highest incomes are to be reduced by the militant use of government taxing powers; in some Western European countries, marginal tax rates have reached 98 percent. Government social security benefits, free medical care, and cradle-to-grave welfare services paid for with progressive taxes increase the well-being of the less privileged and guarantee minimum standards of living for all.
- *Peaceful and democratic evolution.* Socialists often advocate the peaceful and gradual extension of government ownership—evolution by ballot rather than revolution by bullet.

Socialist approaches fell out of favor with the collapse of communism, the stagnation in Europe, and the success of market-oriented economies. Thoughtful socialists are combing through the wreckage to find a future role for this branch of economic thought.

THE FAILED MODEL: CENTRALLY PLANNED ECONOMIES

For many years, developing countries looked to the Soviet Union and other communist countries as role models on how to industrialize. Communism offered both a theoretical critique of Western capitalism and a seemingly workable strategy for economic development. We begin by reviewing the theoretical underpinnings of Marxism and communism and then examine how the Soviet-style command economy worked in practice.



Karl Marx: Economist as Revolutionary

On the surface, Karl Marx (1818–1883) lived an uneventful life, studiously poring through books in the British Museum, writing newspaper articles, and working on his scholarly studies of capitalism. Although originally attracted to German universities, his atheism, pro-constitutionalism, and radical ideas led him to journalism. He was eventually exiled to Paris and London, where he wrote his massive critique of capitalism, *Capital* (1867, 1885, 1894).

The centerpiece of Marx's work is an incisive analysis of the strengths and weaknesses of capitalism. Marx argued that all commodity value is determined by labor content—both the direct labor and the indirect labor embodied in capital equipment. For example, the value of a shirt comes from the efforts of the textile workers who put it together, plus the efforts of the workers who made the looms. By imputing all the value of output to labor, Marx attempted to show that profits—the part of output that is produced by workers but received by capitalists—amount to "unearned income."

In Marx's view, the injustice of capitalists' receiving unearned income justifies transferring the ownership of factories and other means of production from capitalists to workers. He trumpeted his message in *The Communist Manifesto* (1848): "Let the ruling classes tremble at a Communist revolution. The proletarians have nothing to lose but their chains." And the ruling capitalist classes did tremble at Marxism for more than a century!

Like many great economists, but with more passion than most, Marx was deeply moved by the struggle of working people and hoped to improve their lives. He penned the words that appear on his gravestone: "Up 'til now philosophers have only interpreted the world in various ways. The point, though, is to change it!" Our epitaph for Marx might echo the appraisal of the distinguished intellectual historian, Sir Isaiah Berlin: "No thinker in the nineteenth century has had so direct, deliberate, and powerful an influence on mankind as Karl Marx."

Baleful Prophesies

Marx saw capitalism as inevitably leading to socialism. In Marx's world, technological advances enable capitalists to replace workers with machinery as a means of earning greater profits. But this increasing accumulation of capital has two contradictory consequences. As the supply of available capital increases, the rate of profit on capital falls. At the same time, with fewer jobs, the unemployment rate rises and wages fall. In Marx's terms, the "reserve army of the unemployed" would grow, and the working class would become increasingly "immiserized"—by which he meant that working conditions would deteriorate and workers would grow progressively alienated from their jobs.

Eye Therapies Exhibit 2127, 559 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

As profits decline and investment opportunities at home become exhausted, the ruling capitalist classes resort to imperialism. Capital tends to seek higher rates of profit abroad. And, according to this theory (particularly as later expanded by Lenin), the foreign policies of imperialist nations increasingly attempt to win colonies and then mercilessly milk surplus value from them.

Marx believed that the capitalist system could not continue this unbalanced growth forever. Marx predicted increasing inequality under capitalism, along with a gradual emergence of class consciousness among the downtrodden proletariat. Business cycles would become ever more violent as mass poverty resulted in macroeconomic underconsumption. Finally, a cataclysmic depression would sound the death knell of capitalism. Like feudalism before it, capitalism would contain the seeds of its own destruction.

The *economic interpretation of history* is one of Marx's lasting contributions to Western thought. Marx argued that economic interests lie behind and determine our values. Why do business executives vote for conservative candidates, while labor leaders support those who advocate raising the minimum wage or increasing unemployment benefits? The reason, Marx held, is that people's beliefs and ideologies reflect the material interests of their social and economic class. In fact, Marx's approach is hardly foreign to mainstream economics. It generalizes Adam Smith's analysis of self-interest from the dollar votes of the marketplace to the ballot votes of elections and the bullet votes of the barricades.

From Textbooks to Tactics: Soviet-Style Command Economy

Marx wrote extensively about the faults of capitalism, but he left no design for the promised socialist land. His arguments suggested that communism would arise in the most highly developed industrial countries. Instead, it was feudal Russia that adopted the Marxist vision. Let's examine this fascinating and horrifying chapter of economic history.

Historical Roots. An analysis of Soviet communism is of the utmost importance for economics because the Soviet Union served as a laboratory for theories about the functioning of a command economy. Some economists claimed that socialism simply could not work; the Soviet experience proved them wrong. Its advocates argued that communism would overtake capitalism; Soviet history also refutes this thesis.

Although czarist Russia grew rapidly from 1880 to 1914, it was considerably less developed than industrialized countries like the United States or Britain. World War I brought great hardship to Russia and allowed the communists to seize power. From 1917 to 1933, the Soviet Union experimented with different socialist models before settling on central planning. But dissatisfaction with the pace of industrialization led Stalin to undertake a radical new venture around 1928—collectivization of agriculture, forced-draft industrialization, and central planning of the economy.

Under the collectivization of Soviet agriculture between 1929 and 1935, 94 percent of Soviet peasants were forced to join collective farms. In the process, many wealthy peasants were deported, and conditions deteriorated so much that millions perished. The other part of the Soviet "great leap forward" came through the introduction of economic planning for rapid industrialization. The planners created the first 5-year plan to cover the period 1928–1933. The first plan established the priorities of Soviet planning: heavy industry was to be favored over light industry, and consumer goods were to be the residual sector after all the other priorities had been met. Although there were many reforms and changes in emphasis, the Stalinist model of a command economy applied in the Soviet Union and Eastern Europe countries until the fall of Soviet communism at the end of the 1980s.

How the Command Economy Functioned. In the Soviet-style command economy, the broad categories of output were determined by political decisions. Military spending in the Soviet Union was always allocated a substantial part of output and scientific resources, while the other major priority was investment. Consumption claimed the residual output after the quotas of higher-priority sectors were filled.

In large part, decisions about how goods were to be produced were made by the planning authorities. Planners first decided on the quantities of final outputs (the *what*). Then they worked backward from outputs to the required inputs and the flows among different firms. Investment decisions were specified in great detail by the planners, while firms had

Eye Therapies Exhibit 2127, 560 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

considerable flexibility in deciding upon their mix of labor inputs.

Clearly no planning system could specify all the activities of all the firms—this would have required trillions of commands every year. Many details were left to the managers of individual factories. It was here, in what is called the *principal-agent problem,* that the command economy ran into its deepest difficulties.

The principal-agent problem arises because the person at the top of a hierarchy (the "principal") wants to provide appropriate incentives for the people making the decisions down the hierarchy (the "agents") to behave according to the principal's wishes. In a market economy, profits and prices serve as the mechanism for coordinating consumers and producers. A command economy is plagued by an inability to find an efficient substitute for profits and prices as a way of motivating the agents.

A useful example of the failure to solve the principal-agent problem is found in Soviet book publishing. In a market economy, commercial decisions about books are made primarily on the basis of profit and loss. In the Soviet Union, because profits were taboo, planners instead used quantitative targets. A first approach was to reward firms according to the number of books produced, so publishers printed thousands of thin unread volumes. Faced with a clear incentive problem, the center (principal) changed the system so that the producers (agents) were rewarded on the basis of the number of pages printed, and the result was fat books with onion-skin paper and large type. The planners then changed the criterion to the number of words—to which the publishers responded by printing huge volumes with tiny type. None of these mechanisms was capable of signaling consumer wants effectively.

The principal-agent problem crops up in organizations in all countries, but the Soviet model had few mechanisms (like bankruptcy in markets and elections for public goods) to provide an ultimate check on waste.

Comparative Economic Performance. From World War II until the mid-1980s, the United States and the Soviet Union engaged in a superpower competition for public opinion, military superiority, and economic dominance. How well did the command economies perform in the economic growth race? Any attempt at answering this question is bedeviled by the absence of reliable statistics. Most economists believed until recently that the Soviet Union grew rapidly from 1928 until the mid-1960s, with growth rates perhaps surpassing those in North America and Western Europe. After the mid-1960s, growth in the Soviet Union stagnated and output actually began to decline.

A revealing comparison of the performance of market and command economies can be made by contrasting the experiences of East Germany and West Germany. These countries started out with roughly equal levels of productivity and similar industrial structures at the end of World War II. After four decades of capitalism in the West and Soviet-style socialism in the East, productivity in East Germany had fallen to a level estimated between one-fourth and one-third of that in West Germany. Moreover, the East German growth tended to emphasize production of intermediate goods and commodities of little value to consumers. Quantity, not quality, was the goal.

Balance Sheet. Is there a final balance sheet on Soviet central planning? The Soviet model demonstrated that a command economy can work—it is capable of mobilizing capital and labor and producing both guns and butter. But the Soviet economy, with borders closed to trade, technologies, and people, became increasingly obsolete over time. Innovation withered because of poor incentives. In competition with the open-market economies, particularly as the world turned to increasingly high-quality goods and services, Russia could export virtually nothing except raw materials and military equipment.

Growth slowed, and per capita income declined in the latest period of central planning. Its leaders finally abandoned Soviet central planning as it was seen to be morally, politically, and economically bankrupt.

From Marx to Market

Beginning in 1989, the countries of Eastern Europe and the former Soviet Union rejected the communist experiment and introduced market economies. A cruel joke heard in Eastern Europe is "Question: What is communism? Answer: The longest road from capitalism to capitalism."

The road back to capitalism proved a rocky one for many countries. Among the challenges were the following: (1) liberalizing prices to allow supply and demand to determine prices, (2) imposing

Eye Therapies Exhibit 2127, 561 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

hard budget constraints on subsidized enterprises, (3) privatizing enterprises so that the decisions about buying, selling, pricing, producing, borrowing, and lending would be made by private agents, and (4) establishing the institutions of the market, such as a modern banking system, the legal framework for commerce, and the tools for monetary and fiscal policy.

Some countries, like Slovenia and the Czech Republic, made the transition relatively quickly and are now increasingly integrated into the European Union as functioning market democracies. Russia has renationalized much of its energy industry and has become an energy powerhouse. Other countries, particularly the former Soviet Republics in Asia, are still mired in autocracy, corruption, and rigid economic structures. The lessons here are useful for any country attempting to establish the institutions of a market economy.

A Final Note of Cautious Optimism

This chapter has described the problems and prospects of poor countries struggling to be rich and free—to provide the dry houses, education, electric lights, fast horses, automobiles, and long vacations of the excerpt that opened this chapter. What are the prospects of attaining these goals?

We close with a sober assessment by Jeffrey Sachs of Columbia University and the Earth Institute, one of the outstanding development economists of today, and his co-author Andrew Warner:

> The world economy [today] looks much like the world economy at the end of the nineteenth century. A global capitalist system is taking shape, drawing almost all regions of the world into arrangements of open trade and harmonized economic institutions. As in the nineteenth century, this new round of globalization promises to lead to economic convergence for the countries that join the system. . . .
>
> And yet there are also profound risks for the consolidation of market reforms in Russia, China, and Africa, as well as for the maintenance of international agreements among the leading countries. . . . The spread of capitalism in the [last] twenty-five years is an historic event of great promise and significance, but whether we will be celebrating the consolidation of a democratic and market-based world system [twenty-five years hence] will depend on our own foresight and good judgments in the years to come.



SUMMARY

A. Population Growth and Development

1. Malthus's theory of population rests on the law of diminishing returns. He contended that population, if unchecked, would tend to grow at a geometric (or exponential) rate, doubling every generation or so. But each member of the growing population would have less land and natural resources to work with. Because of diminishing returns, income could grow at an arithmetic rate at best; output per person would tend to fall so low as to stabilize population at a subsistence level of near-starvation.
2. Over the last two centuries, Malthus and his followers have been criticized on several grounds. Among the major criticisms are that Malthusians ignored the possibility of technological advance and overlooked the significance of birth control as a force in lowering population growth. The neo-Malthusians see limits to growth from environmental constraints, particularly global warming, where markets provide distorted signals.

B. Economic Growth in Poor Countries

3. Most of the world's population lives in developing countries, which have relatively low per capita incomes. Such countries often exhibit rapid population growth, a low level of literacy, poor health, and a high proportion of their population living and working on farms.
4. The key to development lies in four fundamental factors: human resources, natural resources, capital, and technology. Explosive population causes problems as the Malthusian prediction of diminishing returns haunts the poorest countries. On the constructive agenda, improving the population's health, education, and technical training has high priority.
5. Investment and saving rates in poor countries are low because incomes are so depressed that little can be saved for the future. International financing of investment in poor countries has witnessed many crises over the last two centuries.

Eye Therapies Exhibit 2127, 562 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

6. Technological change is often associated with investment and new machinery. It offers much hope to the developing nations because they can adopt the more productive technologies of advanced nations. This requires entrepreneurship. One task of development is to spur internal growth of the scarce entrepreneurial spirit.
7. Numerous theories of economic development help explain why the four fundamental factors are present or absent at a particular time. Development economists today emphasize the growth advantage of relative backwardness, the need to respect the role of agriculture, and the art of finding the proper boundary between state and market. The most recent consensus is on the advantages of openness.
8. Countries should be concerned about falling into the poverty trap, in which a vicious cycle of poverty leads to poor performance and locks a country into continued poverty.
9. Recall our summary judgment on the role of government policies: (*a*) Foster the rule of law. (*b*) Make the critical investments in human and social overhead capital. (*c*) Limit the public sector to clear areas of comparative advantage. (*d*) Maintain an economy open to trade and foreign investment.

C. Alternative Models for Development

10. Many "isms" have competed with the mixed market economy as models for economic development. Alternative strategies include the managed-market approach of the East Asian countries, socialism, and the Soviet-style command economy.
11. The managed-market approach of Japan and the Asian dragons, such as South Korea, Hong Kong, Taiwan, and Singapore, proved remarkably successful over the last quarter-century. Among the key ingredients were macroeconomic stability, high investment rates, a sound financial system, rapid improvements in education, and an outward orientation in trade and technology policies.
12. Socialism is a middle ground between capitalism and communism, stressing government ownership of the means of production, planning by the state, income redistribution, and peaceful transition to a more egalitarian world.
13. Historically, Marxism took its deepest economic roots in semi-feudal Russia and was then imposed on the rest of the Soviet Union and Eastern Europe. Studies of resource allocation in these countries show that resources were allocated by central planning with severe distortions of prices and outputs. The Soviet economy depended primarily on energy-intensive heavy industry and the military in its early decades. Stagnation and poor incentives for innovation left Russia and other centrally planned countries at income levels far below those of North America, Japan, and Western Europe. These countries have all rejected the centralized command economy for some variant of the mixed market economy.

CONCEPTS FOR REVIEW

Population Theory

Malthus's population theory
geometric vs. arithmetic growth

Economic Development

developing country
indicators of development
four elements in development
vicious cycles, virtuous circles, poverty trap
backwardness hypothesis

Alternative Models for Development

the central dilemma of market vs. command
socialism, communism
the principal-agent problem
command economy

FURTHER READING AND INTERNET WEBSITES

Further Reading

One of the most influential books of all times is T. R. Malthus, *Essay on Population* (1798, many publishers). An online version can be found at *www.ac.wwu.edu/~stephan/malthus/malthus.0.html*. The influential books by the new Malthusians Donella H. Meadows, Dennis L. Meadows, and Jørgen Randers are *The Limits to Growth* (Potomac, Washington, D.C., 1972) and *Beyond the Limits* (Chelsea Green, Post Mills, Vt., 1992).

Eye Therapies Exhibit 2127, 563 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The study on the East Asian miracle is contained in World Bank, *The East Asia Miracle: Economic Growth and Government Policies* (World Bank, Washington, D.C., 1993). The quotation at the end is from Jeffrey Sachs and Andrew Warner, "Economic Reform and the Process of Global Integration," *Brookings Papers on Economic Activity,* no. 1, 1995, pp. 63–64.

A highly readable account of developments in Soviet economic history is contained in Alec Nove, *An Economic History of the U.S.S.R.,* 3d ed. (Penguin, Baltimore, 1990). A careful study of the Soviet economic system is provided by Paul R. Gregory and Robert C. Stuart, *Russian and Soviet Economic Performance and Structure,* 6th ed. (Harper & Row, New York, 1997).

Websites

The World Bank has information on its programs and publications at its site, *www.worldbank.org;* the International Monetary Fund (IMF) provides similar information at *www.imf.org.* The United Nations website has links to most international institutions and their databases at *www.unsystem.org.* A good source of information about high-income countries is the Organisation for Economic Cooperation and Development (OECD) website, *www.oecd.org.* U.S. trade data are available at *www.census.gov.* You can find information on many countries through their statistical offices. A compendium of national agencies is available at *www.census.gov/main.*

Population data are available from the United Nations at *www.un.org/popin/.* One of the best sources for studies of developing countries is the World Bank, especially the annual *World Development Review* at *www.worldbank.org.* The quote from Klitgaard was published in *Finance and Development,* March 1998, and can be found at *www.gwdg.de/~uwvw/icr.htm.*

QUESTIONS FOR DISCUSSION

1. A geometric progression is a sequence of terms $(g_1, g_2, \ldots, g_t, g_{t+1}, \ldots)$, in which each term is the same multiple of its predecessor:

$$\frac{g_2}{g_1} = \frac{g_3}{g_2} = \cdots = \frac{g_{t+1}}{g_t} = \beta$$

   If $\beta = 1 + i > 1$, the terms grow exponentially like compound interest, where i is the interest rate. An arithmetic progression is a sequence $(a_1, a_2, a_3, \ldots, a_t, a_{t+1}, \ldots)$, in which the difference between each term and its predecessor is the same constant:

$$a_2 - a_1 = a_3 - a_2 = \cdots = a_{t+1} - a_t = \cdots = \lambda$$

   Give examples of each. Satisfy yourself that any geometric progression with $\beta > 1$ must eventually surpass any arithmetic progression. Relate this to Malthus's theory.
2. Recall that Malthus asserted that unchecked population would grow geometrically, while food supply—constrained by diminishing returns—would grow only arithmetically. Use a numerical example to show why per capita food production must decline if population is unchecked while diminishing returns lead food production to grow more slowly than labor inputs.
3. Do you agree with the celebration of material well-being expressed in the chapter's opening quotation? What would you add to the list of the benefits of economic development?
4. Delineate each of the four important factors driving economic development. With respect to these, how was it that the high-income oil-exporting countries became rich? What hope is there for a country like Mali, which has very low per capita resources of capital, land, and technology?
5. Some fear the "vicious cycle of underdevelopment." In a poor country, rapid population growth eats into whatever improvements in technology occur and lowers living standards. With a low per capita income, the country cannot save and invest and mainly engages in subsistence farming. With most of the population on the farm, there is little hope for education, decline in fertility, or industrialization. If you were to advise such a country, how would you break the vicious cycle?
6. Compare the situation a developing country faces today with the one it might have faced (at an equivalent level of per capita income) 200 years ago. Considering the four wheels of economic development, explain the advantages and disadvantages that today's developing country might experience.
7. Some economists today question whether it is wise to allow complete openness on both financial and current accounts. They argue that allowing free flow of short-term financial movements increases vulnerability to speculative attacks. Give the pros and cons of limiting short-term financial movements. Might you want to

Eye Therapies Exhibit 2127, 564 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

use a tax on short-term flows rather than quantitative restrictions?

8. Analyze the way that *what, how,* and *for whom* are solved in a Soviet-style command economy, and compare your analysis with the solution of the three central questions in a market economy.
9. **Advanced problem** (relying upon the growth accounting of Chapter 25): We can extend our growth-accounting equation to include three factors and write the following equation:

$$g_Q = s_L g_L + s_K g_K + s_R g_R + \text{T.C.}$$

where g_Q = the growth rate of output, g_i = the growth rate of inputs (i = inputs to production: L for labor, K for capital, and R for land and other natural resources), and s_i = the contribution of each input to output growth as measured by its share of national income ($0 \leq s_i \leq 1$ and $s_L + s_K + s_R = 1$). T.C. measures technological change.

   a. In the poorest developing countries, the share of capital is close to zero, the main resource is agricultural land (which is constant), and there is little technological change. Can you use this to explain the Malthusian hypothesis in which per capita output is likely to be stagnant or even to decline (i.e., $g_Q < g_L$)?
   b. In advanced economies, the share of land resources drops to virtually zero. Why does this lead to the growth-accounting equation studied in the previous chapter? Can you use this to explain how countries can avoid the Malthusian trap of stagnant incomes?
   c. According to economists who are pessimistic about future prospects (including a group of *neo-Malthusians* from the Club of Rome), T.C. is close to zero, the available supply of natural resources is declining, and the share of resources is large and rising. Does this explain why the future of industrial societies might be bleak? Which assumptions of the neo-Malthusians might you question?

Eye Therapies Exhibit 2127, 565 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

27

Exchange Rates and the International Financial System



The benefit of international trade—a more efficient employment of the productive forces of the world.

John Stuart Mill

Economically, no nation is an island unto itself. When the bell tolls recession or financial crisis, the sound reverberates around the world.

We see this point illustrated dramatically in the twentieth century, which we can divide into two distinct periods. The period from 1914 to 1945 was characterized by destructive competition, shrinking international trade, growing financial isolation, hot and cold military and trade wars, dictatorships, and depression. By contrast, after World War II, most of the world enjoyed growing economic cooperation, widening trade linkages, increasingly integrated financial markets, an expansion of democracy, and rapid economic growth. This stark contrast emphasizes how high the stakes are in the wise management of our national and global economies.

What are the economic links among nations? The important economic concepts involve international trade and finance. International trade in goods and services allows nations to raise their standards of living by specializing in areas of comparative advantage, exporting products in which they are relatively efficient while importing ones in which they are relatively inefficient. In a modern economy, trade takes place using different currencies. The international financial system is the lubricant that facilitates trade and finance by allowing people to use and exchange different currencies.

International trade is sometimes seen as a zero-sum, Darwinian conflict. This view is misleading at best and wrong at worst. International trade and finance, like all voluntary exchange, can improve the well-being of all participants in the transactions. When the United States sells wheat to Japan and imports cars, using the medium of dollars and yen, these transactions lower prices and raise living standards in both countries.

But economic integration (sometimes called *globalization*) is not without its perils. Some periods, such as the early 2000s, were relatively tranquil, while others saw crisis after crisis. The 1930s saw the gold standard and the international trading regime collapse. The 1970s saw the failure of the fixed-exchange-rate system, oil embargoes, and a sharp increase in inflation. The 1990s saw a succession of financial crises: a crisis of confidence in the exchange-rate regime in Europe in 1991–1992, capital flight from Mexico in 1994–1995, banking and currency panics in East Asia in 1997, a default on Russian debt and a global liquidity freeze in 1998, and a series of currency problems in Latin America.

After a period of relative tranquility, the world was shocked in 2007–2009 by the bursting of a housing-price bubble, mortgage foreclosures, and financial failures in the world's most sophisticated

Eye Therapies Exhibit 2127, 566 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

economy, the United States. The global nature of the economic system was seen in 2007–2009, when the financial crisis in the United States spread around the world. All of these crises required careful management by the fiscal and monetary authorities of the major countries involved.

This chapter and the next one survey international macroeconomics. This topic includes the principles governing the international monetary system, which is the major focus of the present chapter, as well as the impact of foreign trade on output, employment, and prices, which is covered in the next chapter.

International macroeconomics involves many of the most controversial questions of the day: Does foreign trade raise or lower our output and employment? What is the link between domestic saving, domestic investment, and the trade balance? What are the causes of the occasional financial crises that spread contagiously from country to country? What has been the effect of the European Monetary Union on Europe's macroeconomic performance? And why has the United States become the world's largest debtor country in the last decade? The economic stakes are high in finding wise answers to these questions.

TRENDS IN FOREIGN TRADE

An economy that engages in international trade is called an **open economy.** A useful measure of openness is the ratio of a country's exports or imports to its GDP. Figure 27-1 shows the trend in the shares of imports and exports for the United States over the last half-century. It shows the large export surplus in the early years after World War II as America financed the reconstruction of Europe. But the share of imports and exports was low in the 1950s and 1960s. With growth abroad and a lowering of trade barriers, the share of trade grew steadily and reached an average of 13 percent of GDP in 2008.

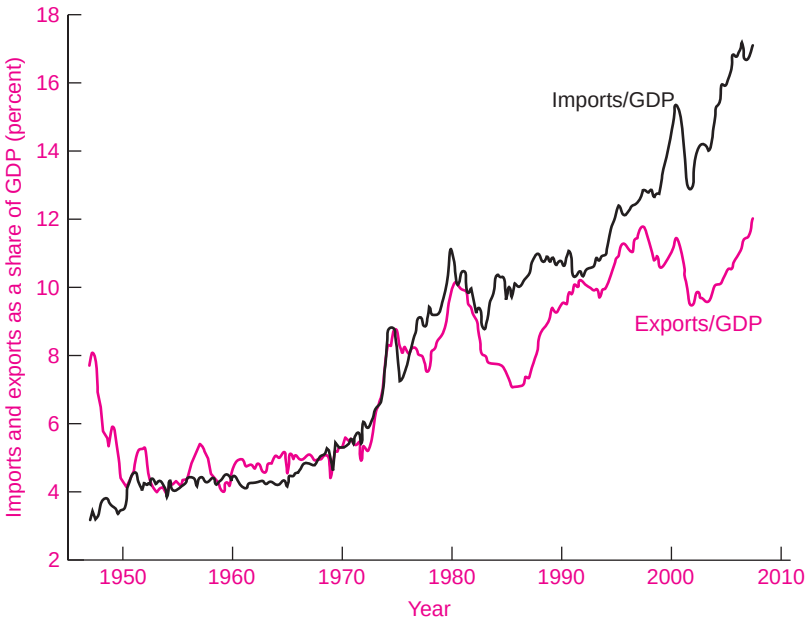


FIGURE 27-1. Growing U.S. Openness

Like all major market economies, the United States has increasingly opened its borders to foreign trade since World War II. This has led to a growing share of output and consumption involved in international trade. Since the 1980s, imports have far outdistanced exports, causing the United States to become the world's largest debtor nation.

Source: U.S. Bureau of Economic Analysis.

Eye Therapies Exhibit 2127, 567 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

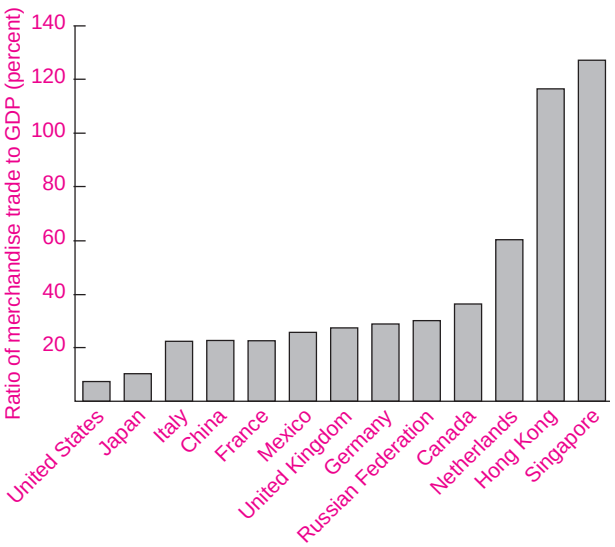


FIGURE 27-2. Openness Varies Enormously across Regions

Large countries like the United States have small trade shares, while tiny countries like Singapore trade more than they produce.

Source: World Trade Organization. Shares are the ratio of merchandise trade to GDP for the period 2002–2005.

You might be surprised to learn that the United States is a relatively self-sufficient economy. Figure 27-2 shows the trade proportions of selected countries. Small countries and those in highly integrated regions like Western Europe are more open than the United States. Moreover, the degree of openness is much higher in many U.S. industries than in the overall economy, particularly in manufacturing industries like steel, textiles, consumer electronics, and autos. Some industries, such as education and health care, are largely insulated from foreign trade.

A. THE BALANCE OF INTERNATIONAL PAYMENTS

BALANCE-OF-PAYMENTS ACCOUNTS

We begin this chapter with an overview of the way nations keep their international accounts. Economists keep score by looking at income statements and balance sheets. In the area of international economics, the key accounts are a nation's **balance of international payments.** These accounts provide a systematic statement of all economic transactions between that country and the rest of the world. Its major components are the current account and the financial account. The basic structure of the balance of payments is shown in Table 27-1, and each element is discussed below.

Debits and Credits

Like other accounts, the balance of payments records each transaction as either a plus or a minus. The general rule in balance-of-payments accounting is the following:

If a transaction earns foreign currency for the nation, it is called a *credit* and is recorded as a plus item. If a transaction involves spending foreign currency, it is a *debit* and is recorded as a negative item. In general, exports are credits and imports are debits.

Exports earn foreign currency, so they are credits. Imports require spending foreign currency, so they are debits. How is the U.S. import of a Japanese camera recorded? Since we ultimately pay for it in Japanese yen, it is clearly a debit. How shall we

I.	**Current account**
	Merchandise (or "trade balance")
	Services
	Investment income
	Unilateral transfers
II.	**Financial account**
	Private
	Government
	Official reserve changes
	Other

TABLE 27-1. Basic Elements of the Balance of Payments

The balance of payments has two fundamental parts. The *current account* represents the spending and receipts on goods and services along with transfers. The *financial account* includes purchases and sales of financial assets and liabilities. An important principle is that the two must always sum to zero:

Current account + financial account = I + II = 0

Eye Therapies Exhibit 2127, 568 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

treat interest and dividend income on investments received by Americans from abroad? Clearly, they are credit items like exports because they provide us with foreign currencies.

Details of the Balance of Payments

Balance on Current Account. The totality of items under section I in Table 27-1 is the **balance on current account.** This includes all items of income and outlay—imports and exports of goods and services, investment income, and transfer payments. The current-account balance is akin to the net income of a nation. It is conceptually similar to net exports in the national output accounts. In the past, many writers concentrated on the **trade balance,** which consists of merchandise imports and exports. The composition of merchandise imports and exports consists mainly of primary commodities (like food and fuels) and manufactured goods. In an earlier era, the mercantilists strove for a trade surplus (an excess of exports over imports), calling this a "favorable balance of trade." They hoped to avoid an "unfavorable trade balance," by which they meant a trade deficit (an excess of imports over exports). Even today, we find traces of mercantilism when nations seek to maintain trade surpluses.

Today, economists avoid this language because a trade deficit is not necessarily harmful. As we will see, the trade deficit is really a reflection of the imbalance between domestic investment and domestic saving. Often, a nation has a trade deficit because it has a low saving rate (perhaps because of a government deficit). It might also have a trade deficit because it has productive uses for domestic investment (as is the case for the United States). An opposite case of a trade surplus would arise when a country has high saving with few productive domestic investments for its saving (as, for example, Saudi Arabia, with vast oil revenues but meager investment opportunities).

In addition, *services* are increasingly important in international trade. Services consist of such items as shipping, financial services, and foreign travel. A third item in the current account is *investment income,* which includes the earnings on foreign investments (such as earnings on U.S. assets abroad). One of the major developments of the last two decades has been the growth in services and investment income. A final element is transfers, which represent payments not in return for goods and services.

Table 27-2 presents a summary of the U.S. balance of international payments for 2007. Note its two main components: current account and financial account. Each item is listed by name in column (a). Credits are listed in column (b), while column (c) shows the debits. Column (d) then lists the net credits or debits; it shows a credit if on balance the item added to our stock of foreign currencies or a debit if the total subtracted from our foreign-currency supply.

In 2007, America's merchandise exports led to credits of $1149 billion. But at the same time, merchandise imports led to debits of $1965 billion. The *net* difference was a merchandise trade deficit of $815 billion. This trade deficit is listed in column (d). (Be sure you understand why the algebraic sign is shown as − rather than as +.) From the table we see that net services and net investment income were positive. The total current-account deficit including merchandise trade, services, investment income, and unilateral transfers was $739 billion for 2007.

(We have omitted an additional item in the accounts called the capital account, which involves capital transfers. This item is extremely small and can be ignored in most circumstances.)

Financial Account. We have now completed our analysis of the current account. But how did the United States "finance" its $739 billion current-account deficit in 2007? It must have either borrowed or reduced its foreign assets, for by definition, when you buy something, you must either pay for it or borrow for it. This identity means that *the balance of international payments as a whole must by definition show a final balance of zero.*

Financial-account transactions are asset transactions between Americans and foreigners. They occur, for example, when a Japanese pension fund buys U.S. government securities or when an American buys stock in a German firm.

Credits and debits are somewhat more complicated in the financial accounts. The general rule, which is drawn from double-entry business accounting, is this: Increases in a country's assets and

Eye Therapies Exhibit 2127, 569 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

U.S. Balance of Payments, 2007
(billions of dollars)

(a) Items	(b) Credits (+)	(c) Debits (−)	(d) Net credits (+) or debits (−)
I. Current account			**−739**
a. Merchandise trade balance	1,149	−1,965	−815
b. Services	479	−372	107
c. Investment income	782	−708	74
d. Unilateral transfers			−104
II. Financial account [lending (−) or borrowing (+)]			**739**
a. Private borrowing or lending	1,451	−1,183	268
b. Government			
Official U.S. reserve assets, changes			−24
Foreign official assets in the U.S., changes			413
c. Statistical discrepancy			83
III. Sum of current and financial accounts			**0**

TABLE 27-2. Basic Elements of the U.S. Balance of Payments, 2007

Source: U.S. Bureau of Economic Analysis. Note that the totals may not equal the sum of the components because of rounding.

decreases in its liabilities are entered as debits; conversely, decreases in a country's assets and increases in its liabilities are entered as credits. A debit entry is represented by a negative (−) sign and a credit entry by a positive (+) sign.

You can usually get the right answer more easily if you remember this simplified rule: Think of the United States as exporting and importing stocks, bonds, or other securities. Then you can treat these exports and imports of securities like other exports and imports. When we borrow abroad, we are sending IOUs (in the form of Treasury bills or corporate stocks) abroad and getting foreign currencies. Is this a credit or a debit? Clearly, this is a credit because it brought foreign currencies into the United States.

Similarly, if U.S. banks lend abroad to finance a computer assembly plant in Mexico, the U.S. banks are importing IOUs from the Mexicans and the United States is losing foreign currencies; this is clearly a debit item in the U.S. balance of payments.

Line II shows that in 2007 the United States was a net *borrower:* we borrowed abroad more than we lent to foreigners. The United States was a net exporter of IOUs (a net borrower) in the amount of $739 billion.[1]



The Paradox of Wealthy Borrowers

What is the typical pattern of surpluses and deficits of nations? You might think that poor countries would have higher productivity of capital and would therefore borrow from rich countries, while rich countries would have used up their investment opportunities and should therefore lend to poor countries.

Indeed, this pattern did hold for most of U.S. history. During the nineteenth century, the United States imported more than it exported. Europe lent the difference, which allowed the United States to build up its capital stock. The

[1] As with all economic statistics, the balance-of-payments accounts necessarily contain statistical errors (called the "statistical discrepancy"). These errors reflect the fact that many flows of goods and finance (from small currency transactions to the drug trade) are not recorded. We include the statistical discrepancy in line II(c) of Table 27-2.

Eye Therapies Exhibit 2127, 570 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

United States was a typical young and growing debtor nation. From about 1873 to 1914, the U.S. balance of trade moved into surplus. Then, during World War I and World War II, America lent money to its allies England and France for war equipment and postwar relief needs. The United States emerged from the wars a creditor nation, with a surplus from earnings on foreign investments matched by a deficit on merchandise trade.

The pattern around the world is quite different today because of financial globalization. In an open financial world, the pattern of trade surpluses and deficits is largely determined by the balance of saving and investment. Table 27-3 shows a summary of the major regions today. This table shows that the pattern of lending and borrowing has virtually no relationship to levels of economic development but is primarily determined by saving and investment patterns. The most interesting situation on the list is that of the United States, which is a wealthy country borrowing abroad. We will explore the reasons for this paradox of wealthy borrowers in the next chapter.

Current Account Balance (billions of dollars)

Region	2007
Rich and low saving:	
United States	−739
Rich and high saving:	
Japan	211
Other rich countries	160
Resource-rich and diversifying:	
OPEC/Middle East	257
Russia	76
Poor and high saving:	
China	372
Poor and low saving:	
Sub-Saharan Africa	−25
Other	−45

TABLE 27-3. Pattern of Current Accounts around the World, 2007

The United States is the world's largest borrower with its low saving rate and stable investment climate. Important savers are rich and high-saving countries (such as Japan), resource-rich countries looking for financial diversification (such as Russia and OPEC countries), and poor and high-saving countries (such as China, which has a saving rate even higher than its high investment rate). The poorest countries do get some small net inflows.

Source: International Monetary Fund, *World Economic Outlook,* available online at *www.imf.gov.*

B. THE DETERMINATION OF FOREIGN EXCHANGE RATES

FOREIGN EXCHANGE RATES

We are all familiar with domestic trade. When I buy Florida oranges or California computers, I naturally want to pay in dollars. Luckily, the orange grower and the computer manufacturer want payment in U.S. currency, so all trade can be carried out in dollars. Economic transactions within a country are relatively simple.

But suppose I am in the business of selling Japanese bicycles. Here, the transaction becomes more complicated. The bicycle manufacturer wants to be paid in Japanese currency rather than in U.S. dollars. Therefore, in order to import the Japanese bicycles, I must first buy Japanese yen (¥) and use those yen to pay the Japanese manufacturer. Similarly, if the Japanese want to buy U.S. merchandise, they must first obtain U.S. dollars. This new complication involves foreign exchange.

Foreign trade involves the use of different national currencies. The **foreign exchange rate** is the price of one currency in terms of another currency. The foreign exchange rate is determined in the **foreign exchange market,** which is the market where different currencies are traded.

We begin with the fact that most major countries have their own currencies—the U.S. dollar, the Japanese yen, the Mexican peso, and so forth. (European countries are an exception in that they have a common currency, the Euro.) We follow the convention of measuring exchange rates, which we denote by the symbol e, as the amount of foreign currency that can be bought with 1 unit of the domestic currency. For example, the foreign exchange rate of the dollar might be 100 yen per U.S. dollar (¥100/$).

When we want to exchange one nation's money for that of another, we do so at the relevant foreign exchange rate. For example, if you traveled to Mexico in the summer of 2008, you would have received

Eye Therapies Exhibit 2127, 571 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

about 11 Mexican pesos for 1 U.S. dollar. There is a foreign exchange rate between U.S. dollars and the currency of every other country. In 2008, the foreign exchange rate per U.S. dollar was 0.68 Euro, 0.54 British pound, and 103 Japanese yen.

With foreign exchange, it is possible for me to buy a Japanese bicycle. Suppose its quoted price is 20,000 yen. I can look in the newspaper for the foreign exchange rate for yen. Suppose the rate is ¥100/$. I could go to the bank to convert my $200 into ¥20,000. With my Japanese money, I then can pay the exporter for my bicycle in the currency it wants.

You should be able to show what Japanese importers of American trucks have to do if they want to buy, say, a $36,000 truck from an American exporter. Here yen must be converted into dollars. You will see that, when the foreign exchange rate is 100 yen per dollar, the truck costs them ¥3,600,000.

Businesses and tourists do not have to know anything more than this for their import or export transactions. But the economics of foreign exchange rates cannot be grasped until we analyze the forces underlying the supply and demand for foreign currencies and the functioning of the foreign exchange market.

The foreign exchange rate is the price of one currency in terms of another currency. We measure the foreign exchange rate (e) as the amount of foreign currency that can be bought with 1 unit of domestic currency:

$$e = \frac{\text{foreign currency}}{\text{domestic currency}} = \frac{\text{yen}}{\$} = \frac{\text{Euros}}{\$} = \dots$$

THE FOREIGN EXCHANGE MARKET

Like most other prices, foreign exchange rates vary from week to week and month to month according to the forces of supply and demand. The *foreign exchange market* is the market in which currencies of different countries are traded and foreign exchange rates are determined. Foreign currencies are traded at the retail level in many banks and firms specializing in that business. Organized markets in New York, Tokyo, London, and Zurich trade hundreds of billions of dollars of currencies each day.

We can use our familiar supply and demand curves to illustrate how markets determine the price of foreign currencies. Figure 27-3 shows the supply and demand for U.S. dollars that arise in dealings with Japan.[2] The *supply* of U.S. dollars comes from people in the United States who need yen to purchase Japanese goods, services, or financial assets. The *demand* for dollars comes from people in Japan who buy U.S. goods, services, or investments and who, accordingly, need dollars to pay for these items. The price of foreign exchange—the foreign exchange rate—settles at that price where supply and demand are in balance.

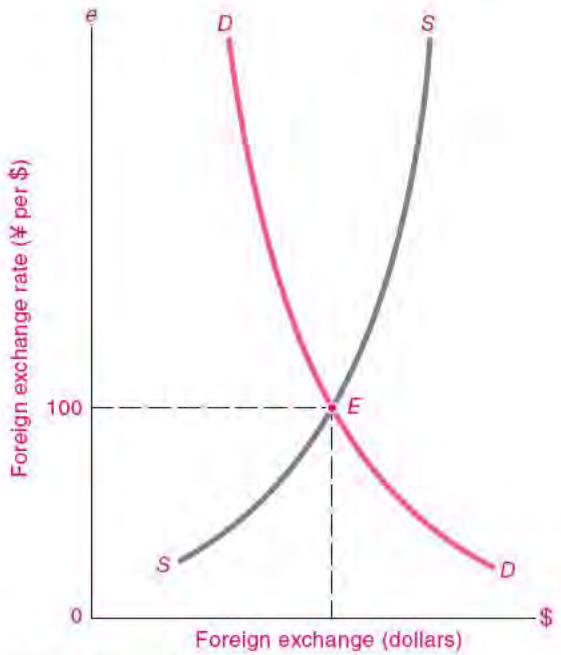


FIGURE 27-3. Exchange-Rate Determination

Behind the supplies and demands for foreign exchange lie purchases of goods, services, and financial assets. Behind the demand for dollars is the Japanese desire for American goods and investments. The supply of dollars comes from Americans desiring Japanese goods and assets. Equilibrium comes at E. If the foreign exchange rate were above E, there would be an excess supply of dollars. Unless the government bought this excess supply with official reserves, market forces would push the foreign exchange rate back down to balance supply and demand at E.

[2] This is a simplified example in which we consider only the bilateral trade between Japan and the United States.

Eye Therapies Exhibit 2127, 572 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Let us first consider the supply side. The supply of U.S. dollars to the foreign exchange market originates when Americans need yen to buy Japanese automobiles, cameras, and other commodities, to vacation in Tokyo, and so forth. In addition, foreign exchange is required if Americans want to purchase Japanese assets, such as shares in Japanese companies. In short, *Americans supply dollars when they purchase foreign goods, services, and assets.*

In Figure 27-3, the vertical axis is the foreign exchange rate (e), measured in units of foreign currency per unit of domestic currency—that is, in yen per dollar, in Mexican pesos per dollar, and so forth. Make sure you understand the units here. The horizontal axis shows the quantity of dollars bought and sold in the foreign exchange market.

The supply of U.S. dollars is represented by the upward-sloping *SS* curve. The upward slope indicates that as the foreign exchange rate rises, the number of yen that can be bought per dollar increases. This means, with other things held constant, that the prices of Japanese goods fall relative to those of American goods. Hence, Americans will tend to buy more Japanese goods, and the supply of U.S. dollars therefore increases.

To see why the supply curve slopes upward, take the example of bicycles. If the foreign exchange rate were to rise from ¥100/$ to ¥200/$, the bicycle which costs ¥20,000 would fall in price from $200 to $100. If other things are constant, Japanese bicycles would be more attractive, and Americans would sell more dollars in the foreign exchange market to buy more bicycles. Hence, the quantity supplied of dollars would be higher at a higher exchange rate.

What lies behind the demand for dollars (represented in Figure 27-3 by the *DD* demand curve? Foreigners demand U.S. dollars when they buy American goods, services, and assets. For example, suppose a Japanese student buys an American economics textbook or takes a trip to the United States. She will require U.S. dollars to pay for these items. Or when Japan Airlines buys a Boeing 787 for its fleet, this transaction increases the demand for U.S. dollars. If Japanese pension funds invest in U.S. stocks, this would require a purchase of dollars. *Foreigners demand U.S. dollars to pay for their purchases of American goods, services, and assets.*

The demand curve in Figure 27-3 slopes downward to indicate that as the dollar's value falls (and the yen therefore becomes more expensive), Japanese residents will want to buy more foreign goods, services, and investments. They will therefore demand more U.S. dollars in the foreign exchange market. Consider what happens when the foreign exchange rate on the dollar falls from ¥100/$ to ¥50/$. American computers, which had sold at $2000 × (¥100/$) = ¥200,000 now sell for only $2000 × (¥50/$) = ¥100,000. Japanese purchasers will therefore tend to buy more American computers, and the quantity demanded of U.S. foreign exchange will increase.

Market forces move the foreign exchange rate up or down to balance the supply and demand. The price will settle at the *equilibrium foreign exchange rate,* which is the rate at which the dollars willingly bought just equal the dollars willingly sold.

The balance of supply and demand for foreign exchange determines the foreign exchange rate of a currency. At the market exchange rate of 100 yen per dollar shown at point *E* in Figure 27-3, the exchange rate is in equilibrium and has no tendency to rise or fall.

We have discussed the foreign exchange market in terms of the supply and demand for dollars. But in this market, there are two currencies involved, so we could just as easily analyze the supply and demand for Japanese yen. To see this, you should sketch a supply-and-demand diagram with yen foreign exchange on the horizontal axis and the yen rate ($ per ¥) on the vertical axis. If ¥100/$ is the equilibrium looking from the point of view of the dollar, then $0.01/¥ is the *reciprocal exchange rate.* As an exercise, go through the analysis in this section for the reciprocal market. You will see that in this simple bilateral world, for every point made about dollars there is an exact yen counterpart: supply of dollars is demand for yen; demand for dollars is supply of yen.

There is just one further extension necessary to get to actual foreign exchange markets. In reality, there are many different currencies. We therefore need to find the supplies and demands for each and every currency. And in a world of many nations, it is the many-sided exchange and trade relationships, with demands and supplies coming from all parts of the globe, that determine the entire array of foreign exchange rates.

Eye Therapies Exhibit 2127, 573 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



Terminology for Exchange-Rate Changes

Foreign exchange markets have a special vocabulary. By definition, a fall in the price of one currency in terms of one or all others is called a *depreciation*. A rise in the price of a currency in terms of another currency is called an *appreciation*. In our example above, when the price of the dollar rose from ¥100/$ to ¥200/$, the dollar appreciated. We also know that the yen depreciated.

In the supply-and-demand diagram for U.S. dollars, a fall in the foreign exchange rate (e) is a depreciation of the U.S. dollar, and a rise in e represents an appreciation.

A different set of terms is used when a currency has a fixed exchange rate. When a country lowers the official price of its currency in the market, this is called a *devaluation*. A *revaluation* occurs when the official foreign exchange rate is raised.

For example, in December 1994 Mexico devalued its currency when it lowered the official price or parity of the peso from 3.5 pesos per dollar to 3.8 pesos per dollar. Mexico soon found it could not defend the new parity and "floated" its exchange rate. At that point, the peso fell, or depreciated, even further.

When a country's currency falls in value relative to that of another country, we say that the domestic currency has undergone a **depreciation** while the foreign currency has undergone an **appreciation.**

When a country's official foreign exchange rate is lowered, we say that the currency has undergone a **devaluation.** An increase in the official foreign exchange rate is called a **revaluation.**

Effects of Changes in Trade

What would happen if there were changes in foreign exchange demand? For example, if Japan has a recession, its demand for imports declines. As a result, the demand for American dollars would decrease. The result is shown in Figure 27-4. The decline in purchases of American goods, services, and investments decreases the demand for dollars in the market. This change is represented by a leftward shift in the demand curve. The result will be a lower foreign exchange rate—that is, the dollar will depreciate and the yen will appreciate. At the lower exchange rate, the quantity of dollars supplied by Americans to the market will decrease because Japanese goods are now more expensive. Moreover, the quantity of dollars demanded by the Japanese will decline because of the recession. How much will exchange rates change? Just enough so that the supply and demand are again in balance. In the example shown in Figure 27-4, the dollar has depreciated from ¥100/$ to ¥75/$.

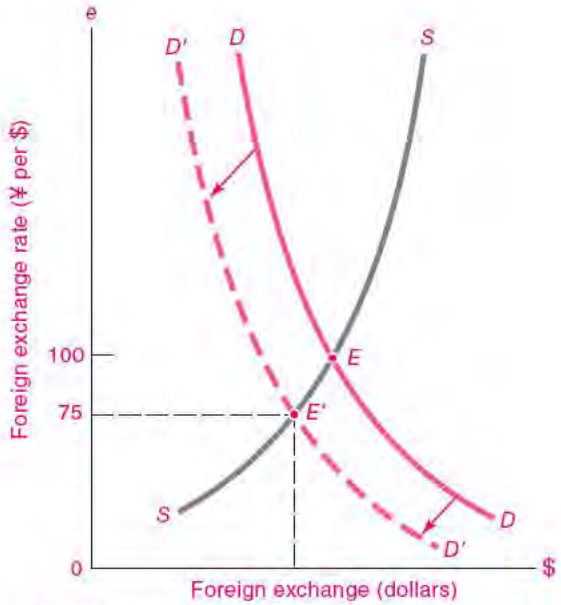


FIGURE 27-4. A Decrease in Demand for Dollars Leads to Dollar Depreciation

Suppose that a recession or deflation in Japan reduces the Japanese demand for dollars. This would shift the demand for dollars to the left from *DD* to *D'D'*. The exchange rate of the dollar depreciates, while the yen appreciates. Why would the new exchange rate discourage American purchases of Japanese goods?

In today's world, exchange rates often react to changes involving the financial account. Suppose that the Federal Reserve raises U.S. interest rates. This would make U.S. dollar assets more attractive than foreign assets as dollar interest rates rise relative to interest rates on foreign securities. As a result, the demand for dollars increases and the dollar appreciates. This sequence is shown in Figure 27-5.

Exchange Rates and the Balance of Payments

What is the connection between exchange rates and adjustments in the balance of payments? In the simplest case, assume that exchange rates are

Eye Therapies Exhibit 2127, 574 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

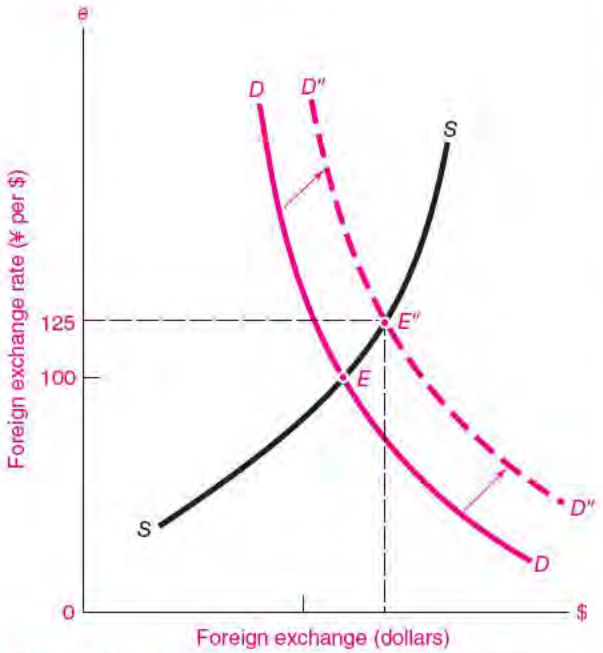


FIGURE 27-5. Monetary Tightening Increases Demand for Dollars and Produces Dollar Appreciation

Monetary policy can affect the exchange rate through the financial account. If the Federal Reserve raises dollar interest rates, this induces investors into dollar securities and raises the demand for dollar foreign exchange. The result is an appreciation of the dollar. (Explain why this leads to depreciation of the Euro.)

determined by private supply and demand with no government intervention. Consider what happened in 1990 after German unification when the German central bank decided to raise interest rates to curb inflation. After the monetary tightening, foreigners moved some of their assets into German marks to benefit from high German interest rates. This produced an excess demand for the German mark at the old exchange rate. In other words, at the old foreign exchange rate, people were, on balance, buying German marks and selling other currencies. (You can redraw Figure 27-5 to show this situation.)

Here is where the exchange rate plays its role as equilibrator. As the demand for German marks increased, it led to an appreciation of the German mark and a depreciation of other currencies, such as the U.S. dollar. The movement in the exchange rate continued until the financial and current accounts were back in balance.

Such a change in the foreign exchange rate has an important effect on trade flows. As the German mark appreciated, German goods became more expensive in foreign markets and foreign goods became less expensive in Germany. This led to a decrease in German exports and an increase in German imports. As a result, the trade balance moved toward deficit. The current-account deficit was the counterpart of the financial-account surplus induced by the higher interest rates.

Exchange-rate movements serve as a balance wheel to remove disequilibria in the balance of payments.

Purchasing-Power Parity and Exchange Rates

In the short run, market-determined exchange rates are highly volatile in response to monetary policy, political events, and changes in expectations. But over the longer run, exchange rates are determined primarily by the relative prices of goods in different countries. An important implication is the *purchasing-power-parity (PPP) theory of exchange rates.* Under this theory, a nation's exchange rate will tend to equalize the cost of buying traded goods at home with the cost of buying those goods abroad.

The PPP theory can be illustrated with a simple example. Suppose the price of a market basket of goods (automobiles, jewelry, oil, food, and so forth) costs $1000 in the United States and 10,000 pesos in Mexico. At an exchange rate of 100 pesos to a dollar, this bundle would cost $100 in Mexico. Given these relative prices and the free trade between the two countries, we would expect to see American firms and consumers streaming across the border to take advantage of the lower Mexican prices. The result would be higher imports from Mexico and an increased demand for Mexican pesos. That would cause the Mexican peso to appreciate relative to the U.S. dollar, so you would need more dollars to buy the same number of pesos. As a result, the prices of the Mexican goods *in dollar terms* would rise even though the prices in pesos have not changed.

Where would this process end? Assuming that domestic prices are unchanged, it would end when the peso's exchange rate falls to 10 pesos to the dollar. Only at this exchange rate would the price of the

Eye Therapies Exhibit 2127, 575 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

market basket of goods be equal in the two countries. At 10 pesos to the dollar, we say that the currencies have equal purchasing power in terms of the traded goods. (You can firm up your understanding of this discussion by calculating the price of the market basket in both Mexican pesos and U.S. dollars before and after the appreciation of the peso.)

The PPP doctrine also holds that countries with high inflation rates will tend to have depreciating currencies. For example, if Country A's inflation rate is 10 percent while inflation in Country B is 2 percent, the currency of Country A will tend to depreciate relative to that of Country B by the difference in the inflation rates, that is, 8 percent annually. Alternatively, let's say that runaway inflation leads to a hundredfold rise of prices in Russia over the course of a year, while prices in the United States are unchanged. According to the PPP theory, the Russian ruble should depreciate by 99 percent in order to bring the prices of American and Russian goods back into equilibrium.

We should caution that the PPP theory only approximates and cannot predict the precise movements in the exchange rate. One reason it does not hold exactly is that many of the goods and services covered in price indexes are not traded. For example, if the PPP uses the consumer price index, then we must take into account that housing is a nontraded service and that the prices for housing of comparable quality can vary greatly over space. Additionally, even for traded goods, there is no "law of one price" that applies uniformly to all goods. If you look at the price of the same item on amazon.com and amazon.co.uk, you will find that (even after applying the current exchange rate) the price is usually different. Price differences for the same good can arise because of tariffs, taxes, and transportation costs. In addition, financial flows can overwhelm the effects of prices in the short run. Therefore, while the PPP theory is a useful guide to exchange rates in the long run, exchange rates can diverge from their PPP levels for many years.



PPP and the Size of Nations

By any measure, the United States still has the largest economy in the world. But which country has the second largest? Is it Japan, Germany, Russia, or some other country? You would think this would be an easy question to answer, like measuring height or weight. The problem, however, is that Japan totes up its national output in yen, while Russia's national output is given in rubles, and America's is in dollars. To be compared, they all need to be converted into the same currency.

The customary approach is to use the market exchange rate to convert each currency into dollars, and by that yardstick Japan has the second-largest economy. However, there are two difficulties with using the market rate. First, because market rates can rise and fall sharply, the "size" of countries might change by 10 or 20 percent overnight. Moreover, the use of market exchange rates tends to underestimate the national output of low-income countries.

Today, economists generally prefer to use PPP exchange rates to compare living standards in different countries. The difference between market exchange rates and PPP exchange rates can be dramatic, as Figure 27-6 shows. When market exchange rates are used, the incomes and outputs of low-income countries like China and India tend to be understated. This understatement occurs because a substantial part of the output of such countries comes from labor-intensive services, which are usually extremely inexpensive in low-wage countries. Hence, when we calculate PPP exchange rates including the prices of nontraded goods, the GDPs of low-income countries rise relative to those of high-income countries. For example, when PPP exchange rates are used, China's GDP is 2.3 times the level calculated using market exchange rates.

C. THE INTERNATIONAL MONETARY SYSTEM

While the simple supply-and-demand diagrams for the foreign exchange market explain the major determinants, they do not capture the drama and central importance of the international monetary system. We saw crisis after crisis in international finance—in Europe in 1991–1992, in Mexico and Latin America in 1994–1995, in East Asia and Russia in 1997–1998, and then back to Latin America in 1998–2002.

What is the **international monetary system?** This term denotes the institutions under which payments

Eye Therapies Exhibit 2127, 576 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



FIGURE 27-6. PPP Calculations Change the Relative Sizes of Nations' Economies, 2006

Using PPP exchange rates instead of market exchange rates changes the economic ranking of nations. After correcting for the purchasing power of incomes, China moves from being the fourth largest to being the second largest. Note that points along the 45° line are ones for which GDPs calculated using the two exchange rates are equal. Points above the line, such as China, are ones for which the PPP estimates of GDP are above those estimated using market exchange rates. Japan is below the line because relative prices in Japan are high due to high rents and trade barriers.

Source: World Bank. Note that outputs are shown on a ratio scale.

are made for transactions that cross national boundaries. In particular, the international monetary system determines how foreign exchange rates are set and how governments can affect exchange rates.

The importance of the international monetary system was well described by economist Robert Solomon:

> Like the traffic lights in a city, the international monetary system is taken for granted until it begins to malfunction and to disrupt people's lives. . . . A well-functioning monetary system will facilitate international trade and investment and smooth adaptation to change. A monetary system that functions poorly may not only discourage the development of trade and investment among nations but subject their economies to disruptive shocks when necessary adjustments to change are prevented or delayed.

The central element of the international monetary system involves the arrangements by which exchange rates are set. In recent years, nations have used one of three major exchange-rate systems:

- A system of fixed exchange rates
- A system of flexible or floating exchange rates, where exchange rates are determined by market forces
- Managed exchange rates, in which nations intervene to smooth exchange-rate fluctuations or to move their currency toward a target zone

FIXED EXCHANGE RATES: THE CLASSICAL GOLD STANDARD

At one extreme is a system of **fixed exchange rates,** where governments specify the exact rate at which dollars will be converted into pesos, yen, and other currencies. Historically, the most important fixed-exchange-rate system was the **gold standard,** which

Eye Therapies Exhibit 2127, 577 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

was used off and on from 1717 until 1936. In this system, each country defined the value of its currency in terms of a fixed amount of gold, thereby establishing fixed exchange rates among the countries on the gold standard.[3]

The functioning of the gold standard can be seen easily in a simplified example. Suppose people everywhere insisted on being paid in bits of pure gold metal. Then buying a bicycle in Britain would merely require payment in gold at a price expressed in ounces of gold. By definition there would be no foreign-exchange-rate problem. Gold would be the common world currency.

This example captures the essence of the gold standard. Once gold became the medium of exchange or money, foreign trade was no different from domestic trade; everything could be paid for in gold. The only difference between countries was that they could choose different *units* for their gold coins. Thus, Queen Victoria chose to make British coins about ¼ ounce of gold (the pound) and President McKinley chose to make the U.S. unit ½₀ ounce of gold (the dollar). In that case, the British pound, being 5 times as heavy as the dollar, had an exchange rate of $5/£1.

This was the essence of the gold standard. In practice, countries tended to use their own coins. But anyone was free to melt down coins and sell them at the going price of gold. So exchange rates were fixed for all countries on the gold standard. The exchange rates (also called "par values" or "parities") for different currencies were determined by the gold content of their monetary units.

Hume's Adjustment Mechanism

The purpose of an exchange-rate system is to promote international trade and finance while facilitating adjustment to shocks. How exactly does the *international adjustment mechanism* function? What happens if a country's wages and prices rise so sharply that its goods are no longer competitive in the world market? Under flexible exchange rates, the country's exchange rate could depreciate to offset the domestic inflation. But under fixed exchange rates, equilibrium must be restored by deflation at home or inflation abroad.

Let's examine the international adjustment mechanism under a fixed-exchange-rate system with two countries, America and Britain. Suppose that American inflation has made American goods uncompetitive. Consequently, America's imports rise and its exports fall. It therefore runs a trade deficit with Britain. To pay for its deficit, America would have to ship gold to Britain. Eventually—if there were no adjustments in either America or Britain—America would run out of gold.

In fact, an automatic adjustment mechanism does exist, as was demonstrated by the British philosopher David Hume in 1752. He showed that the outflow of gold was part of a mechanism that tended to keep international payments in balance. His argument, though nearly 250 years old, offers important insights for understanding how trade flows get balanced in today's economy.

Hume's explanation rested in part upon the quantity theory of prices, which is a theory of the overall price level that is analyzed in macroeconomics. This doctrine holds that the overall price level in an economy is proportional to the supply of money. Under the gold standard, gold was an important part of the money supply—either directly, in the form of gold coins, or indirectly, when governments used gold as backing for paper money.

What would be the impact of a country's losing gold? First, the country's money supply would decline either because gold coins would be exported or because some of the gold backing for the currency would leave the country. Putting both these consequences together, a loss of gold leads to a reduction in the money supply. According to the quantity theory, the next step is that prices and costs would change proportionally to the change in the money supply. If the United States loses 10 percent of its gold to pay for a trade deficit, the quantity theory predicts that U.S. prices, costs, and incomes would fall 10 percent. In other words, the economy would experience a deflation.

The Four-Pronged Mechanism. Now consider Hume's theory of international payments equilibrium. Suppose that America runs a large trade deficit and

[3] Why was gold used as the standard of exchange and means of payment, rather than some other commodity? Certainly other materials could have been used, but gold had the advantages of being in limited supply, being relatively indestructible, and having few industrial uses. Can you see why wine, wheat, or cattle would not be a useful means of payment among countries?

Eye Therapies Exhibit 2127, 578 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

begins to lose gold. According to the quantity theory of prices, this loss of gold reduces America's money supply, driving down America's prices and costs. As a result, (1) America decreases its imports of British and other foreign goods, which have become relatively expensive; and (2) because America's domestically produced goods have become relatively inexpensive on world markets, America's exports increase.

The opposite effect occurs in Britain and other foreign countries. Because Britain's exports are growing rapidly, it receives gold in return. Britain's money supply therefore increases, driving up British prices and costs according to the quantity theory. At this point, two more prongs of the Hume mechanism come into play: (3) British and other foreign exports have become more expensive, so the volume of goods exported to America and elsewhere declines; and (4) British citizens, faced with a higher domestic price level, now import more of America's low-priced goods.

Figure 27-7 illustrates the logic in Hume's mechanism. Make sure you can follow the logical chain from

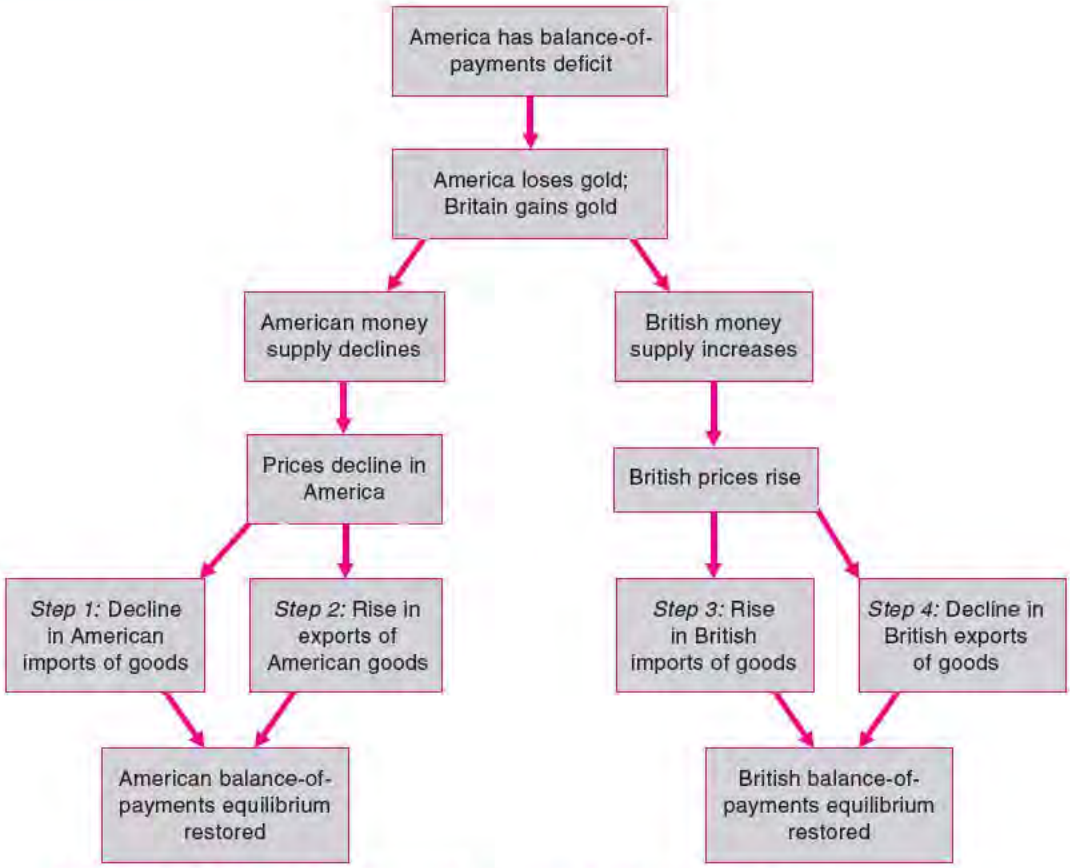


FIGURE 27-7. Hume's Four-Pronged International Adjustment Mechanism

Hume explained how a balance-of-payments disequilibrium would automatically produce equilibrating adjustments under a gold standard. Trace the lines from the original disequilibrium at the top through the changes in prices to the restored equilibrium at the bottom. This mechanism works in modified form under any fixed-exchange-rate system. Modern economics augments the mechanism by replacing the fourth row with "Prices, output, and employment decline in America" and "Prices, output, and employment rise in Britain."

Eye Therapies Exhibit 2127, 579 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the original deficit at the top through the adjustment to the new equilibrium at the bottom.

The result of Hume's four-pronged gold-flow mechanism is an improvement in the balance of payments of the country losing gold and a worsening in that of the country gaining gold. In the end, an equilibrium of international trade and finance is reestablished at new relative prices, which keep trade and international lending in balance with no net gold flow. This equilibrium is a stable one and requires no tariffs or other government intervention.

Updating Hume to Modern Macroeconomics

Hume's theories are no longer completely relevant today. We do not have a gold standard, and the quantity theory of prices is no longer used to explain price movements. However, the basis of Hume's theory can be reinterpreted in the light of modern macroeconomics. The essence of Hume's argument is to explain the adjustment mechanism for imbalances between countries under a fixed exchange rate. The fixed exchange rate might be a gold standard (as existed before 1936), a dollar standard (as under the Bretton Woods system from 1945 to 1971), or a Euro standard (among European Union countries today).

If exchange rates are not free to move when the prices or incomes of different countries get out of line, *then domestic output and prices must adjust to restore equilibrium.* If, under a fixed exchange rate, domestic prices become too high relative to import prices, full adjustment can come only when domestic prices fall. This will occur when domestic output falls sufficiently so that the country's price level will decline relative to world prices. At that point, the country's balance of payments will return to equilibrium. Suppose that Greece's prices rise too far above those in the rest of the European Union and it becomes uncompetitive in the market. Greece will find its exports declining and its imports rising, lowering net exports. Eventually, as wages and prices in Greece decline relative to those in the rest of Europe, Greece will once again be competitive and will be able to restore full employment.

When a country adopts a fixed exchange rate, it faces an inescapable fact: Domestic real output and employment must adjust to ensure that the country's relative prices are aligned with those of its trading partners.

INTERNATIONAL MONETARY INSTITUTIONS AFTER WORLD WAR II

In the early part of the twentieth century, even nations which were ostensibly at peace engaged in debilitating trade wars and competitive devaluations. After World War II, international institutions were developed to foster economic cooperation among nations. These institutions continue to be the means by which nations coordinate their economic policies and seek solutions to common problems.

The United States emerged from World War II with its economy intact—able and willing to help rebuild the countries of friends and foes alike. The postwar international political system responded to the needs of war-torn nations by establishing durable institutions that facilitated the quick recovery of the international economy. The major international economic institutions of the postwar period were the General Agreement on Tariffs and Trade (rechartered as the World Trade Organization in 1995), the Bretton Woods exchange-rate system, the International Monetary Fund, and the World Bank. These four institutions helped the industrial democracies rebuild themselves and grow rapidly after the devastation of World War II, and they continue to be the major international institutions today.

The International Monetary Fund

An integral part of the Bretton Woods system was the establishment of the International Monetary Fund (or IMF), which still administers the international monetary system and operates as a central bank for central banks. Member nations subscribe by lending their currencies to the IMF; the IMF then relends these funds to help countries in balance-of-payments difficulties. The main function of the IMF is to make temporary loans to countries which have balance-of-payments problems or are under speculative attack in financial markets.

The World Bank

Another international financial institution created after World War II was the World Bank. The Bank is capitalized by high-income nations that subscribe in proportion to their economic importance in terms of GDP and other factors. The Bank makes long-term low-interest loans to countries for projects which are

Eye Therapies Exhibit 2127, 580 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

economically sound but which cannot get private-sector financing. As a result of such long-term loans, goods and services flow from advanced nations to developing countries.

The Bretton Woods System

After World War II, governments were determined to replace the gold standard with a more flexible system. They set up the **Bretton Woods system,** which was a system with fixed exchange rates. The innovation here was that exchange rates were *fixed but adjustable.* When one currency got too far out of line with its appropriate or "fundamental" value, the parity could be adjusted.

The Bretton Woods system functioned effectively for the quarter-century after World War II. The system eventually broke down when the dollar became overvalued. The United States abandoned the Bretton Woods system in 1973, and the world moved into the modern era.



How to Ensure a Credibly Fixed Exchange Rate through the "Hard Fix"

Although the collapse of the Bretton Woods system marked the end of a predominantly fixed exchange-rate system, many countries continue to opt for fixed exchange rates. A recurrent problem with fixed-exchange-rate systems is that they are prey to speculative attacks when the country runs low on foreign exchange reserves. (We will return to this problem in the next chapter.) How can countries improve the credibility of their fixed-exchange-rate systems? Are there "hard" fixed-exchange-rate systems that will better withstand speculative attacks?

Specialists in this area emphasize the importance of establishing credibility. In this instance, credibility may be enhanced by creating a system that would actually make it *hard* for the country to change its exchange rate. This approach is similar to a military strategy of burning the bridges behind the army so that there is no retreat and the soldiers will have to fight to the death. Indeed, Argentina's president tried to instill credibility in Argentina's system by proclaiming that he would choose "death before devaluation."

One solution is to create **currency boards.** A currency board is a monetary institution that issues only currency that is fully backed by foreign assets in a key foreign currency, usually the U.S. dollar or the Euro. A currency board defends an exchange rate that is fixed by law rather than just by policy, and the currency board is usually independent, and sometimes even private. Under currency boards, a payments deficit will generally trigger Hume's automatic adjustment mechanism. That is, a balance-of-payments deficit will reduce the money supply, leading to an economic contraction, eventually reducing domestic prices and restoring equilibrium. A currency board system has worked effectively in Hong Kong, but the system in Argentina was unable to withstand economic and political turmoil and collapsed in 2002.

A fixed exchange rate is even more credible when countries adopt a **common currency** through monetary union. The United States has had a common currency since 1789. The most important recent example is the Euro, which has been adopted by 15 countries of the European Union. This is a most unusual arrangement because the currency joins together many powerful sovereign countries. From a macroeconomic point of view, a common currency is the hardest fix of all because the currencies of the different countries are all defined to be the same. A variant of this approach is called "dollarization," which occurs when a country (usually a small one) adopts a key currency for its own money. About a dozen small countries, such as El Salvador, have gone this route.

Fixed exchange rates have fallen out of favor among large countries. Only China continues to use a fixed exchange rate, and it is under intense pressure from other countries to allow the yuan to float. Aside from China, every large region of the world has adopted some variant of flexible exchange rates, which we will analyze shortly.

Intervention

When a government fixes its exchange rate, it must "intervene" in foreign exchange markets to maintain the rate. Government exchange-rate **intervention** occurs when the government buys or sells foreign exchange to affect exchange rates. For example, the Japanese government on a given day might buy $1 billion worth of Japanese yen with U.S. dollars. This would cause a rise in value, or an appreciation, of the yen.

Let's take the case of China. China is the last major country to operate under a fixed exchange rate. The official exchange rate in 2008 was $0.144 per yuan. However, at that exchange rate, China had an enormous current-account surplus, as Table 27-3 on page 548 shows. China has used a strategy of export-led growth, and this requires a below-market

Eye Therapies Exhibit 2127, 581 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

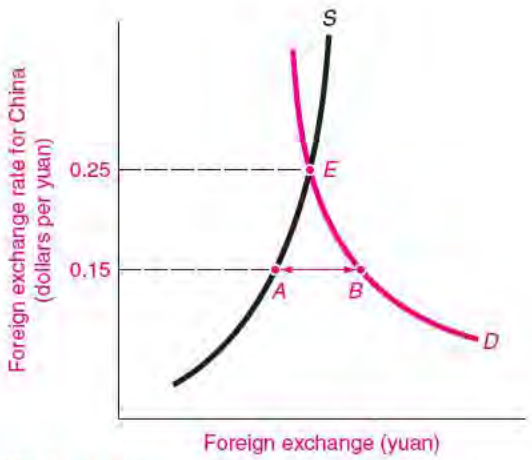


FIGURE 27-8. Chinese Government Intervenes to Maintain Fixed Exchange Rates

Because China has established a fixed exchange rate, it must intervene in the foreign exchange market to defend its established rate. Assume that the market equilibrium without intervention would be $0.25 per yuan, shown as point *E* at the intersection of market supply and demand. However, the government has established an official exchange rate of $0.15 per yuan. At that lower rate, there is excess demand for yuan, shown by the segment *AB*. (Make sure you understand why this is excess demand.) The Chinese government therefore sells a quantity of yuan, shown by the segment *AB*, to keep its exchange rate from appreciating.

exchange rate to make its exports so competitive. So while American and European policymakers have been urging China to revalue its currency, China has insisted that it will continue with its current fixed-exchange-rate policy.

How exactly does China maintain this system? Figure 27-8 illustrates the mechanism. Let us assume that the forces of supply and demand would lead to an equilibrium at point *E*, with a market-determined exchange rate of $0.25 per yuan. At the fixed exchange rate of $0.15 per yuan, the yuan is "undervalued" relative to the market-determined rate. What can the Chinese government do to keep the yuan below its market value?

- One approach is to intervene by *buying dollars and selling yuan*. In this approach, if China's central bank sells a quantity of yuan shown by the segment *AB*, this will increase the supply of yuan to match the quantity demanded and maintain the official exchange rate.
- An alternative would be to use monetary policy. China could *induce the private sector to increase its supply of yuan* by lowering interest rates. Lower interest rates would make dollar investments relatively more attractive and yuan investments relatively less attractive. This would lead investors to sell yuan and shift the yuan supply curve to the right so that it would pass through point *B* and produce the desired exchange rate. (You can pencil in a new *S′* curve that would lead to the induced equilibrium.)

These two operations are not really as different as they sound. In one case, the Chinese government sells yuan and buys dollars; in the other case, the private sector does the same. Both approaches involve monetary expansion. Indeed, we will see that one of the complications of managing an open economy with a fixed exchange rate is that the need to use monetary policy to manage the exchange rate can collide with the desire to use monetary policy to stabilize the domestic business cycle.

FLEXIBLE EXCHANGE RATES

The international monetary system for major countries today relies primarily on **flexible exchange rates.** (Another term often used is **floating exchange rates,** which means the same thing.) Under this system, exchange rates are determined by supply and demand. Here, the government neither announces an official exchange rate nor takes steps to enforce one, and the changes in exchange rates are determined primarily by private supply of and demand for goods, services, and investments.

As noted above, virtually all large and medium-sized countries except China rely upon flexible exchange rates. We can use the example of Mexico to illustrate how such a system works. In 1994, the peso was under attack in foreign exchange markets, and the Mexicans allowed the peso to float. At the original exchange rate of approximately 4 pesos per U.S. dollar, there was an excess supply of pesos. This meant that at that exchange rate, the supply of pesos by Mexicans who wanted to buy American and other foreign goods and assets outweighed the demand for pesos by Americans and others who wanted to purchase Mexican goods and assets.

Eye Therapies Exhibit 2127, 582 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

What was the outcome? As a result of the excess supply, the peso depreciated relative to the dollar. How far did the exchange rates move? Just far enough so that—at the depreciated exchange rate of about 6 pesos to the dollar—the quantities supplied and demanded were balanced.

What is behind the equilibration of supply and demand? Two main forces are involved: (1) With the dollar more expensive, it costs more for Mexicans to buy American goods, services, and investments, causing the supply of pesos to fall off in the usual fashion. (2) With the depreciation of the peso, Mexican goods and assets become less expensive for foreigners. This increases the demand for pesos in the marketplace. (Note that this simplified discussion assumes that all transactions occur only between the two countries; a more complete discussion would involve the demands and supplies of currencies from all countries.)

TODAY'S HYBRID SYSTEM

Unlike the earlier uniform system under either the gold standard or Bretton Woods, today's exchange-rate system fits into no tidy mold. Without anyone's having planned it, the world has moved to a hybrid exchange-rate system. The major features are as follows:

- A few countries allow their currencies to *float freely*. In this approach, a country allows markets to determine its currency's value and it rarely intervenes. The United States has fit this pattern for most of the last three decades. While the Euro is just an infant as a common currency, Europe is clearly in the freely floating group.
- Some major countries have *managed but flexible* exchange rates. Today, this group includes Canada, Japan, and many developing countries. Under this system, a country will buy or sell its currency to reduce the day-to-day volatility of currency fluctuations. In addition, a country will sometimes engage in systematic intervention to move its currency toward what it believes to be a more appropriate level.
- A few small countries and China peg their currencies to a major currency or to a "basket" of currencies in a *fixed exchange rate*. Sometimes, the peg is allowed to glide smoothly upward or downward in a system known as a gliding or crawling peg. A few countries have the hard fix of a currency board, and others set their currencies equal to the dollar in a process called dollarization.
- In addition, almost all countries tend to intervene either when markets become "disorderly" or when exchange rates seem far out of line with the "fundamentals"—that is, when they are highly inappropriate for existing price levels and trade flows.

Concluding Thoughts

The world has made a major transition in its international financial system over the last three decades. In earlier periods, most currencies were linked together in a system of fixed exchange rates, with parities linked either to gold or to the dollar. Today, with the exception of China, all major countries have flexible exchange rates. This new system has the disadvantage that exchange rates are volatile and can deviate greatly from underlying economic fundamentals. But this system also has the advantage of reducing the perils of speculation that undermined earlier fixed-rate systems. Even more important in a world of increasingly open financial markets is that flexible exchange rates allow countries to pursue monetary policies designed to stabilize domestic business cycles. It is this macroeconomic advantage that most economists find most important about the new regime.



SUMMARY

A. The Balance of International Payments

1. The balance of international payments is the set of accounts that measures all the economic transactions between a nation and the rest of the world. It includes exports and imports of goods, services, and financial instruments. Exports are credit items, while imports are debits. More generally, credit items are transactions that increase a country's holdings of foreign currencies; debit items are ones that reduce its holdings of foreign currencies.

Eye Therapies Exhibit 2127, 583 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

2. The major components of the balance of payments are:
   I. Current account (merchandise trade, services, investment income, transfers)
   II. Financial account (private, government, and official-reserve changes)

   The fundamental rule of balance-of-payments accounting is that the sum of all items must equal zero: I + II = 0

B. The Determination of Foreign Exchange Rates

3. International trade and finance involve the new element of different national currencies, which are linked by relative prices called foreign exchange rates. When Americans import Japanese goods, they ultimately need to pay in Japanese yen. In the foreign exchange market, Japanese yen might trade at ¥100/$ (or, reciprocally, ¥1 would trade for $0.01). This price is called the foreign exchange rate.
4. In a foreign exchange market involving only two countries, the supply of U.S. dollars comes from Americans who want to purchase goods, services, and investments from Japan; the demand for U.S. dollars comes from Japanese who want to import commodities or financial assets from America. The interaction of these supplies and demands determines the foreign exchange rate. More generally, foreign exchange rates are determined by the complex interplay of many countries buying and selling among themselves. When trade or financial flows change, supply and demand shift and the equilibrium exchange rate changes.
5. A fall in the market price of a currency is a depreciation; a rise in a currency's value is called an appreciation. In a system where governments announce official foreign exchange rates, a decrease in the official exchange rate is called a devaluation, while an increase is a revaluation.
6. According to the purchasing-power-parity (PPP) theory of exchange rates, exchange rates tend to move with changes in relative price levels of different countries. The PPP theory applies better to the long run than the short run. When this theory is applied to measure the purchasing power of incomes in different countries, it raises the per capita outputs of low-income countries.

C. The International Monetary System

7. A well-functioning international economy requires a smoothly operating exchange-rate system, which denotes the institutions that govern financial transactions among nations. Two important exchange-rate systems are (*a*) flexible exchange rates, in which a country's foreign exchange rate is determined by market forces of supply and demand; and (*b*) fixed exchange rates, such as the gold standard or the Bretton Woods system, in which countries set and defend a given structure of exchange rates.
8. Classical economists like David Hume explained international adjustments to trade imbalances by the gold-flow mechanism. Under this process, gold movements would change the money supply and the price level. For example, a trade deficit would lead to a gold outflow and a decline in domestic prices that would (*a*) raise exports and (*b*) curb imports of the gold-losing country while (*c*) reducing exports and (*d*) raising imports of the gold-gaining country. This mechanism shows that under fixed exchange rates, countries which have balance-of-payments problems must adjust through changes in domestic price and output levels.
9. After World War II, countries created a group of international economic institutions to organize international trade and finance. Under the Bretton Woods system, countries "pegged" their currencies to the dollar and to gold, providing fixed but adjustable exchange rates. After the Bretton Woods system collapsed in 1973, it was replaced by today's hybrid system. Today, virtually all large and medium-sized countries (except China) have flexible exchange rates.

CONCEPTS FOR REVIEW

Balance of Payments

balance of payments
  I. current account
  II. financial account
balance-of-payments identity:
  I + II = 0
debits and credits

Foreign Exchange Rates

foreign exchange rate, foreign exchange market
supply of and demand for foreign exchange
exchange-rate terminology:
  appreciation and depreciation
  revaluation and devaluation

International Monetary System

exchange-rate systems:
  flexible
  fixed rates (gold standard, Bretton Woods, currency board)
  common currency
international adjustment mechanism
Hume's four-pronged gold-flow mechanism

Eye Therapies Exhibit 2127, 584 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

FURTHER READING AND INTERNET WEBSITES

Further Reading

A fascinating collection of essays on international macroeconomics is Paul Krugman, *Pop International* (MIT Press, Cambridge, Mass., 1997). The quotation on the international monetary system is from Robert Solomon, *The International Monetary System, 1945–1981: An Insider's View* (Harper & Row, New York, 1982), pp. 1, 7.

Websites

Data on trade and finance for different countries can be found in the websites listed for Chapter 26.

Some of the best popular writing on international economics is found in *The Economist*, which is available on the Web at *www.economist.com*. One of the best sources for policy writing on international economics is *www.iie.com/homepage.htm*, the website of the Peterson Institute for International Economics. One of the leading scholar-journalists of today is Paul Krugman of Princeton. His blog at *krugman.blogs.nytimes.com* contains many interesting readings on international economics.

QUESTIONS FOR DISCUSSION

1. Table 27-4 shows some foreign exchange rates (in units of foreign currency per dollar) as of late 2008. Fill in the last column of the table with the reciprocal price of the dollar in terms of each foreign currency, being especially careful to write down the relevant units in the parentheses.
2. Figure 27-3 shows the demand and supply for U.S. dollars in an example in which Japan and the United States trade only with each other.
   a. Describe and draw the reciprocal supply and demand schedules for Japanese yen. Explain why the supply of yen is equivalent to the demand for dollars. Also explain and draw the schedule that corresponds to the supply of dollars. Find the equilibrium price of yen in this new diagram and relate it to the equilibrium in Figure 27-3.
   b. Assume that Americans develop a taste for Japanese goods. Show what would happen to the supply and demand for yen. Would the yen appreciate or depreciate relative to the dollar? Explain.
3. Draw up a list of items that belong on the credit side of the balance of international payments and another list of items that belong on the debit side. What is meant by a trade surplus? By the balance on current account?
4. Suppose that China operates a fixed-exchange-rate system and is running a large current-account surplus. The government supports the system by buying large quantities of dollars in the foreign exchange market.

	Price		
Currency	Units of foreign currency per U.S. dollar	U.S. dollars per unit of foreign currency	
Dollar (Canada)	0.9861	1.014	(US$/Canadian dollar)
Real (Brazil)	1.656	_____	(_____)
Yuan (China)	6.942	_____	(_____)
Peso (Mexico)	10.38	_____	(_____)
Pound (Britain)	0.5054	_____	(_____)
Euro	0.6368	_____	(_____)
Dollar (Zimbabwe)	255,771,415	_____	(_____)

TABLE 27-4.

Eye Therapies Exhibit 2127, 585 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Assume that the resulting increase in the supply of yuan leads to an increase in bank reserves.

a. Explain why this would lead to a monetary expansion and lower interest rates in China. Further explain why this would lead to an expansion in aggregate demand, higher output, and a higher price level. (This answer relies on the analysis presented in Chapters 23 and 24.)

b. Explain why, as prices rise because of the effects you described in **a,** Hume's four-pronged mechanism would eventually reduce the Chinese current-account surplus. Interpret your answer as the modern, updated version of Hume's mechanism.

5. Consider the situation for Germany described on page 552. Using a figure like Figure 27-3, show the supply and demand for German marks before and after the shock. Identify on your figure the excess demand for marks *before* the appreciation of the mark. Then show how an appreciation of the mark would wipe out the excess demand.

6. A Middle East nation suddenly discovers huge oil resources. Show how its balance of trade and current account suddenly turn to surplus. Show how it can acquire assets in New York as a financial-account offset. Later, when it uses the assets for domestic capital investment, show how its current and financial items reverse their roles.

7. Consider the following quotation from the 1984 *Economic Report of the President:*

> In the long run, the exchange rate tends to follow the differential trend in the domestic and foreign price level. If one country's price level gets too far out of line with prices in other countries, there will eventually be a fall in demand for its goods, which will lead to a real depreciation of its currency.

Explain how the first sentence relates to the PPP theory of exchange rates. Explain the reasoning behind the PPP theory. In addition, using a supply-and-demand diagram like that of Figure 27-3, explain the sequence of events, described in the second sentence of the quotation, whereby a country whose price level is relatively high will find that its exchange rate depreciates.

8. A nation records the following data for 2008: exports of automobiles ($100) and corn ($150); imports of oil ($150) and steel ($75); tourist expenditures abroad ($25); private lending to foreign countries ($50); private borrowing from foreign countries ($40); official-reserve changes ($30 of foreign exchange bought by domestic central bank). Calculate the statistical discrepancy and include it in private lending to foreign countries. Create a balance-of-payments table like Table 27-2.

9. Consider the following three exchange-rate systems: the classical gold standard, freely flexible exchange rates, and the Bretton Woods system. Compare and contrast the three systems with respect to the following characteristics:

a. Role of government vs. market in determining exchange rates

b. Degree of exchange-rate volatility

c. Method of adjustment of relative prices across countries

d. Need for international cooperation and consultation in determining exchange rates

e. Potential for establishment and maintenance of severe exchange-rate misalignment

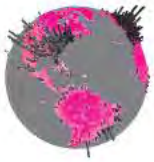
10. Consider the European monetary union. List the pros and cons. How do you come down on the question of the advisability of monetary union? Would your answer change if the question concerned the United States?

Eye Therapies Exhibit 2127, 586 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

28

Open-Economy Macroeconomics



Before I built a wall I'd ask to know
What I was walling in or walling out . . .

Robert Frost

The international business cycle exerts a powerful effect on every nation of the globe. Shocks in one area can have ripple effects around the world. Political disturbances in the Middle East can set off a spiral in oil prices that triggers inflation and unemployment. Defaults can rock stock markets and shake business confidence in distant lands. The interconnectedness of countries was illustrated dramatically in the financial crisis of 2007–2009. When U.S. financial institutions suffered huge losses, stock and bond markets around the world also declined, and a banking crisis in Europe erupted almost simultaneously with that in the United States.

The previous chapter surveyed the major concepts of international macroeconomics—the balance of payments, the determination of exchange rates, and the international monetary system. The present chapter continues the story by showing how macroeconomic shocks in one country have ripple effects on the output and inflation of other countries. We explore the paradoxical finding that trade balances are largely determined by the balances between domestic saving and investment. The chapter concludes with a review of some of the key international issues of today.

A. FOREIGN TRADE AND ECONOMIC ACTIVITY

Net Exports and Output in the Open Economy

Open-economy macroeconomics is the study of how economies behave when the trade and financial linkages among nations are considered. The previous chapter described the basic concepts of the balance of payments. We can restate those concepts here in terms of the national income and product accounts.

Foreign trade involves imports and exports. Although the United States produces most of what it consumes, it nonetheless has a large quantity of **imports,** which are goods and services produced abroad and consumed domestically. **Exports** are goods and services produced domestically and purchased by foreigners.

Net exports are defined as exports of goods and services minus imports of goods and services. In 2007, net exports for the United States were minus $708 billion, as calculated from $1662 billion worth

Eye Therapies Exhibit 2127, 587 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

of exports minus $2370 billion worth of imports. When a country has positive net exports, it is accumulating foreign assets. The counterpart of net exports is **net foreign investment,** which denotes net U.S. savings abroad and is approximately equal to the value of net exports. Because the U.S. had negative net exports, its net foreign investment was negative, implying that the U.S. foreign indebtedness was growing.

In other words, *foreigners were making a significant contribution to U.S. investment.* Why is it that rich America borrowed so much from abroad? As we will see later in this chapter, this paradoxical phenomenon is explained by a relatively low U.S. saving rate, a high foreign saving rate, and an attractive investment climate in the United States.

In an open economy, a nation's expenditures may differ from its production. Total *domestic expenditures* (sometimes called *domestic demand*) are equal to consumption plus domestic investment plus government purchases. This measure differs from total *domestic product* (or GDP) for two reasons. First, some part of domestic expenditures will be on goods produced abroad, these items being imports (denoted by *Im*) like Mexican oil and Japanese automobiles. In addition, some part of America's domestic production will be sold abroad as exports (denoted by *Ex*)—items like Iowa wheat and Boeing aircraft. The difference between national output and domestic expenditures is exports minus imports, which equals net exports, or $Ex - Im = X$.

To calculate the *total production* of American goods and services, we need to add trade to domestic demand. That is, we need to know the total production for American residents as well as the net production for foreigners. This total includes domestic expenditures ($C + I + G$) plus sales to foreigners (Ex) minus domestic purchases from foreigners (Im). Total output, or GDP, equals consumption plus domestic investment plus government purchases plus net exports:

$$\text{Total domestic output} = \text{GDP} = C + I + G + X$$

Determinants of Trade and Net Exports

What determines the levels of exports and imports and therefore of net exports? It is best to think of the import and export components of net exports separately.

Imports into the United States are positively related to U.S. income and output. When U.S. GDP rises, imports into the U.S. increase (1) because some of the increased $C + I + G$ purchases (such as cars and shoes) come from foreign production and also (2) because America uses foreign-made inputs (like oil or lumber) in producing its own goods. The demand for imports depends upon the relative price of foreign and domestic goods. If the price of domestic cars rises relative to the price of Japanese cars, say, because the dollar's exchange rate appreciates, Americans will buy more Japanese cars and fewer American ones. Hence *the volume and value of imports will be affected by domestic output and the relative prices of domestic and foreign goods.*

Exports are the mirror image of imports: U.S. exports are other countries' imports. American exports therefore depend primarily upon foreign output as well as upon the prices of U.S. exports relative to the prices of foreign goods. As foreign output rises, or as the exchange rate of the dollar depreciates, the volume and value of American exports tend to grow.

Figure 28-1 shows the ratio of U.S. net exports to GDP. For most of the period after World War II, the U.S. external accounts were in surplus or balance. Starting in the early 1980s, a decline in national saving, fueled by large federal budget deficits, led to a sharp appreciation of the dollar. Foreign economies grew less rapidly than the U.S. economy, depressing exports. The net effect was a large trade deficit and growing foreign indebtedness. Was it a good thing or a bad thing? The following discussion by the president's Council of Economic Advisers puts the U.S. trade deficit in an economic context:

> By themselves, external trade and current account deficits are neither inherently good nor inherently bad. What matters are the reasons for the deficits. The main reason for the deficits today appears to be the strength of the U.S. economic expansion relative to the slow or negative growth in many other countries. . . . These deficits are essentially a macroeconomic phenomenon, reflecting a higher rate of domestic investment than of national saving. The deficit's growth . . . reflects rising investment rather than falling saving.

Eye Therapies Exhibit 2127, 588 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



FIGURE 28-1. U.S. Net Exports Have Been in Deficit for Many Years

The United States had a large trade surplus after World War II as it helped rebuild Europe. Note how net exports turned sharply negative in the early 1980s as America's saving declined. Net exports grew even more negative in the last decade with the global savings glut.

Source: U.S. Bureau of Economic Analysis.

SHORT-RUN IMPACT OF TRADE ON GDP

How do changes in a nation's trade flows affect its GDP and employment? We first analyze this question in the context of our short-run model of output determination, the multiplier model of Chapter 22. The multiplier model shows how, in the short run when there are unemployed resources, changes in trade will affect aggregate demand, output, and employment.

There are two major new macroeconomic elements in the presence of international trade: First, we have a fourth component of spending, net exports, which adds to aggregate demand. Second, an open economy has different multipliers for private investment and government domestic spending because some spending leaks out to the rest of the world.

Table 28-1 on the next page shows how introducing net exports affects output determination. This table begins with the same components as those for a closed economy. (Look back to Table 22-2 on page 440 to refresh your memory about the major components and the way they sum to total spending.) Total domestic demand in

Eye Therapies Exhibit 2127, 589 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Output Determination with Foreign Trade
(billions of dollars)

(1) Initial level of GDP	(2) Domestic demand ($C + I + G$)	(3) Exports Ex	(4) Imports Im	(5) Net exports ($X = Ex - Im$)	(6) Total spending ($C + I + G + X$)		(7) Resulting tendency of economy
4,100	4,000	250	410	−160	3,840	↓	Contraction
3,800	3,800	250	380	−130	3,670	↓	Contraction
3,500	3,600	250	350	−100	3,500		Equilibrium
3,200	3,400	250	320	−70	3,330	↑	Expansion
2,900	3,200	250	290	−40	3,160	↑	Expansion

TABLE 28-1. Net Exports Add to Aggregate Demand of Economy

To the domestic demand of $C + I + G$, we must add net exports of $X = Ex - Im$ to get total aggregate demand for a country's output. Higher net exports affect aggregate demand just as do investment and government purchases.

column (2) is composed of the consumption, investment, and government purchases we analyzed earlier. Column (3) then adds the exports of goods and services. As described above, exports depend upon foreign incomes and outputs and upon prices and exchange rates, all of which are also taken as given for this analysis. Exports are assumed to be a constant level of $250 billion of foreign spending on domestic goods and services.

The interesting new element arises from imports, shown in column (4). Like exports, imports depend upon exogenous variables such as prices and exchange rates. But, in addition, imports depend upon domestic incomes and output, which clearly change in the different rows of Table 28-1. For simplicity, we assume that the country always imports 10 percent of its total output, so imports in column (4) are 10 percent of column (1).

Subtracting column (4) from column (3) gives net exports in column (5). Net exports are a negative number when imports exceed exports and a positive number when exports are greater than imports. Net exports in column (5) are the net addition to the spending stream contributed by foreign trade. Total spending on domestic output in column (6) equals domestic demand in column (2) plus net exports in column (5). Equilibrium output in an open economy occurs where total net domestic and foreign spending in column (6) exactly equals total domestic output in column (1). In this case, equilibrium comes with net exports of −100, indicating that the country is importing more than it is exporting. At this equilibrium, note as well that domestic demand is greater than output.

Figure 28-2 shows the open-economy equilibrium graphically. The upward-sloping blue line marked $C + I + G$ is the same curve used in Figure 22-10. To this line we must add the level of net exports that is forthcoming at each level of GDP. Net exports from column (5) of Table 28-1 are added to get the green line of total aggregate demand or total spending. When the green line lies below the blue curve, imports exceed exports and net exports are negative. When the green line is above the blue line, the country has a net-export surplus and output is greater than domestic demand.

Equilibrium GDP occurs where the green line of total spending intersects the 45° line. This intersection comes at exactly the same point, at $3500 billion, that is shown as equilibrium GDP in Table 28-1. Only at $3500 billion does GDP exactly equal what consumers, businesses, governments, and foreigners want to spend on goods and services produced in the domestic economy.

Eye Therapies Exhibit 2127, 590 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

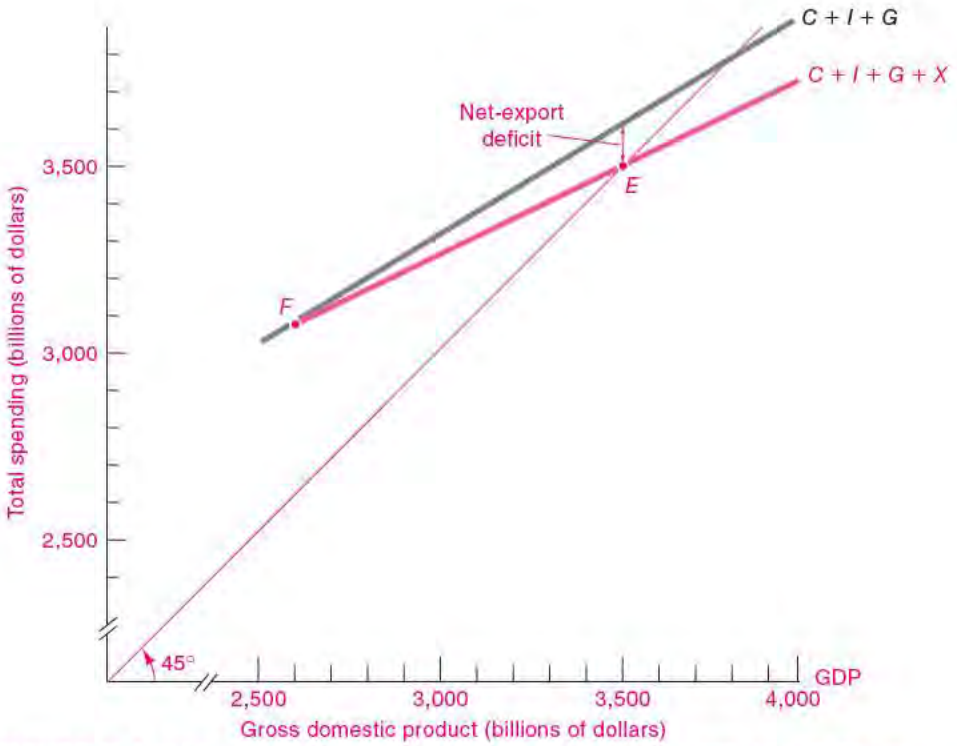


FIGURE 28-2. Adding Net Exports to Domestic Demand Gives Equilibrium GDP in the Open Economy

The blue line represents domestic demand ($C + I + G$), which are purchases by domestic consumers, businesses, and governments. To this must be added net foreign spending. Net exports plus domestic demand give the green line of total spending. Equilibrium comes at point *E*, where total GDP equals total spending on goods and services produced in the United States. Note that the slope of the green total demand curve is less than that of domestic demand to reflect the leakage from spending into imports.

The Marginal Propensity to Import and the Spending Line

Note that the aggregate demand curve, the green $C + I + G + X$ curve in Figure 28-2, has a slightly smaller slope than the blue curve of domestic demand. The explanation of this is that *there is an additional leakage from spending into imports.* This new leakage arises from our assumption that 10 cents of every dollar of income is spent on imports. To handle this requires introducing a new term, the **marginal propensity to import.** The marginal propensity to import, which we will denote *MPm*, is the increase in the dollar value of imports for each $1 increase in GDP.

The marginal propensity to import is closely related to the marginal propensity to save (*MPS*). Recall that the *MPS* tells us what fraction of an additional dollar of income is not spent but leaks into saving. The marginal propensity to import tells how much of additional output and income leaks into imports. In our example, the *MPm* is 0.10 because every $300 billion of increased income leads to $30 billion of increased imports. (What is the marginal propensity to import in an economy with no foreign trade? Zero.)

Eye Therapies Exhibit 2127, 591 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Now examine the slope of the total spending line in Figure 28-2—that line shows total spending on $C + I + G + X$. Note that the slope of the total spending line is less than the slope of the domestic demand line of $C + I + G$. As GDP and total incomes rise by \$300, spending on consumption rises by the income change times the *MPC* (assumed to be two-thirds), or by \$200. At the same time, spending on imports, or foreign goods, also rises by \$30. Hence spending on domestic goods rises by only \$170(= \$200 − \$30), and the slope of the total spending line falls from 0.667 in our closed economy to \$170/\$300 = 0.567 in our open economy.

The Open-Economy Multiplier

Surprisingly, opening up an economy lowers the expenditure multiplier.

One way of understanding the expenditure multiplier in an open economy is to calculate the rounds of spending and respending generated by an additional dollar of government spending, investment, or exports. Suppose that Germany needs to buy American computers to modernize antiquated facilities in what used to be East Germany. Each extra dollar of U.S. computers will generate \$1 of income in the United States, of which \$2/3 = \$0.667 will be spent by Americans on consumption. However, because the marginal propensity to import is 0.10, one-tenth of the extra dollar of income, or \$0.10, will be spent on foreign goods and services, leaving only \$0.567 of spending on domestically produced goods. That \$0.567 of domestic spending will generate \$0.567 of U.S. income, from which 0.567 × \$0.567 = \$0.321 will be spent on consumption of domestic goods and services in the next round. Hence the total increase in output, or the open-economy multiplier, will be

$$\begin{aligned}\text{Open-economy multiplier} &= 1 + 0.567 + (0.567)^2 + \cdots \\ &= 1 + (\tfrac{2}{3} - \tfrac{1}{10}) + (\tfrac{2}{3} - \tfrac{1}{10})^2 + \cdots \\ &= \frac{1}{1 - \tfrac{2}{3} + \tfrac{1}{10}} = \frac{1}{\tfrac{13}{30}} = 2.3\end{aligned}$$

This compares with a closed-economy multiplier of $1/(1 - \frac{2}{3}) = 3$.

Another way of calculating the multiplier is as follows: Recall that the multiplier in our simplest model was $1/MPS$, where *MPS* is the "leakage" into saving. As we noted above, imports are another leakage. The total leakage is the dollars leaking into saving (the *MPS*) plus the dollars leaking into imports (the *MPm*). Hence, the open-economy multiplier should be $1/(MPS + MPm) = 1/(0.333 + 0.1) = 1/0.433 = 2.3$. Note that both the leakage analysis and the rounds analysis provide exactly the same answer.

To summarize:

Because a fraction of any income increase leaks into imports in an open economy, the **open-economy multiplier** is smaller than the multiplier for a closed economy. The exact relationship is

$$\text{Open-economy multiplier} = \frac{1}{MPS + MPm}$$

where *MPS* = marginal propensity to save and *MPm* = marginal propensity to import.

TRADE AND FINANCE FOR THE UNITED STATES UNDER FLEXIBLE EXCHANGE RATES

We begin with a review of major trends in trade and finance for the United States over the period of flexible exchange rates, which began after the abandonment of the Bretton Woods system in 1973 (recall the discussion in the previous chapter).

First, examine the movements in the dollar exchange rate, shown in Figure 28-3. This is an index of the *real exchange rate* of the U.S. dollar against other major currencies. The real exchange rate corrects for movements in the price levels in different countries. Note how the exchange rate was relatively stable under fixed rates. Then, as with all market-determined asset prices, exchange rates became volatile in the flexible-rate era.

Figure 28-4 shows the *real* component of net exports. This is the ratio of real net exports to real GDP. We saw above that an increase in real net exports tends to be expansionary, while a decrease in real net exports tends to reduce output. We describe two periods in the history of the United States to help understand the role of international trade in domestic production.

Trade Movements Reinforce Tight Money in the 1980s. The decade of the 1980s witnessed a dramatic cycle of dollar appreciation and depreciation. The rise in the value of the dollar began in 1980 after tight

Eye Therapies Exhibit 2127, 592 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

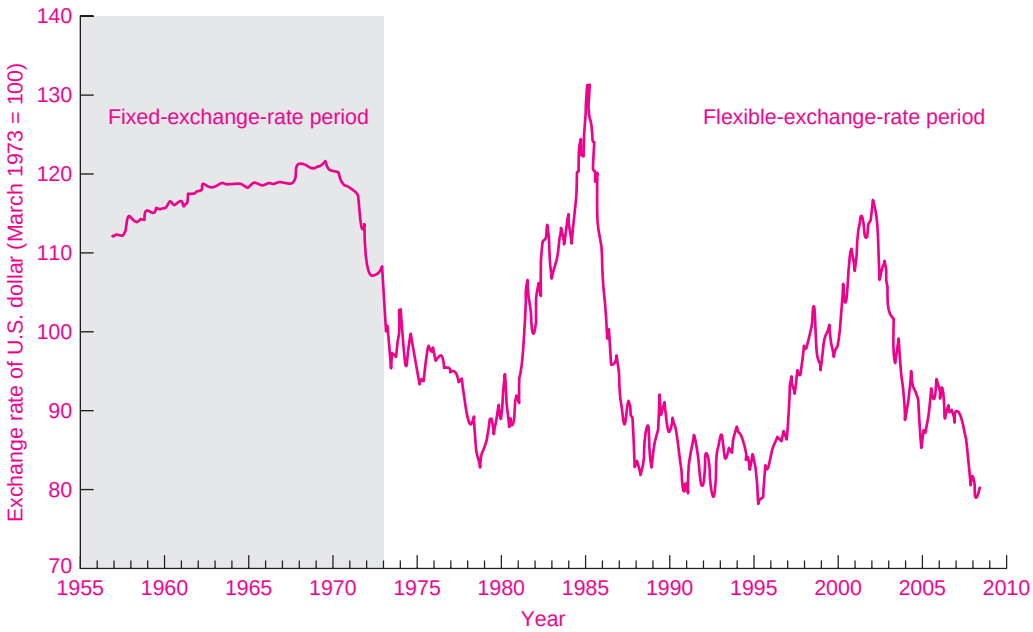


FIGURE 28-3. The Foreign Exchange Rate of the Dollar

During the fixed-exchange-rate (Bretton Woods) period, the dollar's value was stable in exchange markets. After the United States moved to flexible exchange rates in 1973, the dollar's value became more volatile. When the United States pursued its tight-money policies in the early 1980s, the high interest rates pulled up the dollar. With large current-account deficits and the foreign accumulation of dollar-denominated assets, the dollar began to depreciate after 2000.

Source: Federal Reserve System, at *www.federalreserve.gov/releases/h10/summary*.

U.S. monetary policy and loose U.S. fiscal policy drove interest rates up sharply. High interest rates at home and economic turmoil abroad attracted funds into financial investments in U.S. dollars. Figure 28-3 shows that during the period from 1979 to early 1985, the real exchange rate on the dollar rose by 80 percent. Many economists believe the dollar was overvalued in 1985—an *overvalued currency* is one whose value is high relative to its long-run or sustainable level.

As the dollar rose, American export prices increased and the prices of goods imported into the United States fell. Figure 28-5 shows the important relationship between real exchange rates and the trade deficit. It illustrates the dramatic effect of the appreciating dollar on trade flows. From the trough in 1980 to the peak in 1986, the trade deficit increased by 3 percent of GDP as the dollar appreciated.

By itself, this sharp increase in the trade deficit would be contractionary. The decline in net exports reinforced a decline in domestic demand induced by tight monetary policy. The result was the deepest recession in 50 years.

Countercyclical Net Exports in the 1995–2000 Period. The late 1990s were the opposite story. After 1995, the combination of low real interest rates and a booming stock market led to the rapid growth of domestic demand in the United States, particularly in private investment. Unemployment fell sharply. A rapid increase in foreign demand for U.S. assets led to the sharp appreciation of the dollar.

In contrast with the early 1980s, the macroeconomic impact of the dollar appreciation in this period was appropriate. As the American economy approached full employment, import prices rose, net exports declined, and the foreign sector exercised

Eye Therapies Exhibit 2127, 593 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

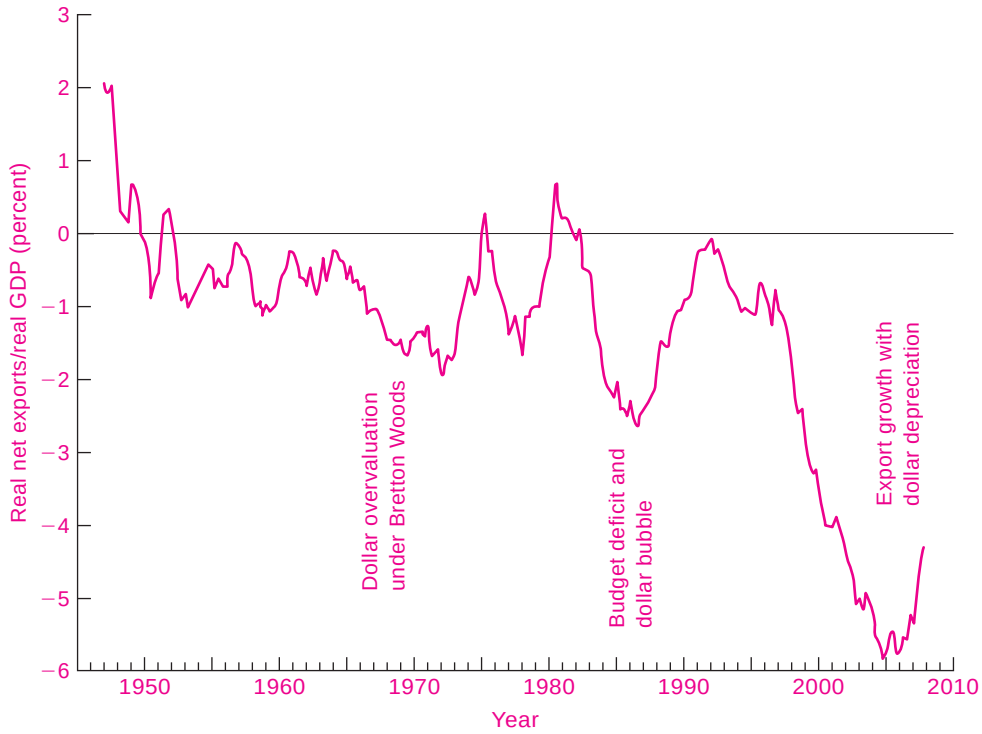


FIGURE 28-4. Real Net Exports Have Been an Important Component of Demand

With a strong rise in the dollar exchange rate and weak economic growth abroad, U.S. real net exports turned sharply negative in the early 1980s. This shift produced a massive drag on aggregate spending in the $C + I + G + X$ equation and helped produce the deep recession of 1982. The growing deficit from the period after 1990 moderated the growth of output. Note how net exports increased after the dollar's depreciation in the late 2000s.

Source: U.S. Bureau of Economic Analysis.

a drag on the economy. Had the dollar depreciated rather than appreciated, the foreign sector would have been expansionary, the American economy would have experienced rising inflation, and the Fed would have found it necessary to tighten money to choke off the boom. In the late 1990s, therefore, an appreciation of the dollar and a decline in net exports were just what the macroeconomic doctor ordered.

THE MONETARY TRANSMISSION MECHANISM IN AN OPEN ECONOMY

Our earlier multiplier analysis of business cycles and economic growth focused on policies in a closed economy. We analyzed the way that monetary and fiscal policies can help stabilize the business cycle. How do the impacts of macroeconomic policies change in an open economy? How is the monetary transmission mechanism different in this situation? Surprisingly, the answer to these questions depends crucially on whether the country has a fixed or a flexible exchange rate.

Our survey here will concentrate on high-income countries whose financial markets are closely linked together—the United States, Japan, and the countries of the European Union. When financial investments can flow easily among countries and the regulatory barriers to financial investments are low, we say that these countries have *high mobility of financial capital.*

Fixed Exchange Rates. The key feature of countries with fixed exchange rates and high capital mobility is

Eye Therapies Exhibit 2127, 594 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



FIGURE 28-5. Trade and Exchange Rates

Trade flows respond to exchange-rate changes, but with a time lag. The real appreciation of the dollar during the early 1980s increased U.S. export prices and reduced prices of goods imported into the United States. As a result, the trade deficit rose sharply. When the dollar depreciated after 1985, the trade deficit began to shrink. The increase in the current-account deficit resulted from dollar appreciation and slow growth outside the United States.

Source: Council of Economic Advisers, *Economic Report of the President, 2000.*

that their interest rates must be very closely aligned. Any divergence in the interest rates between two such countries will attract speculators who will sell one currency and buy the other until the interest rates are equalized.

Consider a small country which pegs its exchange rate to the currency of a larger country. *Because the small country's interest rates are determined by the monetary policy of the large country, the small country can no longer conduct independent monetary policy.* The small country's monetary policy must be devoted to ensuring that its interest rates are aligned with those of its partner.

Macroeconomic policy in such a situation is therefore exactly the case described in our multiplier model discussed earlier. From the small country's point of view, investment is exogenous, because it is determined by world interest rates. Fiscal policy is highly effective because there is no monetary reaction to changes in government spending or taxes.

Flexible Exchange Rates. One important insight in this area is that macroeconomic policy with flexible exchange rates operates in quite a different way from the case of fixed exchange rates. A flexible exchange rate has a reinforcing effect on monetary policy.

Let's consider the case of the United States. The monetary transmission mechanism in the United States has changed significantly in recent decades as a result of increased openness and the change to a flexible exchange rate. In the modern era, international trade and finance have come to play an increasingly important role in U.S. macroeconomic policy.

Figure 28-6 shows the monetary transmission mechanism under flexible exchange rates. Panel (*a*) shows the relationship between net exports and the exchange rate, the actual history of which we saw in Figure 28-5. This is an inverse relationship because a depreciation stimulates exports and discourages imports. Suppose that the Fed decides to reduce interest rates to stimulate the economy. The decline in interest rates would lead to a depreciation in the dollar as financial investors moved from

Eye Therapies Exhibit 2127, 595 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

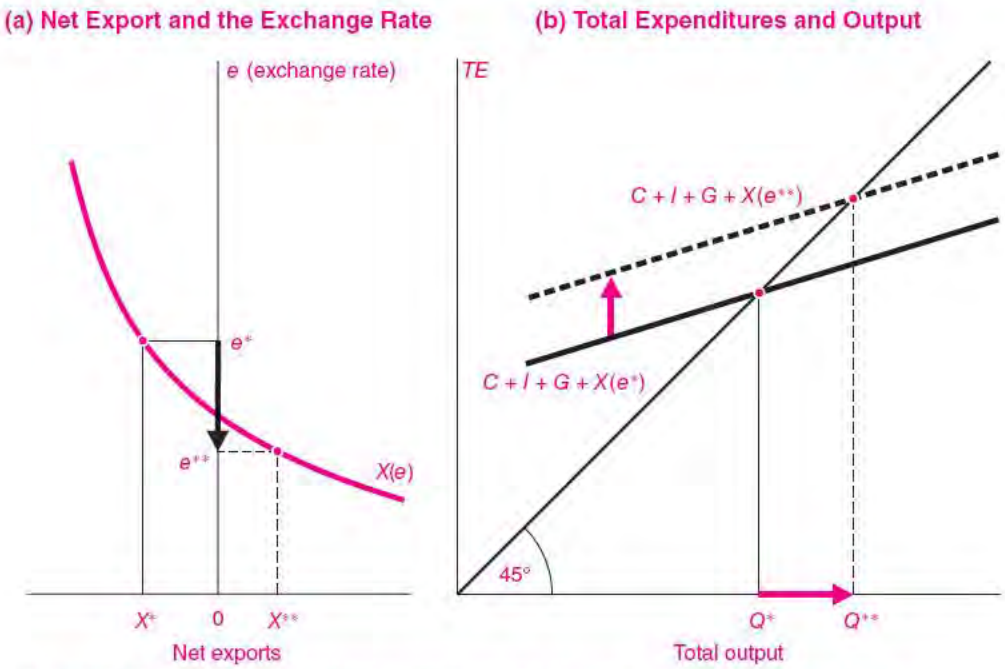


FIGURE 28-6. With Flexible Exchange Rates, the Monetary Transmission Mechanism Is Reinforced

Suppose that the central bank lowers interest rates. This will tend to lower the exchange rate from e^* to e^{**} in a flexible-exchange-rate system. Such a depreciation will stimulate net exports by moving down *along* the net-export curve. This increase in net exports from $X(e^*)$ to $X(e^{**})$ shifts up the total expenditure curve, increasing total output from Q^* to Q^{**}.

dollar to nondollar stocks and bonds. The depreciation is shown in Figure 28-6 as a movement from e^* to e^{**}. This depreciation changes a net export deficit of X^* to a net export surplus of X^{**}. The decline in interest rates would also tend to increase domestic investment, but we omit that effect from our discussion.

We show the result of this net export expansion in Figure 28-6(b). (This assumes, as with all our multiplier analyses, a situation where there are unemployed resources.) The increase in net exports shifts the total expenditure curve up from $C + I + G + X(e^*)$ to $C + I + G + X(e^{**})$. The result is an increase in total expenditure and an increase in output from Q^* to Q^{**}. All the changes shown in Figure 28-6 illustrate the policies and reactions during the 1995–2000 period discussed in the previous section.

Alternatively, take the opposite case. Suppose that the Fed decides to slow the economy, as it did after 1979. The monetary tightening raised U.S. interest rates, which attracted funds into dollar securities. This increase in the demand for dollars led to an appreciation of the dollar. The high dollar exchange rate reduced net exports and contributed to the recession of 1981–1983, as we described earlier. The impact on net exports in such a situation would be the opposite of that shown in Figure 28-6.

Foreign trade produces a new and powerful link in the monetary transmission mechanism when a country has a flexible exchange rate. When monetary policy changes interest rates, this affects exchange rates and net exports as well as domestic investment. Monetary tightening leads to an appreciation in the exchange rate and a corresponding decline in net exports; monetary easing does the opposite. The impact of changes in interest rates on net exports reinforces the impact on domestic investment.

Eye Therapies Exhibit 2127, 596 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

B. INTERDEPENDENCE IN THE GLOBAL ECONOMY

ECONOMIC GROWTH IN THE OPEN ECONOMY

The first section described the short-run impact of international trade and policy changes in the open economy. These issues are crucial for open economies combating unemployment and inflation. But countries must also keep their eye on the implications of their policies for long-run economic growth. Particularly for small open economies, effective use of international trade and international finance is central for promoting economic growth.

Economic growth involves a wide variety of issues, as we saw in Chapter 25. Perhaps the single most important approach for promoting rapid economic growth is to ensure high levels of saving and investment.

But economic growth involves more than just capital. It requires moving toward the technological frontier by adopting the best technological practices. It requires developing institutions that nurture investment and the spirit of enterprise. Other issues—trade policies, intellectual property rights, policies toward direct investment, and the overall macroeconomic climate—are essential ingredients in the growth of open economies.

SAVING AND INVESTMENT IN THE OPEN ECONOMY

In a closed economy, total investment equals domestic saving. Open economies, however, can draw upon world financial markets for investment funds, and other countries can be an outlet for domestic saving. (Recall Table 27-3, which shows the net saving of important regions.) We first review the investment-saving relationship, and then we examine the mechanisms for allocating saving among different countries.



The Saving-Investment Relation in an Open Economy

Let's pause to recall our saving-investment identities from Chapter 20:

$$I_T = I + X = S + (T - G)$$

This states that total national investment (I_T) consists of investment in domestic capital (I) plus net foreign

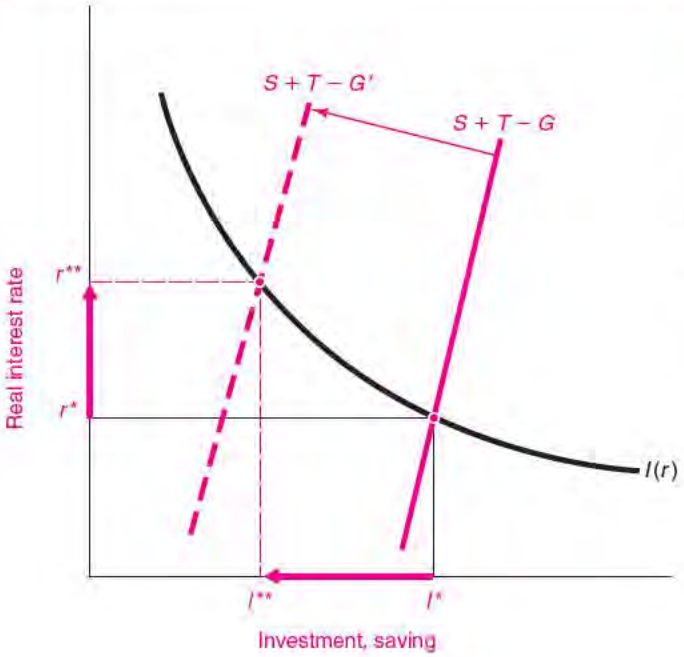


FIGURE 28-7. Saving and Investment in the Closed Economy

Investment is inversely related to the real interest rate, while private saving and public saving are relatively unresponsive to the interest rate. Equilibrium saving and investment comes at r^*. Suppose that government military spending increases. This increases the government deficit and therefore reduces public saving. The result is a shift in the national saving curve to the left to $S + T - G'$, raising the market interest rate to r^{**} and reducing national saving and investment to I^{**}.

Eye Therapies Exhibit 2127, 597 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

investment or net exports (X). This must equal total private saving (S) by households and businesses plus total public saving, which is given by the government surplus ($T - G$).

We can rewrite the identity as follows to emphasize the components of net exports:

$$X = S + (T - G) - I$$

or

$$\text{Net exports} = (\text{private saving} + \text{government saving}) - \text{domestic investment}$$

This important equation shows that net exports are the difference between domestic saving and domestic investment. The components of total U.S. national investment for recent decades are shown in Table 28-2.

Determination of Saving and Investment at Full Employment

We need to go beyond the identities to understand the *mechanism* by which saving and investment are equalized in the open economy. This analysis concerns primarily the long run in which there is full employment and output equals its potential. That is, we consider how saving and investment are allocated in the long run in a "classical" economy.

Closed Economy. We begin with a closed economy where there is no inflation and no uncertainty. In this situation, investment must equal private saving plus the government surplus. The equilibrating price is the real interest rate, which adjusts to balance the levels of saving and investment.

Figure 28-7 shows how national saving and investment are equilibrated in a full-employment closed economy. The $S + T - G$ curve shows national saving, which is assumed to increase slightly with the real interest rate. Additionally, as we learned in Chapter 21, there is an inverse relationship between investment and the interest rate. Higher interest rates reduce spending on housing and on business plant and equipment. We therefore write our investment schedule as $I(r)$ to indicate that investment depends upon the real interest rate, r.

The saving and investment schedules intersect in Figure 28-7 to determine an interest rate at r^* with high levels of saving and investment.

Now suppose that the government increases its purchases without increasing taxes, say, because of an increase in military spending to fight foreign wars. This will shift the saving schedule to the left to $S + T - G'$. As a result, the real interest rate increases to equilibrate saving and investment, and the level of investment falls. A similar outcome would occur if the government lowered taxes or if the private sector lowered its desired savings.

In a full-employment closed economy (always holding other things constant), higher government

Saving and Investment as Percentage of NNP

Sector	1959–1981	1982–2001	2002–2007
Net domestic saving	**11.5**	**6.4**	**1.7**
Net private saving	11.6	8.8	4.6
Net government saving	−0.1	−2.5	−2.8
Net domestic investment (in capital)	**11.1**	**8.5**	**7.7**
Net foreign investment	**0.4**	**−2.1**	**−6.0**

TABLE 28-2. The Declining U.S. Saving Rate

This table shows the changing structure of U.S. saving over the last half-century. For most of the 1959–1981 period, saving and investment were about equal and at a high level. Then, after 1981, government saving declined as the federal budget moved into deficit. This decline was reinforced in the 2000s as personal and other private saving dropped sharply. By the 2002–2007 period, most U.S. capital investment was financed by foreign saving, which is the counterpart to the large current-account deficit.

Source: Bureau of Economic Analysis.

Eye Therapies Exhibit 2127, 598 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

spending, lower taxes, or lower desired private saving will raise the real interest rate and lower equilibrium saving and investment.

Open-Economy Equilibrium. Now consider the situation of an open economy in which financial markets are integrated with world markets. An open economy has alternative sources of investment and alternative outlets for saving. We simplify by assuming that the economy is small and cannot affect world interest rates. We show this situation in Figure 28-8 for a small open economy with a high degree of mobility of financial capital. A small open economy must equate its domestic real interest rate with the world real interest rate, r^W. Because financial markets are open, financial capital will move to equilibrate interest rates at home and abroad.

Figure 28-8 helps explain the determination of saving, investment, and net exports in the open economy. At the prevailing world interest rate, domestic investment is shown at point *A*, which is the intersection of the investment schedule and the interest rate. Total national saving is given at point *B* on the total saving schedule, $S + T - G$. The difference between them—given by the line segment *AB*—is net exports. (This equality is shown by the saving-investment identity in the box on page 574.)

Hence net exports are determined by the difference between national saving and national

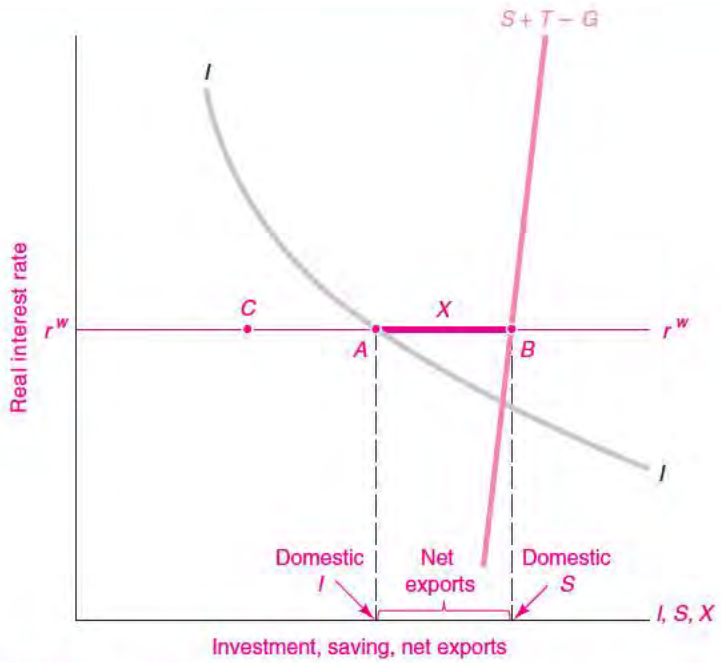


FIGURE 28-8. Saving and Investment in a Small Open Economy

Domestic investment and domestic saving are determined by income, interest rates, and government fiscal policy, as in Fig. 28-7. But the small open economy with mobile financial capital has its real interest rates determined in world financial markets. At the relatively high real interest rate at r^W, domestic saving exceeds domestic investment and the excess saving flows to more lucrative investment opportunities abroad. The difference between national saving and domestic investment is net exports (also equal to net foreign investment), shown as *X* in the figure. A trade surplus such as has been seen in Japan and China is caused by the interaction of high domestic saving and low domestic investment.

Eye Therapies Exhibit 2127, 599 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

investment, which is determined by domestic factors plus the world interest rate.

This discussion pushes into the background the mechanism by which a country adjusts its trade, saving, and investment. It is here that the exchange rate plays the crucial equilibrating role. *Changes in exchange rates are the mechanism by which saving and investment adjust.* That is, exchange rates move to ensure that the level of net exports balances the difference between domestic saving and investment.

This analysis can help explain the trends in saving, investment, and trade patterns in major countries in recent years. Figure 28-8 describes well the role of Japan in the world economy. Japan has traditionally had a high domestic saving rate. Yet in recent years—because of high production costs at home and competitive conditions in neighboring newly industrialized countries—the return on Japanese capital has been depressed. Japanese saving therefore seeks outlets abroad, with the consequence that Japan has had a large trade surplus and high net exports.

The United States has seen an interesting twist in its saving and investment position, as was shown in Table 28-2. Until 1980, the United States had a modestly positive net-export position. But in the early 1980s the U.S. government's fiscal position shifted sharply toward deficit. You can depict this by drawing a new $S + T' - G'$ line in Figure 28-8 that intersects the real-interest-rate line at point *C*. You can see that total national saving would decline with a larger government deficit. Domestic investment would be unchanged. Net exports would turn negative and be given by the line segment *CA*.

We can also use this analysis to explain the mechanism by which net exports adjust to provide the necessary investment when the government runs a budget deficit. Consider a country with a net-export surplus as shown in Figure 28-8. Suppose that the government suddenly begins to run a large budget deficit. This change will lead to an imbalance in the saving-investment market, which would tend to push up domestic interest rates relative to world interest rates. The rise in domestic interest rates will attract funds from abroad and will lead to an appreciation in the foreign exchange rate of the country running the budget deficit. The appreciation will lead to falling exports and rising imports, or a decrease in net exports. This trend will continue until net exports have fallen sufficiently to close the saving-investment gap.

Other important examples of the open-economy saving-investment theory in the small open economy are the following:

- An increase in private saving or lower government spending will increase national saving as represented by a rightward shift in the national saving schedule in Figure 28-8. This will lead to a depreciation of the exchange rate until net exports have increased enough to balance the increase in domestic saving.
- An increase in domestic investment, say, because of an improved business climate or a burst of innovations, will lead to a shift in the investment schedule. This will lead to an appreciation of the exchange rate until net exports decline enough to balance saving and investment. In this case, domestic investment crowds out foreign investment.
- An increase in world interest rates will reduce the level of investment. This will lead to an increase in the difference between saving and investment, to a depreciation in the foreign exchange rate, and to an increase in net exports and foreign investment. (This would be a shift along the investment schedule.)

Table 28-3 summarizes the major results for the small open economy. Make sure you can also work through the cases of decreases in the government's fiscal deficit, in private saving, in investment, and in world interest rates. This handy table and its explanation deserve careful study.[1]

Integration of a country into the world economy adds an important new dimension to macroeconomic performance and policy. Key findings are:

- The foreign sector provides an important source of domestic investment and a potential outlet for domestic saving.
- Higher saving at home—whether in the form of higher private saving or higher public saving—will lead to higher net exports.

[1] This discussion covers "small" open economies that cannot affect the world interest rate. For "large" open economies like the United States, the impact would be somewhere between the small-economy and the closed-economy cases. This more complex case is covered in intermediate textbooks (see the Further Reading section in Chapter 19).

Eye Therapies Exhibit 2127, 600 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Change in policy or exogenous variable	Change in exchange rate	Change in investment	Change in net exports
Increase in G or decrease in T	$e\uparrow$	0	$X\downarrow$
Increase in private S	$e\downarrow$	0	$X\uparrow$
Increase in investment demand	$e\uparrow$	$I\uparrow$	$X\downarrow$
Increase in world interest rates	$e\downarrow$	$I\downarrow$	$X\uparrow$

TABLE 28-3. Major Conclusions of Saving-Investment Model in Small Open Economy

Make sure you understand the mechanism by which each of these occurs.

- A country's trade balance is primarily a reflection of its national saving and investment balance rather than of its absolute productivity or wealth.
- Adjustments in a country's trade accounts require a change in domestic saving or investment.
- In the long run, adjustments in trade accounts will be brought about by movements in the country's relative prices, often through exchange-rate changes.

PROMOTING GROWTH IN THE OPEN ECONOMY

Increasing the growth of output in open economies involves more than just waving a magic wand that will attract investors or savers. A favorable saving and investing climate involves a wide array of policies, including a stable macroeconomic environment, secure property rights, and, above all, a predictable and attractive returns on investment. We review in this section some of the ways that open economies can improve their growth rates by using the global marketplace to their best advantage.

Over the long run, the single most important way of increasing per capita output and living standards is to ensure that the country *adopts best-practice techniques* in its production processes. It does little good to have a high investment rate if the investments are in the wrong technology. This point was abundantly shown in the last years of Soviet central planning (discussed in Chapter 26), when the investment rate was extremely high but much investment was poorly designed, left unfinished, or put in unproductive sectors. Moreover, individual poor countries do not need to start from scratch in designing their own turbines, machinery, computers, and management systems. Often, reaching the technological frontier will involve engaging in joint ventures with foreign firms, which in turn requires that the institutional framework be hospitable to foreign capital.

Another important set of policies is *trade policies*. Evidence shows that an open trading system promotes competitiveness and adoption of best-practice technologies. By keeping tariffs and other barriers to trade low, countries can ensure that domestic firms feel the spur of competition and that foreign firms are permitted to enter domestic markets when domestic producers sell at inefficiently high prices or monopolize particular sectors.

When countries consider their saving and investment, they must not concentrate entirely on physical capital. *Intangible capital* is just as important. Studies show that countries that invest in human capital through education tend to perform well and be resilient in the face of shocks. Many countries have valuable stocks of natural resources—forests, minerals, oil and gas, fisheries, and arable land—that must be managed carefully to ensure that they provide the highest yield for the country.

One of the most complex factors in a country's growth involves *immigration* and *emigration*. Historically, the United States has attracted large flows of immigrants that not only have increased the size of its labor force but also have enhanced the quality of its culture and scientific research. More recently, however, the immigrants have possessed less education and lower skills than the domestic labor force. As a result, according to some studies, immigration has depressed the relative wages of low-wage workers in the United States. Countries that "export" workers, such as Mexico, often

Eye Therapies Exhibit 2127, 601 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

have a steady stream of earnings that are sent home by citizens to their relatives, and this can provide a nice supplement to export earnings.

One of the most important yet subtle influences concerns the *institutions of the market*. The most successful open economies—like the Netherlands and Luxembourg in Europe or Taiwan and Hong Kong in Asia—have provided a secure environment for investment and entrepreneurship. This involved establishing a secure set of property rights, guided by the rule of law. Increasingly important is the development of intellectual property rights so that inventors and creative artists are assured that they will be able to profit from their activities. Countries must fight corruption, which is a kind of private taxation system that preys on the most profitable enterprises, creates uncertainty about property rights, raises costs, and has a chilling effect on investment.

A *stable macroeconomic climate* means that taxes are reasonable and predictable and that inflation is low, so lenders need not worry about inflation confiscating their investments. It is crucial that exchange rates be relatively stable, with a convertibility that allows easy and inexpensive entry into and exit out of the domestic currency. Countries that provide a favorable institutional structure attract large flows of foreign financial capital, while countries that have unstable institutions attract relatively little foreign funds and suffer "capital flight," in which local residents move their funds abroad to avoid taxes, expropriation, or loss of value.

Figure 28-9 illustrates the impact of the investment climate on national investment. The left-hand panel

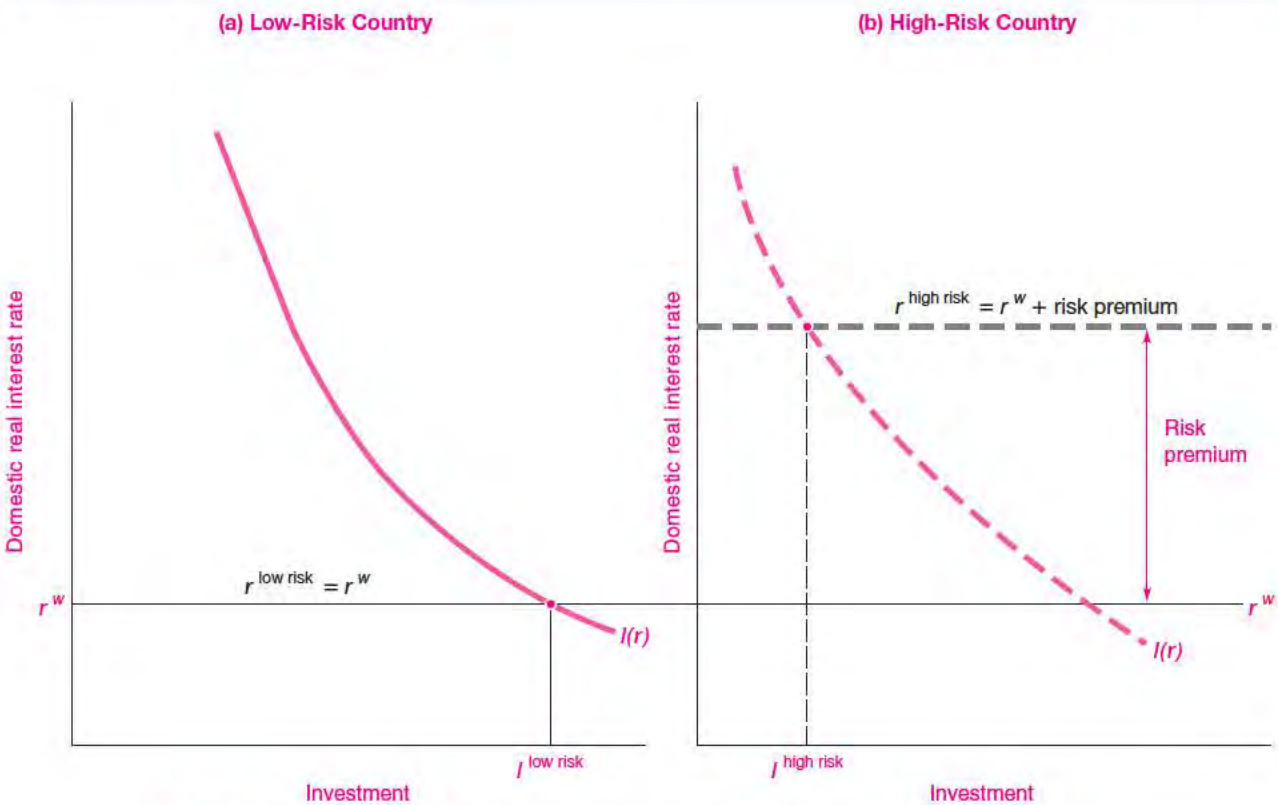


FIGURE 28-9. Business Climate Affects Interest Rate and Investment Level

In the low-risk country in (**a**), a stable economic climate leads to a low domestic interest rate at r^W and a high level of investment at $I^{\text{low risk}}$. In the high-risk country, racked by political turmoil, corruption, and economic uncertainty, investors require a large risk premium on their investments, so the domestic interest rate is far above the world interest rate. The result is a depressed level of investment as foreign investors seek safer terrain.

Eye Therapies Exhibit 2127, 602 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

depicts a country that has a favorable investment climate, so the domestic interest rate is equal to the world interest rate. The overall level of investment there is high, and the country can attract foreign funds to finance domestic investment.

Panel (*b*) shows a high-risk country. Look back at Figure 26-2 on page 528, which shows the premium on emerging-market bonds. In periods of crisis, these countries might pay interest rates 8 or 10 or 12 percentage points above the rate paid by investors in advanced countries. The high risk premium might arise because of high inflation, unpredictable taxes, nationalizations, default, corruption, an unstable foreign exchange rate, or sometimes just panic and contagion. The real cost of capital would therefore be extremely high. The risky country will have trouble attracting both domestic *and* foreign investment, and the resulting level of investment will be low. Compare the equilibrium level of investment in low-risk panel (*a*) to that of high-risk panel (*b*).

Promoting economic growth in an open economy involves ensuring that business is attractive for foreign and domestic investors who have a wide array of investment opportunities in the world economy. The ultimate goals of policy are to have high rates of saving and investment in productive channels and to ensure that businesses use best-practice techniques. Achieving these goals involves setting a stable macroeconomic climate, guaranteeing dependable property rights for both tangible investments and intellectual property, providing exchange-rate convertibility that allows investors to take home their profits, and maintaining confidence in the political and economic stability of the country.

C. INTERNATIONAL ECONOMIC ISSUES

In this final section, we apply the tools of international economics to examine two of the central issues that have concerned nations in recent years. In the first part, we examine the issue of the difference between competitiveness and productivity. In the second part, we examine the birth of the European Monetary Union.

COMPETITIVENESS AND PRODUCTIVITY

"The Deindustrialization of America"

Often, when the trade deficit becomes large, people become concerned and worry about the nation's productivity and competitiveness. Just such a situation occurred in the United States in the 1980s, and later resurfaced in the 2000s. A review of this history is a helpful reminder about the determinants of trade flows.

The appreciation of the dollar in the 1980s produced severe economic hardships in many U.S. sectors exposed to international trade. Industries like automobiles, steel, and textiles found the demand for their products shrinking as an appreciation of the exchange rate led to a rise in their prices relative to those of their foreign competitors. Unemployment in America's manufacturing heartland increased sharply, factories were closed, and the Midwest became known as the "rust belt."

Many noneconomists interpreted U.S. trade problems as indicative of "America in decline." They fretted that America's technological leadership was eroding because of what they saw as unfair trade practices, excessive regulation, declining innovation, and managerial sloth. Some called for a reversal of trade agreements such as the North American Free Trade Agreement (NAFTA). America was pictured as a land condemned to serving potato chips while others were manufacturing our computer chips.

Economists saw a different syndrome at work—this situation is a classic disease of an overvalued exchange rate. To understand the fundamentals, we must distinguish a nation's competitiveness from its productivity. *Competitiveness* refers to the extent to which a nation's goods can compete in the marketplace; this depends primarily upon the relative prices of domestic and foreign products. Competitiveness should not be confused with *productivity,* which is measured by the output per unit of input. Productivity is fundamental to the growth of living standards in a nation; to a first approximation, a nation's real income grows in step with its productivity growth.

It is true that U.S. competitiveness fell sharply during the 1980s and again in the early 2000s. However, these changes were not caused by a deterioration in productivity growth. Actually, productivity

Eye Therapies Exhibit 2127, 603 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

growth increased just as the trade deficit increased. Macroeconomists believe that deteriorating competitiveness arose because the decline in national saving in the United States led to an appreciation of the dollar and raised American prices relative to those of its trading partners.

Trends in Productivity

The real story about U.S. real incomes is not about competitiveness but about productivity. Recall that productivity measures the output per unit of input (such as labor-hours). Our chapter on economic growth showed that increases in real wages depend primarily on the growth of domestic labor productivity.

Competitiveness is important for trade but has no intrinsic relationship to the level or growth of real incomes. China enjoyed a massive trade surplus in the 2000s at the same time as the United States ran a large trade deficit. But would Americans therefore trade their living standards for those in China with jobs paying $1 an hour? Loss of competitiveness in international markets results from a nation's *prices* being out of line with those of its trading partners; it has no necessary connection with how a nation's *productivity* compares with that of other countries.

Studies of productivity differences among countries emphasize the importance of *competition* and *outward orientation*. An essential aspect of policy designed to increase productivity is to force domestic industries to compete with foreign firms, who often have superior, frontier technologies. Foreign direct investment by the most productive countries (such as the Japanese automobile plants operating in the United States) has contributed to dramatic productivity improvements through both the introduction of cutting-edge technologies and the stimulation of competition.

Conclusion on productivity and competitiveness: As the theory of comparative advantage demonstrates, nations are not inherently uncompetitive. Rather, they become uncompetitive when their prices move out of line with those of their trading partners. The surest route to high productivity and high living standards is to expose domestic industries to world markets and to encourage vigorous domestic competition with foreign companies that have adopted the most advanced technologies.

THE EUROPEAN MONETARY UNION

An ideal exchange-rate system is one that allows high levels of predictability of relative prices while stabilizing the economy in the face of economic shocks. In a well-functioning system, people can trade and invest in other countries without worrying that exchange rates will suddenly change and make their ventures unprofitable.

From the early 1990s, however, fixed-exchange-rate systems were often *destabilizing* rather than stabilizing. Time and again, fixed-exchange-rate systems were the subject of intense speculative attacks that spread to other countries through contagion. They were seen in Europe in 1991–1992, Mexico in 1994–1995, Russia and East Asia in 1997–1998, and Latin America from 1998 to 2002.

Nowhere were problems with the exchange-rate system more persistent and profound than in Western Europe. As a result, the countries of the European Union took the giant step of linking their economic fortunes through the European Monetary Union, which forged a common currency, the Euro.



The Fundamental Trilemma of Fixed Exchange Rates

"You can't have it all" is one of the central tenets of economics. This was driven home in macroeconomic affairs on several occasions during the 1990s. As countries on fixed exchange rates liberalized their financial markets, they encountered a *fundamental trilemma of fixed exchange rates: A country can have only two of the following (a) a fixed but adjustable exchange rate, (b) free capital and financial movements, and (c) an independent domestic monetary policy.*

This inconsistency among the three objectives was explained by Paul Krugman as follows:

> The point is that you can't have it all: A country must pick two out of three. It can fix its exchange rate without emasculating its central bank, but only by maintaining controls on capital flows (like China today); it can leave capital movement free and retain monetary autonomy, but only by letting the exchange rate fluctuate (like Britain—or Canada); or it can choose to leave capital free and stabilize the currency, but only by abandoning any ability to adjust interest rates to fight inflation or recession (like Argentina today, or for that matter most of Europe).[2]

[2] See this chapter's Further Reading section.

Eye Therapies Exhibit 2127, 604 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Toward a Common Currency: The Euro

Since World War II, the democratic countries of Western Europe have pursued ever-closer economic integration, primarily to promote political stability after two devastating wars. Peace and trade go hand in hand, according to many political scientists. Beginning in 1957 with a free-trade agreement, Western Europeans gradually removed all barriers to trade in goods, services, and finance. The final step in economic integration was to adopt a common currency. This would not only foster closer economic ties but also resolve the problem of unstable currencies that plagued the earlier fixed-exchange-rate systems.

Eleven European countries joined the European Monetary Union (EMU) in 1999. These countries, sometimes called Euroland, adopted the Euro as their unit of account and medium of exchange. The first step was to begin transactions in Euros. The trickiest step came on January 1, 2002, when the countries of Euroland replaced their national currencies with Euro coins and notes, saying, in effect, "*Au revoir,* French franc; *bonjour,* Euro." The Euro was launched smoothly and has now taken its place among the world's major currencies.

The monetary structure under the European Monetary Union resembles that of the United States. Control over European monetary policy is exercised by the *European Central Bank (ECB),* which conducts monetary policy for countries in the accord. The ECB undertakes open-market operations and thereby determines interest rates for the Euro.

One of the major questions for monetary policy involves the objectives of the central bank. The ECB is directed under its charter to pursue "price stability" as its primary objective, although it can pursue other communitywide goals as long as these do not compromise price stability. The ECB defines price stability as an increase in Euroland consumer prices of below 2 percent per year over the medium term.

Costs and Benefits of Monetary Union

What are the costs and benefits of European monetary union? Advocates of monetary union see important *benefits.* Under a common currency, exchange-rate volatility within Europe will be reduced to zero, so trade and finance will no longer have to contend with the uncertainties about prices induced by changing exchange rates. The primary result will be a reduction in transactions costs among countries. To the extent that national financial markets are segmented, moving to a common currency may allow a more efficient allocation of capital across countries. Some believe that firm macroeconomic discipline will be preserved by having an independent European central bank committed to strict inflation targets. Perhaps the most important benefit may be political integration and stability of Western Europe—a region that has been at peace for half a century after being at war with itself for most of its recorded history.

Some economists are skeptical about the wisdom of monetary union in Europe and point to significant *costs* of such a union. The dominant concern is that the individual countries will lose the use of both monetary policy and exchange rates as tools for macroeconomic adjustment. This question concerns the optimal currency area, a concept first proposed by Columbia's Robert Mundell, who won the 1999 Nobel Prize for his contributions in this field. An **optimal currency area** is one whose regions have high labor mobility or have common and synchronous aggregate supply or demand shocks. In an optimal currency area, significant changes in exchange rates are not necessary to ensure rapid macroeconomic adjustment.

Most economists believe that the United States is an optimal currency area. When the United States is faced with a shock that affects the different regions asymmetrically, labor migration tends to restore balance. For example, workers left the hard-hit northern states and migrated to the oil-rich southwestern states after the oil shocks of the 1970s.

Is Europe an optimal currency area? Some economists think it is not because of the rigidity of its wage structures and the low degree of labor mobility among the different countries. When a shock has occurred—for example, after the 1990 reunification of Germany—inflexible wages and prices led to rising inflation in the regions with a demand increase and rising unemployment in depressed regions. Monetary union might therefore condemn unfortunate regions to persistent low growth and high unemployment.

What is the initial verdict on the European Monetary Union? The creation of the Euro has removed one of the major sources of instability in the European economy—intra-European exchange-rate movements. In addition, it has led to a convergence of interest rates and inflation rates among European countries. On the other hand, Europe has

Eye Therapies Exhibit 2127, 605 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

continued to experience high unemployment rates since the Euro's introduction. The financial crisis of 2007–2009 was the first major test of the European Monetary System, and economists will study how well this new multinational institution weathers the storm.

The European Monetary Union is one of history's great economic experiments. Never before has such a large and powerful group of countries turned its economic fortunes over to a multinational body like the European Central Bank. Never before has a central bank been charged with the macroeconomic fortunes of a large group of nations with 325 million people producing $16 trillion of goods and services. While optimists point to the microeconomic benefits of a larger market and lower transactions costs, pessimists worry that monetary union threatens stagnation and unemployment because of the lack of price and wage flexibility and insufficient labor mobility among countries. The financial crisis of 2007–2009 is the first major test of this new monetary system.

FINAL ASSESSMENT

This survey of international economics must acknowledge a mixed picture, with both successes and failures. It is true that market economies occasionally suffer from inflation and recession. Moreover, in the most recent downturn in 2007–2009, unemployment rose sharply and many financial giants teetered on the edge of bankruptcy. Nonetheless, if we step back, an impartial jury of historians would surely rate the last half-century as one of unparalleled success for the countries of North America and Western Europe:

- *Robust economic performance.* The period has seen the most rapid and sustained economic growth in recorded history. It is the only period since the Industrial Revolution in which these countries have avoided deep depression and the cancer of hyperinflation.
- *The emerging monetary system.* The international monetary system continues to be a source of turmoil, with frequent crises as countries encounter balance-of-payments or currency difficulties. Nonetheless, we can see an emerging system in which the major economic regions—the United States, Europe, and Japan—conduct independent monetary policies with flexible exchange rates, while smaller countries either float or have "hard" fixed exchange rates tied to one of the major blocks. A major challenge for the future will be to integrate the Asian giants China and India into the international trade and financial systems.
- *The reemergence of free markets.* You often hear that imitation is the sincerest form of flattery. In economics, imitation occurs when a nation adopts the economic structure of another in the hope that it will produce growth and stability. In the last two decades, country after country threw off the shackles of communism and stifling central planning. This occurred not only because economics textbooks explained the miracle of the free market but primarily because people could see with their own eyes how the market-oriented countries of the West prospered while the centrally planned command economies collapsed. *For the first time, an empire collapsed because it could not produce sufficient butter along with its guns.*



SUMMARY

A. Foreign Trade and Economic Activity

1. An open economy is one that engages in international exchange of goods, services, and investments. Exports are goods and services sold to buyers outside the country, while imports are those purchased from foreigners. The difference between exports and imports of goods and services is called net exports.
2. When foreign trade is introduced, domestic demand can differ from national output. Domestic demand comprises consumption, investment, and government purchases ($C + I + G$). To obtain GDP, exports (Ex) must be added and imports (Im) subtracted, so

$$\text{GDP} = C + I + G + X$$

Eye Therapies Exhibit 2127, 606 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

where X = net exports = $Ex - Im$. Imports are determined by domestic income and output along with the prices of domestic goods relative to those of foreign goods; exports are the mirror image, determined by foreign income and output along with relative prices. The dollar increase of imports for each dollar increase in GDP is called the marginal propensity to import (MPm).

3. Foreign trade has an effect on GDP similar to that of investment or government purchases. As net exports rise, there is an increase in aggregate demand for domestic output. Net exports hence have a multiplier effect on output. But the expenditure multiplier in an open economy will be smaller than that in a closed economy because of leakages from spending into imports. The multiplier is

$$\text{Open-economy multiplier} = \frac{1}{MPS + MPm}$$

Clearly, other things equal, the open-economy multiplier is smaller than the closed-economy multiplier, where $MPm = 0$.

4. The operation of monetary policy has new implications in an open economy. An important example involves the operation of monetary policy in a small open economy that has a high degree of capital mobility. Such a country must align its interest rates with those in the countries to whom it pegs its exchange rate. This means that countries operating on a fixed exchange rate essentially lose monetary policy as an independent instrument of macroeconomic policy. Fiscal policy, by contrast, becomes a powerful instrument because fiscal stimulus is not offset by changes in interest rates.
5. An open economy operating with flexible exchange rates can use monetary policy for macroeconomic stabilization which operates independently of other countries. In this case, the international link adds another powerful channel to the domestic monetary transmission mechanism. A monetary tightening leads to higher interest rates, attracting foreign financial capital and leading to a rise (or appreciation) of the exchange rate. The exchange-rate appreciation tends to depress net exports, so this impact reinforces the contractionary impact of higher interest rates on domestic investment.

B. Interdependence in the Global Economy

6. In the longer run, operating in the global marketplace provides new constraints and opportunities for countries to improve their economic growth. Perhaps the most important element concerns saving and investment, which are highly mobile and respond to incentives and the investment climate in different countries.
7. The foreign sector provides another source of funds for investment and another outlet for saving. Higher domestic saving—whether through private saving or government fiscal surpluses—will increase the sum of domestic investment and net exports. Recall the identity

$$X = S + (T - G) - I$$

or

$$\begin{aligned}\text{Net exports} = {} & \text{private saving} \\ & + \text{government saving} \\ & - \text{domestic investment}\end{aligned}$$

In the long run, a country's trade position primarily reflects its national saving and investment rates. Reducing a trade deficit requires changing domestic saving and investment. One important mechanism for bringing trade flows in line with domestic saving and investment is the exchange rate.

8. Besides promoting high saving and investment, countries increase their growth through a wide array of policies and institutions. Important considerations are a stable macroeconomic climate, strong property rights for both tangible investments and intellectual property, a convertible currency with few restrictions on financial flows, and political and economic stability.

C. International Economic Issues

9. Popular analysis looks at large trade deficits and sees "deindustrialization." But this analysis overlooks the important distinction between productivity and competitiveness. Competitiveness refers to how well a nation's goods can compete in the global marketplace and is determined primarily by relative prices. Productivity denotes the level of output per unit of input. Real incomes and living standards depend primarily upon productivity, whereas the trade and current-account positions depend upon competitiveness. There is no close linkage between competitiveness and productivity.
10. Fixed exchange rates are a source of instability in a world of highly mobile financial capital. Recall the fundamental trilemma of fixed exchange rates: A country cannot simultaneously have a fixed but adjustable exchange rate, free capital and financial movements, and an independent domestic monetary policy.
11. In 1999, European countries chose to move to a common currency and a unitary central bank. A common currency is appropriate when a region forms an optimal currency area. Advocates of European monetary union point to the improved predictability, lower transactions costs, and potential for better capital allocation. Skeptics worry that a common currency—like any irrevocably fixed exchange-rate system—will require flexible wages and prices to promote adjustment to macroeconomic shocks.

Eye Therapies Exhibit 2127, 607 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CONCEPTS FOR REVIEW

$C + I + G + X$ curve for open economy
net exports = $X = Ex - Im$
domestic demand vs. spending on GDP
marginal propensity to import (MPm)
expenditure multiplier:
in closed economy = $1/MPS$
in open economy = $1/(MPS + MPm)$
impact of trade flows and exchange rates on GDP
saving-investment identity in open economies: $X = S + (T - G) - I$
equilibration in saving-investment market in closed and open economies
growth policies in the open economy
competitiveness vs. productivity

FURTHER READING AND INTERNET WEBSITES

Further Reading

The quotation from the *Economic Report of the President, 2000* (Government Printing Office, Washington, D.C., 2000), can also be found at *fraser.stlouisfed.org/publications/ERP,* pp. 231–235.

Websites

Data on trade and finance for different countries can be found in the section on websites for Chapter 26.

Robert Mundell won the Nobel Prize in 1999 for his contribution to international macroeconomics. Visit *www.nobel.se/laureates* to read about his contribution.

The website of the European Central Bank, at *www.ecb.int/ecb/html/index.en.html,* explains some of the issues involved in the management of the Euro. Also see the sites listed for Chapter 26.

QUESTIONS FOR DISCUSSION

1. Assume that an expansionary monetary policy leads to a decline or depreciation of the U.S. dollar relative to the currencies of America's trading partners in the short run with unemployed resources. Explain the mechanism by which this will produce an economic expansion in the United States. Explain how the trade impact reinforces the impact on domestic investment.
2. Explain the short-run impact upon net exports and GDP of the following in the multiplier model, using Table 28-1 where possible:
   a. An increase in investment (I) of $100 billion
   b. A decrease in government purchases (G) of $50 billion
   c. An increase in foreign output which increased exports by $10 billion
   d. A depreciation of the exchange rate that raised exports by $30 billion and lowered imports by $20 billion at every level of GDP
3. What would the expenditure multiplier be in an economy without government spending or taxes where the MPC is 0.8 and the MPm is 0? Where the MPm is 0.1? Where the MPm is 0.9? Explain why the multiplier might even be less than 1.
4. Consider Table 28-3.
   a. Explain each of the entries in the table.
   b. Add another column with the heading "Change in interest rates" to Table 28-3. Then, on the basis of the graph in Figure 28-7, fill in the table for a closed economy.
5. An eminent macroeconomist recently wrote: "Moving toward a monetary union by adopting a common currency is not really about the currency. The most important factor is that countries in the union must agree on a single monetary policy for the entire region." Explain this statement. Why might adopting a single monetary policy cause troubles?
6. Consider the city of New Heaven, which is a very open economy. The city exports reliquaries and has no investment or taxes. The city's residents consume 50 percent of their disposable incomes, and 90 percent

Eye Therapies Exhibit 2127, 608 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

of all purchases are imports from the rest of the country. The mayor proposes levying a tax of $100 million to spend on a public-works program. Mayor Cains argues that output and incomes in the city will rise nicely because of something called "the multiplier." Estimate the impact of the public-works program on the incomes and output of New Heaven. Do you agree with the mayor's assessment?

7. Review the bulleted list of the three interactions of saving, investment, and trade on page 577. Make a graph like that of Figure 28-8 to illustrate each of the impacts. Make sure that you can explain the reverse cases mentioned in the paragraph that follows the bulleted list.
8. Politicians often decry the large trade deficit of the United States. Economists reply that to reduce the trade deficit would require a tax increase or a cut in government expenditures. Explain the economists' view using the analysis of the saving-investment balance in Figure 28-8. Also, explain the quotation from the *Economic Report 2000* on page 565.
9. Look back at Figure 26-2 and make sure you understand it. Now, consider an emerging-market country like Brazil or Argentina.
   a. Draw a diagram like Figure 28-9(*b*) for the country in good times, when the risk premium on its borrowing is low. Call this Figure A.
   b. Next, consider a shock that raises the risk premium by a large amount. Draw a new figure with the high premium and the new equilibrium. Call this Figure B.
   c. Now compare the equilibria in Figures A and B. Specifically, explain the difference in (i) the equilibrium domestic real interest rate, (ii) domestic investment, (iii) the exchange rate, and (iv) net exports.
10. Consider the example of small open economies like Belgium and the Netherlands that have highly mobile financial capital and fixed exchange rates but also have high government budget deficits. Suppose that these countries find themselves in a depressed economic condition, with low output and high unemployment. Explain why they cannot use monetary policy to stimulate their economies. Why would fiscal expansion be effective if they could tolerate higher budget deficits?
11. **Advanced problem.** After the reunification of Germany, payments to rebuild the former East Germany led to a major expansion of aggregate demand in Germany. The German central bank responded by raising German real interest rates. These actions took place in the context of the European Monetary System, in which most countries had fixed exchange rates and where the German central bank was dominant in monetary policy.
   a. Explain why European countries having fixed exchange rates and following the lead of the German central bank would find their interest rates rising along with German interest rates. Explain why other European countries would thereby be plunged into deep recessions.
   b. Explain why countries would prefer the European Monetary Union to the earlier system.
   c. Trace through why this German monetary tightening would be expected to lead to a depreciation of the dollar. Explain why the depreciation would stimulate economic activity in the United States.
12. **Advanced problem.** Reread the definition of the fundamental trilemma as well as the discussion by Paul Krugman on page 581. Explain why the three elements cannot go together. Why is there not a fundamental trilemma for the fixed-exchange-rate system between "California dollars" and "Texas dollars"? Explain how the trilemma would apply to China today. Explain the arguments for and against each of the three possible choices in the trilemma described by Krugman.

Eye Therapies Exhibit 2127, 609 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



PART SEVEN

Unemployment, Inflation, and Economic Policy

CHAPTER

Unemployment and the Foundations of Aggregate Supply

29



Be nice to people on your way up because you'll meet them on your way down.

Wilson Mizner

Among the persistent features of a market economy are business recessions, in which employment and output fall and unemployment rises. For most of the period since World War II, the United States avoided prolonged and deep recessions. However, even during the mild business contractions, joblessness increased and incomes fell sharply.

Occasionally, and often without much warning, countries suffer severe recessions or even decade-long depressions, and high unemployment persists for several years or even a decade. Such a situation was seen in the U.S. during the 1930s, when the unemployment rate was above 10 percent of the labor force for ten years.

The world's richest economies entered a recession in 2007, and it turned sharply worse in 2008–2009. Faced with a housing bubble, failing banks, a loss of confidence in the economy, weak investment, and a liquidity trap, the unemployment rate rose sharply in the 2007–2009 period. Although a better understanding of macroeconomics has allowed most countries to take countercyclical measures, prospects for a strong recovery of output and employment were slim.

This chapter presents an analysis of the macroeconomics of unemployment. It begins by analyzing the foundations of aggregate supply. This analysis shows how rising unemployment is the result of slow growth of aggregate demand relative to potential output. We then examine the major policy issues surrounding unemployment.

A. THE FOUNDATIONS OF AGGREGATE SUPPLY

Earlier chapters focused on aggregate demand and economic growth. This section describes the factors determining aggregate supply. In the short run, the nature of the inflationary process and the effectiveness of government countercyclical policies depend on aggregate demand. In the long run of a decade or more, economic growth and rising living standards are closely linked with increases in aggregate supply.

This distinction between short-run and long-run aggregate supply is crucial to modern macroeconomics. In the short run, it is the interaction of aggregate supply and demand that determines business-cycle fluctuations, inflation, unemployment, recessions, and booms. But in the long run, it is the growth of potential output working through aggregate supply which explains the trend in output and living standards.

Eye Therapies Exhibit 2127, 611 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

It will be useful to summarize the key points at the outset:

- **Aggregate supply** describes the behavior of the production side of the economy. The **aggregate supply curve,** or *AS* curve, is the schedule showing the level of total national output that will be produced at each possible price level, other things held constant.
- In analyzing aggregate supply, we will make the central distinction between the long run and the short run. The short run, corresponding to the behavior over periods of a few months to a few years, involves the **short-run aggregate supply schedule.** In the short run, prices and wages have elements of inflexibility. As a result, higher prices are associated with higher production of goods and services. This is shown as an *upward-sloping AS* curve.
- The long run refers to periods associated with economic growth, after most of the elements of business cycles have damped out; it refers to a period of several years or decades. In the long run, prices and wages are perfectly flexible. Output is determined by potential output and is independent of the price level. We depict the **long-run aggregate supply schedule** as *vertical.*

This section is devoted to explaining these central points.

DETERMINANTS OF AGGREGATE SUPPLY

Aggregate supply depends fundamentally upon two distinct sets of forces: potential output and input costs. Let us examine each of these influences.

Potential Output

The key concept for understanding aggregate supply is *potential output* or *potential GDP.* **Potential output** is the maximum sustainable output that can be produced without triggering rising inflationary pressures.

Over the long run, aggregate supply depends primarily upon potential output. Hence, long-run *AS* is determined by the same factors which influence long-run economic growth: the quantity and quality of labor, the supply of capital and natural resources, and the level of technology.

Macroeconomists generally use the following definition of potential output:

Potential GDP is the highest sustainable level of national output. It is the level of output that would be produced if we remove business-cycle influences. As an operational measure, we measure potential GDP as the output that would be produced at a benchmark level of the unemployment rate called the *nonaccelerating inflation rate of unemployment* (or the *NAIRU*).

Potential output is a growing target. As the economy grows, potential output increases as well, and the aggregate supply curve shifts to the right. Table 29-1 shows the key determinants of aggregate supply, broken down into factors affecting potential output and production costs. From our analysis of economic growth, we know that the prime factors determining the growth in potential output are the growth in inputs and technological progress.



Potential Output Is Not Maximum Output

We must emphasize a subtle point about potential output: Potential output is the maximum sustainable output but not the absolute maximum output that an economy can produce. The economy can operate with output levels above potential output for a short time. Factories and workers can work overtime for a while, but production above potential is not indefinitely sustainable. If the economy produces more than its potential output for long, price inflation tends to rise as unemployment falls, factories are worked intensively, and workers and businesses try to extract higher wages and profits.

A useful analogy is someone running a marathon. Think of potential output as the maximum speed that a marathoner can run without becoming "overheated" and dropping out from exhaustion. Clearly, the runner can run faster than the sustainable pace for a while, just as the U.S. economy grew faster than its potential growth rate during the 1990s. But over the entire course, the economy, like the marathoner, can produce only at a maximum sustainable "speed," and this sustainable output speed is what we call potential output.

Input Costs

It is not surprising that increased potential output would lead to increased aggregate supply. The role

Eye Therapies Exhibit 2127, 612 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Variable	Impact on aggregate supply
Potential output	
Inputs	Supplies of capital, labor, and natural resources are the important inputs. Potential output comes when employment of labor and other inputs is at the maximum sustainable level. Growth of inputs increases potential output and aggregate supply.
Technology and efficiency	Innovation, technological improvement, and increased efficiency increase the level of potential output and raise aggregate supply.
Production costs	
Wages	Lower wages lead to lower production costs; lower costs mean that quantity supplied will be higher at every price level for a given potential output.
Import prices	A decline in foreign prices or an appreciation in the exchange rate reduces import prices. This leads to lower production costs and raises aggregate supply.
Other input costs	Lower oil prices lower production costs and thereby raise aggregate supply.

TABLE 29-1. Aggregate Supply Depends upon Potential Output and Production Costs

Aggregate supply relates total output supplied to the price level. The *AS* curve depends upon fundamental factors such as potential output and production costs. The factors listed in the table would increase aggregate supply, shifting the *AS* curve down or to the right.

of costs in *AS* is less obvious. We will see, however, that aggregate supply *in the short run* is affected by the costs of production.

The intuition behind this point is the following: Businesses have certain costs that are inflexible in the short run. For example, consider an airline that has a long-term lease and a multiyear labor contract. If the demand for air travel increases, the airline will find it profitable to add flights and to raise its ticket prices. In other words, both prices and output increase with an increase in demand in the short run.

We can also see that changes in production costs will affect aggregate supply in the short run. For example, consider what happened in the early 2000s when oil prices rose sharply, increasing the price of jet fuel. Airlines were unable to adjust their operations and ticket prices sufficiently to offset the higher costs. They were making record losses. They therefore cut some of their operations, abandoned routes, cut back on food service, and mothballed a substantial number of airplanes. This example shows how input costs can affect supply behavior.

Table 29-1 shows some of the cost factors affecting aggregate supply. These examples are ones in which lower costs will increase *AS,* meaning that the *AS* curve shifts down.

AS *Shifts.* We can illustrate the effects of changes in costs and potential output graphically in Figure 29-1. The left-hand panel shows that an increase in potential output with no change in production costs would shift the aggregate supply curve outward from *AS* to *AS′*. If production costs were to increase with no change in potential output, the curve would shift straight up from *AS* to *AS″*, as shown in Figure 29-1(*b*).

The real-world shifting of *AS* is displayed in Figure 29-2. The curves are realistic empirical estimates for two different years, the recession year of 1982 and the peak year of 2000. The vertical lines indicate the levels of potential output in the two years. According to studies, real potential output grew about 72 percent over this period.

The figure shows how the *AS* curve shifted outward and upward over the period. The *outward* shift was caused by the increase in potential output that came from growth in the labor force and the capital stock as well as from improvements in technology. The *upward* shift was caused by increases in the cost of production, as wages, oil prices, and other production costs rose. Putting together the cost increases and the potential-output growth gives the aggregate supply shift shown in Figure 29-2.

Eye Therapies Exhibit 2127, 613 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

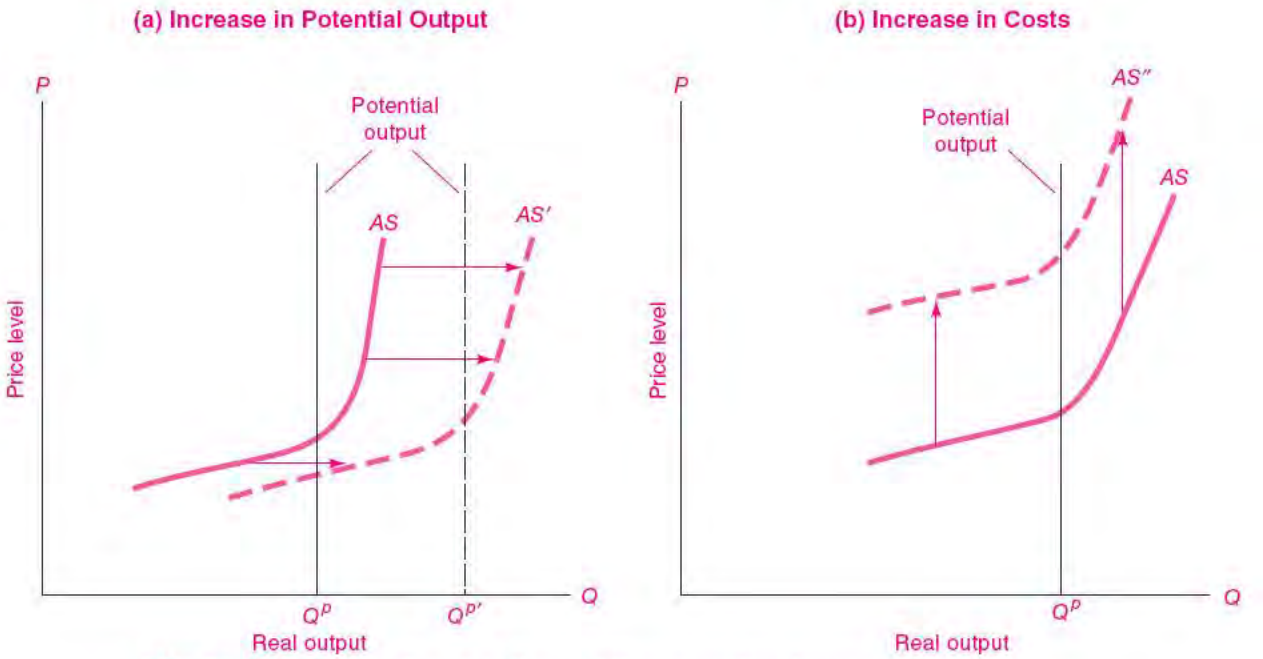


FIGURE 29-1. How Do Growth in Potential Output and Cost Increases Affect Aggregate Supply?

In (**a**), growth in potential output with unchanged production costs shifts the *AS* curve rightward from *AS* to *AS′*. When production costs increase, say, because of higher wages or oil costs, but with unchanged potential output, the *AS* curve shifts vertically upward, as from *AS* to *AS″* in (**b**).

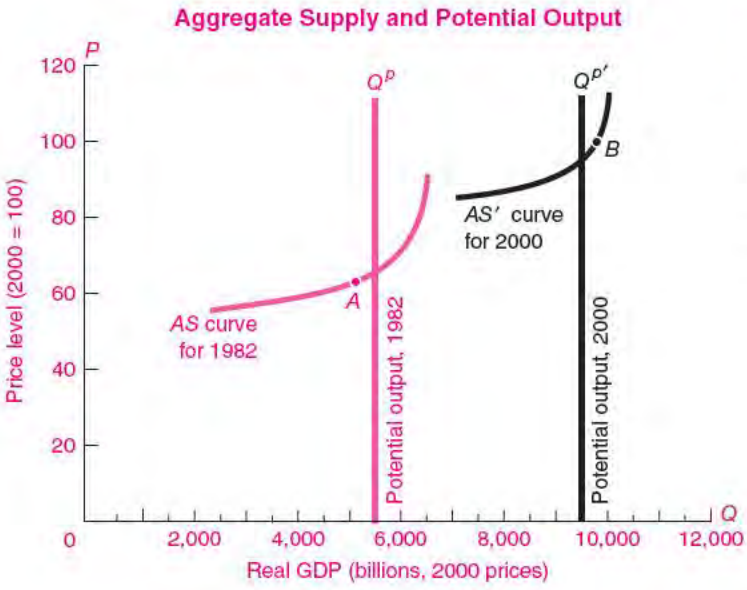


FIGURE 29-2. In Reality, Aggregate Supply Shifts Combine Cost Increases and Increased Potential Output

Between 1982 and 2000, potential output grew due to increases in capital and labor inputs along with technological improvements, shifting out the *AS* curve. At the same time, increases in production costs shifted up the *AS* curve. The net effect was to shift the *AS* curve upward and to the right.

Eye Therapies Exhibit 2127, 614 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

AGGREGATE SUPPLY IN THE SHORT RUN AND LONG RUN

How do shifts in aggregate demand affect output and employment? The answer to this question differs between the short run (which applies to business cycles) and the long run (which applies to comparisons of countries over long periods of time or to comparisons among countries). The two approaches are illustrated in Figure 29-3.

The upward-sloping, short-run aggregate supply curve is associated with the analysis called **Keynesian macroeconomics.** In this situation, changes in aggregate demand have a significant effect on output. In other words, if aggregate demand falls because of a monetary tightening or a falloff in consumer spending, this will lead to falling output and prices. In terms of our curves, this means that the *AS* curve is upward-sloping, so a decline in *AD* will lead to a decline in both prices and output.

The long-run approach, sometimes called **classical macroeconomics,** holds that changes in *AD* affect prices but have no effect on real output. In the long run, prices and wages adjust fully to changes in aggregate demand. The classical or long-run *AS* curve is vertical; changes in aggregate demand therefore have no effect on output.

We can summarize the reasons for the difference as follows: The short-run *AS* curve in Figure 29-3(*a*) indicates that firms are willing to increase their output levels in response to changes in aggregate demand. Clearly, there must be unemployed resources in the economy. But the expansion of output cannot go on forever. As output rises, labor shortages appear and factories operate close to capacity. Wages and prices begin to rise more rapidly. A larger fraction of the response to aggregate demand increase comes in the form of price increases and a smaller fraction comes in output increases.

Figure 29-3(*b*) shows what happens in the long run—after wages and prices have had time to react fully. When all adjustments have taken place, the long-run *AS* curve becomes vertical or classical. In the long run, the level of output supplied is independent of aggregate demand.

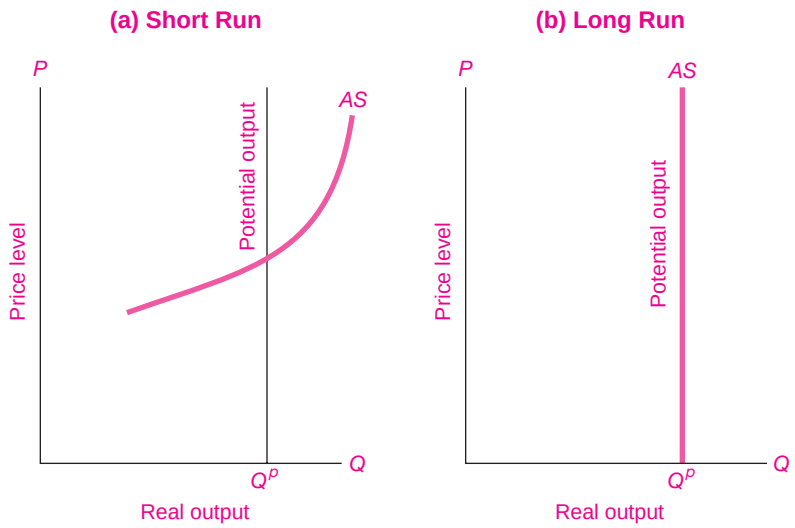


FIGURE 29-3. ***AS*** **Is Upward-Sloping in the Short Run but Turns Vertical in the Long Run**

The short-run *AS* curve in (**a**) slopes upward because many costs are inflexible in the short run. But sticky prices and wages become unstuck as time passes, so the long-run *AS* curve in (**b**) is vertical and output is determined by potential output. Can you see why a Keynesian economist in (**a**) might desire to stabilize the economy through policies that change aggregate demand while a classical economist in (**b**) would concentrate primarily on increasing potential output?

Eye Therapies Exhibit 2127, 615 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Sticky Wages and Prices and the Upward-Sloping AS Curve

Economists generally agree that the *AS* curve slopes up in the short run—which is to say that both output and prices respond to demand shifts. It has proved very difficult to develop a complete theory to explain this relationship, and controversies about aggregate supply are among the most heated in all of economics. We will describe one of the important and durable theories here—one involving sticky wages and prices—but don't be surprised if you hear other ones as well.

The puzzle is why firms raise both prices and output in the short run as aggregate demand increases, whereas increases in demand lead primarily to price changes in the long run. The key to this puzzle lies in the behavior of wages and prices in a modern market economy. Some elements of business costs are *inflexible* or *sticky* in the short run. As a result of this inflexibility, businesses can profit from higher levels of aggregate demand by producing more output.

For example, suppose that a wartime emergency leads to an increase in military spending. Firms know that in the short run many of their production costs are fixed in dollar terms—workers are paid $15 per hour, rentals are $1500 per month, and so forth. In response to the higher demand, firms will generally raise their output prices and increase production. This positive association between prices and output is seen in the upward-sloping *AS* curve in Figure 29-3(*a*).

We have spoken repeatedly of "sticky" or "inflexible" costs. What are some examples? The most significant is wages. Take unionized workers as an example. They are usually paid according to a long-term union contract which specifies a dollar wage rate. For the life of the labor agreement, the wage rate faced by the firm will be largely fixed in dollar terms. It is quite rare for wages to be raised more than once a year even for nonunion workers. It is even more uncommon for money wages or salaries actually to be cut, except when a company is visibly facing the threat of bankruptcy.

Other prices and costs are similarly sticky in the short run. When a firm rents a building, the lease will often last for a year or more and the rental is generally set in dollar terms. In addition, firms often sign contracts with their suppliers specifying the prices to be paid for materials or components.

Putting all these cases together, you can see how a certain short-run stickiness of wages and prices exists in a modern market economy.

What happens in the long run? Eventually, the inflexible or sticky elements of cost—wage contracts, rental agreements, regulated prices, and so forth—become unstuck and negotiable. Firms cannot take advantage of fixed-money wage rates in their labor agreements forever; labor will soon recognize that prices have risen and insist on compensating increases in wages. Ultimately, all costs will adjust to the higher output prices. If the general price level rises by x percent because of the higher demand, then money wages, rents, regulated prices, and other costs will in the end respond by moving up around x percent as well.

Once costs have adjusted upward as much as prices, firms will be unable to profit from the higher level of aggregate demand. In the long run, after all elements of cost have fully adjusted, firms will face the same ratio of price to costs as they did before the change in demand. There will be no incentive for firms to increase their output. The long-run *AS* curve therefore tends to be vertical, which means that output supplied is independent of the level of prices and costs.

Aggregate supply differs depending upon the period. In the short run, inflexible elements in wages and prices lead firms to respond to higher demand by raising both production and prices. In the longer run, as costs respond fully, all of the response to increased demand takes the form of higher prices. Whereas the short-run *AS* curve is upward-sloping, the long-run *AS* curve is vertical because, given sufficient time, all prices and costs adjust fully.

B. UNEMPLOYMENT

During the recession that began in 2007, the number of unemployed people in the United States rose by more than 4 million. Of the 11 million unemployed people at the end of 2008, half were "job losers," people who lost their jobs involuntarily. In earlier periods, such as the Great Depression or the early 1980s, the unemployment rate rose much more, reaching an all-time high of 25 percent in 1933.

Eye Therapies Exhibit 2127, 616 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The presence of involuntary unemployment in a market economy raises important questions: How can millions of people be unemployed when there is so much useful work to be done? Is there some flaw in the market mechanism that forces so many who want to work to remain idle? Alternatively, is high unemployment primarily due to flawed government programs (such as unemployment insurance) that reduce the incentive to work, or is it due to inherent properties of a market economy? The balance of this chapter provides a survey of the meaning of unemployment and some answers to these important questions.

MEASURING UNEMPLOYMENT

Changes in the unemployment rate make monthly headlines. Look back to Figure 19-3 on page 373 to refresh your memory about the long-term trend. What lies behind the numbers? Statistics on unemployment and the labor force are among the most carefully designed and comprehensive economic data the nation collects. The data are gathered monthly in a procedure known as *random sampling* of the population. Each month about 60,000 households are interviewed about their recent work history.

The survey divides the population of those 16 years and older into four groups:

- **Employed.** These are people who perform any paid work, as well as those who have jobs but are absent from work because of illness, strikes, or vacations.
- **Unemployed.** Persons are classified as unemployed if they do not have a job, have actively looked for work in the prior 4 weeks, and are currently available for work. An important point to note is that unemployment requires more than being without a job—it requires taking steps to find a job.
- **Not in the labor force.** This includes the 34 percent of the adult population that is keeping house, retired, too ill to work, or simply not looking for work.
- **Labor force.** This includes all those who are either employed or unemployed.

Figure 29-4 shows how the population in the United States is divided among the categories of employed, unemployed, and not in the labor force.



FIGURE 29-4. Labor-Force Status of the Population, 2007

How do Americans spend their time? This figure shows how teenagers (ages 16–19), prime-age adults (ages 25–54), and seniors (65 and older) divided their time among employment, unemployment, and not in the labor force. Many young workers are out of the labor force and in school, while most older workers are retired.

Source: Bureau of Labor Statistics.

(The status of students is examined in question 6 at the end of this chapter.)

The definition of labor-force status used by the government is the following:

People with jobs are employed; people without jobs but looking for work are unemployed; people without jobs who are not looking for work are outside the labor force. The **unemployment rate** is the number of unemployed divided by the total labor force.

IMPACT OF UNEMPLOYMENT

High unemployment is both an economic and a social problem. Unemployment is an economic problem because it represents waste of a valuable resource. Unemployment is a major social problem because it causes enormous suffering as unemployed workers struggle with reduced incomes. During periods of high unemployment, economic distress spills over to affect people's emotions and family lives.

Eye Therapies Exhibit 2127, 617 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Economic Impact

When the unemployment rate goes up, the economy is in effect throwing away the goods and services that the unemployed workers could have produced.

How much waste results from high unemployment? What is the opportunity cost of recessions? Table 29-2 provides a calculation of how far output fell short of potential GDP during three periods of high unemployment over the last half-century. The largest economic loss occurred during the Great Depression, but the oil and inflation crises of the 1970s and 1980s also generated more than a trillion dollars of lost output.

The economic losses during periods of high unemployment are the greatest documented wastes in a modern economy. They are many times larger than the estimated inefficiencies from microeconomic waste due to monopoly or from the waste induced by tariffs and quotas.

Social Impact

The economic cost of unemployment is certainly large, but no dollar figure can adequately convey the human and psychological toll of long periods of persistent involuntary unemployment. The personal tragedy of unemployment has been proved again and again. We can read of the futility of a job search in San Francisco during the Great Depression:

> I'd get up at five in the morning and head for the waterfront. Outside the Spreckles Sugar Refinery, outside the gates, there would be a thousand men. You know dang well there's only three or four jobs. The guy would come out with two little Pinkerton cops: "I need two guys for the bull gang. Two guys to go into the hole." A thousand men would fight like a pack of Alaskan dogs to get through. Only four of us would get through.

Or we can listen to the recollection of an unemployed construction worker:

> I called the roofing outfits and they didn't need me because they already had men that had been working for them five or six years. There wasn't that many openings. You had to have a college education for most of them. And I was looking for anything, from car wash to anything else.
>
> So what do you do all day? You go home and you sit. And you begin to get frustrated sitting home. Everybody in the household starts getting on edge. They start arguing with each other over stupid things 'cause they're all cramped in that space all the time. The whole family kind of got crushed by it.

	Average unemployment rate (%)	Lost Output: GDP loss ($, billion, 2008 prices)	Lost Output: As percentage of GDP during the period
Great Depression (1930–1939)	18.2	2,796	30.0
Oil and inflation crises (1975–1984)	7.7	1,694	2.7
Slump after dot.com bust (2001–2003)	5.5	509	1.4

TABLE 29-2. Economic Costs from Periods of High Unemployment

The two major periods of high unemployment since 1929 occurred during the Great Depression and during the oil shocks and high inflation from 1975 to 1984. The lost output is calculated as the cumulative difference between potential GDP and actual GDP. Note that during the Great Depression losses relative to GDP were 10 times greater than losses in the oil-inflation slump. The slowdown in the early 2000s was mild by comparison to earlier downturns.

Source: Authors' estimates on the basis of official GDP and unemployment data.

Eye Therapies Exhibit 2127, 618 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Unemployment is not limited to the unskilled, as many well-paid managers, professionals, and white-collar workers learned in the corporate downsizings of the last two decades. Listen to the story of one middle-aged corporate manager who lost his job in 1988 and was still without permanent work in 1992:

> I have lost the fight to stay ahead in today's economy.... I was determined to find work, but as the months and years wore on, depression set in. You can only be rejected so many times; then you start questioning your self-worth.

OKUN'S LAW

The most traumatic consequence of a recession is the accompanying rise in unemployment. As output falls, firms need fewer labor inputs, so new workers are not hired and current workers are laid off. We see that the unemployment rate usually moves inversely with output over the business cycle. This co-movement is known as Okun's Law.

Okun's Law states that for every 2 percent that GDP falls relative to potential GDP, the unemployment rate rises about 1 percentage point.

This means that if GDP begins at 100 percent of its potential and falls to 98 percent of potential, the unemployment rate rises by 1 percentage point, say, from 6 to 7 percent. Figure 29-5 shows how output and unemployment have moved together over time.

We can illustrate Okun's Law by examining output and unemployment trends in the 1990s. At the trough of the recession of 1991, the unemployment rate rose to 7 percent. At that point, actual GDP was estimated to be 3 percent below potential output. Then, over the next 8 years, output grew 5 percent faster than potential output, so in 1999 actual GDP was estimated to be 2 percent above potential output. According to Okun's Law, the unemployment rate should have fallen by 2½ percentage points (5/2) to 4½ percent (7 − 2½). In fact, the unemployment rate for 1999 was 4¼ percent—a remarkably accurate prediction. This shows how Okun's Law can be used to relate changes in the unemployment rate to the growth in output.

One important consequence of Okun's Law is that actual GDP must grow as rapidly as potential GDP just to keep the unemployment rate from rising. In a sense, GDP has to keep running just to keep unemployment in the same place. Moreover, if you want to bring the unemployment rate down, actual GDP must be growing faster than potential GDP.

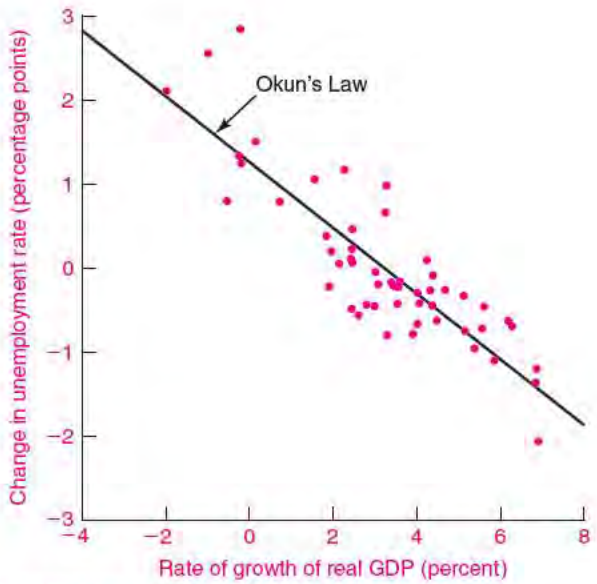


FIGURE 29-5. Okun's Law Illustrated, 1955–2007

According to Okun's Law, whenever output grows 2 percent faster than potential GDP, the unemployment rate declines 1 percentage point. This graph shows that unemployment changes are well predicted by the rate of GDP growth. What output growth would lead to no change in unemployment according to the line?

Source: U.S. Departments of Commerce and Labor.

Okun's Law provides the vital link between the output market and the labor market. It describes the association between short-run movements in real GDP and changes in unemployment.

ECONOMIC INTERPRETATION OF UNEMPLOYMENT

On the face of it, the cause of unemployment seems clear: too many workers chasing too few jobs. Yet this simple phenomenon has presented a tremendous puzzle for economists for many years. Experience shows that prices rise or fall to clear competitive markets. At the market-clearing price, buyers willingly buy what sellers willingly sell. But something is

Eye Therapies Exhibit 2127, 619 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

gumming up the workings of the labor market when many hospitals are searching for nurses but cannot find them while thousands of coal miners want to work at the going wage but cannot find a job. Similar symptoms of labor market failures are found in all market economies.

Let's turn now to the economic analysis of unemployment. As with other economic phenomena, we would like to understand the reasons for unemployment. Can we understand why unemployment varies sharply over the business cycle, as well as why some groups have higher unemployment rates than other groups? We will see that a combination of imperfections in the labor market, as well as personal search dynamics, lies behind the observed behavior.

Equilibrium Unemployment

We begin by analyzing unemployment in a supply-and-demand framework. To begin with, we will consider equilibrium unemployment. **Equilibrium unemployment** arises when people become unemployed voluntarily as they move from job to job or into and out of the labor force. This is also sometimes called *frictional unemployment* because people cannot move instantaneously between jobs. Here are some examples: Someone working at the local hamburger stand might decide that the pay is too low, or the hours are too inconvenient, and quit to look for a better job. Others might decide to take time off between school and their first job. A new mother might take 3 months of unpaid maternity leave. These workers have chosen unemployment rather than work in balancing their relative preferences of income, job characteristics, leisure, and family responsibilities.

This kind of unemployment is equilibrium because firms and workers are on their supply and demand schedules. The market is clearing properly in the sense that all workers who desire jobs at the going wages and working conditions have them and all firms that wish to hire workers at the going compensation can find them. Some economists label this *voluntary unemployment* to denote that people are unemployed because they prefer that state over other labor market states.

Equilibrium unemployment is shown in Figure 29-6(*a*). The workers have a labor supply schedule shown as *SS*. The left-hand panel shows the usual picture of competitive supply and demand, with a market equilibrium at point *E* and a wage of *W**. At the competitive, market-clearing equilibrium, firms willingly hire all qualified workers who desire to work at the market wage. The number of employed is represented by the line from *A* to *E*.

However, even though the market is in equilibrium, some people would like to work but only at a higher wage rate. These unemployed workers, represented by the segment *EF*, are unemployed in the sense that they choose not to work at the market wage rate. But this is equilibrium unemployment in the sense that they are not working because of their choice between work and nonwork given the market wages.

The existence of equilibrium unemployment leads to an often misunderstood point: *Unemployment may be an efficient outcome in a situation where heterogeneous workers are searching for work or testing different kinds of jobs.* The voluntarily unemployed workers might prefer leisure or other activities to jobs at the going wage rate. Or they may be frictionally unemployed, perhaps searching for their first job. Or they might be low-productivity workers who prefer retirement or unemployment insurance to low-paid work. There are countless reasons why people might voluntarily choose not to work at the going wage rate, and yet these people might be counted as unemployed in the official statistics.

Disequilibrium Unemployment

Go back to reread the paragraphs above on the experiences of the three workers. The situation outside the Spreckles Sugar Refinery hardly sounds like equilibrium conditions. The unemployed workers surely do not seem like people carefully balancing the value of work against the value of leisure. Nor do they resemble people choosing unemployment as they search for a better job. Rather, these workers are in a situation of disequilibrium unemployment. This occurs when the labor market or the macroeconomy is not functioning properly and some qualified people who are willing to work at the going wage cannot find jobs. Two examples of disequilibrium are structural and cyclical unemployment.

Structural unemployment signifies a mismatch between the supply of and the demand for workers. Mismatches can occur because the demand for one kind of labor is rising while the demand for another kind is falling and markets do not quickly adjust. We often see structural imbalances across occupations or

Eye Therapies Exhibit 2127, 620 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

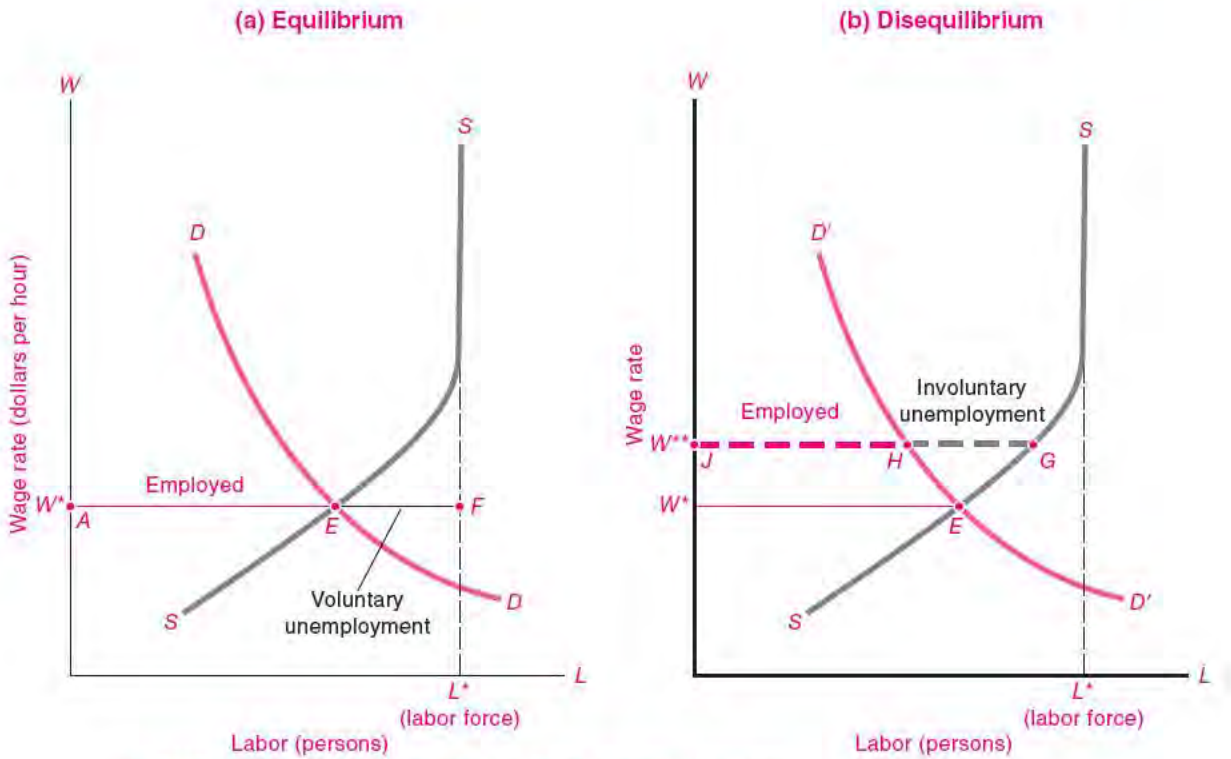


FIGURE 29-6. Equilibrium vs. Disequilibrium Unemployment

We can depict different kinds of unemployment by using the microeconomic supply-and-demand framework.

Panel (**a**) shows a standard market-clearing equilibrium with flexible wages. Here, wages decline to W^* to clear the labor market and balance supply and demand. All unemployment is voluntary.

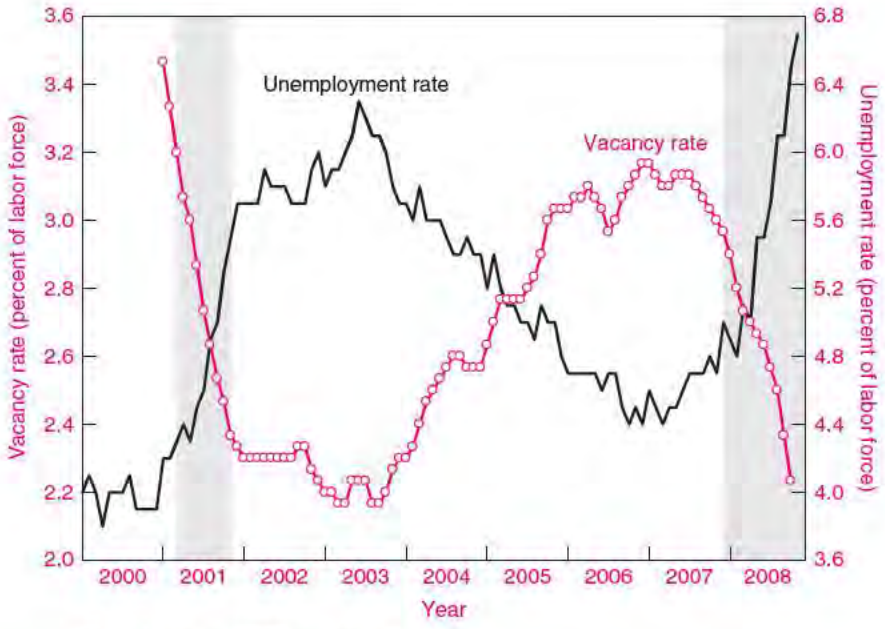
Panel (**b**) shows disequilibrium unemployment, with sticky wages that do not adjust to clear the labor market. At the too high wage at W^{**}, JH workers are employed, but HG workers are involuntarily unemployed.

regions as certain sectors grow while others decline. For example, an acute shortage of nurses arose recently as the number of skilled nurses grew slowly while the demand for nursing care grew rapidly because of an aging population. Not until nurses' salaries rose rapidly and the supply adjusted did the structural shortage of nurses decline. By contrast, the demand for coal miners has been depressed for decades because of the lack of geographic mobility of labor and capital; unemployment rates in coal-mining communities remain high today.

Cyclical unemployment exists when the overall demand for labor declines in business-cycle downturns, as described in the Keynesian business-cycle theory. For example, in the major recession of 2007–2009, the demand for labor declined and unemployment rose in virtually every industry and region. Similarly, in the long expansion of the 2000s, the unemployment rate fell in virtually every state in the United States. The labor market consequences of business cycles differ from case to case, from mild declines in employment growth to job losses totaling a sizable fraction of the population.

The key to understanding disequilibrium unemployment is to see that labor markets are not at their supply-and-demand equilibrium, as is shown in Figure 29-6(*b*). For this example, we assume that wages are sticky in the short run at the initial level of W^{**}.

Eye Therapies Exhibit 2127, 621 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



Shaded areas are NBER recessions.

FIGURE 29-7. Vacancy and Unemployment Rates

The vacancy and unemployment rates move inversely over the business cycle. This is an important prediction of the Keynesian sticky-wage theory of unemployment.

Source: Bureau of Labor Statistics.

Hence, when there is a decline in the demand for labor, and labor demand declines to the $D'D'$ curve in (*b*), the market wage at W^{**} is above the market-clearing wage at W^{*}.

At the too high wage rate, there are more qualified workers looking for work than there are vacancies looking for workers. The number of workers desiring to work at wage W^{**} is at point G on the supply curve, but firms want to hire only H workers, as shown by the demand curve. Because the wage exceeds the market-clearing level, there is a surplus of workers. The unemployed workers represented by the dashed line segment HG constitute *disequilibrium unemployment*. Alternatively, we may call them "involuntarily unemployed," signifying that they are qualified workers who want to work at the prevailing wage but cannot find jobs.

The opposite case occurs when the wage is below the market-clearing rate. Here, in a labor-shortage economy, employers cannot find enough workers to fill the existing vacancies. Firms put help-wanted signs in their windows, advertise in newspapers or on Monster.com, and even recruit people from other towns.

Figure 29-7 shows the vacancy rate along with the unemployment rate for the last decade. The two curves move inversely, as predicted by the sticky-wage theory shown in Figure 29-6.

The Analogy of College Admissions. The example of college admissions illustrates the kind of adjustment that takes place when shortages or gluts occur because prices do not adjust. Many colleges have enjoyed soaring applications in recent years. How did they react? Did they raise their tuition enough to choke off the excess demand? No. Instead, they raised their admission standards, requiring better grades in high school and higher average SAT scores. Upgrading the requirements rather than changing wages and prices is exactly what happens in the short run when firms experience an excess supply of labor.

Eye Therapies Exhibit 2127, 622 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Microeconomic Foundations of Inflexible Wages

Economists have developed many approaches to understanding the microeconomic foundations of unemployment. This issue remains one of the deepest unresolved mysteries of modern macroeconomics. Our survey emphasizes the importance of inflexibility of wages and prices. But this raises the further question: Why are wages and prices inflexible? Why do wages not move up or down to clear markets?

These are controversial questions. Few economists today would argue that wages move quickly to erase labor shortages and surpluses. Yet no one completely understands the reasons for the sluggish behavior of wages and salaries. We can therefore provide no more than a tentative assessment of the sources of wage inflexibility.

Auction vs. Administered Markets. A helpful distinction is that between auction markets and administered markets. An *auction market* is a highly organized and competitive market at which the price floats up or down to balance supply and demand. At the Chicago Board of Trade, for example, the price of "number 2 hard red wheat delivered in Kansas City" or "dressed 'A' broiler chickens delivered in New York" changes every minute to reflect market conditions.

Auction markets are the exception. Most goods and all labor are sold in administered markets. Nobody grades labor into "grade B Web page developer" or "class AAA assistant professor of economics." No market specialist ensures that every job and worker is quickly matched at a market-clearing wage.

Rather, most firms *administer* their wages and salaries, setting pay scales and hiring people at an entry-level wage or salary. These wage scales are generally fixed for a year or so, and when they are adjusted, the pay goes up for all categories. For example, every pay grade in a hospital might get a 4 percent pay increase for this year. Sometimes, the firm might decide to move one category up or down more than the average. Under standard procedures, firms will make only partial adjustments when there are shortages or gluts in a particular area.

For unionized labor markets, the wage patterns are even more rigid. Wage scales are typically set for a 3-year contract period; during that period, there are no adjustments in wages if shortages or gluts appear in particular jobs.

Menu Costs of Adjusting Wages and Prices. What is the economic reason for inflexible wages and salaries? Many economists believe that the inflexibility arises because of the costs of administering compensation (these are called "menu costs"). To take the example of union wages, negotiating a contract is a long process that requires much worker and management time and produces no output. Because collective bargaining is so costly, such agreements are generally negotiated only once every 3 years.

Setting compensation for nonunion workers is less costly, but it nevertheless requires scarce management time and has important effects on worker morale. Every time wages or salaries are set, every time fringe benefits are changed, earlier compensation agreements are changed as well. Some workers will feel the changes are unfair, others will complain about unjust procedures, and grievances may be triggered.

Personnel managers therefore prefer a system in which wages are adjusted infrequently and most workers in a firm get the same pay increase, regardless of the market conditions for different skills or categories. This system may appear inefficient because it does not allow for a perfect adjustment of wages to reflect market supply and demand. But it does economize on scarce managerial time and helps promote a sense of fair play and equity in the firm. In the end, it may be cheaper to recruit workers more vigorously or to change the required qualifications than to upset the entire wage structure of a firm simply to hire a few new workers.

We can summarize the microeconomic foundations as follows:

Most wages in market economies are administered by firms or contracts. Wages and salaries are adjusted infrequently because of the costs of negotiation and wage setting. When labor supply or demand changes, because of sticky wages, the reaction is primarily in quantities of labor employed rather than wages.

LABOR MARKET ISSUES

Having analyzed the causes of unemployment, we turn next to major labor market issues for today. Which groups are most likely to be unemployed? How long are they unemployed? What explains differences in unemployment across countries?

Eye Therapies Exhibit 2127, 623 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Labor market group	Unemployment Rate of Different Groups (% of labor force)		Distribution of Total Unemployment across Different Groups (% of total unemployed)	
	Trough (1982)	Peak (March 2000)	Trough (1982)	Peak (March 2000)
By age:				
16–19	23.2	13.3	18.5	20.2
20 years and older	8.6	3.3	81.5	80.0
By race:				
White	8.6	3.6	77.2	77.6
Black and other	17.3	7.3	22.8	22.4
By sex (adults only):				
Male	8.8	3.8	58.5	50.5
Female	8.3	4.3	41.5	49.5
All workers	**9.7**	**4.1**	**100.0**	**100.0**

TABLE 29-3. Unemployment by Demographic Group

This table shows how unemployment varies across different demographic groups in peak and trough years. The first set of figures shows the unemployment rate for each group in 1982 and during the peak period of 2000. The last two columns show the percent of the total pool of unemployed that is in each group.

Source: U.S. Department of Labor, *Employment and Earnings*.

Who Are the Unemployed?

We can diagnose labor market conditions by comparing years in which output is above its potential (of which 1999–2000 was a recent period) with those of deep recessions (such as was seen in 1982). Differences between these years show how business cycles affect the amount, sources, duration, and distribution of unemployment.

Table 29-3 shows unemployment statistics for peak and trough years. The first two columns of numbers are the unemployment rates by age, race, and sex. These data show that the unemployment rate of every group tends to rise during recession. The last two columns show how the total pool of unemployment is distributed among different groups; observe that the distribution of unemployment across groups changes relatively little throughout the business cycle.

Note also that nonwhite workers tend to experience unemployment rates more than twice those of whites in both trough and peak periods. Until the 1980s, women tended to have higher unemployment rates than men, but in the last two decades unemployment rates differed little by gender. Teenagers, with high frictional unemployment, have generally had unemployment rates much higher than adults.

Duration of Unemployment

Another key question concerns duration. How much of the unemployment experience is long-term and of major social concern, and how much is short-term as people move quickly between jobs?

Figure 29-8 shows the duration of unemployment in 2000–2007. A surprising feature of American labor markets is that a very large fraction of unemployment is of short duration. In 2003, one-third of unemployed workers were jobless for less than 5 weeks, and long-term unemployment was relatively rare.

In Europe, with lower mobility and greater legal obstacles to economic change, long-term unemployment in the mid-1990s reached 50 percent of the

Eye Therapies Exhibit 2127, 624 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

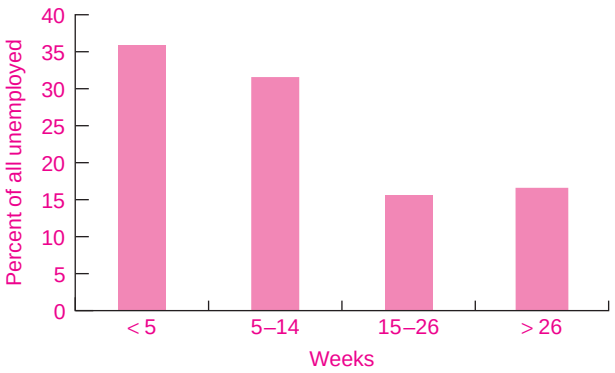


FIGURE 29-8. Duration of Unemployment in the United States, 2000–2007

Most unemployment is short-term in the United States. This suggests a frictional interpretation, where people move quickly between jobs.

Source: Bureau of Labor Statistics.

unemployed. Long-term unemployment poses a serious social problem because the resources that families have available—their savings, unemployment insurance, and goodwill toward one another—begin to run out after a few months.

Sources of Joblessness

Why are people unemployed? Figure 29-9 shows how people responded when asked the source of their unemployment, looking at the recession year of 1982 and the full-employment year of 2000.

There is always some frictional unemployment that results from changes in people's residence or from the life cycle—moving, entering the labor force for the first time, and so forth. The major changes in the unemployment rate over the business cycle arise from the increase in job losers. This source swells enormously in a recession for two reasons: First, the number of people who lose their jobs increases, and then it takes longer to find a new job.

Unemployment by Age

How does unemployment vary over the life cycle? Teenagers generally have the highest unemployment rate of any demographic group, and nonwhite teenagers in recent years have experienced unemployment rates between 30 and 50 percent. Is this unemployment frictional, structural, or cyclical?

Recent evidence indicates that, particularly for whites, teenage unemployment has a large frictional component. Teenagers move in and out of the labor force very frequently. They get jobs quickly and change jobs often. The average duration of teenage unemployment is only half that of adult unemployment; by contrast, the average length of a typical job is 12 times greater for adults than teenagers. In most years, half the unemployed teenagers are "new entrants" who have never had a paying job before. All these factors suggest that teenage unemployment is largely frictional; that is, it represents the job search and turnover necessary for young people to discover their personal skills and to learn what working is all about.

But teenagers do eventually learn the skills and work habits of experienced workers. The acquisition of experience and training, along with a greater desire and need for full-time work, is the reason middle-aged workers have much lower unemployment rates than teenagers.

Teenage Unemployment of Minority Groups. While most evidence suggests that unemployment is largely frictional for white teenagers, the labor market for young African-American workers has behaved quite differently. For the first decade after World War II, the labor-force participation rates and unemployment rates of black and white teenagers were virtually identical. After that time, however, unemployment rates for black teenagers rose sharply relative to those of other groups while their labor-force participation rates have fallen. By 2008, only 20 percent of black teenagers (16 to 19 years of age) were employed, compared to 35 percent of white teenagers.

What accounts for this extraordinary divergence in the experience of minority teenagers from that of other groups? One explanation might be that labor market forces (such as the composition or location of jobs) have worked against black workers in general. This explanation does not tell the whole story. While adult black workers have always suffered higher unemployment rates than adult white workers—because of lower education attainment, fewer contacts with people who can provide jobs, less on-the-job training, and racial discrimination—the ratio of black to white adult unemployment rates has not increased since World War II.

Eye Therapies Exhibit 2127, 625 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

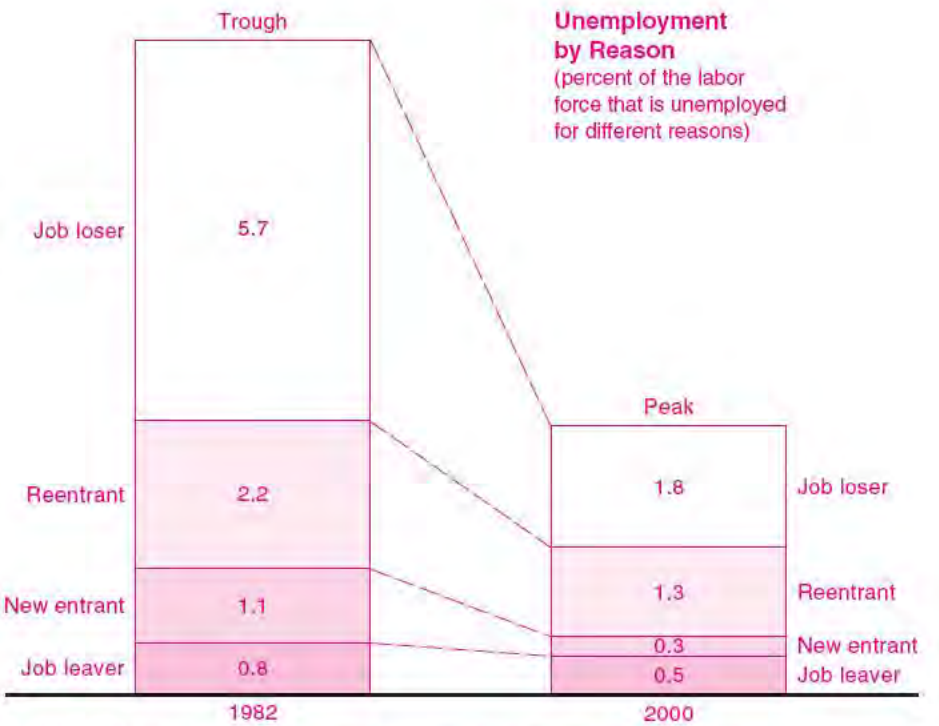


FIGURE 29-9. Distribution of Unemployment by Reason, 1982 and 2000

Why do people become unemployed? Very few were unemployed in the full-employment year of 2000 because they left their jobs, and almost 2 percent were new entrants into the labor force (say, because they just graduated from college) or reentrants (people who earlier left the labor force and are back looking for a job). The major change in unemployment from peak to trough, however, is found in the number of job losers. From 1982 to 2000 the fraction of workers who became unemployed because they lost their jobs fell from 5.7 to 1.8 percent.

Source: Bureau of Labor Statistics, at *www.bls.gov/data*.

Numerous studies of the sources of the rising black teenage unemployment rate have turned up no clear explanations for the trend. One possible source is discrimination, but a rise in the black-white unemployment differential would require an increase in racial discrimination—even in the face of increased legal protection for minority workers. Another theory holds that a high minimum wage along with rising costs of fringe benefits tends to drive low-productivity black teenagers into unemployment.

Does high teenage unemployment lead to long-lasting labor market damage, with permanently lower levels of skills and wage rates? This question is a topic of intensive ongoing research, and the tentative answer is yes, particularly for minority teenagers. It appears that when youths are unable to develop on-the-job skills and work attitudes, they earn lower wages and experience higher unemployment when they are older. This finding suggests that public policy has an important stake in devising programs to reduce teenage unemployment among minority groups.



Unemployment Trends in America and Europe

Unemployment rates in the United States and Europe show different trends in recent years. European unemployment was low until the supply shocks of the 1970s and has been relatively high since that time. American unemployment rates were generally lower than those in

Eye Therapies Exhibit 2127, 626 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

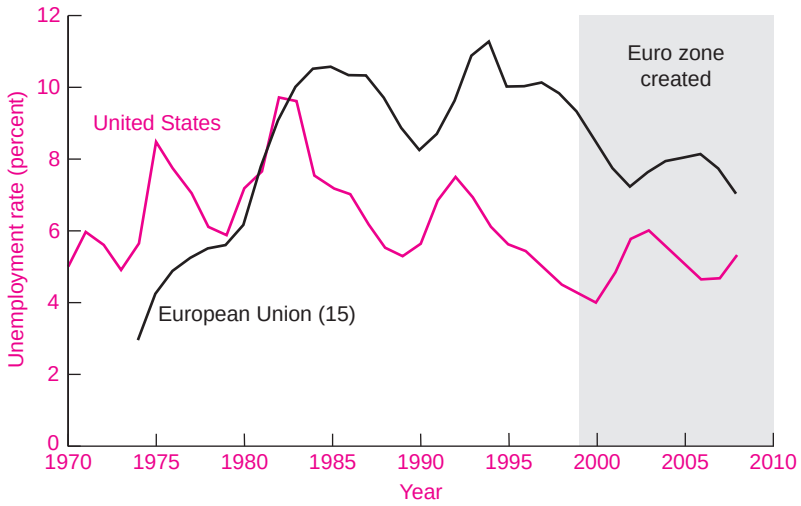


FIGURE 29-10. Unemployment in the United States and Europe

While unemployment has remained low in the United States, European unemployment has risen sharply over the last two decades. Many believe that the rising unemployment was due to labor market rigidities, while others think a fragmented monetary policy was to blame. With the introduction of the Euro and the integrated European Central Bank in 1999, European unemployment has declined gradually.

Source: U.S. Department of Labor, the OECD, and Eurostat. Data are for the EU 15 countries.

Europe over the last quarter-century. Figure 29-10 shows the unemployment-rate history for the two regions.

How can we explain the divergent labor markets of these two regions? Part of the reason probably lies in differences in macroeconomic policies. The United States has for almost a century had a single central bank, the Federal Reserve, which keeps careful watch over the American economy. When unemployment begins to rise, the Fed lowers interest rates to stimulate aggregate demand, increase output, and stem the unemployment increase.

Central banking in Europe was fragmented until very recently. Until 1999, Europe was a confederation of countries whose monetary policies were dominated by the German central bank, the Bundesbank. The Bundesbank was fiercely independent and aimed primarily at maintaining price stability *in Germany*. When unemployment rose in the rest of Europe and inflation rose in Germany—as happened after the reunification of Germany in 1990—the Bundesbank increased interest rates. This tended to depress output and raise unemployment in countries whose monetary policies were tied to Germany's. You can see this syndrome in the rise in unemployment in Europe after 1990.

A second feature of European unemployment relates to rising structural unemployment. Europe was the birthplace of the welfare state; countries like Germany, France, and Sweden legislated generous welfare benefits, unemployment insurance, minimum wages, and job protection for workers. These policies tend to increase real wages because workers possess greater bargaining power and have more attractive alternative uses for their time. Persons who are collecting welfare or unemployment benefits might be voluntarily unemployed, but they are generally counted as unemployed in the actual statistics. The United States has been less generous in its unemployment and welfare benefits.

What is the remedy for the high level of unemployment in Europe? Some economists emphasize reducing labor market barriers and welfare benefits. Other economists believe that the new European Central Bank may maintain a better balance of aggregate supply and demand in that region. (Recall our discussion of the European Monetary Union in Chapter 28.) It does appear that European unemployment has declined since the introduction of the Euro in 1999, although it is still above that in the United States.

Eye Therapies Exhibit 2127, 627 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



SUMMARY

A. The Foundations of Aggregate Supply

1. Aggregate supply describes the relationship between the output that businesses willingly produce and the overall price level, other things being constant. The factors underlying aggregate supply are (*a*) potential output, determined by the inputs of labor, capital, and natural resources available to an economy, along with the technology or efficiency with which these inputs are used, and (*b*) input costs, such as wages and oil prices. Changes in these underlying factors will shift the *AS* curve.
2. A central distinction in *AS* analysis is between the long run and the short run. The short run, corresponding to the behavior in business cycles of a few months to a few years, involves the short-run aggregate supply schedule. In the short run, prices and wages have elements of inflexibility. As a result, higher prices are associated with increases in the production of goods and services. This is shown as an upward-sloping *AS* curve. The short-run *AS* and *AD* analyses are used in Keynesian analysis of the business cycle.
3. The long run refers to periods associated with economic growth, after most of the elements of business cycles have damped out. In the long run, prices and wages are perfectly flexible; output is determined by potential output and is independent of the price level. The long-run aggregate supply schedule is *vertical*. The long-run *AS* and *AD* analyses are used in the classical analysis of economic growth.

B. Unemployment

4. The government gathers monthly statistics on unemployment, employment, and the labor force in a sample survey of the population. People with jobs are categorized as employed; people without jobs who are looking for work are said to be unemployed; people without jobs who are not looking for work are considered outside the labor force.
5. There is a clear connection between movements in output and the unemployment rate over the business cycle. According to Okun's Law, for every 2 percent that actual GDP declines relative to potential GDP, the unemployment rate rises 1 percentage point. This rule is useful in translating cyclical movements of GDP into their effects on unemployment.
6. Economists distinguish between equilibrium and disequilibrium unemployment. Equilibrium unemployment arises when people become unemployed voluntarily as they move from job to job or into and out of the labor force. This is also called frictional unemployment.
7. Disequilibrium unemployment occurs when the labor market or the macroeconomy is not functioning properly and some qualified people who are willing to work at the going wage cannot find jobs. Two examples of disequilibrium are structural and cyclical unemployment. Structural unemployment arises for workers who are in regions or industries that are in a persistent slump because of labor market imbalances or high real wages. Cyclical unemployment is a situation where workers are laid off when the overall economy suffers a downturn.
8. Understanding the causes of unemployment has proved to be one of the major challenges of modern macroeconomics. The discussion here emphasizes that involuntary unemployment arises because the slow adjustment of wages produces surpluses (unemployment) and shortages (vacancies) in individual labor markets. If inflexible wages are above market-clearing levels, some workers are employed but other equally qualified workers cannot find jobs.
9. Wages are inflexible because of the costs involved in administering the compensation system. Frequent changes of compensation for market conditions would command too large a share of management time, would upset workers' perceptions of fairness, and would undermine worker morale and productivity.
10. A careful look at the unemployment statistics reveals several regularities:
    a. Recessions hit all segments of the labor force, from the unskilled to the most skilled and educated.
    b. A very substantial part of U.S. unemployment is short-term. The average duration of unemployment rises sharply in deep and prolonged recessions.
    c. In most years, a substantial amount of unemployment is due to simple turnover, or frictional causes, as people enter the labor force for the first time or reenter it. Only during recessions is the pool of unemployed composed primarily of job losers.
    d. The difference in unemployment rates in Europe and the United States reflects both structural policies and the effectiveness of monetary management.

Eye Therapies Exhibit 2127, 628 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CONCEPTS FOR REVIEW

Foundations of Aggregate Supply

aggregate supply, *AS* curve
factors underlying and shifting aggregate supply
aggregate supply: role of potential output and production costs
short-run vs. long-run *AS*

Unemployment

population status:
- unemployed
- employed
- labor force
- not in labor force

unemployment rate
Okun's Law
equilibrium vs. disequilibrium unemployment
inflexible wages, unemployment, vacancies

FURTHER READING AND INTERNET WEBSITES

Further Reading

The quotations in the text are from Studs Terkel, *Hard Times: An Oral History of the Great Depression in America* (Pantheon, New York, 1970) for the Great Depression; Harry Maurer, *Not Working: An Oral History of the Unemployed* (Holt, New York, 1979) for the construction worker; and *Business Week*, March 23, 1992, for the corporate manager.

Websites

Analysis of employment and unemployment for the United States comes from the Bureau of Labor Statistics, at *www.bls.gov*. Statistics on unemployment in Europe and other OECD countries can be found at *www.oecd.org*. The BLS site also has an online version of *The Monthly Labor Review* at *www.bls.gov/opub/mlr/mlrhome.htm,* which is an excellent source for studies about employment, labor issues, and compensation. It contains articles on everything from "The Sandwich Generation" (*www.bls.gov/opub/mlr/2006/09/contents.htm*) to an analysis of the effect of going to war on labor market performance (*www.bls.gov/opub/mlr/2007/12/contents.htm*).

QUESTIONS FOR DISCUSSION

1. Explain carefully what is meant by the aggregate supply curve. Distinguish between movements along the curve and shifts of the curve. What might increase output by moving along the *AS* curve? What could increase output by shifting the *AS* curve?
2. Construct a table parallel to Table 29-1, illustrating events that would lead to a decrease in aggregate supply. (Be imaginative rather than simply using the same examples.)
3. What, if anything, would be the effect of each of the following on the *AS* curve in both the short run and the long run, other things being constant?
   a. Potential output increases by 25 percent.
   b. Oil prices double because of rising demand from China and India with a fixed supply of oil.
   c. Consumers become pessimistic and increase their saving rate.
4. Assume that the unemployment rate is 7 percent and GDP is $4000 billion. What is a rough estimate of potential GDP if the NAIRU is 5 percent? Assume that potential GDP is growing at 3 percent annually. What will potential GDP be in 2 years? How fast will GDP have to grow to reach potential GDP in 2 years?
5. What is the labor-force status of each of the following?
   a. A teenager who sends out résumés in searching for a first job
   b. An autoworker who has been laid off and would like to work but has given up hope of finding work or being recalled
   c. A retired person who moved to Florida and answers advertisements for part-time positions
   d. A parent who works part-time, wants a full-time job, but doesn't have time to look
   e. A teacher who has a job but is too ill to work

Eye Therapies Exhibit 2127, 629 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

6. In explaining its procedures, the Department of Labor gives the following examples:
   a. "Joan Howard told the interviewer that she has filed applications with three companies for summer jobs. However, it is only April and she doesn't wish to start work until at least June 15, because she is attending school. Although she has taken specific steps to find a job, Joan is classified as not in the labor force because she is not currently available for work."
   b. "James Kelly and Elyse Martin attend Jefferson High School. James works after school at the North Star Café, and Elyse is seeking a part-time job at the same establishment (also after school). James' job takes precedence over his non-labor force activity of going to school, as does Elyse's search for work; therefore, James is counted as employed and Elyse is counted as unemployed."

   Explain each of these examples. Take a survey of your classmates. Using the examples above, have people classify themselves in terms of their labor-force status as employed, unemployed, or not in the labor force.
7. Assume that Congress is considering a law that would set the minimum wage above the market-clearing wage for teenagers but below that for adult workers. Using supply-and-demand diagrams, show the impact of the minimum wage on the employment, unemployment, and incomes of both sets of workers. Is any unemployment voluntary or involuntary? What would you recommend to Congress if you were called to testify about the wisdom of this measure?
8. Do you think that the economic costs and personal stress of a teenager unemployed for 1 month of the summer might be less or more than those of a head-of-household unemployed for 1 year? Do you think that this suggests that public policy should have a different stance with respect to these two groups?

Eye Therapies Exhibit 2127, 630 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

30

Inflation



Lenin is said to have declared that the best way to destroy the capitalist system was to debauch the currency. By a continuing process of inflation, governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens.

J. M. Keynes

For most of the last quarter-century, the United States succeeded in maintaining low and stable inflation. This experience was primarily due to the success of monetary and fiscal policies in keeping output in a narrow corridor between inflationary excesses and sharp downturns, but favorable experience with commodity prices as well as moderation of wage increases helped reinforce the policies.

One new factor in the inflation equation was the growing "globalization" of production. As the United States became more integrated in world markets, domestic firms found that their prices were constrained by the prices of their international competitors.

Even when sales of clothing and electronic goods were booming, domestic companies could not raise their prices too much for fear of losing market share to foreign producers.

The 2000s were a turbulent period for prices. In the first part of the decade, inflation awoke from its long slumber. Particularly under the impetus of rising oil and food prices, prices rose rapidly. Then a steep recession starting in 2007 caused commodity prices to drop sharply, and countries were faced with the peril of deflation.

What are the macroeconomic dynamics of inflation? Why does deflation pose such a challenge for policy makers? The present chapter will examine the meaning and determinants of inflation and describe the important public-policy issues that arise in this area.

A. DEFINITION AND IMPACT OF INFLATION

WHAT IS INFLATION?

We described the major price indexes and defined inflation in Chapter 20, but it will be useful to reiterate the basic definitions here:

Inflation occurs when the general level of prices is rising. Today, we calculate inflation by using price indexes—weighted averages of the prices of thousands of individual products. The consumer price index (CPI) measures the cost of a market basket of consumer goods and services relative to the cost of that bundle during a particular base year. The GDP deflator is the price of all of the different components of GDP.

Eye Therapies Exhibit 2127, 631 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



FIGURE 30-1. English Price Level and Real Wage, 1264–2007 (1270 = 100)

The graph shows England's history of prices and real wages since the Middle Ages. In early years, price increases were associated with increases in the money supply, such as from discoveries of New World treasure and the printing of money during the Napoleonic Wars. Note the meandering of the real wage prior to the Industrial Revolution. Since then, real wages have risen sharply and steadily.

Source: E. H. Phelps Brown and S. V. Hopkins, *Economica,* 1956, updated by the authors.

The rate of inflation is the percentage change in the price level:

$$\text{Rate of inflation in year } t = 100 \times \frac{P_t - P_{t-1}}{P_{t-1}}$$

If you are unclear on the definitions, refresh your memory by reviewing Chapter 20.

The History of Inflation

Inflation is as old as market economies. Figure 30-1 depicts the history of prices in England since the thirteenth century. Over the long haul, prices have generally risen, as the green line reveals. But examine also the blue line, which plots the path of *real wages* (the wage rate divided by consumer prices).

Eye Therapies Exhibit 2127, 632 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

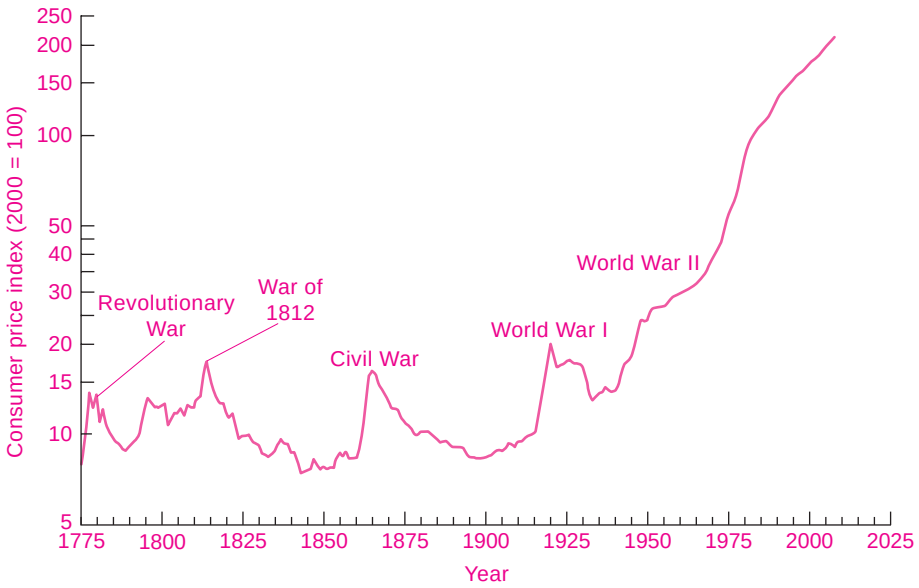


FIGURE 30-2. Consumer Prices in the United States, 1776–2008

Until World War II, prices fluctuated trendlessly—rising rapidly with each war and then drifting down afterward. But since then, the trend has been upward, both here and abroad.

Source: U.S. Department of Labor, Bureau of Labor Statistics for data since 1919.

Real wages meandered along until the Industrial Revolution. Comparing the two lines shows that inflation is not necessarily accompanied by a decline in real income. You can see, too, that real wages have climbed steadily since around 1800, rising more than tenfold.

Figure 30-2 focuses on the behavior of consumer prices in the United States since the Revolutionary War. Until World War II, the United States was generally on a combination of gold and silver standards, and the pattern of price changes was regular: Prices would soar during wartime and then fall back during the postwar slump. But the pattern changed dramatically after World War II. Prices and wages now travel on a one-way street that goes only upward. They rise rapidly in periods of economic expansion and slow down in periods of slack.

Figure 30-3 shows CPI inflation over the last half-century. You can see that inflation in recent years has moved in a narrow range, fluctuating primarily because of volatile food and energy prices.

Three Strains of Inflation

Like diseases, inflations exhibit different levels of severity. It is useful to classify them into three categories: low inflation, galloping inflation, and hyperinflation.

Low Inflation. Low inflation is characterized by prices that rise slowly and predictably. We might define this as single-digit annual inflation rates. When prices are relatively stable, *people trust money* because it retains its value from month to month and year to year. People are willing to write long-term contracts in money terms because they are confident that the relative prices of goods they buy and sell will not get too far out of line. Most countries have experienced low inflation over the last decade.

Galloping Inflation. Inflation in the double-digit or triple-digit range of 20, 100, or 200 percent per year is called **galloping inflation** or "very high inflation." Galloping inflation is relatively common, particularly in countries suffering from weak governments, war, or revolution. Many Latin American countries, such

Eye Therapies Exhibit 2127, 633 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

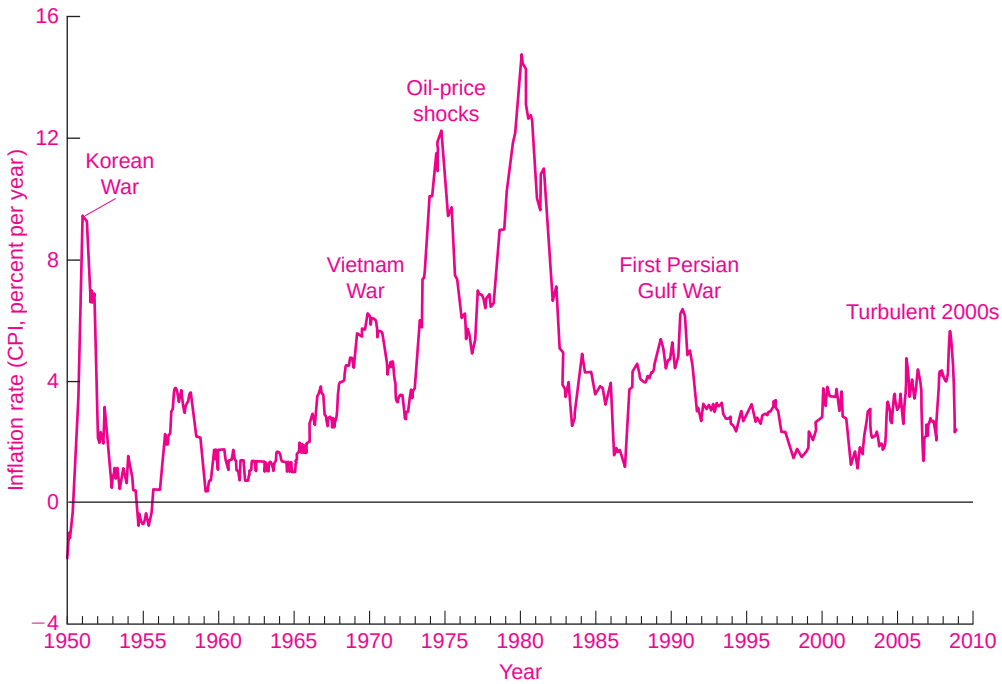


FIGURE 30-3. Inflation Has Remained Low and Stable in Recent Years

Historically, inflation in the United States was variable, and it reached unacceptably high rates in the early 1980s. In the last decade, skillful monetary management by the Federal Reserve along with favorable supply shocks has kept inflation low and in a narrow range.

Source: Bureau of Labor Statistics, *www.bls.gov*. This graph shows inflation of the consumer price index. The graph shows the rate of inflation over the prior 12 months.

as Argentina, Chile, and Brazil, had inflation rates of 50 to 700 percent per year in the 1970s and 1980s.

Once galloping inflation becomes entrenched, serious economic distortions arise. Generally, most contracts get indexed to a price index or to a foreign currency like the dollar. In these conditions, money loses its value very quickly, so people hold only the bare-minimum amount of money needed for daily transactions. Financial markets wither away, as capital flees abroad. People hoard goods, buy houses, and never, ever lend money at low nominal interest rates.

Hyperinflation. While economies seem to survive under galloping inflation, a third and deadly strain takes hold when the cancer of **hyperinflation** strikes. Nothing good can be said about an economy in which prices are rising a million or even a trillion percent per year.

Hyperinflations are particularly interesting to students of inflation because they highlight its disastrous impacts. Consider this description of hyperinflation in the Confederacy during the Civil War:

> We used to go to the stores with money in our pockets and come back with food in our baskets. Now we go with money in baskets and return with food in our pockets. Everything is scarce except money! Prices are chaotic and production disorganized. A meal that used to cost the same amount as an opera ticket now costs twenty times as much. Everybody tends to hoard "things" and to try to get rid of the "bad" paper money, which drives the "good" metal money out of circulation. A partial return to barter inconvenience is the result.

The most thoroughly documented case of hyperinflation took place in the Weimar Republic of Germany in the 1920s. Figure 30-4 shows how the government unleashed the monetary printing presses,

Eye Therapies Exhibit 2127, 634 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

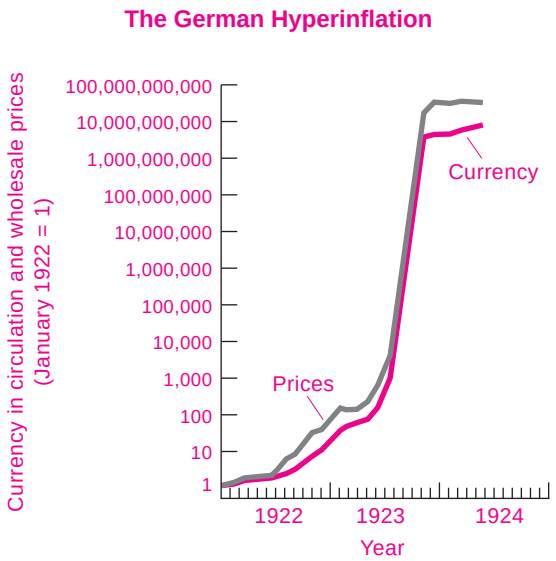


FIGURE 30-4. Money and Hyperinflation in Germany, 1922–1924

In the early 1920s, Germany could not raise enough taxes, so it used the monetary printing press to pay the government's bills. The stock of currency rose astronomically from January 1922 to December 1923, and prices spiraled upward as people frantically tried to spend their money before it lost all value.

driving both money and prices to astronomical levels. From January 1922 to November 1923, the price index rose from 1 to 10,000,000,000. If a person had owned 300 million marks worth of German bonds in early 1922, this amount would not have bought a piece of candy 2 years later.

Studies have found several common features in hyperinflations. First, the real money stock (measured by the money stock divided by the price level) falls drastically. By the end of the German hyperinflation, real money demand was only one-thirtieth of its level 2 years earlier. People were seen running from store to store, dumping their money like hot potatoes before they get burned by money's loss of value. Second, relative prices become highly unstable. Under normal conditions, a person's real wages move only a percent or less from month to month. During 1923, German real wages changed on average one-third (up or down) each month. This huge variation in relative prices and real wages—and the inequities and distortions caused by these fluctuations—took an enormous toll on workers and businesses, highlighting one of the major costs of inflation.

The impact of inflation was eloquently expressed by J. M. Keynes:

> As inflation proceeds and the real value of the currency fluctuates wildly from month to month, all permanent relations between debtors and creditors, which form the ultimate foundation of capitalism, become so utterly disordered as to be almost meaningless; and the process of wealth-getting degenerates into a game and a lottery.

Anticipated vs. Unanticipated Inflation

An important distinction in the analysis of inflation is whether the price increases are anticipated or unanticipated. Suppose that all prices are rising at 3 percent each year and everyone expects this trend to continue. Would there be any reason to get excited about inflation? Would it make any difference if both the actual and the expected inflation rates were 1 or 3 or 5 percent each year? Economists generally believe that anticipated inflation at low rates has little effect on economic efficiency or on the distribution of income and wealth. People would simply be adapting their behavior to a changing monetary yardstick.

But the reality is that inflation is usually unanticipated. For example, the Russian people had become accustomed to stable prices for many decades. When prices were freed from controls of central planning in 1992, no one, not even the professional economists, guessed that prices would rise by 400,000 percent over the next 5 years. People who naïvely put their money into ruble savings accounts saw their net worth evaporate. Those who were more sophisticated manipulated the system, and some even became fabulously wealthy "oligarchs."

In more stable countries like the United States, the impact of unanticipated inflation is less dramatic, but the same general point applies. An unexpected jump in prices will impoverish some and enrich others. How costly is this redistribution? Perhaps "cost" does not describe the problem. The effects may be more social than economic. An epidemic of burglaries may not lower GDP, but it causes great distress. Similarly, randomly redistributing wealth by inflation is like forcing people to play a lottery they would prefer to avoid.

Eye Therapies Exhibit 2127, 635 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



The Quagmire of Deflation

If inflation is so bad, should societies instead strive for *deflation*—a situation where prices are actually falling rather than rising? Historical experience and macroeconomic analysis suggest that deflation combined with low interest rates can produce serious macroeconomic difficulties.

A gentle deflation by itself is not particularly harmful. Rather, deflations generally trigger economic problems because they may lead to a situation where monetary policy becomes impotent.

Normally, if prices begin to fall because of a recession, the central bank can stimulate the economy by increasing bank reserves and lowering interest rates. But if prices are falling rapidly, then real interest rates may be relatively high. For example, if the nominal interest rate is ¼ percent and prices are falling at 3¾ percent per year, then the real interest rate is 4 percent per year. At such a high real interest rate, investment may be choked off, with recessionary consequences.

The central bank may decide to lower interest rates. *But the lower limit on nominal interest rates is zero.* Why so? Because when interest rates are zero, then bonds are essentially money, and people will hardly want to hold a bond paying negative interest when money has a zero interest rate. Now, when the central bank has lowered interest rates to zero, in our example, real interest rates would still be 3¾ percent per year, which might still be too high to stimulate the economy. The central bank is trapped in a quagmire—a quagmire called the *liquidity trap*—in which it can lower short-term interest rates no further. The central bank has run out of ammunition.

Deflation was frequently observed in the nineteenth and early twentieth centuries but largely disappeared by the late twentieth century. However, at the end of the 1990s, Japan entered a period of sustained deflation. This was in part caused by a tremendous fall in asset prices, particularly land and stocks, but also by a long recession. Short-term interest rates were essentially zero after 2000. For example, the yield on 1-year bank deposits was 0.032 percent per year in mid-2003. The Bank of Japan was helpless in the face of deflation and zero interest rates.

The United States entered liquidity-trap territory in late 2008. Short-term, risk-free dollar securities (such as 90-day Treasury bills) fell to under 1/10th of 1 percent in late 2008 and early 2009. At that point, many economists believed, the Fed had "run out of ammunition"—that is, there was no further room to lower short-run interest rates.

Are there any remedies for deflation and the liquidity trap? One solution is to use fiscal policy, as was emphasized by the new Obama administration in emphasizing a large fiscal stimulus plan in early 2009. A fiscal stimulus will increase aggregate demand, and it will do so without any crowding out from higher interest rates.

Monetary policy could also expand its range of instruments, as discussed in Chapter 24. For example, the Fed could attempt to lower long-run interest rates or to lower the risk premium on risky assets, but these steps have proven difficult to achieve. Many economists believe that the best defense against a liquidity trap is a good offense. Policy makers should ensure that the economy stays safely away from deflation and the liquidity trap by maintaining full employment, ensuring a gradually rising price level, and avoiding the asset-price booms and busts that have been experienced over the last decade.

THE ECONOMIC IMPACTS OF INFLATION

Central bankers are united in their determination to contain inflation. During periods of high inflation, opinion polls often find that inflation is economic enemy number one. What is so dangerous and costly about inflation? We noted above that during periods of inflation all prices and wages do not move at the same rate; that is, changes in *relative prices* occur. As a result of the diverging relative prices, two definite effects of inflation are:

- A *redistribution* of income and wealth among different groups
- *Distortions* in the relative prices and outputs of different goods, or sometimes in output and employment for the economy as a whole

Impacts on Income and Wealth Distribution

Inflation affects the distribution of income and wealth primarily because of differences in the assets and liabilities that people hold. When people owe money, a sharp rise in prices is a windfall gain for them. Suppose you borrow $100,000 to buy a house and your annual fixed-interest-rate mortgage payments are $10,000. Suddenly, a great inflation doubles all wages and incomes. Your *nominal* mortgage payment is still $10,000 per year, but its real cost is halved. You will need to work only half as long as before to make your mortgage payment. The great inflation has increased

Eye Therapies Exhibit 2127, 636 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

your wealth by cutting in half the real value of your mortgage debt.

If you are a lender and have assets in fixed-interest-rate mortgages or long-term bonds, the shoe is on the other foot. An unexpected rise in prices will leave you the poorer because the dollars repaid to you are worth much less than the dollars you lent.

If an inflation persists for a long time, people come to anticipate it and markets begin to adapt. An allowance for inflation will gradually be built into the market interest rate. Say the economy starts out with interest rates of 3 percent and stable prices. Once people expect prices to rise at 9 percent per year, bonds and mortgages will tend to pay 12 percent rather than 3 percent. The 12 percent nominal interest rate reflects a 3 percent real interest rate plus a 9 percent inflation premium. There are no further major redistributions of income and wealth once interest rates have adapted to the new inflation rate. The adjustment of interest rates to chronic inflation has been observed in all countries with a long history of rising prices.

Because of institutional changes, some old myths no longer apply. It used to be thought that common stocks were a good inflation hedge, but stocks generally move inversely with inflation today. A common saying was that inflation hurts widows and orphans; today, they are insulated from inflation because social security benefits are indexed to consumer prices. Also, unanticipated inflation benefits debtors and hurts lenders less than before because many kinds of debt (like "floating-rate" mortgages) have interest rates that move up and down with market interest rates.

The major redistributive impact of inflation comes through its effect on the real value of people's wealth. In general, unanticipated inflation redistributes wealth from creditors to debtors, helping borrowers and hurting lenders. An unanticipated deflation has the opposite effect. But inflation mostly churns incomes and assets, randomly redistributing wealth among the population with little significant impact on any single group.

Impacts on Economic Efficiency

In addition to redistributing incomes, inflation affects the real economy in two specific areas: It can harm economic efficiency, and it can affect total output. We begin with the efficiency impacts.

Inflation impairs economic efficiency because it *distorts prices and price signals.* In a low-inflation economy, if the market price of a good rises, both buyers and sellers know that there has been an actual change in the supply and/or demand conditions for that good, and they can react appropriately. For example, if the neighborhood supermarkets all boost their beef prices by 50 percent, perceptive consumers know that it's time to start eating more chicken. Similarly, if the prices of new computers fall by 90 percent, you may decide it's time to turn in your old model.

By contrast, in a high-inflation economy it's much harder to distinguish between changes in relative prices and changes in the overall price level. If inflation is running at 20 or 30 percent per month, price changes are so frequent that changes in relative prices get missed in the confusion.

Inflation also *distorts the use of money.* Currency is money that bears a zero nominal interest rate. If the inflation rate rises from 0 to 10 percent per year, the real interest rate on currency falls from 0 to −10 percent per year. There is no way to correct this distortion.

As a result of the negative real interest rate on money, people devote real resources to reducing their money holdings during inflationary times. They go to the bank more often—using up "shoe leather" and valuable time. Corporations set up elaborate cash-management schemes. Real resources are thereby consumed simply to adapt to a changing monetary yardstick rather than to make productive investments.

Economists point to the *distortionary effect of inflation on taxes.* Part of the tax code is written in dollar terms. When prices rise, the real value of the taxes paid rises even though real incomes have not changed. For example, suppose you were taxed at a rate of 30 percent on your income. Further suppose that the nominal interest rate was 6 percent and the inflation rate was 3 percent. You would, in reality, be paying a 60 percent tax rate on the real interest earnings of 3 percent. Many similar distortions are present in the tax code today.

But these are not the only costs; some economists point to *menu costs* of inflation. The idea is that when prices are changed, firms must spend real resources adjusting their prices. For instance, restaurants reprint their menus, mail-order firms reprint their catalogs, taxi companies remeter their cabs, cities adjust parking meters, and stores change the price tags of goods. Sometimes, the costs are intangible, such as those involved in gathering people to make new pricing decisions.

Eye Therapies Exhibit 2127, 637 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Macroeconomic Impacts

What are the macroeconomic effects of inflation? This question is addressed in the next section, so we merely highlight the major points here. Until the 1970s, high inflation in the United States usually went hand in hand with economic expansions; inflation tended to increase when investment was brisk and jobs were plentiful. Periods of deflation or declining inflation—the 1890s, the 1930s, some of the 1950s—were times of high unemployment of labor and capital.

But a more careful examination of the historical record reveals an interesting fact: The positive association between output and inflation appears to be only a temporary relationship. Over the longer run, there seems to be an inverse-U-shaped relationship between inflation and output growth. Table 30-1 shows the results of a multicountry study of the association between inflation and growth. It indicates that economic growth is strongest in countries with low inflation, while countries with high inflation or deflation tend to grow more slowly. (But beware the *ex post* fallacy here, as explored in question 7 at the end of this chapter.)

What Is the Optimal Rate of Inflation?

Most nations seek rapid economic growth, full employment, and price stability. But just what is meant by "price stability"? Exactly zero inflation? Over what period? Or is it perhaps low inflation?

One school of thought holds that policy should aim for absolutely stable prices or zero inflation. If we are confident that the price level in 20 years will be very close to the price level today, we can make better long-term investment and saving decisions.

Many macroeconomists believe that, while a zero-inflation target might be sensible in an ideal economy, we do not live in a frictionless system. One friction arises from the resistance of workers to declines in money wages. When inflation is literally zero, efficient labor markets would require that the money wages in some sectors are reduced while wages in other sectors are increased. Yet workers and firms are extremely reluctant to cut money wages. Some economists believe that, in the context of downward rigidity of nominal wages, a zero rate of inflation would lead to higher unemployment on average.

An additional and more serious concern about zero inflation is that economies might find themselves in the liquidity trap discussed above. If a country in a zero-inflation situation were to encounter a major contractionary shock, it might need negative real interest rates to climb out of the recession with monetary policy. While fiscal policy would still be effective, most macroeconomists believe that a better solution is to aim for a positive inflation rate so that the threat of liquidity traps is minimized.

We can summarize our discussion in the following way:

Most economists agree that a predictable and gently rising price level provides the best climate for healthy economic growth. A careful analysis of the evidence suggests that low inflation has little impact on productivity or real output. By contrast, galloping inflation or hyperinflation can harm productivity and redistribute income and wealth in an arbitrary fashion. A gradual rise in prices will help avoid the deadly liquidity trap.

Inflation rate (% per year)	Growth of per capita GDP (% per year)
−20–0	0.7
0–10	2.4
10–20	1.8
20–40	0.4
100–200	−1.7
1,000+	−6.5

TABLE 30-1. Inflation and Economic Growth

The pooled experience of 127 countries shows that the most rapid growth is associated with low inflation rates. Deflation and moderate inflation accompany slow growth, while hyperinflations are associated with sharp downturns.

Source: Michael Bruno and William Easterly, "Inflation Crises and Long-Run Growth," *Journal of Monetary Economics,* 1998.

B. MODERN INFLATION THEORY

What are the economic forces that cause inflation? What is the relationship between unemployment and inflation in the short run and in the long run? How

Eye Therapies Exhibit 2127, 638 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

can nations reduce an unacceptably high inflation rate? What is the role of inflation targeting in central-bank policies?

Questions, questions, questions. Yet answers to these are critical to the economic health of modern mixed economies. In the balance of this chapter we explore modern inflation theory and analyze the costs of lowering inflation.

PRICES IN THE *AS-AD* FRAMEWORK

There is no single source of inflation. Like illnesses, inflations occur for many reasons. Some inflations come from the demand side; others, from the supply side. But one key fact about modern inflations is that they develop an internal momentum and are costly to stop once underway.

Expected Inflation

In modern economies like that of the United States, inflation has great momentum and tends to persist at the same rate. Expected inflation is like a lazy old dog. If the dog is not "shocked" by the push of a foot or the pull of a cat, it will stay put. Once disturbed, the dog may chase the cat, but then it eventually lies down in a new spot where it stays until the next shock.

Over the last three decades, prices in the United States rose on average around 3 percent annually, and most people came to expect this rate of inflation. This expected rate was built into the economy's institutions: wage agreements between labor and management were designed around a 3 percent inflation rate; government monetary and fiscal plans assumed a 3 percent rate as well. During this period, the *expected rate of inflation* was 3 percent per year.

Another closely related concept is the *core rate of inflation,* which is a term often used in monetary policy. This is the inflation rate without volatile elements such as food and energy prices.

While inflation can persist at the same rate for a while, history shows that shocks to the economy tend to push inflation up or down. The economy is constantly subject to changes in aggregate demand, sharp oil- and commodity-price changes, poor harvests, movements in the foreign exchange rate, productivity changes, and countless other economic events that push inflation away from its expected rate.

Inflation has a high degree of inertia in a modern economy. People form an **expected rate of inflation,** and that rate is built into labor contracts and other agreements. The expected rate of inflation tends to persist until a shock causes it to move up or down.

Demand-Pull Inflation

One of the major shocks to inflation is a change in aggregate demand. In earlier chapters we saw that changes in investment, government spending, or net exports can change aggregate demand and propel output beyond its potential. We also saw how a nation's central bank can affect economic activity. Whatever the reason, **demand-pull inflation** occurs when aggregate demand rises more rapidly than the economy's productive potential, pulling prices up to equilibrate aggregate supply and demand. In effect, demand dollars are competing for the limited supply of commodities and bid up their prices. As unemployment falls and workers become scarce, wages are bid up and the inflationary process accelerates.

A particularly damaging form of demand-pull inflation occurs when governments engage in deficit spending and rely on the monetary printing press to finance their deficits. The large deficits and the rapid money growth increase aggregate demand, which in turn increases the price level. Thus, when the German government financed its spending in 1922–1923 by printing billions and billions of paper marks, which came into the marketplace in search of bread and fuel, it was no wonder that the German price level rose a billionfold. This was demand-pull inflation with a vengeance. This scene was replayed in the early 1990s when the Russian government financed its budget deficit by printing monetary rubles. The result was an inflation rate that averaged 25 percent *per month,* or 1355 percent per year. (Make sure you understand how 25 percent per month becomes 1355 percent per year.)

Figure 30-5 illustrates the process of demand-pull inflation in terms of aggregate supply and demand. Starting from an initial equilibrium at point *E,* suppose there is an expansion of spending that pushes the *AD* curve up and to the right. The economy's equilibrium moves from E to E'. At this higher level of demand, prices have risen from P to P'. Demand-pull inflation has taken place.

Eye Therapies Exhibit 2127, 639 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

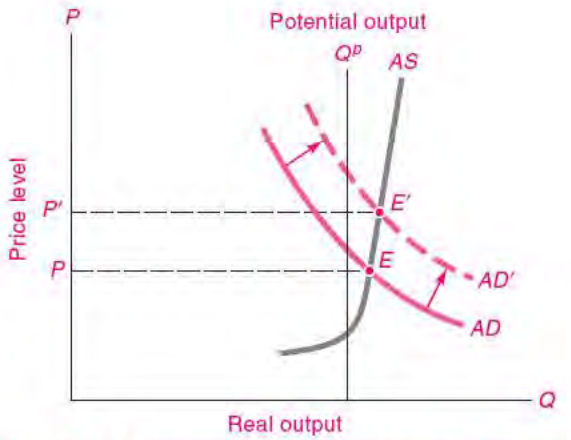


FIGURE 30-5. Demand-Pull Inflation Occurs When Too Much Spending Chases Too Few Goods

When aggregate demand increases, the rising spending is competing for limited goods. Prices rise from P to P' in demand-pull inflation.

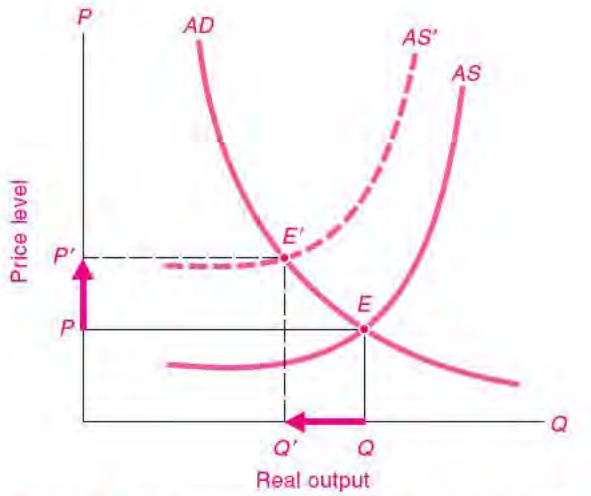


FIGURE 30-6. Increases in Production Costs Can Cause Stagflation, with Falling Output and Rising Prices

In periods marked by rapid increases in production costs, such as with the oil-price shocks, countries can experience the dilemma of rising inflation along with falling output, the combination of which is called stagflation. Policies to affect aggregate demand can cure one problem or the other but not both simultaneously.

Cost-Push Inflation and "Stagflation"

The classical economists understood the rudiments of demand-pull inflation and used that theory to explain historical price movements. But a new phenomenon has emerged over the last half-century. We see today that inflation sometimes increases because of increases in costs rather than because of increases in demand. This phenomenon is known as *cost-push* or *supply-shock* inflation. Often, it leads to an economic slowdown and to a syndrome called "stagflation," or *stag*nation with in*flation*.

Figure 30-6 shows the workings of supply-shock inflation. In 1973, 1978, 1999, and again in the late 2000s, countries were minding their macroeconomic business when severe shortages occurred in oil markets. Oil prices rose sharply, business costs of production increased, and a sharp burst of cost-push inflation followed. These situations can be seen as an upward shift in the *AS* curve. Equilibrium output falls while prices and inflation rise.

Stagflation poses a major dilemma for policymakers. They can use monetary and fiscal policies to change aggregate demand. However, *AD* shifts cannot simultaneously increase output *and* lower prices and inflation. An outward shift of the *AD* curve in Figure 30-6 through monetary expansion would offset the decline in output but raise prices further. Or an attempt to curb inflation by tightening monetary policy would only lower output even further. Economists explain this situation by saying that policymakers have two targets or goals (low inflation and low unemployment) but only one instrument (aggregate demand).

Such a dilemma is often faced by monetary policy makers. When inflation and unemployment are rising at the same time, what stance should the Federal Reserve or the European Central Bank take? Should it tighten money to reduce inflation? Or focus primarily on reducing unemployment? Or make some compromise between the two? Economics can provide no definitive answer to this dilemma. The response will depend upon society's values as well as the mandates imposed by the national legislatures (such as inflation targeting for the ECB versus a dual mandate for the Fed).

Inflation resulting from rising costs during periods of high unemployment and slack resource utilization is called **supply-shock inflation.** It can lead to the policy dilemma of stagflation when output declines at the same time as inflation is rising.

Eye Therapies Exhibit 2127, 640 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Expectations and Inflation

Why, you might ask, does inflation have such strong momentum? The answer is that most prices and wages are set with an eye to future economic conditions. When prices and wages are rising rapidly and are expected to continue doing so, businesses and workers tend to build the rapid rate of inflation into their price and wage decisions. High or low inflation expectations tend to be self-fulfilling prophecies.

We can use a hypothetical example to illustrate the role of expectations in the inflation process. Say that in 2009, Brass Mills Inc., a nonunionized light-manufacturing firm, was contemplating its annual wage and salary decisions for 2010. Its sales were growing as well. Brass Mills' chief economist reported that no major inflationary or deflationary shocks were foreseen, and the major forecasting services were expecting national wage growth of 4 percent in 2010. Brass Mills had conducted a survey of local companies and found that most employers were planning on increases in compensation of 3 to 5 percent during the next year. All the signals, then, pointed to wage increases of around 4 percent from 2009 to 2010.

In examining its own internal labor market, Brass Mills determined that its wages were in line with the local labor market. Because the managers did not want to fall behind local wages, Brass Mills decided that it would try to match local wage increases. It therefore set wage increases at the expected market increase, an average 4 percent wage increase for 2010.

The process of setting wages and salaries with an eye to expected future economic conditions can be extended to virtually all employers. This kind of reasoning also applies to many product prices—such as college tuitions, automobile prices, and long-distance telephone rates—that cannot be easily changed after they have been set. Because of the length of time involved in modifying inflation expectations and in adjusting most wages and many prices, expected inflation will change only if there are major shocks or changes in economic policy.

Figure 30-7 illustrates the process of expected inflation. Suppose that potential output is constant and that there are no supply or demand shocks. If everyone expects average costs and prices to rise at 3 percent each year, the *AS* curve will shift upward at 3 percent per year. If there are no demand shocks, the *AD* curve will also shift up at that rate. The intersection of the *AD* and *AS* curves will come at a price that is 3 percent higher each year. Hence, the macroeconomic equilibrium moves from E to E' to E''. Prices are rising 3 percent from one year to the next; expected inflation has set in at 3 percent.

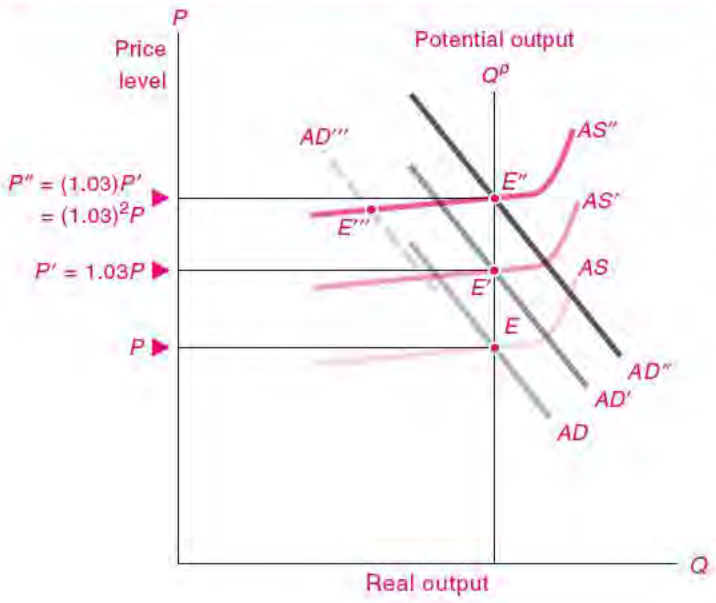


FIGURE 30-7. An Upward Spiral of Prices and Wages Occurs When Aggregate Supply and Demand Shift Up Together

Suppose that production costs and *AD* rise by 3 percent each year. *AS* and *AD* curves would shift up 3 percent each year. As the equilibrium moves from E to E' to E'', prices march up steadily because of expected inflation.

Eye Therapies Exhibit 2127, 641 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Steady inflation occurs when the *AS* and *AD* curves are moving steadily upward at the same rate.

Price Levels vs. Inflation

Using Figure 30-7, we can make the useful distinction between movements in the price level and movements in inflation. In general, an increase in aggregate demand will raise prices, other things being equal. Similarly, an upward shift in the *AS* curve resulting from an increase in wages and other costs will raise prices, other things being equal.

But of course other things always change; in particular, *AD* and *AS* curves never sit still. Figure 30-7 shows, for example, the *AS* and *AD* curves marching up together.

What if there were an unexpected shift in the *AS* or *AD* curve during the third period? How would prices and inflation be affected? Suppose, for example, that the third period's *AD″* curve shifted to the left to *AD‴* because of a monetary contraction. This might cause a recession, with a new equilibrium at *E‴* on the *AS″* curve. At this point, output would have fallen below potential; prices and the inflation rate would be lower than at *E″*, but the economy would still be experiencing inflation because the price level at *E‴* is still above the previous period's equilibrium *E′* with price *P′*.

This example is a reminder that supply or demand shocks may reduce the price level below the level it would otherwise have attained. Nonetheless, because of inflation's momentum, the economy may continue to experience inflation.

THE PHILLIPS CURVE

The major macroeconomic tool used to understand inflation is the **Phillips curve.** This curve shows the relationship between the unemployment rate and inflation. The basic idea is that when output is high and unemployment is low, wages and prices tend to rise more rapidly. This occurs because workers and unions can press more strongly for wage increases when jobs are plentiful and firms can more easily raise prices when sales are brisk. The converse also holds—high unemployment tends to slow inflation.

Short-Run Phillips Curve

Macroeconomists distinguish between the short-run Phillips curve and the long-run Phillips curve. A typical

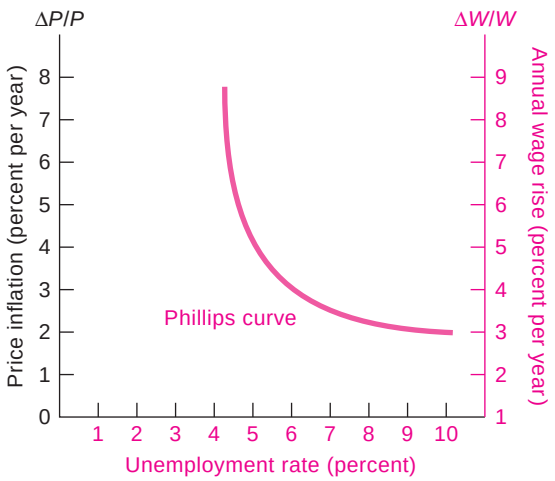


FIGURE 30-8. The Short-Run Phillips Curve Depicts the Tradeoff between Inflation and Unemployment

A short-run Phillips curve shows the inverse relationship between inflation and unemployment. The green wage-change scale on the right-hand vertical axis is higher than the blue left-hand inflation scale by the assumed 1 percent rate of growth of average labor productivity.

short-run Phillips curve is shown in Figure 30-8. On the diagram's horizontal axis is the unemployment rate. On the blue left-hand vertical scale is the annual rate of price inflation. The green right-hand vertical scale shows the rate of money-wage inflation. As you move leftward on the Phillips curve by reducing unemployment, the rate of price and wage increase indicated by the curve becomes higher.

An important piece of inflation arithmetic underlies this curve. Say that labor productivity (output per worker) rises at a steady rate of 1 percent each year. Further, assume that firms set prices on the basis of average labor costs, so prices always change just as much as average labor costs per unit of output. If wages are rising at 4 percent, and productivity is rising at 1 percent, then average labor costs will rise at 3 percent. Consequently, prices will also rise at 3 percent.

Using this inflation arithmetic, we can see the relation between wage and price increases in Figure 30-8. The two scales in the figure differ only by the assumed rate of productivity growth (so the price change of 4 percent per year would correspond to a wage change of 5 percent per year

Eye Therapies Exhibit 2127, 642 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

if productivity grew by 1 percent per year and if prices always rose as fast as average labor costs).



The Logic of Wage-Price Arithmetic

This relationship between prices, wages, and productivity can be formalized as follows: The fact that prices are based on average labor costs per unit of output implies that P is always proportional to WL/Q, where P is the price level, W is the wage rate, L is labor-hours, and Q is output. Assume that average labor productivity (Q/L) is growing smoothly at 1 percent per year. Hence, if wages are growing at 4 percent annually, prices will grow at 3 percent annually (= 4 percent growth in wages − 1 percent growth in productivity). More generally,

$$\text{Rate of inflation} = \text{rate of wage growth} - \text{rate of productivity growth}$$

This shows the relationship between price inflation and wage inflation.

We can illustrate how closely this relationship holds with actual numbers for a high-inflation period and for a low-inflation period. The following table shows the major long-run determinants of inflation to be wage growth and productivity change. From the first to the second period, inflation rose because wage growth increased slightly while productivity fell sharply. In the third period, inflation was low because wage growth was restrained while productivity growth rebounded.

	Rate of CPI inflation (%)	Rate of wage growth (%)	Rate of productivity growth (%)
1958–1973	2.9	5.4	3.1
1973–1995	5.6	5.9	1.5
1995–2007	2.6	4.3	2.6

Source: Bureau of Labor Statistics data on the business sector, at *www.bls.gov*.

The Nonaccelerating Inflation Rate of Unemployment

Economists who looked carefully at inflationary periods noticed that the simple two-variable Phillips curve drawn in Figure 30-8 was unstable. On the basis of theoretical work of Edmund Phelps and Milton Friedman, along with statistical tests of the actual history, macroeconomists developed the modern theory of inflation, which distinguishes between the long run and the short run. The downward-sloping Phillips curve of Figure 30-8 holds only in the short run. In the long run, the Phillips curve is *vertical*, not downward-sloping. This approach implies that in the long-run there is a minimum unemployment rate that is consistent with steady inflation. This is the *nonaccelerating inflation rate of unemployment* or *NAIRU* (pronounced "nay-rew").[1]

The **nonaccelerating inflation rate of unemployment** (or **NAIRU**) is that unemployment rate consistent with a constant inflation rate. At the NAIRU, upward and downward forces on price and wage inflation are in balance, so there is no tendency for inflation to change. The NAIRU is the lowest unemployment rate that can be sustained without upward pressure on inflation.

The idea behind the NAIRU is that the state of the economy can be divided into three situations:

- *Excess demand.* When markets are extremely tight, with low unemployment and high utilization of capacity, then prices and wages will be subject to demand-pull inflation.
- *Excess supply.* In recessionary situations, with high unemployment and idled factories, firms tend to sell at discounts and workers push less aggressively for wage increases. Wage and price inflation tend to moderate.
- *Neutral pressures.* Sometimes the economy is operating "in neutral." The upward wage pressures from job vacancies just match the downward wage pressures from unemployment. There are no supply shocks from oil or other exogenous sources. Here, the economy is at the NAIRU, and inflation neither rises nor falls.

From Short Run to Long Run

How does the economy move from the short run to the long run? The basic idea is that when price changes are unanticipated, the short-run Phillips curve tends to shift up or down. This point is

[1] Other terms will sometimes be encountered. The original name for the NAIRU was the "natural rate of unemployment." This term is unsatisfactory because there is nothing natural about the NAIRU.

Eye Therapies Exhibit 2127, 643 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

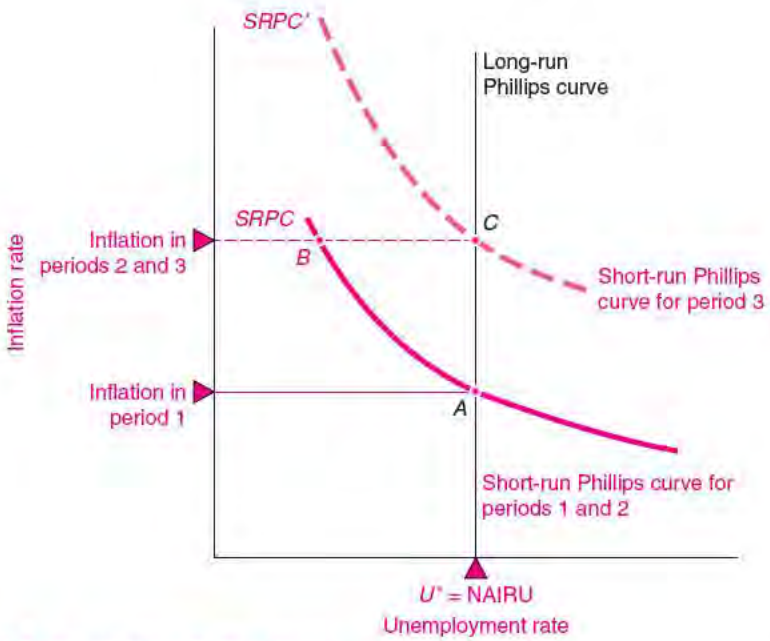


FIGURE 30-9. The Shifting Phillips Curve

This figure shows how economic expansion leads to an inflationary surprise and an upward shift in the short-run Phillips curve. The steps in the shift are explained by the bullets in the text. Note that if you connect points *A*, *B*, and *C*, the shifting curve produces a clockwise loop.

illustrated by a series of steps in a "boom cycle" here and in Figure 30-9:

- *Period 1.* In the first period, unemployment is at the NAIRU. There are no demand or supply surprises, and the economy is at point *A* on the lower short-run Phillips curve (*SRPC*) in Figure 30-9.
- *Period 2.* Next, suppose there is an economic expansion which lowers the unemployment rate. As unemployment declines, firms recruit workers more vigorously, giving larger wage increases than formerly. As output approaches capacity, price markups rise. Wages and prices begin to accelerate. In terms of our Phillips curve, the economy moves up and to the left to point *B* on its short-run Phillips curve (along *SRPC* in Figure 30-9). As shown in the figure, inflation expectations have not yet changed, so the economy stays on the original Phillips curve, on *SRPC*. The lower unemployment rate raises inflation during the second period.
- *Period 3.* Because inflation has risen, firms and workers are surprised, and they revise upward their inflationary expectations. They begin to incorporate the higher expected inflation into their wage and price decisions. The result is a *shift in the short-run Phillips curve.* We can see the new curve as *SRPC'* in Figure 30-9. The new short-run Phillips curve lies above the original Phillips curve, reflecting the higher expected rate of inflation. We have drawn the curve so that the new expected inflation rate for period 3 equals the actual inflation rate in period 2. If a slowdown in economic activity brings the unemployment rate back to the NAIRU in period 3, the economy moves to point *C*. Even though the unemployment rate is the same as it was in period 1, actual inflation will be higher, reflecting the upward shift in the short-run Phillips curve.

Note the surprising outcome. Because the expected inflation rate has increased, the rate of

Eye Therapies Exhibit 2127, 644 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

inflation is higher in period 3 than during period 1 even though the unemployment rate is the same. The economy in period 3 will have the same *real* GDP and unemployment rate as it did in period 1, even though the *nominal* magnitudes (prices and nominal GDP) are now growing more rapidly than they did before the expansion raised the expected rate of inflation.

We can also track a "recession cycle" that occurs when unemployment rises and the actual inflation rate falls below its expected rate. The expected rate of inflation declines in recessions, and the economy enjoys a lower inflation rate when it returns to the NAIRU. This painful cycle of austerity occurred during the Carter-Volcker-Reagan wars against inflation during 1979–1984.

The Vertical Long-Run Phillips Curve

When the unemployment rate departs from the NAIRU, the inflation rate will tend to change. What happens if the gap between the actual unemployment rate and the NAIRU persists? For example, say that the NAIRU is 5 percent while the actual unemployment rate is 3 percent. Because of the gap, inflation will tend to rise from year to year. Inflation might be 3 percent in the first year, 4 percent in the second year, 5 percent in the third year—and might continue to move upward thereafter. When would this upward spiral stop? It stops only when unemployment moves back to the NAIRU. Put differently, as long as unemployment is below the NAIRU, wage inflation will tend to increase.

The opposite behavior will be seen at high unemployment. In that case, inflation will tend to fall as long as unemployment is above the NAIRU.

Only when unemployment is *at* the NAIRU will inflation stabilize; only then will the shifts of supply and demand in different labor markets be in balance; only then will inflation—at whatever is its inertial rate—tend neither to increase nor to decrease.

The modern theory of inflation has important implications for economic policy. It implies that there is a minimum level of unemployment that an economy can enjoy in the long run. If the economy is pushed to very high levels of output and employment, this will ignite an upward spiral of wage and price inflation. This theory also provides a formula for curbing inflation. When the inflation rate is too high, a country can tighten money, trigger a recession, raise the unemployment rate above the NAIRU, and thereby reduce inflation.

The NAIRU defines the neutral zone between excessive tightness/rising inflation and high unemployment/falling inflation. In the short run, inflation can be reduced by raising unemployment above the NAIRU, but in the long run, the NAIRU is the lowest sustainable rate of unemployment.

Quantitative Estimates

Although the NAIRU is a crucial macroeconomic concept, precise numerical estimates of the NAIRU have proved elusive. Many macroeconomists have used advanced techniques to estimate the NAIRU. For this text, we have adopted the estimates prepared by the Congressional Budget Office (CBO). According to the CBO, the NAIRU rose gradually from the 1950s, peaked at 6.3 percent of the labor force around 1980, and declined to 4.8 percent by 2008. CBO estimates, along with the actual unemployment rate through the end of 2008, are shown in Figure 30-10.

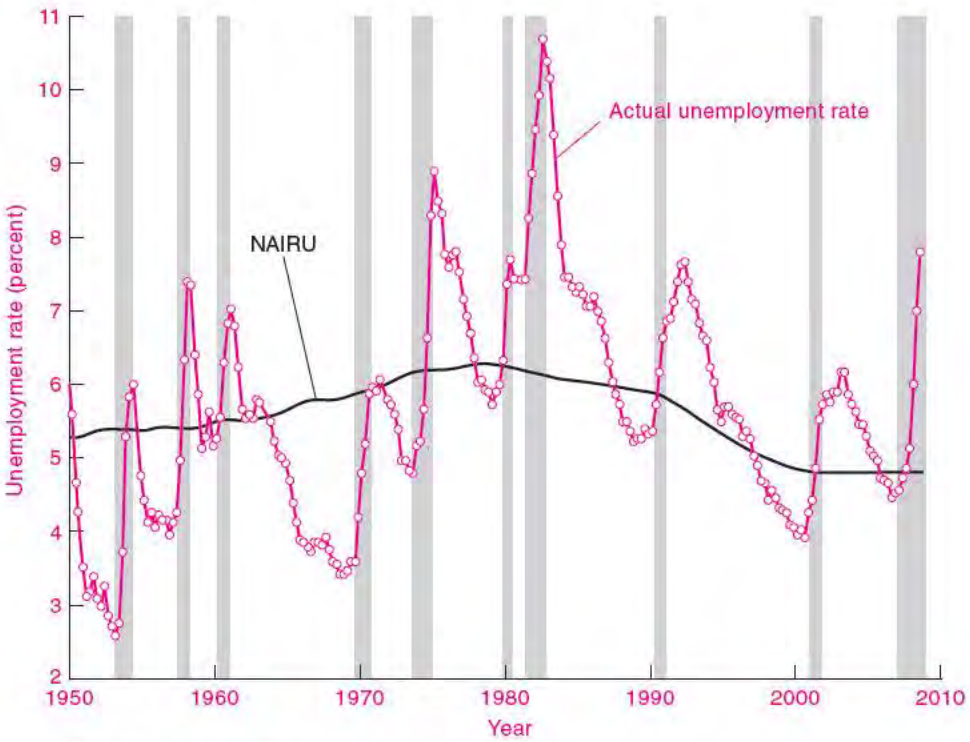
Doubts about the NAIRU

The concept of the nonaccelerating inflation rate of unemployment, along with its output twin of potential GDP, is crucial for understanding inflation and the connection between the short run and the long run in macroeconomics. But the mainstream view remains controversial.

Critics wonder whether the NAIRU is a stable and reliable concept. The inflation experience of the United States has led economists to question whether there is in fact a stable NAIRU for the country. Another question is whether an extended period of high unemployment will lead to a deterioration of job skills, to loss of on-the-job training and experience, and thereby to a higher NAIRU. Might not slow growth of real GDP reduce investment and leave the country with a diminished capital stock? Might not that capacity shortage produce rising inflation even with unemployment rates above the NAIRU?

Experience in Europe over the last two decades confirms some of these worries (recall our discussion of the European unemployment puzzle at the end of the previous chapter). In the early 1960s, labor markets in Germany, France, and Britain appeared to be in equilibrium with unemployment rates between 1 and 2 percent. By the late 1990s, after a decade of stagnation and slow job growth, labor market

Eye Therapies Exhibit 2127, 645 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563



Shaded areas are NBER recessions.

FIGURE 30-10. Actual Unemployment Rate and NAIRU for the United States

The NAIRU is the unemployment rate at which upward and downward forces acting on inflation are in balance.

Source: Actual unemployment rate from Bureau of Labor Statistics; NAIRU from estimates of the Congressional Budget Office.

equilibrium seemed to be in balance with unemployment rates in the 6 to 12 percent range. On the basis of recent European experience, many macroeconomists are looking for ways to explain the instability of the NAIRU and its dependence upon actual unemployment as well as labor market institutions.

Review

The major points to understand are the following:

- In the short run, an increase in aggregate demand which lowers the unemployment rate below the NAIRU will tend to increase the inflation rate. Recessions and high unemployment tend to lower inflation. In the short run, there is a tradeoff between inflation and unemployment.
- When inflation is higher or lower than what people expect, inflation expectations adjust. The changed inflation expectations will generally shift the short-run Phillips curve up or down.
- The long-run Phillips curve is vertical at the non-accelerating inflation rate of unemployment (NAIRU). Unemployment above (below) the NAIRU will tend to lower (increase) the rate of inflation.

C. DILEMMAS OF ANTI-INFLATION POLICY

The economy evolves in response to political forces and technological change. Our economic theories, designed to explain issues like inflation and unemployment, must also adapt. In this final section on

Eye Therapies Exhibit 2127, 646 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

inflation theory, we discuss the pressing issues that arise in combating inflation.

How Long Is the Long Run?

The NAIRU theory holds that the Phillips curve is vertical in the long run. Just how long is the long run for this purpose? The length of time that it takes the economy to adjust fully to a shock is not known with precision. Recent studies suggest that full adjustment takes at least 5 years or perhaps even a decade. The reason for the long delay is that it takes years for expectations to adjust, for labor and other long-term contracts to be renegotiated, and for all these effects to percolate through the economy.

How Much Does It Cost to Reduce Inflation?

Our analysis suggests that a nation can reduce the expected rate of inflation by temporarily reducing output and raising unemployment. But policymakers may want to know just how much it costs to squeeze inflation out of the economy. How costly is *disinflation,* which denotes the policy of lowering the rate of inflation?

Studies of this subject find that the cost of reducing inflation varies depending upon the country, the initial inflation rate, and the policy used. Analyses for the United States give a reasonably consistent answer: Lowering the expected inflation rate by 1 percentage point costs the nation about 4 percent of 1 year's GDP. In terms of the current level of GDP, this amounts to an output loss of about $600 billion (in 2008 prices) to reduce the inflation rate by 1 percentage point.

To understand the cost of disinflation, consider the Phillips curve. If the Phillips curve is relatively flat, reducing inflation will require much unemployment and loss in output; if the Phillips curve is steep, a small rise in unemployment will bring down inflation quickly and relatively painlessly. Statistical analyses indicate that when the unemployment rate rises 1 percentage point above the NAIRU for 1 year and then returns to the NAIRU, the inflation rate will decline about ½ percentage point. Therefore, to reduce inflation by 1 full percentage point, unemployment must be held 2 percentage points above the NAIRU for 1 year.

The loss associated with disinflationary policies is called the **sacrifice ratio.** More precisely, the sacrifice ratio is the cumulative loss in output, measured as a percent of 1 year's GDP, associated with a 1-percentage-point permanent reduction in inflation.



FIGURE 30-11. The Costs of Disinflation, 1979–1987

This graph shows a disinflation cycle. High interest rates led to slow economic growth and high unemployment in the early 1980s. The result was unemployment above the NAIRU and output below potential. Core inflation declined by about 5 percentage points, while cumulative output loss was about 20 percent of GDP, which leads to a sacrifice ratio of 4 percent.

We can illustrate the sacrifice ratio using the period of disinflation after 1979. The scatter plot of inflation and unemployment during this period is shown in Figure 30-11. This is an *austerity cycle* or *disinflation cycle,* which is the opposite of the boom cycle illustrated in Figure 30-9. During these years, the Federal Reserve took strong steps to reduce inflation. Tight money drove the unemployment rate up above 10 percent for 2 years, and output was below its potential for 7 years. We have shown the average NAIRU as the vertical line, which would also be the long-run Phillips curve for this period.

Tight money did reduce core inflation from around 8 to 3 percent per year during this period. The cumulative loss of output associated with this disinflation is estimated to be about 20 percent of GDP. This provides an estimate of the sacrifice ratio for this period of 4 percent [= (20 percent of GDP)/(5 percentage points of disinflation)]. In the American economy today, this implies that lowering the core inflation rate by 1 percentage point would cost about $600 billion, or around $6000 per American household.

Eye Therapies Exhibit 2127, 647 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The Phillips-curve theory illustrates how policy can reduce inflation by raising unemployment above the NAIRU for a period of time. Estimates of the cost of disinflation are typically around 4 percent of 1 year's GDP for 1 point of disinflation. This calculation shows why containing inflation is a costly policy and one not undertaken lightly.

Credibility and Inflation

One of the most important questions in anti-inflation policy concerns the role of credibility of policy. Many economists argue that the Phillips-curve approach is too pessimistic. The dissenters hold that credible and publicly announced policies—for example, adopting fixed monetary rules or targeting nominal GDP—would allow anti-inflation policies to reduce inflation with lower output and unemployment costs.

The idea relies on the fact that inflation is a process that depends on people's expectations of future inflation. A credible monetary policy—such as one that relentlessly targets a fixed, low inflation rate—might lead people to expect that inflation would be lower in the future and that this belief might in some measure be a self-fulfilling prophecy. Those emphasizing credibility backed their theories by citing fundamental policy changes, such as occurred with monetary and fiscal reforms that ended Austrian and Bolivian hyperinflations at relatively low cost in terms of unemployment or lost GDP.

Many economists were skeptical about claims that credibility would significantly lower the output costs of disinflation. While such policies might work in countries torn by hyperinflation, war, or revolution, Draconian anti-inflation policies would be less credible in the United States. Congress and the president often lose heart in the fight against inflation when unemployment rises sharply and farmers or construction workers storm the Capitol and circle the White House.

The U.S. experience during the 1980s, shown in Figure 30-11, provides a good laboratory to test the credibility critique. During this period, monetary policy was tightened in a clear and forceful manner. Yet the price tag was still high, as the sacrifice calculations indicate. Using tough, preannounced policies to enhance credibility does not appear to have lowered the cost of disinflation in the United States.

Because the United States has such a high degree of stability of its political and economic institutions, its experience may be unusual. Economists have examined anti-inflation policies in other countries and have determined that anti-inflation policies can sometimes be *expansionary*. A recent study by Stanley Fischer, Ratna Sahay, and Carlos A. Végh concluded as follows:

> Periods of high inflation are associated with bad macroeconomic performance. In particular, high inflation is bad for growth. The evidence is based on a sample of 18 countries which have experienced very high inflation episodes. During such periods, real GDP per capita fell on average by 1.6 percent per annum (compared to positive growth of 1.4 percent in low inflation years). . . . Exchange rate-based stabilizations appear to lead to an initial expansion in real GDP and real private consumption.

Policies to Lower Unemployment

Given the costs of high unemployment, we might ask: Is the NAIRU the optimal level of unemployment? If not, what can we do to lower it toward a more desirable level? Some economists believe that the NAIRU (sometimes also called the "natural rate of unemployment") represents the economy's efficient unemployment level. They hold that it is the outcome of an efficient pattern of employment, job vacancies, and job search. In their view, holding the unemployment rate below the NAIRU would be like driving your car without a spare tire.

Other economists strongly disagree, reasoning that the NAIRU is likely to be above the optimal unemployment rate. In their view, economic welfare would be increased if the NAIRU could be lowered. This group argues that there are many spillovers or externalities in the labor market. For example, workers who have been laid off suffer from a variety of social and economic hardships. Yet employers do not pay the costs of unemployment; most of the costs (unemployment insurance, medical costs, family distress, etc.) spill over as external costs and are absorbed by the worker or by the government. Moreover, there may be congestion externalities when an additional unemployed worker makes it harder for other workers to find jobs. To the extent that unemployment has external costs, the NAIRU is likely to be higher than the optimal unemployment

Eye Therapies Exhibit 2127, 648 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

rate; consequently, lowering the unemployment rate would raise the nation's net economic welfare.

A large social dividend would reward the society that discovers how to lower the NAIRU. What measures might lower the NAIRU?

- *Improve labor market services.* Some unemployment occurs because job vacancies are not matched up with unemployed workers. Through better information, the amount of frictional and structural unemployment can be reduced. A recent innovation is Internet matching, run by states or private companies, which can help people find jobs and firms find qualified workers more quickly.
- *Bolster training programs.* If you look at the Internet or at help-wanted ads in the newspaper, you will see that most of the job vacancies call for skilled workers. Conversely, most of the unemployed are unskilled or semiskilled workers, or workers who are in a depressed industry. Many economists believe that government or private training programs can help unemployed workers retool for better jobs in growing sectors. If successful, such programs provide the double bonus of allowing people to lead productive lives and of reducing the burden on government transfer programs.
- *Reduce disincentives to work.* In protecting people from the hardships of unemployment and poverty, the government has at the same time removed the sting of unemployment and reduced incentives to seek work. Some economists call for reforming the unemployment-insurance system and reforming health care, disability, and social security programs to improve work incentives. Others note that the lack of a national health insurance system may increase "job lock" and reduce the mobility of workers.

* * *

Having surveyed the history and theory of unemployment and inflation, we conclude with the following cautious summary:

Critics believe that the high unemployment that often prevails in North America and Europe is a central flaw in modern capitalism. Indeed, unemployment must sometimes be kept above its socially optimal level to ensure price stability, and the tension between price stability and low unemployment is one of the cruelest dilemmas of modern society.



SUMMARY

A. Definition and Impact of Inflation

1. Recall that inflation occurs when the general level of prices is rising. The rate of inflation is the percentage change in a price index from one period to the next. The major price indexes are the consumer price index (CPI) and the GDP deflator.
2. Like diseases, inflations come in different strains. We generally see low inflation in the United States (a few percentage points annually). Sometimes, galloping inflation produces price rises of 50 or 100 or 200 percent each year. Hyperinflation takes over when the printing presses spew out currency and prices start rising many times each month. Historically, hyperinflations have almost always been associated with war and revolution.
3. Inflation affects the economy by redistributing income and wealth and by impairing efficiency. Unanticipated inflation usually favors debtors, profit seekers, and risk-taking speculators. It hurts creditors, fixed-income classes, and timid investors. Inflation leads to distortions in relative prices, tax rates, and real interest rates. People take more trips to the bank, taxes may creep up, and measured income may become distorted.

B. Modern Inflation Theory

4. At any time, an economy has a given expected inflation rate. This is the rate that people have come to anticipate and that is built into labor contracts and other agreements. The expected rate of inflation is a short-run equilibrium and persists until the economy is shocked.
5. In reality, the economy receives incessant price shocks. The major kinds of shocks that propel inflation away from its expected rate are demand-pull and supply-shock. Demand-pull inflation results from too much spending chasing too few goods, causing

Eye Therapies Exhibit 2127, 649 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the aggregate demand curve to shift up and to the right. Wages and prices are then bid up in markets. Supply-shock inflation is a new phenomenon of modern industrial economies and occurs when the costs of production rise even in periods of high unemployment and idle capacity.

6. The Phillips curve shows the relationship between inflation and unemployment. In the short run, lowering one rate means raising the other. But the short-run Phillips curve tends to shift over time as expected inflation and other factors change. If policymakers attempt to hold unemployment below the NAIRU for long periods, inflation will tend to spiral upward.
7. Modern inflation theory relies on the concept of the nonaccelerating inflation rate of unemployment, or NAIRU, which is the lowest sustainable unemployment rate that the nation can enjoy without risking an upward spiral of inflation. It represents the level of unemployment of resources at which labor and product markets are in inflationary balance. Under the NAIRU theory, there is no permanent tradeoff between unemployment and inflation, and the long-run Phillips curve is vertical.

C. Dilemmas of Anti-inflation Policy

8. A central concern for policymakers is the cost of reducing inflation. Current estimates indicate that a substantial recession is necessary to slow expected inflation.
9. Economists have put forth many proposals for lowering the NAIRU; notable proposals include improving labor market information, improving education and training programs, and refashioning government programs so that workers have greater incentives to work.

CONCEPTS FOR REVIEW

History and Theories of Inflation

Rate of inflation in year t

$$= 100 \times \frac{P_t - P_{t-1}}{P_{t-1}}$$

strains of inflation:
- low
- galloping
- hyperinflation

impacts of inflation (redistributive, on output and employment)
anticipated and unanticipated inflation
costs of inflation:
- "shoe leather"
- menu costs
- income and tax distortions
- loss of information

short-run and long-run Phillips curves
nonaccelerating inflation rate of unemployment (NAIRU) and the long-run Phillips curve

Anti-inflation Policy

costs of disinflation
measures to lower the NAIRU
sacrifice ratio

FURTHER READING AND INTERNET WEBSITES

Further Reading

The quotation from Stanley Fischer, Ratna Sahay, and Carlos A. Végh is from their article, "Modern Hyper- and High Inflations," *Journal of Economic Literature,* September 2002, pp. 837–880.

A discussion of factors influencing the NAIRU can be found in Congressional Budget Office, *The Effect of Changes in Labor Markets on the Natural Rate of Unemployment,* April 2002, available at *www.cbo.gov.*

Websites

Analysis of the consumer price data for the United States comes from the Bureau of Labor Statistics, at *www.bls.gov.* This site also contains useful discussions of inflation trends in the *Monthly Labor Review,* online at *www.bls.gov/opub/mlr/mlrhome.htm.*

Eye Therapies Exhibit 2127, 650 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

QUESTIONS FOR DISCUSSION

1. Consider the following impacts of inflation: tax distortions, income and wealth redistribution, shoe-leather costs, and menu costs. For each, define the cost and provide an example.
2. "During periods of inflation, people use real resources to reduce their holdings of fiat money. Such activities produce a private benefit with no corresponding social gain, which illustrates the social cost of inflation." Explain this quotation and give an example.
3. Unanticipated deflation also produces serious social costs. For each of the following, describe the deflation and analyze the associated costs:
   a. During the Great Depression, prices of major crops fell along with the prices of other commodities. What would happen to farmers who had large mortgages?
   b. Japan experienced a mild deflation in the 1990s. Assume that Japanese students each borrowed 2,000,000 yen (about $20,000) to pay for their education, hoping that inflation would allow them to pay off their loans in inflated yen. What would happen to these students if wages and prices began to *fall* at 5 percent per year?
4. The data in Table 30-2 describe inflation and unemployment in the United States from 1979 to 1987. Note that the economy started out near the NAIRU in 1979 and ended near the NAIRU in 1987. Can you explain the decline of inflation over the intervening years? Do so by drawing the short-run and long-run Phillips curves for each of the years from 1979 to 1987.
5. Many economists argue as follows: "Because there is no long-run tradeoff between unemployment and inflation, there is no point in trying to shave the peaks and troughs from the business cycle." This view suggests that we should not care whether the economy is stable or fluctuating widely as long as the average level of unemployment is the same. Discuss critically.
6. A leading economist has written: "If you think of the social costs of inflation, at least of moderate inflation, it is hard to avoid coming away with the impression that they are minor compared with the costs of unemployment and depressed production." Write a short essay describing your views on this issue.
7. Consider the data on annual inflation rates and growth of per capita GDP shown in Table 30-1. Can you see that low inflation is associated with the highest growth rates? What are the economic reasons that growth might be lower for deflation and for hyperinflation. Explain why the *ex post* fallacy might apply here (see the discussion in Chapter 1).
8. The following policies and phenomena affected labor markets over the last three decades. Explain the likely effect of each on the NAIRU:
   a. Unemployment insurance became subject to taxation.
   b. Funds for training programs for unemployed workers were cut sharply by the federal government.
   c. The fraction of the workforce in labor unions fell sharply.
   d. The welfare-reform act of 1996 sharply reduced payments to low-income families and required them to work if they were to receive government payments.

Year	Unemployment rate (%)	Inflation rate, CPI (% per year)
1979	5.8	11.3
1980	7.1	13.5
1981	7.6	10.3
1982	9.7	6.2
1983	9.6	3.2
1984	7.5	4.4
1985	7.2	3.6
1986	7.0	1.9
1987	6.2	3.6

TABLE 30-2. Unemployment and Inflation Data for the United States, 1979–1987

Eye Therapies Exhibit 2127, 651 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CHAPTER

31

Frontiers of Macroeconomics



The task of economic stabilization requires keeping the economy from straying too far above or below the path of steady high employment. One way lies inflation, and the other lies recession. Flexible and vigilant fiscal and monetary policy will allow us to hold the narrow middle course.

President John F. Kennedy
(1962)

The U.S. economy has changed enormously over the last 50 years. The shares of farming and manufacturing have declined. People work with computers instead of with tractors. Trade is a growing share of production and consumption. Technology has revolutionized daily life. Advanced telecommunications systems enable businesses to control their operations across the country and around the world, and ever more powerful computers have eliminated many of the tedious tasks that used to employ so many people.

Yet, even with these tectonic shifts in our economic structure, the central goals of macroeconomic policy remain the same: stable employment, good pay, low unemployment, rising productivity and real incomes, and low and stable inflation. The challenge remains to find policies that can achieve these objectives.

This chapter uses the tools of macroeconomics to examine some of today's major policy issues. We begin with an assessment of the consequences of government deficits and debt on economic activity. We then present some of the new approaches to macroeconomics. Some of these theories are on the frontiers of our science today but will be the staples of classroom economics in a generation. We analyze controversies involving short-run economic stabilization, including current questions on the roles of monetary and fiscal policy. Should the government stop trying to smooth out business cycles? Should policy makers rely on fixed rules rather than discretion? We then conclude with an epilogue on the importance of economic growth.

A. THE ECONOMIC CONSEQUENCES OF THE GOVERNMENT DEBT

As the United States entered the twenty-first century, its fiscal policies were stable and the federal government was running a budget surplus. Then, like a monster rising from the deep, the budget deficit rose up to swallow the nation's fiscal resources and terrify its populace.

Eye Therapies Exhibit 2127, 652 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The budget deficit increased even during the prosperous years of the mid-2000s as taxes were cut and spending increased on new entitlement programs and seemingly endless wars in Iraq and Afghanistan. Then, the nation's banking system ran mammoth losses and the economy went into a deep recession. Tax revenues fell sharply, and hundreds of billions of dollars were spent to prop up the financial system and stimulate the economy. For 2009, the federal government was running an annual deficit of close to $2 trillion, which was the largest percent of GDP since World War II.

How did the budget deficit get so high? What are the economic impacts of fiscal deficits? These important questions will be addressed in this section. We will see that the popular concern with deficits has a firm economic foundation. Deficit spending may be necessary to reduce the length and depth of recessions, particularly when the economy is in a liquidity trap. But high deficits during periods of full employment carry serious consequences, including reduced national saving and investment and slower long-run economic growth.

Government Budgets. Governments use budgets to plan and control their fiscal affairs. A **budget** shows, for a given year, the planned expenditures of government programs and the expected revenues from tax systems. The budget typically contains a list of specific programs (education, welfare, defense, etc.), as well as tax sources (individual income tax, social-insurance taxes, etc.).

A **budget surplus** occurs when all taxes and other revenues exceed government expenditures for a year. A **budget deficit** is incurred when expenditures exceed taxes. When revenues and expenditures are equal during a given period—a rare event on the federal level—the government has a **balanced budget.**

When the government incurs a budget deficit, it must borrow from the public to pay its bills. To borrow, the government issues bonds, which are IOUs that promise to pay money in the future. The **government debt** (sometimes called the *public debt*) consists of the total or accumulated borrowings by the government; it is the total dollar value of government bonds.

It is useful to distinguish between the total debt and the net debt. The *net debt*, also called the *debt held by the public*, excludes debt held by the government itself. Net debt is owned by households, banks, businesses, foreigners, and other nonfederal entities. The *gross debt* equals the net debt plus bonds owned by the government, primarily by the social security trust fund. The social security trust fund is running a large surplus, so the difference between these two concepts is growing rapidly today.



Debt versus Deficit

People often confuse the debt with the deficit. You can remember the difference as follows: Debt is water in the tub, while a deficit is water flowing into the tub. The government debt is the *stock* of liabilities of the government. The deficit is a *flow* of new debt incurred when the government spends more than it raises in taxes. For example, when the government ran a deficit of $640 billion in 2008, it added that amount to the stock of government debt. By contrast, when the government enjoyed a surplus of $200 billion in 2000, this reduced the government debt by that amount.

FISCAL HISTORY

Like Sisyphus, federal policymakers toil endlessly to push the stone of fiscal balance up the hill only to have it roll down to crush them again. The government passed law after law in the 1980s and 1990s to stop the rising deficit. No sooner was the deficit vanquished than it reappeared and grew rapidly after 2001. Was this typical, or was it a new feature of the American economy?

Deficits were not new to the American economy, but large deficits during peacetime are a unique feature of recent economic history. For the first two centuries after the American Revolution, the federal government of the United States generally balanced its budget. Heavy military spending during wartime was financed by borrowing, so the government debt soared in wartime. In peacetime, the government would pay off some of its debt, and the debt burden would shrink.

Then, starting in 1940, the fiscal affairs of state began to change rapidly. Table 31-1 illuminates the major trends. This table lists the major federal budget categories and their shares in GDP for the period from 1940 to 2008. The key features were the following:

- The share of federal spending and taxes grew sharply from 1940 to 1960 primarily because of the expansion of military and civilian spending. This growth was financed by a significant increase in individual and corporate taxation.

Eye Therapies Exhibit 2127, 653 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Federal budget component	Percent of GDP				
	1940	1960	1980	2000	2008
Revenues	**6.4**	**17.6**	**18.5**	**20.6**	**17.7**
Individual income taxes	0.9	7.7	8.8	10.2	8.1
Corporation income taxes	1.2	4.1	2.3	2.1	2.1
Social insurance and retirement receipts	1.8	2.8	5.7	6.7	6.3
Other	2.7	3.0	1.8	1.6	1.2
Expenditures	**9.4**	**17.5**	**21.2**	**18.2**	**20.9**
National defense and international affairs	1.8	9.7	5.3	3.2	4.4
Health	0.1	0.2	2.0	3.6	4.7
Income security	1.5	1.4	3.1	2.6	3.0
Social security	0.0	2.2	4.2	4.2	4.3
Net interest	0.9	1.3	1.9	2.3	1.7
Other	5.2	2.7	4.7	2.4	2.5
Surplus or deficit	**−2.9**	**0.1**	**−2.6**	**2.4**	**−3.2**

TABLE 31-1. Federal Budget Trends, 1940–2008

The federal share of the economy grew sharply from 1940 to 1960 as the United States took an active military role in world affairs during the hot and cold wars. After 1960, the federal-spending share stabilized, but the composition of spending moved from military to health care and other social spending. The federal government deficit grew sharply in the 2000s as revenues declined sharply due to individual income-tax cuts.

Source: Data are for fiscal years and come from the Department of the Treasury, Office of Management and Budget, and Department of Commerce. They are summarized in *Economic Indicators*, available at *origin.www.gpoaccess.gov/indicators/*.

- The period from 1960 to 1980 marked the "New Society" programs for health, income security, and expanded social security. As a result, the expenditure share grew sharply. The share of federal revenues in GDP stabilized over this period.
- Beginning in 1981, both political parties declared that the era of big government was over. Presidents Ronald Reagan and George W. Bush introduced large tax cuts, which in each case led to large government budget deficits. From 1980 to 2008, as shown in Table 31-1, the ratio of total federal spending to GDP was essentially constant. Spending on health care rose sharply as other civilian programs were squeezed.

GOVERNMENT BUDGET POLICY

The government budget serves two major economic functions. First, it is a device by which the government can set national priorities, allocating national output among private and public consumption and investment and providing incentives to increase or reduce output in particular sectors. From a macroeconomic point of view, it is through fiscal policy that the budget affects the key macroeconomic goals. More precisely, by **fiscal policy** we mean the setting of taxes and public expenditures to help dampen the swings of the business cycle and contribute to the maintenance of a growing, high-employment economy, free from high or volatile inflation.

Some early enthusiasts of the Keynesian approach believed that fiscal policy was like a knob they could turn to control or "fine-tune" the pace of the economy. A bigger budget deficit meant more stimulus for aggregate demand, which could lower unemployment and pull the economy out of recession. A budget surplus could slow down an overheated economy and dampen the threat of inflation.

Few today hold such an idealized view of fiscal policy. With many decades of practice, economies

Eye Therapies Exhibit 2127, 654 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

still experience recessions and inflations. Fiscal policy works better in theory than in practice. Moreover, monetary policy has become the preferred tool for moderating business-cycle swings. Still, when unemployment rises, there is usually strong public pressure for the government to boost spending. In this section, we will review the major ways in which the government can employ fiscal policy, and we will examine the practical shortcomings that have become apparent.

Actual, Structural, and Cyclical Budgets

Modern public finance distinguishes between structural and cyclical deficits. The idea is simple. The *structural* part of the budget is active—determined by discretionary policies such as those covering tax rates, public-works or education spending, or the size of defense purchases. In contrast, the *cyclical* part of the budget is determined passively by the state of the business cycle, that is, by the extent to which national income and output are high or low. The precise definitions follow:

The **actual budget** records the actual dollar expenditures, revenues, and deficits in a given period.

The **structural budget** calculates what government revenues, expenditures, and deficits would be if the economy were operating at potential output.

The **cyclical budget** is the difference between the actual budget and the structural budget. It measures the impact of the business cycle on the budget, taking into account the effect of the cycle on revenues, expenditures, and the deficit.

The distinction between the actual and the structural budgets is important for policymakers who want to distinguish between long-term or trend budget changes and short-term changes that are primarily driven by the business cycle. Structural spending and revenues consist of the discretionary programs enacted by the legislature; cyclical spending and deficits consist of the taxes and spending that react automatically to the state of the economy.

The nation's saving and investment balance is primarily affected by the structural budget. Efforts to change government saving should focus on the structural budget because no durable change comes simply from higher revenues due to an economic boom.

THE ECONOMICS OF THE DEBT AND DEFICITS

No macroeconomic issue is more controversial today than the impact of large government deficits upon the economy. Some argue that large deficits are placing a heavy burden on future generations. Others rejoin that there is little evidence of an impact of deficits on interest rates or investment. Yet a third group argues that deficits are favorable for the economy in recessionary times.

How can we sort through the conflicting points of view? At one extreme, we must avoid the customary practice of assuming that a public debt is bad because private debtors are punished. On the other hand, we must recognize the genuine problems associated with large government deficits and the advantages that come from a lower government debt.

THE SHORT-RUN IMPACT OF GOVERNMENT DEFICITS

Short Run vs. Long Run

It is useful to separate the impact of fiscal policy into the short run and the long run. The *short run* in macroeconomics considers situations where less than full employment may prevail—that is, where actual output may differ from potential output. This is the world of the Keynesian multiplier model. The *long run* refers to a full-employment situation, where actual output equals potential output. This is the world of our economic-growth analysis.

We have already discussed the role of fiscal policy in the short run, so that needs only a brief review in this section. The impact in the long run is more novel and will be presented in the next section.

Fiscal Policy and the Multiplier Model

We discussed in earlier chapters the way that fiscal policy affects the economy in the short run—that is, in an economy with less than full employment.

Suppose that the government purchases computers for its schools or missiles for its army. Our multiplier model says that in the short run, with no change in interest or exchange rates, GDP will rise by a multiple (perhaps 1½ or 2) times the increase in *G*. The same argument applies (with a smaller multiplier) to reductions in taxes, *T*. At the same time, the

Eye Therapies Exhibit 2127, 655 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

government deficit will rise because the deficit equals $T - G$ and thus rises with T cuts or G increases.

This then is the basic result for the short run: With less than full employment, increases in the structural deficit arising from discretionary T cuts or G increases will tend to produce higher output and lower unemployment, and perhaps higher inflation.

We must, however, expand on the simplest multiplier analysis to incorporate the reactions of financial markets and monetary policy. As output rises and inflation threatens, central banks may raise interest rates, discouraging domestic investment. Higher interest rates may also cause a country's foreign exchange rate to appreciate if the country has a flexible exchange rate; the appreciation leads to a decline in net exports. These financial reactions would tend to choke off or "crowd out" investment, with a resulting decrease in the expenditure multiplier of our simplest model.

Fiscal policy tends to expand the economy in the short run—that is, when there are unemployed resources. Higher spending and lower tax rates increase aggregate demand, output, employment, and inflation. However, this expansionary impact is reduced by the subsequent financial reactions of interest rates and foreign exchange rates.

GOVERNMENT DEBT AND ECONOMIC GROWTH

We turn now from the short run to the long run—to the impact of fiscal policy, and particularly a large government debt, on investment and economic growth. The analysis here deals with the costs of servicing a large external debt, the inefficiencies of levying taxes to pay interest on the debt, and the impact of the debt on capital accumulation.

Historical Trends

Before we begin our analysis of government debt, it is useful to review historical trends. Long-run data for the United States appear in the figure on page 716 of this text, which shows the ratio of net federal debt to GDP since 1789. Notice how wars drove up the ratio of debt to GDP, while rapid output growth with generally balanced budgets in peacetime reduced the ratio of debt to GDP.

Figure 31-1 shows the debt-GDP ratio for the United States over the last seven decades. You can see the dramatic effect of government deficits during World War II, as well as during the 1980s and the 2000s.

Most industrialized countries are today saddled with large public debts. Table 31-2 compares the United States with seven other large countries. Japan's debt-GDP ratio has climbed sharply over the last two decades because of the nation's aggressive fiscal policy and a prolonged recession. Many economists worry that Japan is caught in a vicious cycle of high debt leading to high interest payments, which in turn increase the growth of the debt.

External vs. Internal Debt

The first distinction to be made is between an internal debt and an external debt. *Internal government debt* is owed by a nation to its own residents. Many argue that an internal debt poses no burden because "we owe it all to ourselves." While this statement is oversimplified, it does represent a genuine insight. If each citizen owned $10,000 of government bonds and were liable for the taxes to service just that debt, it would make no sense to think of debt as a heavy load of rocks that each citizen must carry. People simply owe the debt to themselves.

An external debt is quite a different situation. An *external debt* occurs when foreigners own a fraction of the assets of a country. For example, because of

	Ratio of Gross Government Debt to GDP (%)			
	1980	1990	2000	2007
Japan	37	47	106	161
Italy	53	93	104	96
France	30	40	47	52
United Kingdom	51	35	43	43
Germany	13	20	34	39
United States	26	41	34	36
South Korea	4	13	17	32
Mexico	18	46	23	24

TABLE 31-2. Central-Government Debt in Eight Major Countries

Slow economic growth and rising spending on entitlement programs led to growing public debts in most major countries in the last three decades. Japan's debt-GDP ratio led to a downgrading of the nation's debt rating even though Japan is one of the world's richest countries.

Source: OECD at *webnet.oecd.org/wbos/index.aspx*.

Eye Therapies Exhibit 2127, 656 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

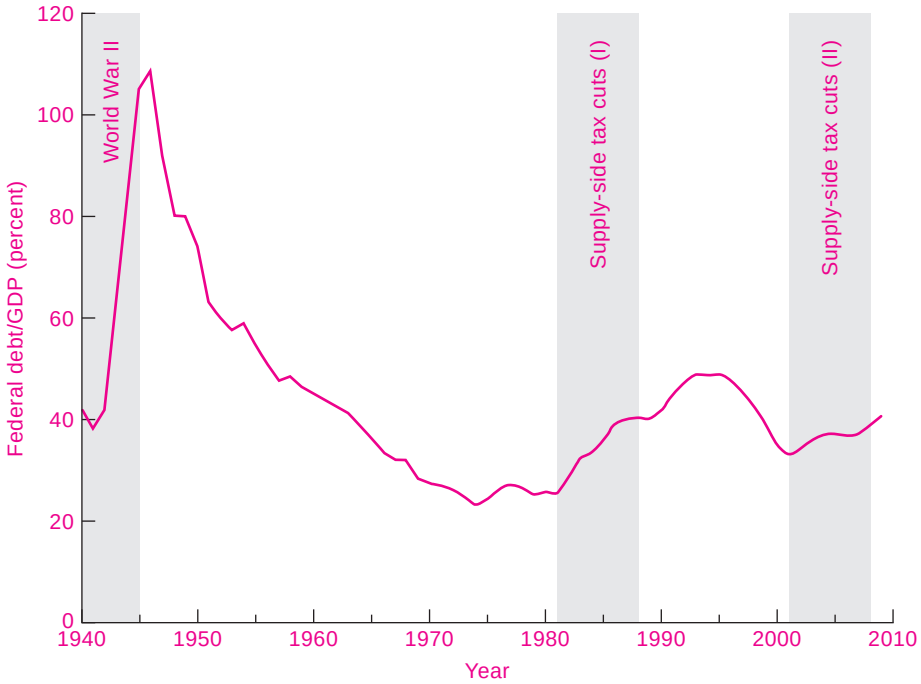


FIGURE 31-1. Debt-GDP Ratio for the U.S. Federal Government

This figure shows the ratio of net debt, or debt in the hands of the public, to GDP. See the effect of World War II and the two periods of supply-side tax cuts on the ratio.

Source: U.S. Office of Management and Budget, available at *www.gpoaccess.gov/eop/tables08.html,* Table B-78.

its large current-account deficits, the United States owed the rest of the world $3 trillion at the end of 2008. What this means is that U.S. residents will eventually have to export that much in goods and services or sell that much of the nation's assets to foreigners. Suppose that the real interest rate on that debt is 5 percent per year. Then, each year, U.S. residents would need to ship abroad $150 billion (about $500 per capita) to "service" the external debt.

So an external debt definitely does involve a net subtraction from the resources available for consumption in the debtor nation. This lesson has been learned time and again by developing countries—particularly when their creditors wanted their debts paid back quickly.

Efficiency Losses from Taxation

An internal debt requires payments of interest to bondholders, and taxes must be levied for this purpose. But even if the same people were taxed to pay the same amounts they receive in interest, there would still be the *distorting effects on incentives* that are inescapably present in the case of any taxes. Taxing Paula's interest income or wages to pay Paula interest would introduce microeconomic distortions. Paula might work less and save less; either of these outcomes must be reckoned as a distortion of efficiency and well-being.

Displacement of Capital

Perhaps the most serious consequence of a large public debt is that it displaces capital from the nation's stock of private wealth. As a result, the pace of economic growth slows and future living standards will decline.

What is the mechanism by which debt affects capital? Recall from our earlier discussion that people accumulate wealth for a variety of purposes, such as retirement, education, and housing. We can separate the assets people hold into two groups: (1) government debt and (2) capital like houses and financial assets like corporate stocks that represent ownership of private capital.

Eye Therapies Exhibit 2127, 657 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The effect of government debt is that people will accumulate government debt instead of private capital, and the nation's private capital stock will be displaced by public debt.

To illustrate this point, suppose that people desire to hold exactly 1000 units of wealth for retirement and other purposes. As the government debt increases, people's holdings of other assets will be reduced dollar for dollar. This occurs because as the government sells its bonds, other assets must be reduced, since total desired wealth holdings are fixed. But these other assets ultimately represent the stock of private capital; stocks, bonds, and mortgages are the counterparts of factories, equipment, and houses. In this example, if the government debt goes up 100 units, we would see that people's holdings of capital and other private assets fall by 100 units. This is the case of 100 percent displacement (which is the long-run analog of 100 percent crowding out).

Full displacement is unlikely to hold in practice. The higher debt may increase interest rates and stimulate domestic saving. In addition, the country may borrow abroad rather than reduce its domestic investment (as has been the case for the U.S. in recent years). The exact amount of capital displacement will depend on the conditions of production and on the saving behavior of domestic households and foreigners.

A Geometric Analysis. The process by which the stock of capital is displaced in the long run is illustrated in Figure 31-2. The left panel shows the supply

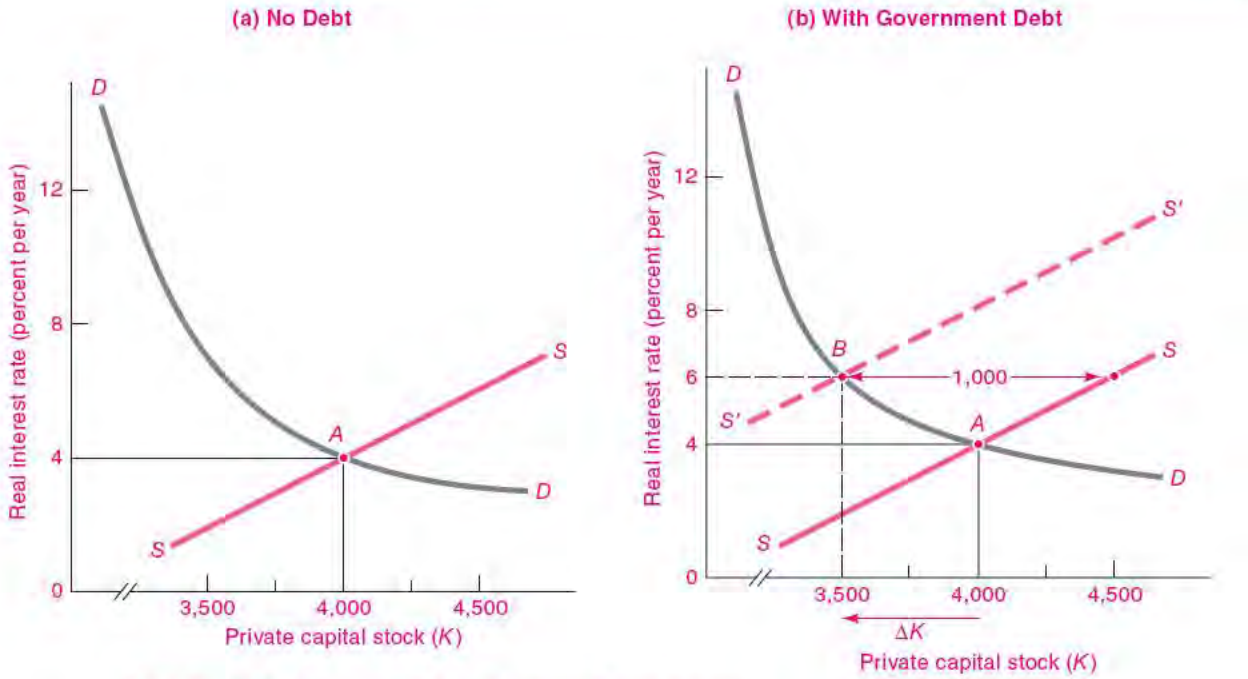


FIGURE 31-2. Government Debt Displaces Private Capital

Firms demand capital, while households supply capital by saving in private and public assets. The demand curve is the downward-sloping business demand for *K*, while the supply curve is the upward-sloping household supply of wealth.

Before-debt case in **(a)** shows the equilibrium without government debt: *K* is 4000 and the real interest rate is 4 percent.

After-debt case in **(b)** shows the impact of 1000 units of government debt. Debt shifts the net supply of *K* to the left by the 1000 units of the government debt. The new equilibrium arises northwest along the demand-for-*K* curve, moving from point *A* to point *B*. The interest rate is higher, firms are discouraged from holding *K*, and the capital stock falls.

Eye Therapies Exhibit 2127, 658 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and demand for capital as a function of the real interest rate or return on capital. As interest rates rise, firms demand less capital while individuals may want to supply more. The equilibrium shown is for a capital stock of 4000 units with a real interest rate of 4 percent.

Now say that the government debt rises from 0 to 1000—because of war, recession, supply-side fiscal policies, or some other reason. The impact of the increase in debt can be seen in the right-hand diagram of Figure 31-2. This figure shows the 1000-unit increase in debt as a shift in the supply-of-capital (or *SS*) curve. As depicted, the households' supply-of-capital schedule shifts 1000 units to the left, to $S'S'$.

We represent an increase in government debt as a leftward shift in the households' supply-of-capital schedule. Note that, because the *SS* curve represents the amount of private capital that people willingly hold at each interest rate, the capital holdings are equal to the total wealth holdings minus the holdings of government debt. Since the amount of government debt (or assets other than capital) rises by 1000, the amount of private capital that people can buy after they own the 1000 units of government debt is 1000 less than total wealth at each interest rate. Therefore, if *SS* represents the total wealth held by people, $S'S'$ (equal to *SS* less 1000) represents the total amount of capital held by people. In short, after 1000 units of government debt are sold, the new supply-of-capital schedule is $S'S'$.

As the supply of capital dries up—with national saving going into government bonds rather than into housing or into companies' stocks and bonds—the market equilibrium moves northwest along the demand-for-*K* curve. Interest rates rise. Firms slow their purchases of new factories, trucks, and computers.

In the illustrative new long-run equilibrium, the capital stock falls from 4000 to 3500. Thus, in this example, 1000 units of government debt have displaced 500 units of private capital. Such a reduction has significant economic effects, of course. With less capital, potential output, wages, and the nation's income are lower than they would otherwise be.

The diagrams in Figure 31-2 are illustrative. Economists do not have a firm estimate of the magnitude of the displacement effect. In a look at historical trends, the best evidence suggests that domestic capital is partially displaced by government debt but that some of the impact comes in higher foreign debt.

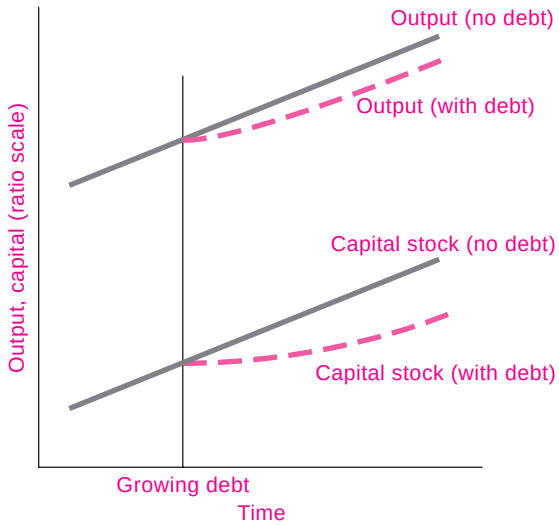


FIGURE 31-3. Impact of Government Debt on Economic Growth

The solid lines show the paths of capital and output if the government balances its books and has no debt. When the government incurs a debt, private capital is reduced. The dashed lines illustrate the impact on capital and output of the higher government debt.

Debt and Growth

If we consider all the effects of government debt on the economy, a large public debt is likely to reduce long-run economic growth. Figure 31-3 illustrates this connection. Say that an economy were to operate over time with no debt. According to the principles of economic growth outlined in Chapter 25, the capital stock and potential output would follow the hypothetical paths indicated by the solid blue lines in Figure 31-3.

Next consider a situation with a growing national debt. As the debt accumulates over time, more and more capital is displaced, as shown by the dashed green line for the capital stock in the bottom of Figure 31-3. As taxes are raised to pay interest on the debt, inefficiencies further lower output. Also, an increase in external debt lowers national income and raises the fraction of national output that has to be set aside for servicing the external debt. All the effects taken together, output and consumption will grow more slowly than they would have had there been no large government debt and deficit, as can be seen by comparing the top lines in Figure 31-3.

Eye Therapies Exhibit 2127, 659 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

What is the impact of a budget surplus and a *declining* government debt? Here, the argument works in the other direction. A lower national debt means that more of national wealth is put into capital rather than government bonds. A higher capital stock increases the growth of output and increases wages and consumption per person.

This is the major point about the long-run impact of a large government debt on economic growth: A large government debt tends to reduce the growth in potential output because it displaces private capital, increases the inefficiency from taxation, and forces a nation to reduce consumption to service its foreign borrowing.



Deficit Confusions Unraveled

Having completed our analysis of the economic impacts of deficits and debt, we can summarize the key points by unraveling some of the major confusions in this area.

The impact of fiscal policy on the economy is one of the most misunderstood facets of macroeconomics. The confusion arises because fiscal policy operates differently depending upon the time period:

- *In the short run, higher spending and lower tax rates tend to increase aggregate demand and thereby to raise output and lower unemployment.* This is the Keynesian impact of fiscal policy, which operates by raising actual output relative to potential output. We would expect that the expansionary impact of fiscal policy—the increase in capacity utilization—would last at most for a few years. It might be offset by a monetary tightening, especially if the central bank thought the economy was operating near the inflation danger zone.
- *In the long run, higher spending and lower tax rates tend to depress the growth rate of the economy.* This is the growth impact of fiscal policy. The growth impact concerns the impact of government deficits on the national saving and investment balance in a full-employment economy. If taxes are lower, this will decrease public saving and, because private saving is unlikely to rise as much as public saving falls, total national saving and investment will decline. The investment decline will lead to slower growth in the capital stock and therefore in potential output.

These two impacts of fiscal policy can easily confuse people and are the source of many debates about fiscal policy. Consider the following debate between Senators Hawk and Dove:

Senator Dove: The economy is tipping into recession. We cannot afford to sit around while millions of people lose their jobs. Now is the time for a big stimulus package with tax cuts and new spending on infrastructure and pressing public needs. Recessions are not the time for old-fashioned dogmas about deficits.

Senator Hawk: A huge stimulus package today would be the height of fiscal irresponsibility. With higher government spending, the deficit will grow even larger, interest rates will rise, and businesses will reduce their spending on new plant, equipment, and information technology. With all the critical needs facing the nation, we can ill-afford slower economic growth over the next decade.

Make sure that you understand the implicit theories underlying the positions of the two distinguished senators. They are both right . . . and both wrong.

B. ADVANCES IN MODERN MACROECONOMICS

Our philosophy in this textbook is to consider all the important schools of thought. We emphasize the modern mainstream Keynesian approach as the best way to explain the business cycle in market economies. At the same time, the forces behind long-run economic growth are best understood by using the neoclassical growth model.

While our key task has been to present mainstream thinking, experience shows how important it is to keep our minds open to alternative points of view. Time and again in science, the orthodoxies of one era are overturned by new discoveries in the next. Schools, like people, are subject to hardening of the arteries. Students learn the embalmed truth from their teachers and sacred textbooks, and the imperfections in the orthodox doctrines are glossed over as unimportant. For example, John Stuart Mill, one of the greatest economists and philosophers of all time, wrote in his 1848 classic, *Principles of Political Economy:* "Happily, there is nothing in the laws of Value which remains for the present and any future writer to clear up." Yet the next century and a half

Eye Therapies Exhibit 2127, 660 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

saw two major revolutions in economics—the marginal revolution in microeconomics and the discovery of macroeconomics.

Historians of science observe that the progress of science is discontinuous. New schools of thought rise, spread their influence, and convince skeptics. In this section, we sketch some of the leading new lines of thinking in modern macroeconomics.

CLASSICAL MACROECONOMICS AND SAY'S LAW

Since the dawn of economics two centuries ago, economists have wondered if a market economy has a tendency to move spontaneously toward a long-run, full-employment equilibrium without the need for government intervention. Using modern language, we label as **classical** those approaches that emphasize the self-correcting forces in an economy. The classical approach holds that prices and wages are flexible and that the economy is stable, so the economy moves automatically and quickly to its full-employment equilibrium.

Say's Law of Markets

Before Keynes developed his macroeconomic theories, the major economic thinkers generally adhered to the classical view of the economy, at least in good times. Early economists knew about business cycles, but they viewed them as temporary and self-correcting aberrations.

Classical analysis revolved around **Say's Law of Markets.** This theory, advocated in 1803 by the French economist J. B. Say, states that overproduction is impossible by its very nature. This is sometimes expressed as "supply creates its own demand." This law rests on a view that there is no essential difference between a monetary economy and a barter economy—in other words, people can afford to buy whatever factories can produce. Say's Law is illustrated in Figure 31-4. In the classical world, output is determined by aggregate supply, and aggregate demand affects only the price level.

A long line of the most distinguished economists, including David Ricardo (1817), John Stuart Mill (1848), and Alfred Marshall (1890), subscribed to the classical macroeconomic view that overproduction is impossible.

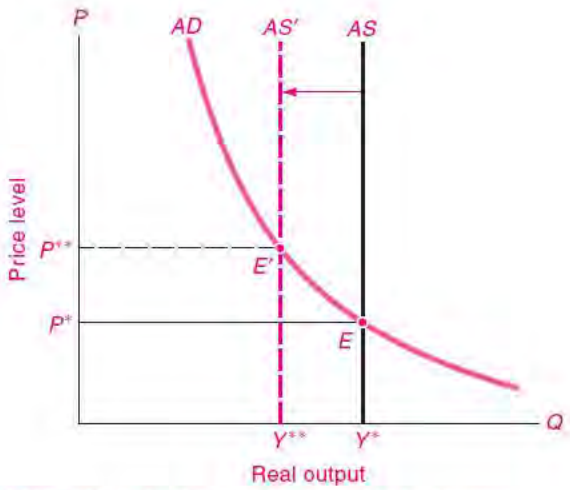


FIGURE 31-4. In the Real Business Cycle, Output Changes Come from Technological Shocks

In the classical as well as the real-business-cycle (RBC) approach, *AS* reflects classical flexible wages and prices and is therefore vertical. Output fluctuations come as technological shocks percolate through the economy. This figure shows how a decline in productivity can be the cause of a RBC recession. Can you see why policies to increase *AD* will affect prices but not output?

The classical view is that the economy moves automatically toward its full-employment equilibrium. Changes in the money supply, fiscal policy, investment, or other spending factors have no lasting impact upon output or employment. Prices and wages adjust quickly and flexibly to maintain full employment.

MODERN CLASSICAL MACROECONOMICS

While classical economists were preaching the impossibility of persistent unemployment, eclectic economists of the 1930s could hardly ignore the vast army of unemployed workers begging for work and selling pencils on street corners. Keynes's *The General Theory of Employment, Interest and Money* (1936) offered an alternative macroeconomic theory—a new set of theoretical spectacles for looking at the impacts of shocks and economic policies. The analysis of business cycles and short-run aggregate demand presented in this text reflects the modern synthesis of the Keynesian approach.

Eye Therapies Exhibit 2127, 661 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

While mainstream business-cycle analysis relies primarily on the Keynesian *AS* and *AD* model, a new branch of the classical school challenges the standard approach. This theory, called **new classical macroeconomics,** was developed by Robert Lucas (University of Chicago), Thomas Sargent (Stanford University and New York University), and Robert Barro (Harvard University). This approach is much in the spirit of the classical approach in emphasizing the role of flexible wages and prices, but it also adds a new feature called rational expectations to explain observations such as the Phillips curve.

Rational Expectations

The major innovation of new classical economics has been to introduce the principle of rational expectations into macroeconomics. Some background on expectations will help to explain this new approach. In many areas of economics, particularly those involving investment and financial decisions, expectations are a central factor in decision making. They influence how much businesses will spend on investment goods and whether consumers spend now or save for the future. For example, assume that you are considering how much to spend on your first house. Your decision will be affected by your *expectations* about your future income, family size, and future housing prices.

How do people form their expectations? According to the **rational-expectations hypothesis,** expectations are unbiased and based on all available information.

We pause for a statistical aside: A forecast is unbiased if it contains no systematic forecasting errors. Clearly, a forecast cannot always be perfectly accurate—you cannot foresee how a coin flip will come up on a single toss. However, you should not commit the statistical sin of *bias* by predicting that a fair coin will come up tails 25 percent of the time. You would be making an unbiased forecast if you predicted that the coin would come up tails 50 percent of the time or that each of the numbers on a die would, on average, come up one-sixth of the time.

People have **rational expectations** when, in addition to lacking bias, they use all available information in making their decisions. This implies that people understand how the economy works and what the government is doing. Thus, suppose that the government always boosts spending in election years to promote its election prospects. Under rational expectations, people will anticipate this kind of behavior and act accordingly. (Recall that this principle is also an important assumption behind the efficient-market hypothesis of financial markets, as described in Chapter 23.)

Real Business Cycles

The major application of modern classical macroeconomics is an exciting field known as **real-business-cycle (RBC) theory.** This theory was developed principally by Finn Kydland and Edward C. Prescott, who won the Nobel Prize for their work in this area. This approach holds that business cycles are primarily due to technological shocks and do not invoke any monetary or demand-side forces.

In the RBC approach, shocks to technology, investment, or the labor supply change the potential output of the economy. In other words, the shocks shift a *vertical AS* curve. These supply shocks are transmitted into actual output by the fluctuations of aggregate supply and are completely independent of *AD*. Similarly, movements in the unemployment rate are the result of movements in the natural rate of unemployment (the NAIRU) due either to microeconomic forces, such as the intensity of sectoral shocks, or to tax and regulatory policies. Standard Keynesian monetary and fiscal policies have no effect on output or employment in RBC models; they affect only *AD* and the price level. Figure 31-4 shows an example of a RBC recession caused by a decline in productivity.

The Ricardian View of Fiscal Policy

One of the most influential criticisms of Keynesian macroeconomics was a new view of the role of fiscal policy. This view, known as the **Ricardian view of fiscal policy** and developed by Harvard University's Robert Barro, argues that changes in tax rates have no impact upon consumption spending.

This idea is a logical extension of the life-cycle model of consumption, introduced in Chapter 21. Under the Ricardian view, individuals are farsighted and form part of a succession of family members, like a dynasty. Parents care not only about their own consumption but also about the well-being of their children; the children, in turn, care about the well-being of their own children; and so on. This structure, called "dynastic preferences," implies that the current generation's horizon stretches into the

Eye Therapies Exhibit 2127, 662 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

indefinite future through the overlapping concerns of each generation about its offspring.

Here is where the surprising result comes: If the government cuts taxes but leaves expenditures unchanged, this necessarily requires increased government borrowing. But, with unchanged expenditures, the government will have to raise taxes at some point in the future to pay the interest on its new borrowing. In the Ricardian view, consumers have rational expectations about future policies, so when a tax cut occurs, they know they must plan for a future tax increase. They will therefore increase their saving by the amount of the tax cut, and their consumption will remain unchanged. Moreover, people take into account the well-being of their children. So, even if the future tax increase comes after their lifetime, they will save enough to increase their bequests to their children so that their children can pay the extra taxes.

The net result in the Ricardian view is that tax changes have no impact upon consumption. Moreover, government debt is not net debt from the point of view of households because they offset these assets in their mental calculations with the present value of taxes that must be paid to service the government debt.

The Ricardian view of debt and deficits has stirred much controversy among macroeconomists. Critics point out that it requires that households be extremely farsighted, planning to give bequests to their children and constantly weighing their own interests against those of their descendants. The chain would be broken if there were no children, no bequests, no concern for children, or poor foresight. The empirical evidence to date provides little support for the Ricardian view, but it is a useful reminder of the logical limitations on fiscal policy.

Efficiency Wages

Another important recent development, fusing elements of both classical and Keynesian economics, is called **efficiency-wage theory.** This approach was developed by Edmund Phelps (Columbia University), Joseph Stiglitz (Columbia University), and Janet Yellen (president of the Federal Reserve Bank of San Francisco). It explains the rigidity of real wages and the existence of involuntary unemployment in terms of firms' attempts to increase productivity by keeping wages above the market-clearing level. According to this theory, higher wages lead to higher productivity because workers are healthier, because workers will have higher morale and be less likely to surf the Internet at work for fear of losing their jobs, because good workers are less likely to quit and look for new jobs, and because higher wages may attract better workers.

As firms raise their wages to increase worker productivity, job seekers may be willing to stand in line for these high-paying jobs, thereby producing involuntary unemployment. The innovation in this theory is that involuntary unemployment is an equilibrium feature and will not disappear over time.

Supply-Side Economics

In the early 1980s, a group of economists and journalists developed a popular school known as **supply-side economics,** which emphasized incentives and tax cuts as a means of increasing economic growth. Supply-side economics was espoused forcefully by President Reagan in the United States (1981–1989) and by Prime Minister Thatcher in Great Britain (1979–1990).

Supply siders argued that Keynesians, in their excessive concern with the business cycle, had ignored the impact of tax rates and incentives on economic growth. According to supply siders, high taxes lead people to reduce their labor and capital supply. Indeed, supply-side economists like Arthur Laffer suggested that high tax rates might actually lower tax revenues. This *Laffer-curve* proposition holds that high tax rates shrink the tax base because they reduce economic activity. To fix what they view as an inefficient tax system, supply-side economists proposed a radical restructuring of the tax system, through an approach sometimes called "supply-side tax cuts."

After occupying center stage during the 1980s, the supply-side theories largely waned after Ronald Reagan left office. In studying this period, economists have generally found that many of the supply-side assertions were not supported by economic experience. Supply-side tax cuts produced lower, not higher, revenues.

Many of the supply-side policies were revived in 2001, when President George W. Bush successfully negotiated another round of income-tax cuts. These cuts were rationalized not by the argument that they would raise revenues but, instead, by the theory that they would improve the efficiency of the tax system

Eye Therapies Exhibit 2127, 663 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and raise the long-run rate of economic growth. Like their precursor in 1981, these tax cuts led to lower, rather than higher, tax revenues (see Table 31-1).

POLICY IMPLICATIONS

Policy Ineffectiveness

The new classical approaches have several important implications for macroeconomic policy. One of the most important contentions is the *ineffectiveness of systematic fiscal and monetary policies in reducing unemployment*. The basic idea here is that a predictable attempt to stimulate the economy would be known in advance and would therefore have no effect on the economy.

For example, suppose that the government has always stimulated the economy whenever elections were approaching. After a couple of episodes of politically motivated fiscal policy, people would rationally come to expect that behavior. They might say to themselves:

> Elections are coming. From experience I know that the government always pumps up the economy before elections. I will probably get an election-year tax cut, but that will be followed by a stealth tax increase next year. They can't fool me into consuming more, working harder, and voting for incumbents.

This is the **policy-ineffectiveness theorem** of classical macroeconomics. With rational expectations and flexible prices and wages, anticipated government policy cannot affect real output or unemployment.

The Desirability of Fixed Rules

We described the monetarist case for fixed rules in Chapter 24. New classical macroeconomics puts this argument on firmer footing. This approach holds that an economic policy can be divided into two parts, a predictable part (the "rule") and an unpredictable part ("discretion").

New classical macroeconomists argue that discretion is a snare and a delusion. Policymakers, they contend, cannot forecast the economy any better than can the private sector. Therefore, by the time policymakers act on the news, flexibly moving prices in markets populated by well-informed buyers and sellers have already adapted to the news and reached their efficient supply-and-demand equilibrium. There are no further *discretionary* steps the government can take to improve the outcome or prevent the unemployment that is caused by temporary misperceptions or real-business-cycle shocks.

Although they cannot make things better, government policies can definitely make things worse. The government can generate unpredictable discretionary policies that give misleading economic signals, confuse people, distort their economic behavior, and cause waste. According to new classical macroeconomists, governments should avoid any discretionary macroeconomic policies rather than risk producing such confusing "noise."

A New Synthesis?

After three decades of digesting the new classical approach to macroeconomics, elements of a synthesis of old and new theories are beginning to appear. Economists today emphasize the importance of expectations. A useful distinction is between the adaptive (or "backward-looking") approach and the rational (or "forward-looking") approach. The adaptive assumption holds that people form their expectations on the basis of past information; the forward-looking or rational approach was described above. The importance of forward-looking expectations is crucial to understanding behavior, particularly in competitive auction markets like those in the financial sector.

Some macroeconomists have begun to fuse the new classical view of expectations with the Keynesian view of product and labor markets. This synthesis is embodied in macroeconomic models that assume (1) labor and goods markets display inflexible wages and prices, (2) the prices in financial auction markets adjust rapidly to economic shocks and expectations, and (3) the expectations in auction markets are formed in a forward-looking way.

One important forecast of such new approaches is that forward-looking models tend to have large "jumps" or discontinuous changes in interest rates, stock prices, foreign exchange rates, and oil prices in reaction to major news. Sharp reactions are often seen after elections or when wars break out. For example, when the United States invaded Iraq in March 2003, oil prices declined by 35 percent and stock prices rose by 10 percent *in a single week*. The new classical prediction of "jumpy" prices replicates one realistic feature of auction markets and thus suggests one area where forward-looking expectations might be important in the real world.

Eye Therapies Exhibit 2127, 664 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The new classical approach to macroeconomics has brought many fruitful insights. Most important, it reminds us that the economy is populated by intelligent consumers and investors who react to and often anticipate policy. This reaction and counterreaction can actually change the way the economy behaves.

C. STABILIZING THE ECONOMY

The period since World War II has been one of remarkable economic progress for the high-income market democracies. Average incomes and employment grew rapidly, international trade broadened and deepened, and many poor countries, notably India and China, began to close the gap with rich countries.

The economies performed so well that some proclaimed a "Great Moderation," in which business cycles were disappearing. Some "new" economics textbooks virtually ignored the macroeconomics of business cycles.

This fantasy was dispelled with the financial crisis and deep recession that began in 2007. Words like "recession" and "depression"—which had been banished to the history books—again took on meaning in people's daily lives.

It is critical to find policies which can help avoid the excesses of the business cycle. We have seen that the path of output and prices is determined by the interaction of aggregate supply and aggregate demand. *However, policies designed to stabilize the business cycle must operate primarily through their impact on aggregate demand.* The government can affect the growth of aggregate demand primarily through the use of its monetary and fiscal levers and thereby counter recessions.

These observations leave open two crucial questions: What is the best mix of monetary and fiscal policies for stabilizing the economy? Should there be tight rules on policy-making, or should policymakers be allowed great discretion in their actions?

THE INTERACTION OF MONETARY AND FISCAL POLICIES

For large economies like the United States or Euroland, the best combination of monetary and fiscal policies will depend upon two factors: the need for demand management and the desired fiscal-monetary mix.

Demand Management

The top consideration in business-cycle management is the overall state of the economy and the need to adjust aggregate demand. When the economy is stagnating, fiscal and monetary policies can be used to stimulate the economy and promote economic recovery. When inflation threatens, monetary and fiscal policies can help slow the economy and dampen inflationary fires. These are examples of *demand management*, which refers to the active use of monetary and fiscal policies to affect the level of aggregate demand.

Suppose, for example, that the economy is entering a severe recession. Output is low relative to its potential. What can the government do to revive the lagging economy? It can increase aggregate demand by raising money growth or by boosting government spending or both. After the economy has responded to the monetary and fiscal stimulus, output growth and employment will increase and unemployment will fall. (What steps could the government take during inflationary periods?)

Let's review the relative strengths and weaknesses of monetary policy and fiscal policy.

The Role of Fiscal Policy. In the early stages of the Keynesian revolution, macroeconomists emphasized fiscal policy as the most powerful and balanced remedy for demand management. Critics of fiscal policy pointed to shortcomings stemming from timing, politics, and macroeconomic theory.

One concern is the time span between cyclical shock and policy response. It takes time to recognize that a cyclical turning point has been reached—the policy lag. For example, it took one year for the NBER to declare the latest business-cycle peak. (The December 2007 peak was not announced until December 2008.) After a turning point is identified, it takes time for the President to decide what policies are necessary and then still more time for the Congress to act. Finally, even when taxation or spending is changed, there is an effectiveness lag before the economy responds.

Critics also point out that it is easier to cut taxes than to raise them, and easier to raise spending than to cut it. During the 1960s, Congress was enthusiastic about passing the Kennedy-Johnson tax cuts. Two years later, when the Vietnam War expansion ignited inflationary pressures, contractionary policies were called for.

Eye Therapies Exhibit 2127, 665 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

There are two situations when countercyclical fiscal policies appear to be particularly useful. One case is temporary tax cuts in recessions. Temporary tax cuts may be aimed primarily at low- and middle-income households. The reason is that these households have high marginal propensities to consume because they have little excess saving to fall back on in hard times. Statistical studies indicate that these measures have indeed been effective in increasing aggregate demand in the short run without leading to long-run fiscal deficits.

An even more important situation is when the economy is in a liquidity trap and the central bank has no further room to lower short-term interest rates. (Recall our discussion of the liquidity trap in Chapter 24.) This was the case during the 2007–2009 recession. In its effort to revive the economy, the Obama administration worked with Congress in early 2009 to pass the largest fiscal stimulus package in U.S. history. While some people worried about the long-term impact of the fiscal stimulus on the government debt, most macroeconomists believed that fiscal policy was the only feasible way to reduce the depth and the severity of the downturn in this circumstance.

Effectiveness of Monetary Policy. Compared to fiscal policy, monetary policy operates much more indirectly on the economy. Whereas an expansive fiscal policy actually buys goods and services or puts income into the hands of consumers and businesses, monetary policy affects spending by altering interest rates, credit conditions, exchange rates, and asset prices. In the early years of the Keynesian revolution, some macroeconomists were skeptical about the effectiveness of monetary policy—some said, "Monetary policy was like pushing on a string." Over the last two decades, however, these concerns have been put to rest as the Federal Reserve has shown itself quite capable of slowing down, or speeding up, the economy.

The Federal Reserve is much better placed to conduct stabilization policy than are the fiscal-policy makers. Its staff of professional economists can recognize cyclical movements as well as anyone. And it can move quickly when the need arises. For example, a cascade of failures of financial institutions caused a major financial crisis when the investment-banking firm Bear, Stearns had severe liquidity problems on Friday, March 14, 2008. The Fed needed to come up with a solution before markets opened on Monday morning. By Sunday, working with the U.S. Treasury Department, the Fed had engineered a takeover of Bear by J.P. Morgan and had opened an entire new credit facility for its primary dealers. It is difficult to conceive of any legislature taking such complex measures in such a short time.

A key ingredient in Fed policy is its independence, and the Fed has proved that it can stand the heat of making politically unpopular decisions when they are necessary to slow inflation. Most important is that—with some qualifications—from the point of view of demand management, monetary policy can do, or undo, anything that fiscal policy can accomplish. The major reservation is that if the economy gets stuck in a liquidity trap, with nominal interest rates at or near zero, then monetary policy loses its ability to stimulate the economy. When the economy is in or near a liquidity trap, fiscal policy must therefore take over the major expansionary role.

We can summarize the current state of fiscal and monetary policy as follows:

Because of their political independence and rapid decision making, central banks are well placed to be on the front line of defense in stabilizing the economy against business-cycle shocks. Discretionary fiscal policy is useful in recessions as a one-time stimulus. When the economy approaches a liquidity trap, fiscal policy must be the primary source of economic stimulus.

The Fiscal-Monetary Mix

The second factor affecting fiscal and monetary policy is the desired **fiscal-monetary mix,** which refers to the relative strength of fiscal and monetary policies and their effect on different sectors of the economy. A *change in the fiscal-monetary mix* is an approach which tightens one policy while easing the other in such a way that aggregate demand and therefore total output remain constant. The basic idea is that fiscal policy and monetary policy are substitutes in demand management. But while alternative combinations of monetary and fiscal policies can be used to stabilize the economy, they have different impacts upon the *composition* of output. By varying the mix of taxes, government spending, and monetary policy, the government can change the fraction of GDP devoted to business investment, consumption, net exports, and government purchases of goods and services.

Eye Therapies Exhibit 2127, 666 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Sector		Change in output ($, billion, 2008 prices)
Investment sectors		**132**
Gross private domestic investment	48	
Housing	18	
Business fixed investment	30	
Net exports	83	
Consumption sectors		**−106**
Government purchases of goods and services	−68	
Personal consumption expenditures	−38	
Memoranda:		
Change in real GDP		26
Change in federal deficit		−100

TABLE 31-3. Changing the Fiscal-Monetary Mix

What would be the impact of a change in the fiscal-monetary mix for the United States? This simulation assumes that the federal deficit is cut by $100 billion through higher personal taxes and lower federal nondefense expenditures while the Federal Reserve uses monetary policy to keep unemployment on an unchanged trajectory. The simulation takes the average of the changes from the baseline path over the period 2000–2009.

Source: Simulation using the DRI model of the U.S. economy.

Effect of Changing the Mix of Monetary and Fiscal Policies. To understand the impact of changing the fiscal-monetary mix, let's examine a specific set of policies. Suppose that the federal government reduces the federal budget deficit by $100 billion and that the Fed lowers interest rates to offset the contractionary impact of such a fiscal policy.

We can estimate the impact using a quantitative economic model. Table 31-3 shows the results of this experiment. Two interesting features emerge: First, the simulation indicates that a change in the fiscal-monetary mix would indeed change the composition of real GDP. While the deficit declines by $100 billion, business investment goes up by $30 billion. Investment in housing also increases as interest rates fall. At the same time, personal consumption declines, freeing up resources for investment. This simulation shows how a change in the fiscal-monetary mix might change the composition of output.

The simulation contains one particularly interesting result: Net exports rise far more than either housing or business fixed investment. This occurs because of the strong depreciation of the dollar which results from the lower interest rates. While this result is clearly sensitive to the reaction of financial markets and exchange rates to the deficit-reduction package, it suggests that some of the popular analyses of the impact of such a package may be misleading. Many analysts have argued that a deficit-reduction package would have a significant impact upon domestic business investment and upon productivity. However, to the extent that lower deficits mainly increase net exports and housing, the nation is likely to experience relatively little increase in productivity growth. According to the estimates, cutting the budget deficit by $100 billion will raise the growth rate of potential output from 2.3 percent per year to 2.5 percent per year over a 10-year period. Perhaps the small size of the payoff explains why it is so hard to muster the political will to cut the deficit.



Alternative Mixes in Practice

The fiscal-monetary mix has been sharply debated in American economic policy. Here are two major alternatives:

- *Loose fiscal—tight monetary policy.* Assume that the economy begins in an initial situation with low inflation

Eye Therapies Exhibit 2127, 667 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and output at its potential. A new president decides that it is necessary to increase defense spending sharply without raising taxes. By itself, this would increase the government deficit and increase aggregate demand. In this situation, the Federal Reserve would need to tighten monetary policy to prevent the economy from overheating. The result would be higher real interest rates and an appreciation of the dollar exchange rate. The higher interest rates would squeeze investment, while the appreciated dollar would reduce net exports. The net effect therefore would be that the higher defense spending would crowd out domestic investment and net exports. This policy was the one followed by the United States in the 1980s and again in the 2000s.

- *Tight fiscal—loose monetary policy.* Suppose that a country becomes concerned about a low national saving rate and desires to raise investment so as to increase the capital stock and boost the growth rate of potential output. To implement this approach, the country could raise consumption taxes and squeeze transfer payments so as to reduce disposable income and thereby lower consumption (tight fiscal policy). This would be accompanied by an expansionary monetary policy to lower interest rates and raise investment, lower the exchange rate, and expand net exports. This course would encourage private investment by increasing public saving. This was the economic philosophy of President Clinton which was embodied in the 1993 Budget Act and led to the budget surplus at decade's end.

RULES VS. DISCRETION

We have seen that fiscal and monetary policy can *in principle* stabilize the economy. Many economists believe that countries should *in practice* take steps to shave the peaks and troughs off the business cycle. Other economists are skeptical of our ability to forecast cycles and take the right steps at the right time for the right reasons; this second group concludes that government cannot be trusted to make good economic policy, so its freedom to act should be strictly limited.

For example, fiscal conservatives worry that it's easier for Congress to increase spending and cut taxes than to do the reverse. That means it's easy to increase the budget deficit during recessions but much harder to turn around and shrink the deficit again during booms, as a countercyclical fiscal policy would require. For that reason, conservatives have made several attempts to limit the ability of Congress to appropriate new funds or increase the deficit.

At the same time, monetary conservatives would like to tie the hands of central banks and force them to target inflation. Such a policy would eliminate the uncertainty about policy and enhance the credibility of the central bank as an inflation fighter.

At the most general level, the debate about "rules versus discretion" boils down to whether the advantages of flexibility in decision making are outweighed by the uncertainties and potential abuse in unconstrained decisions. Those who believe that the economy is inherently unstable and complex and that governments generally make wise decisions are comfortable with giving policymakers wide discretion to react aggressively to stabilize the economy. Those who believe that the government is the major destabilizing force in the economy and that policymakers are prone to selfishness and misjudgments favor tying the hands of the fiscal and monetary authorities.

Budget Constraints on Legislatures?

As deficits began to grow during the 1980s, many people argued that Congress lacks the self-control to curb excessive spending and a burgeoning government debt. One proposal put forth by conservatives was a *constitutional amendment requiring a balanced budget.* Such an amendment was criticized by economists because it would make it difficult to use fiscal policy to fight recessions. To date, none of the proposed constitutional amendments has passed Congress.

Instead, Congress legislated a series of *budgetary rules to limit spending and tax reductions.* The first attempt was the Gramm-Rudman Act in 1985, which required that the deficit be reduced by a specified dollar amount each year and that the budget be balanced by 1991. This approach failed to limit spending and was abandoned.

A second approach was a *pay-as-you-go budget rule,* which was adopted in 1990. This required that Congress find the revenues to pay for any new spending program. In a sense, pay-as-you-go imposes a budget constraint on Congress, requiring that the costs of new programs be explicitly recognized either through higher taxes or through a reduction in other spending.

What was the impact of the budget constraints on Congress? Economic studies indicate that the

Eye Therapies Exhibit 2127, 668 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

budget rules produced significant fiscal discipline, helped reduce the deficit over the 1990s, and eventually produced the surplus after 1998. However, when the deficit changed to surplus and the urgency of deficit-reduction declined, policymakers evaded the earlier budget caps with gimmicks like "emergency spending" for predictable items like the decennial census. Finally, in 2002, the budget caps were allowed to expire. Many economists believe that a pay-as-you-go rule is a useful mechanism to impose budget constraints on legislatures, and there were proposals to reinstate these in 2009.

Monetary Rules for the Fed?

In our discussion of monetarism in Chapter 24, we laid out the case for fixed policy rules. The traditional argument for fixed rules is that the private economy is relatively stable and active policy-making is likely to destabilize rather than stabilize the economy. Moreover, to the extent that a central bank under the thumb of the government may be tempted to expand the economy before elections and to create a political business cycle, fixed rules will tie its hands. In addition, modern macroeconomists point to the value of being able to commit to action in advance. If the central bank can commit to follow a noninflationary rule, people's expectations will adapt to this rule and inflationary expectations may be dampened.

One of the most important new developments in the last decade has been the trend toward inflation targeting in many countries. **Inflation targeting** is the announcement of official target ranges for the inflation rate along with an explicit statement that low and stable inflation is the overriding goal of monetary policy. Inflation targeting in hard or soft varieties has been adopted in recent years by many industrialized countries, including Canada, Britain, Australia, and New Zealand. Moreover, the treaty authorizing the new European Central Bank mandates that price stability be the ECB's primary objective, although it is not formally required to target inflation. A number of economists and legislators are advocating this approach for the United States as well.

Inflation targeting involves the following:

- The government or central bank announces that monetary policy will strive to keep inflation near a numerically specified target.
- The target usually involves a range, such as 1 to 3 percent per year, rather than literal price stability. Generally, the government targets a core inflation rate, such as the CPI excluding volatile food and energy prices.
- Inflation is the primary or overriding target of policy in the medium run and long run. However, countries always make room for short-run stabilization objectives, particularly with respect to output, unemployment, financial stability, and the foreign exchange rate. These short-run objectives recognize that supply shocks can affect output and unemployment and that it may be desirable to have temporary departures from the inflation target to avoid excessive unemployment or output losses.

Proponents of inflation targeting point to many advantages. If there is no long-run tradeoff between unemployment and inflation, a sensible inflation target is that rate which maximizes the efficiency of the price system. Our analysis of inflation in Chapter 30 suggested that a low and stable rate of inflation would promote efficiency and minimize unnecessary redistribution of income and wealth. In addition, some economists believe that a strong and credible commitment to low and stable inflation will improve the short-run inflation-unemployment tradeoff. Finally, an explicit inflation target would increase the transparency of monetary policy.

Inflation targeting is a compromise between rule-based approaches and purely discretionary policies. The main disadvantage would come if the central bank began to rely too rigidly on the inflation rule and thereby allowed excessive unemployment in periods of severe supply shocks. Skeptics worry that the economy is too complex to be governed by fixed rules. Arguing by analogy, they ask whether one would advocate a fixed speed limit for cars or an automatic pilot for aircraft in all kinds of weather and emergencies.

Critics point to the financial crisis of 2007–2009 as an example of the peril of relying on rigid targets. The Fed lowered interest rates and expanded credit throughout this period, even though supply shocks were raising inflation above the Fed's "comfort zone." If the Fed had focused entirely on inflation under an inflation-targeting approach, it would have raised interest rates, tightened credit, and reinforced the recessionary tendencies and economic distress in

Eye Therapies Exhibit 2127, 669 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

this period. Instead, the Fed concentrated on trying to cushion the economy from a deep recession and to prevent wholesale bankruptcies of financial institutions (see the discussion of Bear, Stearns above).

Monetary policy cannot banish all recessions or remove every temporary spike of inflation. However, working with fiscal policy, it can reduce the chance of spiraling contractions or hyperinflation.

The debate over rules versus discretion is one of the oldest debates of political economy. This dilemma reflects the difficult tradeoffs that democratic societies face in making decisions between short-run policies intended to attract political support and long-run policies designed to improve the general welfare. There is no single best approach for all times and places. For monetary policy, the United States has resolved the dilemma by creating an independent central bank, accountable to the legislature but given discretion to act forcefully when economic or financial crises arise.

Country	Per capita GDP, 2006
United States	44,070
Hong Kong	39,200
United Kingdom	33,650
Japan	32,840
Germany	32,680
Slovenia	23,970
South Korea	22,990
Poland	14,250
Mexico	11,990
Botswana	11,730
Argentina	11,670
China	4,660
Nigeria	1,410
Congo	270

TABLE 31-4. Current Incomes Represent Effects of Past Growth

Those countries that have grown most rapidly in the past have reached the highest levels of per capita GDP today.

Source: World Bank.

D. ECONOMIC GROWTH AND HUMAN WELFARE

We have come to the end of our survey of modern macroeconomics. Let us step back and reflect on the central long-run message as stated by economist-journalist Paul Krugman:

> Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its living standards over time depends almost entirely on its ability to raise its output per worker.

Promoting a high and growing standard of living for the nation's residents is one of the fundamental goals of macroeconomic policy. Because the current *level* of real income reflects the history of the *growth* of productivity, we can measure the relative success of past growth by examining the per capita GDPs of different countries. A short list is presented in Table 31-4. This table compares incomes by using *purchasing-power-parity* exchange rates that measure the purchasing power of (or quantity of goods and services that can be bought by) different national currencies. Evidently, the United States has been successful in its past growth performance. Perhaps the most worrisome issue in recent years is that the growth in living standards has not been universally shared around the world.

In discussions of growth rates, the numbers often seem tiny. A successful policy might increase a country's growth rate by only 1 percentage point per year (recall the estimated impact of the deficit-reduction package in the last section). But over long periods, this makes a big difference. Table 31-5 shows how tiny acorns grow into mighty oaks as small growth-rate differences cumulate and compound over time. A 4 percent-per-year growth difference leads to a 50-fold difference in income levels over a century.

How can public policy boost economic growth? As we emphasized in our chapters on economic growth, the growth of output per worker and of living standards depends upon a country's saving rate and upon its technological advance. Issues involving saving were discussed earlier in this chapter. Technological change includes not only new products and processes but also improvements in management as well as entrepreneurship and the spirit of enterprise—and we close our discussion with this topic.

Eye Therapies Exhibit 2127, 670 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Growth rate (% per year)	Real Income per Capita (constant prices) 2000	2050	2100
0	$ 24,000	$ 24,000	$ 24,000
1	24,000	39,471	64,916
2	24,000	64,598	173,872
4	24,000	170,560	1,212,118

TABLE 31-5. Small Differences in Growth Rates Compound into Large Income Differentials over the Decades

THE SPIRIT OF ENTERPRISE

Although investment is a central factor in economic growth, technological advance is perhaps even more important. If we took the workers in 1900 and doubled or tripled their capital in mules, saddles, picks, and cow paths, their productivity still could not come close to that of today's workers using huge tractors, superhighways, and supercomputers.

Fostering Technological Advance

While it is easy to see how technological advance promotes growth in productivity and living standards, governments cannot simply command people to think harder or be smarter. Centrally planned socialist countries used "sticks" to promote science, technology, and innovation, but their efforts failed because neither the institutions nor the "carrots" were present to encourage both innovation and introduction of new technologies. Governments often promote rapid technological change best when they set a sound economic and legal framework with strong intellectual property rights and then allow great economic freedom within that framework. *Free markets in labor, capital, products, and ideas have proved to be the most fertile soil for innovation and technological change.*

Within the framework of free markets, governments can foster rapid technological change both by encouraging new ideas and by ensuring that technologies are effectively used. Policies can focus on both the supply side and the demand side.

Promoting Demand for Better Technologies. The world is full of superior technologies that have not been adopted; otherwise, how could we explain the vast differences in productivity shown in Table 31–4? In considering technology policies, therefore, governments must ensure that firms and industries move toward the *technological frontier*, adopting the best-practice technology available in the global marketplace.

The major lesson here is that "necessity is the mother of invention." In other words, vigorous competition among firms and industries is the ultimate discipline that ensures innovation. Just as athletes perform better when they are trying to outrun their competitors, so are firms spurred to improve their products and processes when the victors are given fame and fortune while the laggards may go bankrupt.

Vigorous competition involves both domestic and foreign competitors. For large countries on the technological frontier, domestic competition is necessary to promote innovation. The movement to deregulation over the last three decades has brought competition to airlines, energy, telecommunications, and finance, and the positive impact on innovation has been dramatic. For small or technologically backward countries, import competition is crucial to adopting advanced technologies and ensuring product market competition.

Promoting Supply of New Technologies. Rapid economic growth requires pushing out the technological frontier by increasing the supply of inventions as well as ensuring that there is adequate demand for existing advanced technologies. There are three ways by which governments can encourage the supply of new technologies.

First, governments can ensure that the basic science, engineering, and technology are appropriately supported. In this respect, the world leader in the

Eye Therapies Exhibit 2127, 671 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

last half-century has been the United States, which combines company support for applied research with top-notch university basic research generously supported by government funding. Particularly outstanding have been the impressive improvements in biomedical technology in the form of new drugs and equipment that benefit consumers directly in daily life. The government's role in supporting for-profit research is accomplished by a strong patent system, predictable and cost-effective regulations, and fiscal incentives such as the current R&D tax credit.

Second, governments can advance technologies at home through encouraging investment by foreign firms. As foreign countries reach and pass the American technological frontier, they can also contribute to American know-how by establishing operations in the United States. The last two decades have brought a number of Japanese automakers to the United States, and Japanese-owned plants have introduced new technologies and managerial practices to the benefit of both the profits of Japanese shareholders and the productivity of American workers.

Third, governments can promote new technologies by pursuing sound macroeconomic policies. These include low and stable taxes on capital income and a low cost of capital to firms. Indeed, the importance of the cost of capital brings us back full circle to the issue of the low saving rate and high real interest rate. American firms are sometimes accused of being myopic and being unwilling to invest for the long run. At least part of this myopia comes from being faced with high real interest rates—high real interest rates *force* rational American firms to look for quick payoffs in their investments. A change in economic policy that lowered real interest rates would change the "economic spectacles" through which firms look when considering their technological policies. If real interest rates were lower, firms would view long-term, high-risk projects such as investments in technology more favorably, and the increased investment in knowledge would lead to more rapid improvements in technology and productivity.



Valediction on Economic Growth

Following the Keynesian revolution, the leaders of the market democracies believed that they could flourish and grow rapidly. By using the tools of modern economics, countries could moderate the extremes of unemployment and inflation, poverty and wealth, privilege and deprivation. Indeed, many of these goals were achieved as the market economies experienced a period of output expansion and employment growth never seen before.

At the same time, Marxists carped that capitalism was doomed to crash in a cataclysmic depression; ecologists fretted that market economies would choke on their own fumes; and libertarians worried that government planning was leading us down the road to serfdom. But the pessimists overlooked the spirit of enterprise, which was nurtured by an open society and free markets and which led to a continuous stream of technological improvements.

A valediction from John Maynard Keynes, as timely today as it was in an earlier age, provides a fitting summary of our survey of modern economics:

> It is Enterprise which builds and improves the world's possessions. If Enterprise is afoot, wealth accumulates whatever happens to Thrift; and if Enterprise is asleep, wealth decays whatever Thrift may be doing.



SUMMARY

A. The Economic Consequences of the Government Debt

1. Budgets are systems used by governments and organizations to plan and control expenditures and revenues. Budgets are in surplus (or deficit) when the government has revenues greater (or less) than its expenditures. Macroeconomic policy depends upon fiscal policy, which comprises the overall stance of spending and taxes.
2. Economists separate the actual budget into its structural and cyclical components. The structural budget calculates how much the government would collect

Eye Therapies Exhibit 2127, 672 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and spend if the economy were operating at potential output. The cyclical budget accounts for the impact of the business cycle on tax revenues, expenditures, and the deficit. To assess fiscal policy, we should pay close attention to the structural deficit; changes in the cyclical deficit are a *result* of changes in the economy, while structural deficits are a *cause* of changes in the economy.

3. The government debt represents the accumulated borrowings from the public. It is the sum of past deficits. A useful measure of the size of the debt is the debt-GDP ratio, which for the United States has tended to rise during wartime and fall during peacetime.
4. In understanding the impact of government deficits and debt, it is crucial to distinguish between the short run and the long run. Review the box on page 638 and make sure you understand why a larger deficit can increase output in the short run while decreasing output in the long run.
5. To the degree that we borrow from abroad for consumption and pledge posterity to pay back the interest and principal on such external debt, our descendants will indeed find themselves sacrificing consumption to service this debt. If we leave future generations an internal debt but no change in capital stock, there are various internal effects. The process of taxing Peter to pay Paula, or taxing Paula to pay Paula, can involve various microeconomic distortions of productivity and efficiency but should not be confused with owing money to another country.
6. Economic growth may slow if the public debt displaces capital. This syndrome occurs when people substitute public debt for capital or private assets, thereby reducing the economy's private capital stock. In the long run, a larger government debt may slow the growth of potential output and consumption because of the costs of servicing an external debt, the inefficiencies that arise from taxing to pay the interest on the debt, and the diminished capital accumulation that comes from capital displacement.

B. Advances in Modern Macroeconomics

7. Classical economists relied upon Say's Law of Markets, which holds that "supply creates its own demand." In modern language, the classical approach means that flexible wages and prices quickly remove any excess supply or demand and thereby reestablish full employment. In a classical system, macroeconomic policy has no role to play in stabilizing the real economy, although it will still affect the path of prices.
8. New classical macroeconomics holds that expectations are rational, prices and wages are flexible, and unemployment is largely voluntary. The policy-ineffectiveness theorem holds that predictable government policies cannot affect real output and unemployment. The theory of the real business cycle points to supply-side technological disturbances and to labor market shifts as the clues to business-cycle fluctuations.
9. What is our appraisal of the contribution of the new classical approach to short-run macroeconomics? The new classical approach properly insists that the economy is populated by forward-looking consumers and investors. These economic actors react to and often anticipate policy and can thereby change economic behavior. This lesson is particularly important in financial markets, where reactions and anticipations often have dramatic effects.

C. Stabilizing the Economy

10. Nations face two considerations in setting monetary and fiscal policies: the appropriate level of aggregate demand and the best monetary-fiscal mix. The mix of fiscal and monetary policies helps determine the composition of GDP. A high-investment strategy would call for a budget surplus along with low real interest rates.
11. Should governments follow fixed rules or discretion? The answer involves both positive economics and normative values. Conservatives often espouse rules, while liberals often advocate active fine-tuning to attain economic goals. More basic is the question of whether active and discretionary policies stabilize or destabilize the economy. Economists often stress the need for *credible* policies, whether credibility is generated by rigid rules or by wise leadership. A recent trend among countries is inflation targeting for monetary policy, which is a flexible rule-based system that sets a medium-term inflation target while allowing short-run flexibility when economic shocks make attaining a rigid inflation target too costly.

D. Economic Growth and Human Welfare

12. Remember the dictum: "Productivity isn't everything, but in the long run it is almost everything." A country's ability to improve its living standards over time depends almost entirely on its ability to improve the technologies and capital used by the workforce.
13. Promoting economic growth entails advancing technology. The major role of government is to ensure free markets, protect strong intellectual property rights, promote vigorous competition, and support basic science and technology.

Eye Therapies Exhibit 2127, 673 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

CONCEPTS FOR REVIEW

The Economics of Debt and Deficits

government budget
budget deficit, surplus, and balance
budget:
  actual
  structural
  cyclical
short-run impact of *G* and *T* on output
long-run impacts on economic growth:
  internal vs. external debt
  distortions from taxation
  displacement of capital

Advances in Modern Macroeconomics

Say's Law of Markets
rational (forward-looking) expectations, adaptive (backward-looking) expectations
policy-ineffectiveness theorem
real business cycle, efficiency wages
Ricardian view of fiscal policy

Stabilization

demand management
fiscal-monetary mix
fixed rules vs. discretion
inflation targeting

Long-Run Growth

reaching the technological frontier vs. moving it outward
Keynes's spirit of enterprise

FURTHER READING AND INTERNET WEBSITES

Further Reading

The Krugman quotation is from Paul Krugman, *The Age of Diminished Expectations* (MIT Press, Cambridge, Mass., 1990), p. 9. Many of the foundations of new classical economics were developed by Robert Lucas and republished in *Studies in Business-Cycle Theory* (MIT Press, Cambridge, Mass., 1990). Modern efficiency-wage theory is presented in Edmund Phelps, *Structural Slumps: The Modern Equilibrium Theory of Unemployment, Interest, and Assets* (Harvard University Press, Cambridge, Mass., 1994).

A nontechnical review of the different schools of macroeconomics is provided by Paul Krugman, *Peddling Prosperity: Economic Sense and Nonsense in the Age of Diminished Expectations* (Norton, New York, 1994).

Websites

Economic issues and data on fiscal policy, budgets, and the debt are regularly provided by the nonpartisan Congressional Budget Office, which is staffed by professional economists. Recent documents are available at *www.cbo.gov.*

A survey of issues involved in inflation targeting can be found in a 2003 speech by Fed chair Ben Bernanke, "A Perspective on Inflation Targeting," at *www.federalreserve.gov/Boarddocs/Speeches/2003/20030325/default.htm*. Real-business-cycle theory has its own website at *dge.repec.org/index.html.*

QUESTIONS FOR DISCUSSION

1. A common confusion is that between the debt and the deficit. Explain each of the following:
   a. A budget deficit leads to a growing government debt.
   b. Reducing the deficit does not reduce the government debt.
   c. Reducing the government debt requires running a budget surplus.
   d. Even though the government deficit was reduced in the 1993–1998 period, the government debt still rose in these years.
2. Is it possible that government *promises* might have a displacement effect along with government debt? Thus, if the government were to promise large future social security benefits to workers, would workers feel richer? Might they reduce saving as a result? Could

Eye Therapies Exhibit 2127, 674 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the capital stock end up smaller? Illustrate using Figure 31-2.

3. Trace the impact upon the government debt, the nation's capital stock, and real output of a government program that borrows abroad and spends the money on the following:
   a. Capital to drill for oil, which is exported (as did Mexico in the 1970s)
   b. Grain to feed its population (as did Nigeria in the 2000s)
4. Construct a graph like that in Figure 31-3 showing:
   a. The paths of consumption and net exports with and without a large government debt
   b. The paths of consumption with a balanced budget and with a government fiscal surplus
5. Review the debate between the senators on page 638. Explain which senator would be correct in the following situations:
   a. The government increased military spending during the Great Depression.
   b. The government reduced tax rates during a period of full employment in the early 1960s.
   c. The government refused to raise taxes during the full-employment period of the Vietnam War.
6. Suppose someone advocates that monetary policy should target a specific inflation rate every year—say, 2 percent per year for the CPI. What are the various arguments for and against this proposal? Specifically, consider the difficulties of attaining a strict inflation target after a sharp supply shock shifts the Phillips curve up. Compare a rigid inflation target with a flexible inflation target in which the target would be attained at the end of a 5-year period.
7. Political candidates have proposed the policies listed below to speed economic growth in recent years. For each, explain qualitatively the impact upon the growth of potential output and upon the growth of per capita potential output. If possible, give a quantitative estimate of the increase in the growth of potential output and per capita potential output over the next decade.
   a. Cut the federal budget deficit (or raise the surplus) by 2 percent of GDP, increasing the ratio of investment to GDP by the same amount.
   b. Increase the federal subsidy to R&D by ½ percent of GDP, assuming that this subsidy will increase private R&D by the same amount and that R&D has a social rate of return that is 4 times that of private investment.
   c. Decrease defense spending by 1 percent of GDP at full employment.
   d. Decrease the number of immigrants so that the labor force declines by 5 percent.
   e. Increase investments in human capital (or education and on-the-job training) by 1 percent of GDP.
8. J. M. Keynes wrote, "If the Treasury were to fill old bottles with banknotes, bury them in disused coal mines, and leave it to private enterprise to dig the notes up again, there need be no more unemployment and the real income of the community would probably become a good deal greater than it actually is" (*The General Theory*, p. 129). Explain why Keynes's analysis of the utility of a discretionary public-works program might be correct during a depression. How could well-designed monetary policies have the same impact on employment while producing a larger quantity of useful goods and services?
9. What would Keynesians and new classical macroeconomists predict to be the impacts of each of the following on the course of prices, output, and employment? In each case, hold tax rates and interest rates constant unless specifically mentioned:
   a. A large tax cut
   b. A large cut in interest rates
   c. A wave of innovations that increases potential output by 10 percent
   d. A burst of exports
10. **Advanced problem** (on rational expectations): Consider the effect of rational expectations on consumption behavior.
   a. Say that the government proposes a temporary tax cut of $20 billion, lasting for a year. Consumers with adaptive expectations consequently assume that their disposable incomes would be $20 billion higher every year. What would be the resulting impact on consumption spending and GDP in the simple multiplier model of Chapter 22?
   b. Next suppose that consumers have rational expectations. They rationally forecast that the tax cut is only for 1 year. Being "life-cycle" consumers, they recognize that their average lifetime incomes will increase by only $2 billion per year, not by $20 billion per year. What would be the reaction of such consumers? Analyze, then, the impact of rational expectations on the effectiveness of temporary tax cuts.
   c. Finally, assume that consumers behave according to the Ricardian view. What would be the impact of the tax cut on saving and consumption? Explain the differences between the models discussed in **a, b,** and **c.**

Eye Therapies Exhibit 2127, 675 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Glossary of Terms[1]

A

Ability-to-pay principle (of taxation). The principle that one's tax burden should depend upon the ability to pay as measured by income or wealth. This principle does not specify *how much* more those who are better off should pay.

Absolute advantage (in international trade). The ability of Country A to produce a commodity more efficiently (i.e., with greater output per unit of input) than Country B. Possession of such an absolute advantage does not necessarily mean that A can export this commodity to B successfully. Country B may still have the comparative advantage.

Actual, cyclical, and structural budget. The *actual budget* deficit or surplus is the amount recorded in a given year. This is composed of the *structural budget,* which calculates what government revenues, expenditures, and deficits would be if the economy were operating at potential output, and the *cyclical budget,* which measures the effect of the business cycle on the budget.

Adaptive expectations. See **expectations.**

Adverse selection. A type of market failure in which those people with the highest risk are the most likely to buy insurance. More broadly, adverse selection encompasses situations in which sellers and buyers have different information about a product, such as in the market for used cars.

Aggregate demand. Total planned or desired spending in the economy during a given period. It is determined by the aggregate price level and influenced by domestic investment, net exports, government spending, the consumption function, and the money supply.

Aggregate demand (*AD*) curve. The curve showing the relationship between the quantity of goods and services that people are willing to buy and the aggregate price level, other things equal. As with any demand curve, important variables lie behind the aggregate demand curve, e.g., government spending, exports, and the money supply.

Aggregate supply. The total value of goods and services that firms would willingly produce in a given time period. Aggregate supply is a function of available inputs, technology, and the price level.

Aggregate supply (*AS*) curve. The curve showing the relationship between the output firms would willingly supply and the aggregate price level, other things equal. The *AS* curve tends to be vertical at potential output in the very long run but may be upward-sloping in the short run.

Allocative efficiency. See **Pareto efficiency.**

Appreciation (of a currency). See **depreciation** (of a currency).

Appropriable. Term applied to resources for which the owner can capture the full economic value. In a well-functioning competitive market, appropriable resources are priced and allocated efficiently. Also refer to **inappropriable.**

Arbitrage. The purchase of a good or asset in one market for immediate resale in another market in order to profit from a price discrepancy. Arbitrage is an important force in eliminating price discrepancies, thereby making markets function more efficiently.

Asset. A physical property or intangible right that has economic value. Important examples are plant, equipment, land, patents, copyrights, and financial instruments such as money or bonds.

Asymmetric information. A situation where one party to a transaction has better information than the other party. This often leads to a market failure or even to no market at all.

Automatic (or built-in) stabilizers. The property of a government tax and spending system that cushions income changes in the private sector. Examples include unemployment compensation and progressive income taxes.

[1] Words in bold type within definitions appear as separate entries in the glossary. For a more detailed discussion of particular terms, the text will provide a useful starting point. More complete discussions are contained in Douglas Greenwald, ed., *The McGraw-Hill Encyclopedia of Economics* (McGraw-Hill, New York, 1994), and David W. Pearce, *The MIT Dictionary of Modern Economics,* 4th ed. (Macmillan, London, 1992). For a comprehensive encyclopedia, see Steven N. Durlauf and Lawrence E. Blume, *The New Palgrave Dictionary of Economics,* 8 vols. (Macmillan, London, 2008). A reasonably accurate online dictionary by *The Economist* is at *www.economist.com/research/economics/.*

Eye Therapies Exhibit 2127, 676 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Average cost. Refer to **cost, average.**

Average cost curve, long-run (*LRAC*, or *LAC*). The graph of the minimum average cost of producing a commodity for each level of output, assuming that technology and input prices are given but that the producer is free to choose the optimal size of plants.

Average cost curve, short-run (*SRAC*, or *SAC*). The graph of the minimum average cost of producing a commodity for each level of output, using the given state of technology, input prices, and existing plant.

Average fixed cost. Refer to **cost, average fixed.**

Average product. Total product or output divided by the quantity of one of the inputs. Hence, the average product of labor is defined as total product divided by the amount of labor input, and similarly for other inputs.

Average revenue. Total revenue divided by total number of units sold—i.e., revenue per unit. Average revenue is generally equal to price.

Average tax rate. Total taxes divided by total income; also known as *effective tax rate.*

Average variable cost. Refer to **cost, average variable.**

B

Balance of international payments. A statement showing all of a nation's transactions with the rest of the world for a given period. It includes purchases and sales of goods and services, gifts, government transactions, and capital movements.

Balance of trade. The part of a nation's balance of payments that deals with imports or exports of *goods,* including such items as oil, capital goods, and automobiles. When services and other current items are included, this measures the *balance on current account.* In balance-of-payments accounting, the current account is financed by the *financial account.*

Balance on current account. See **balance of trade.**

Balance sheet. A statement of the financial position of an entity (person, firm, government) as of a given date, listing **assets** in one column and **liabilities** plus **net worth** in the other. Each item is listed at its actual or estimated money value. Totals of the two columns must balance because net worth is defined as assets minus liabilities.

Balanced budget. Refer to **budget, balanced.**

Bank, commercial. A financial intermediary whose prime distinguishing feature is that it accepts checkable deposits. All financial institutions that hold savings and checkable deposits are called depository institutions.

Bank money. Money created by banks, particularly the checking accounts (part of M_1) that are generated by a multiple expansion of bank reserves.

Bank reserves. Refer to **reserves, bank.**

Barriers to entry. Factors that impede entry into a market and thereby reduce the amount of competition or the number of producers in an industry. Important examples are legal barriers, regulation, and product differentiation.

Barter. The direct exchange of one good for another without using anything as money or as a medium of exchange.

Benefit principle (of taxation). The principle that people should be taxed in proportion to the benefits they receive from government programs.

Bond. An interest-bearing certificate issued by a government or corporation, promising to repay a sum of money (the principal) plus interest at a specified date in the future.

Break-even point (in macroeconomics). For an individual, family, or community, that level of income at which 100 percent is spent on consumption (i.e., the point where there is neither saving nor dissaving). Positive saving begins at higher income levels.

Broad money (M_2). A measure of the **money supply** that includes transactions money (or M_1) as well as savings accounts in banks and similar assets that are very close substitutes for transactions money.

Budget. An account, usually for a year, of planned expenditures and expected receipts. For a government, the receipts are tax revenues. See also **actual, cyclical,** and **structural budget.**

Budget, balanced. A budget in which total expenditures just equal total receipts (excluding any receipts from borrowing).

Budget constraint. See **budget line.**

Budget deficit. For a government, the excess of total expenditures over total receipts, with borrowing not included among receipts. This difference (the deficit) is ordinarily financed by borrowing.

Budget line. A line indicating the combination of commodities that a consumer can buy with a given income at a given set of prices. Also sometimes called the *budget constraint.*

Budget surplus. Excess of government revenues over government spending; the opposite of *budget deficit.*

Business cycles. Fluctuations in total national output, income, and employment, usually lasting for a period of 2 to 10 years, marked by widespread and simultaneous expansion or contraction in many sectors of the economy.

C

***C + I + G + NX* schedule.** A schedule showing the planned or desired levels of aggregate demand for each level of GDP, or the graph on which this schedule is depicted.

Eye Therapies Exhibit 2127, 677 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

The schedule includes consumption (C), investment (I), government spending on goods and services (G), and net exports (NX).

Capital (capital goods, capital equipment). (1) In economic theory, one of the triad of productive inputs (land, labor, and capital). Capital consists of durable produced items that are in turn used in production. (2) In accounting and finance, "capital" means the total amount of money subscribed by the shareholder-owners of a corporation, in return for which they receive shares of the company's stock.

Capital consumption allowance. See **depreciation** (of an asset).

Capital deepening. In economic-growth theory, an increase in the capital-labor ratio. (Contrast with **capital widening.**)

Capital gains. The rise in value of a capital asset, such as land or common stocks, the gain being the difference between the sales price and the purchase price of the asset.

Capital markets (also **financial markets**). Markets in which financial resources (money, bonds, stocks) are traded. These, along with **financial intermediaries,** are institutions through which saving in the economy is transferred to investors.

Capital-output ratio. In economic-growth theory, the ratio of the total capital stock to annual GDP.

Capital widening. A rate of growth in real capital stock just equal to the growth of the labor force (or of the population), so the ratio between total capital and total labor remains unchanged. (Contrast with **capital deepening.**)

Capitalism. An economic system in which most property (land and capital) is privately owned. In such an economy, private markets are the primary vehicles used to allocate resources and generate incomes.

Cardinal utility. See **ordinal utility.**

Cartel. An organization of independent firms producing similar products that work together to raise prices and restrict output. Cartels are illegal under U.S. antitrust laws.

Central bank. A government-established agency (in the United States, the Federal Reserve System) responsible for controlling the nation's money supply and credit conditions and for supervising the financial system, especially commercial banks and other depository institutions.

Change in demand vs. change in quantity demanded. A change in the quantity buyers want to purchase, prompted by any reason other than a change in price (e.g., increase in income, change in tastes), is a *change in demand.* In graphical terms, it is a shift of the demand curve. If, in contrast, the decision to buy more or less is prompted by a change in the good's price, then it is a *change in quantity demanded.* In graphical terms, a change in quantity demanded is a movement along an unchanging demand curve.

Change in supply vs. change in quantity supplied. This distinction for supply is the same as that for demand, so see **change in demand vs. change in quantity demanded.**

Checking accounts (also **checkable deposits** and **bank money**). A deposit in a commercial bank or other financial intermediary upon which checks can be written and which is therefore transactions money (or M_1). Checkable deposits are about half of M_1.

Chicago School of Economics. A group of economists (among whom Henry Simons, F. A. von Hayek, and Milton Friedman have been the most prominent) who believe that competitive markets free of government intervention will lead to the most efficient operation of the economy.

Classical approach. See **classical economics.**

Classical economics. The predominant school of economic thought prior to the appearance of Keynes's work; founded by Adam Smith in 1776. Other major figures who followed Smith include David Ricardo, Thomas Malthus, and John Stuart Mill. By and large, this school believed that economic laws (particularly individual self-interest and competition) determine prices and factor rewards and that the price system is the best possible device for resource allocation.

Classical macroeconomics. See **classical theories**.

Classical theories (in **macroeconomics**). Theories emphasizing the self-correcting forces in the economy. In the classical approach, there is generally full employment, and policies to stimulate aggregate demand have no impact upon output.

Clearing market. A market in which prices are sufficiently flexible to equilibrate supply and demand very quickly. In markets that clear, there is no rationing, unemployed resources, or excess demand or supply. In practice, this is thought to apply to many commodity and financial markets but not to labor or many product markets.

Closed economy. See **open economy.**

Collective bargaining. The process of negotiations between a group of workers (usually a union) and their employer. Such bargaining leads to an agreement about wages, fringe benefits, and working conditions.

Collusion. An agreement between different firms to cooperate by raising prices, dividing markets, or otherwise restraining competition.

Collusive oligopoly. A market structure in which a small number of firms (i.e., a few oligopolists) collude and jointly make their

Eye Therapies Exhibit 2127, 678 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

decisions. When they succeed in maximizing their joint profits, the price and quantity in the market closely approach those prevailing under monopoly.

Command economy. A mode of economic organization in which the key economic functions—*what, how,* and *for whom*—are principally determined by government directive. Sometimes called a *centrally planned economy.*

Commodity money. Money with **intrinsic value;** also, the use of some commodity (cattle, beads, etc.) as money.

Common currency. A situation where several countries form a monetary union with a single currency and a unified central bank; e.g., the European Monetary Union (EMU), which introduced the Euro in 1999.

Common stock. The financial instrument representing ownership and, generally, voting rights in a corporation. A certain share of a company's stock gives the owner title to that fraction of the votes, net earnings, and assets of the corporation.

Communism. A communist economic system (also called *Soviet-style central planning*) is one in which the state owns and controls the means of production, particularly industrial capital. Such economies are also characterized by extensive central planning, with the state setting many prices, output levels, and other important economic variables.

Comparative advantage (in international trade)**.** The law of comparative advantage says that a nation should specialize in producing and exporting those commodities which it can produce at *relatively* lower cost and that it should import those goods for which it is a *relatively* high-cost producer. Thus it is a comparative advantage, not an absolute advantage, that should dictate trade patterns.

Compensating differentials. Differences in wage rates among jobs that serve to offset or compensate for the nonmonetary differences of the jobs. For example, unpleasant jobs that require isolation for many months in Alaska pay wages much higher than those for similar jobs nearer to civilization.

Competition, imperfect. Term applied to markets in which perfect competition does not hold because at least one seller (or buyer) is large enough to affect the market price and therefore faces a downward-sloping demand (or supply) curve. Imperfect competition refers to any kind of market imperfection—pure **monopoly, oligopoly,** or **monopolistic competition.**

Competition, perfect. Term applied to markets in which no firm or consumer is large enough to affect the market price. This situation arises where (1) the number of sellers and buyers is very large and (2) the products offered by sellers are homogeneous (or indistinguishable). Under such conditions, each firm faces a horizontal (or perfectly elastic) demand curve.

Competitive equilibrium. The balancing of supply and demand in a market or economy characterized by **perfect competition.** Because perfectly competitive sellers and buyers individually have no power to influence the market, price will move to the point at which it equals both marginal cost and marginal utility.

Competitive market. See **competition, perfect.**

Complements. Two goods which "go together" in the eyes of consumers (e.g., left shoes and right shoes). Goods are *substitutes* when they compete with each other (as do gloves and mittens).

Compound interest. Interest computed on the accrued total of interest and principal. For example, suppose $100 (the principal) is deposited in an account earning 10 percent interest compounded annually. At the end of year 1, interest of $10 is earned. At the end of year 2, the interest payment is $11, $10 on the original principal and $1 on the interest—and so on in future years.

Concentration ratio. The percentage of an industry's total output accounted for by the largest firms. A typical measure is the *four-firm concentration ratio,* which is the fraction of output accounted for by the four largest firms.

Constant returns to scale. See **returns to scale.**

Consumer price index (CPI). A price index that measures the cost of a fixed basket of consumer goods in which the weight assigned to each commodity is the share of expenditures on that commodity in a base year.

Consumer surplus. The difference between the amount that a consumer would be willing to pay for a commodity and the amount actually paid. This difference arises because the marginal utilities (in dollar terms) of all but the last unit exceed the price. Under certain conditions, the money value of consumer surplus can be measured (using a demand curve diagram) as the area under the demand curve but above the price line.

Consumption. In macroeconomics, the total spending, by individuals or a nation, on consumer goods during a given period. Strictly speaking, consumption should apply only to those goods totally used, enjoyed, or "eaten up" within that period. In practice, consumption expenditures include all consumer goods bought, many of which last well beyond the period in question—e.g., furniture, clothing, and automobiles.

Consumption function. A schedule relating total consumption to

Eye Therapies Exhibit 2127, 679 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

personal **disposable income** (*DI*). Total wealth and other variables are also frequently assumed to influence consumption.

Consumption-possibility line. See **budget line.**

Cooperative equilibrium. In game theory, an outcome in which the parties act in unison to find strategies that will optimize their joint payoffs.

Core rate of inflation. Inflation after removing the influence of volatile elements like food and energy prices. This concept is often used by central banks in inflation targeting.

Corporate income tax. A tax levied on the annual net income of a corporation.

Corporation. The dominant form of business organization in modern capitalist economies. A corporation is a firm owned by individuals or other corporations. It has the same rights to buy, sell, and make contracts as a person would have. It is legally separate from those who own it and has **limited liability.**

Correlation. The degree to which two variables are systematically associated with each other.

Cost, average. Total cost (refer to **cost, total**) divided by the number of units produced.

Cost, average fixed. Fixed cost (refer to **cost, fixed**) divided by the number of units produced.

Cost, average variable. Variable cost (refer to **cost, variable**) divided by the number of units produced.

Cost, fixed. The cost a firm would incur even if its output for the period in question were zero. Total fixed cost is made up of such individual contractual costs as interest payments, mortgage payments, and directors' fees.

Cost, marginal. The extra cost (or the increase in total cost) required to produce 1 extra unit of output (or the reduction in total cost from producing 1 unit less).

Cost, minimum. The lowest attainable cost per unit (whether average, variable, or marginal). Every point on an average cost curve is a minimum in the sense that it is the best the firm can do with respect to cost for the output which that point represents. Minimum average cost is the lowest point, or points, on that curve.

Cost, total. The minimum attainable total cost, given a particular level of technology and set of input prices. *Short-run total cost* takes existing plant and other fixed costs as given. *Long-run total cost* is the cost that would be incurred if the firm had complete flexibility with respect to all inputs and decisions.

Cost, variable. A cost that varies with the level of output, such as raw-material, labor, and fuel costs. Variable costs equal total cost minus fixed cost.

Cost-push inflation. See **supply-shock inflation.**

Credit. (1) In monetary theory, the use of someone else's funds in exchange for a promise to pay (usually with interest) at a later date. The major examples are short-term loans from a bank, credit extended by suppliers, and commercial paper. (2) In balance-of-payments accounting, an item such as exports that earns a country foreign currency.

Cross elasticity of demand. A measure of the influence of a change in one good's price on the demand for another good. More precisely, the cross elasticity of demand equals the percentage change in demand for good A when the price of good B changes by 1 percent, assuming other variables are held constant.

Currency. Coins and paper money.

Currency appreciation (or depreciation). See **depreciation** (of a currency).

Currency board. A monetary institution operating like a central bank for a country that issues only currency that is fully backed by assets denominated in a key foreign currency, often the U.S. dollar.

Current account. See **balance of trade.**

Cyclical budget. See **actual, cyclical, and structural budget.**

Cyclical unemployment. See **frictional unemployment.**

D

Deadweight loss. The loss in real income or consumer and producer surplus that arises because of monopoly, tariffs and quotas, taxes, or other distortions. For example, when a monopolist raises its price, the loss in consumer satisfaction is more than the gain in the monopolist's revenue—the difference being the deadweight loss to society due to monopoly.

Debit. (1) An accounting term signifying an increase in assets or decrease in liabilities. (2) In balance-of-payments accounting, a debit is an item such as imports that reduces a country's stock of foreign currencies.

Decreasing returns to scale. See **returns to scale.**

Deficit spending. Government's expenditures on goods and services and transfer payments in excess of its receipts from taxation and other revenue sources. The difference must be financed by borrowing from the public.

Deflating (of economic data). The process of converting "nominal" or current-dollar variables into "real" terms. This is accomplished by dividing current-dollar variables by a **price index.**

Deflation. A fall in the general level of prices.

Demand curve (or demand schedule). A schedule or curve showing the quantity of a good that buyers would purchase at each price, other things equal. Normally a demand curve has price on

Eye Therapies Exhibit 2127, 680 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

the vertical or *Y* axis and quantity demanded on the horizontal or *X* axis. Also see **change in demand vs. change in quantity demanded.**

Demand for money. A summary term used by economists to explain why individuals and businesses hold money balances. The major motivations for holding money are (1) *transactions demand,* signifying that people need money to purchase things, and (2) *asset demand,* relating to the desire to hold a very liquid, risk-free asset.

Demand-pull inflation. Price inflation caused by an excess demand for goods in general, caused, e.g., by a major increase in aggregate demand. Often contrasted with **supply-shock inflation.**

Demography. The study of the behavior of a population.

Depreciation (of an asset)**.** A decline in the value of an asset. In both business and national accounts, depreciation is the dollar estimate of the extent to which capital has been "used up" or worn out over the period in question. Also termed *capital consumption allowance* in national-income accounting.

Depreciation (of a currency)**.** A nation's currency is said to depreciate when it declines relative to other currencies. For example, if the foreign exchange rate of the dollar falls from 200 to 100 Japanese Yen per U.S. dollar, the dollar's value has fallen, and the dollar has undergone a depreciation. The opposite of a depreciation is an *appreciation,* which occurs when the foreign exchange rate of a currency rises.

Depression. A prolonged period characterized by high unemployment, low output and investment, depressed business confidence, falling prices, and widespread business failures. A milder form of business downturn is a **recession,** which has many of the features of a depression to a lesser extent.

Derived demand. The demand for a factor of production that results (is "derived") from the demand for the final good to which it contributes. Thus the demand for tires is derived from the demand for automobile transportation.

Devaluation. A decrease in the official price of a nation's currency, usually expressed in the currency of another nations (such as the U.S. dollar) or in terms of gold (in a gold standard). The opposite of devaluation is *revaluation,* which occurs when a nation raises its official foreign exchange rate relative to another currency.

Developing country. A country with a per capita income far below that of "developed" nations (the latter usually includes most nations of North America and Western Europe). Same as *less developed country.*

Differentiated products. Products which compete with each other and are close substitutes but are not identical. Differences may be manifest in the product's function, appearance, location, quality, or other attributes.

Diminishing marginal utility, law of. The law which says that as more and more of any one commodity is consumed, its marginal utility declines.

Diminishing returns, law of. A law stating that the additional output from successive increases of one input will eventually diminish when other inputs are held constant. Technically, the law is equivalent to saying that the marginal product of the varying input declines after a point.

Direct taxes. Taxes levied directly on individuals or firms, including taxes on income, labor earnings, and profits. Direct taxes contrast with *indirect taxes,* which are levied on goods and services and thus only indirectly on people, such as sales taxes and taxes on property, alcohol, imports, and gasoline.

Discount rate. (1) The interest rate charged by a Federal Reserve Bank (the central bank) on a loan that it makes to a commercial bank. (2) The rate used to calculate the present value of some asset.

Discounting (of future income)**.** The process of converting future income into an equivalent present value. This process takes a future dollar amount and reduces it by a discount factor that reflects the appropriate interest rate. For example, if someone promises you $121 in 2 years, and the appropriate interest rate or discount rate is 10 percent per year, then we can calculate the present value by discounting the $121 by a discount factor of $(1.10)^2$. The rate at which future incomes are discounted is called the **discount rate.**

Discrimination. Differences in earnings that arise because of personal characteristics that are unrelated to job performance, especially those related to gender, race, ethnicity, sexual orientation, or religion.

Disequilibrium. The state in which an economy is not in **equilibrium.** This may arise when shocks (to income or prices) have shifted demand or supply schedules but the market price (or quantity) has not yet adjusted fully. In macroeconomics, unemployment is often thought to stem from market disequilibria.

Disinflation. The process of reducing a high inflation rate. For example, the deep recession of 1980–1983 led to a sharp disinflation over that period.

Disposable income (*DI*). Roughly, take-home pay, or that part of the total national income that is available to households for consumption or saving. More precisely, it is equal to GDP less all taxes, business saving, and depreciation plus government and other transfer payments and government interest payments.

Eye Therapies Exhibit 2127, 681 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Disposable personal income. Same as **disposable income.**

Dissaving. Negative saving; spending more on consumption goods during a period than the disposable income available for that period (the difference being financed by borrowing or drawing on past savings).

Distribution. In economics, the manner in which total output and income is distributed among individuals or factors (e.g., the distribution of income between labor and capital).

Distribution theory. See **theory of income distribution.**

Division of labor. A method of organizing production whereby each worker specializes in part of the productive process. Specialization of labor yields higher total output because labor can become more skilled at a particular task and because specialized machinery can be introduced to perform more carefully defined subtasks.

Dominant equilibrium. See **dominant strategy.**

Dominant strategy. In game theory, a situation where one player has a best strategy no matter what strategy the other player follows. When all players have a dominant strategy, we say that the outcome is a *dominant equilibrium.*

Downward-sloping demand, law of. The rule which says that when the price of some commodity falls, consumers will purchase more of that good, other things held equal.

Duopoly. A market structure in which there are only two sellers. (Compare with **oligopoly.**)

E

Econometrics. The branch of economics that uses the methods of statistics to measure and estimate quantitative economic relationships.

Economic efficiency. See **efficiency.**

Economic good. A good that is scarce relative to the total amount of it that is desired. It must therefore be rationed, usually by charging a positive price.

Economic growth. An increase in the total output of a nation over time. Economic growth is usually measured as the annual rate of increase in a nation's real GDP (or real potential GDP).

Economic regulation. See **regulation.**

Economic rent. Refer to **rent, economic.**

Economic surplus. A term denoting the excess in total satisfaction or utility over the costs of production; equals the sum of consumer surplus (the excess of consumer satisfaction over total value of purchases) and producer surplus (the excess of producer revenues over costs).

Economics. The study of how societies use scarce resources to produce valuable commodities and distribute them among different people.

Economics of information. Analysis of economic situations that involve information as a commodity. Because information is costly to produce but cheap to reproduce, market failures are common in markets for informational goods and services such as invention, publishing, and software.

Economies of scale. Increases in productivity, or decreases in average cost of production, that arise from increasing all the factors of production in the same proportion.

Effective tax rate. Total taxes paid as a percentage of the total income or other tax base; also known as *average tax rate.*

Efficiency. Absence of waste, or the use of economic resources that produces the maximum level of satisfaction possible with the given inputs and technology. A shorthand expression for **Pareto efficiency.**

Efficiency-wage theory. According to this theory, higher wages lead to higher productivity. This occurs because with higher wages workers are healthier, have higher morale, and have lower turnover.

Efficient financial market. A financial market displaying the characteristics of an **efficient market.**

Efficient market (also efficient-market theory). A market or theory in which all new information is quickly absorbed by market participants and becomes immediately incorporated into market prices. In economics, efficient-market theory holds that all currently available information is already incorporated into the price of common stocks (or other assets).

Elasticity. A term widely used in economics to denote the responsiveness of one variable to changes in another. Thus the elasticity of X with respect to Y means the percentage change in X for every 1 percent change in Y. For especially important examples, see **price elasticity of demand** and **price elasticity of supply.**

Employed. According to official U.S. definitions, persons are employed if they perform any paid work or if they hold jobs but are absent because of illness, strike, or vacations.

Equal-cost line. A line in a graph showing the various possible combinations of factor inputs that can be purchased with a given quantity of money.

Equal-product curve (or isoquant). A line in a graph showing the various possible combinations of factor inputs which will yield a given quantity of output.

Equation of exchange. A definitional equation which states that $MVP \equiv PQ$, or the money stock times velocity of money equals the price level times output. This equation forms the core of **monetarism.**

Eye Therapies Exhibit 2127, 682 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Equilibrium. The state in which an economic entity is at rest or in which the forces operating on the entity are in balance so that there is no tendency for change.

Equilibrium (for a business firm)**.** That position or level of output in which the firm is maximizing its profit, subject to any constraints it may face, and therefore has no incentive to change its output or price level. In the standard theory of the firm, this means that the firm has chosen an output at which marginal revenue is just equal to marginal cost.

Equilibrium (for the individual consumer)**.** That position in which the consumer is maximizing utility, i.e., has chosen the bundle of goods which, given income and prices, best satisfies the consumer's wants.

Equilibrium, competitive. Refer to **competitive equilibrium.**

Equilibrium, general. Refer to **general-equilibrium analysis.**

Equilibrium, macroeconomic. A GDP level at which intended aggregate demand equals intended aggregate supply. At the equilibrium, desired consumption (C), government expenditures (G), investment (I), and net exports (X) just equal the quantity that businesses wish to sell at the going price level.

Equilibrium unemployment. Equilibrium unemployment arises when people are voluntarily unemployed rather than unemployed because of a failure of labor markets to clear. An example is the frictional unemployed that occurs when people move voluntarily from job to job or in and out of the labor force.

Equimarginal principle. A principle for deciding the allocation of income among different consumption goods. Under this principle, a consumer's utility is maximized by choosing the consumption bundle such that the marginal utility per dollar spent is equal for all goods.

Exchange rate. See **foreign exchange rate.**

Exchange-rate system. The set of rules, arrangements, and institutions under which payments are made among nations. Historically, the most important exchange-rate systems have been the gold exchange standard, the Bretton Woods system, and today's flexible-exchange-rate system.

Excise tax vs. sales tax. An excise tax is one levied on the purchase of a specific commodity or group of commodities (e.g., alcohol or tobacco). A *sales tax* is one levied on all commodities with only a few specific exclusions (e.g., all purchases except food).

Exclusion principle. A criterion by which public goods are distinguished from private goods. When a producer sells a commodity to person A and can easily exclude B, C, D, etc., from enjoying the benefits of the commodity, the exclusion principle holds and the good is a private good. If, as in public health or national defense, people cannot easily be excluded from enjoying the benefits of the good's production, then the good has public-good characteristics.

Exogenous vs. induced variables. Exogenous variables are those determined by conditions outside the economy. They are contrasted with *induced variables,* which are determined by the internal workings of the economic system. Changes in the weather are exogenous; changes in consumption are often induced by changes in income.

Expectations. Views or beliefs about uncertain variables (such as future interest rates, prices, or tax rates). Expectations are said to be *rational* if they are not systematically wrong (or "biased") and use all available information. Expectations are said to be *adaptive* if people form their expectations on the basis of past behavior.

Expected rate of inflation. A process of steady inflation that occurs when inflation is expected to persist and the ongoing rate of inflation is built into contracts and people's expectations.

Expenditure multiplier. See **multiplier.**

Exports. Goods or services that are produced in the home country and sold to another country. These include merchandise trade (like cars), services (like transportation), and interest on loans and investments. *Imports* are simply flows in the opposite direction—into the home country from another country.

External diseconomies. Situations in which production or consumption imposes uncompensated costs on other parties. Steel factories that emit smoke and sulfurous fumes harm local property and public health, yet the injured parties are not paid for the damage. The pollution is an external diseconomy.

External economies. Situations in which production or consumption yields positive benefits to others without those others paying. A firm that hires a security guard scares thieves from the neighborhood, thus providing external security services. Together with external diseconomies, these are often referred to as **externalities.**

External variables. Same as **exogenous variables.**

Externalities. Activities that affect others for better or worse, without those others paying or being compensated for the activity. Externalities exist when private costs or benefits do not equal social costs or benefits. The two major species are **external economies** and **external diseconomies.**

Eye Therapies Exhibit 2127, 683 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

F

Factors of production. Productive inputs, such as labor, land, and capital; the resources needed to produce goods and services. Also called *inputs.*

Fallacy of composition. The fallacy of assuming that what holds for individuals also holds for the group or the entire system.

Federal funds rate. The interest rate that banks pay each other for the overnight use of bank reserves.

Federal Reserve System. The **central bank** of the United States; consists of the Board of Governors and 12 regional Federal Reserve Banks.

Fiat money. Money, like today's paper currency, without **intrinsic value** but decreed (by fiat) to be legal tender by the government. Fiat money is accepted only as long as people have confidence that it will be accepted.

Final good. A good that is produced for final use and not for resale or further manufacture. (Compare with **intermediate goods.**)

Finance. The process by which economic agents borrow from and lend to other agents in order to save and spend.

Financial account. See **balance of trade.**

Financial assets. Monetary claims or obligations by one party against another party. Examples are bonds, mortgages, bank loans, and equities.

Financial economics. That branch of economics which analyzes how rational investors should invest their funds to attain their objectives in the best possible manner.

Financial intermediaries. Institutions which provide financial services and products. These include depository institutions (such as commercial or savings banks) and nondepository institutions (such as money market mutual funds, brokerage houses, insurance companies, or pension funds).

Financial markets. Markets whose products and services consist of financial instruments like stocks and bonds.

Financial system. The markets, firms, and other institutions which carry out the financial decisions of households, businesses, governments, and the rest of the world. Important parts of the financial system include the money market, markets for fixed-interest assets like bonds or mortgages, stock markets for the ownership of firms, and foreign exchange markets which trade the monies of different countries.

Firm (business firm). The basic, private producing unit in an economy. It hires labor, rents or owns capital and land, and buys other inputs in order to make and sell goods and services.

Fiscal-monetary mix. The combination of fiscal and monetary policies used to influence macroeconomic activity. A tight monetary–loose fiscal policy will tend to encourage consumption and retard investment, while an easy monetary–tight fiscal policy will have the opposite effect.

Fiscal policy. A government's program with respect to (1) the purchase of goods and services and spending on transfer payments and (2) the amount and type of taxes.

Fixed cost. Refer to **cost, fixed.**

Fixed exchange rate. See **foreign exchange rate.**

Flexible exchange rates. A system of foreign exchange rates among countries wherein the exchange rates are predominantly determined by private market forces (i.e., by supply and demand) without governments' setting and maintaining a particular pattern of exchange rates; also sometimes called *floating exchange rates.* When the government refrains from any intervention in exchange markets, the system is called a pure flexible-exchange-rate system.

Floating exchange rates. See **flexible exchange rates.**

Flow of funds. The account which traces how money and other financial instruments flow through the economy.

Flow vs. stock. A *flow* variable is one that has a time dimension or flows over time (like the flow through a stream). A *stock* variable is one that measures a quantity at a point of time (like the water in a lake). Income represents dollars per year and is thus a flow. Wealth as of December 2005 is a stock.

Foreign exchange. Currency (or other financial instruments) of different countries that allow one country to settle amounts owed to other countries.

Foreign exchange market. The market in which currencies of different countries are traded.

Foreign exchange rate. The rate, or price, at which one country's currency is exchanged for the currency of another country. For example, if you can buy 10 Mexican pesos for 1 U.S. dollar, then the exchange rate for the peso is 10. A country has a *fixed exchange rate* if it pegs its currency at a given exchange rate and stands ready to defend that rate. Exchange rates which are determined by market supply and demand are called **flexible exchange rates.**

Four-firm concentration ratio. See **concentration ratio.**

Fractional-reserve banking. A regulation in modern banking systems whereby financial institutions are legally required to keep a specified fraction of their deposits in the form of deposits with the central bank (or in vault cash).

Free goods. Those goods that are not **economic goods.** Like air or seawater, they exist in such large quantities that they need not be rationed out among those wishing

Eye Therapies Exhibit 2127, 684 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

to use them. Thus, their market price is zero.

Free trade. A policy whereby the government does not intervene in trading between nations by tariffs, quotas, or other means.

Frictional unemployment. Temporary unemployment caused by changes in individual markets. It takes time, for example, for new workers to search among different job possibilities; even experienced workers often spend a minimum period of unemployed time moving from one job to another. Frictional is thus distinct from *cyclical unemployment*, which results from a low level of aggregate demand in the context of sticky wages and prices.

Full employment. A term that is used in many senses. Historically, it was taken to be that level of employment at which no (or minimal) involuntary unemployment exists. Today, economists rely upon the concept of the **nonaccelerating inflation rate of unemployment** (**NAIRU**) to indicate the highest sustainable level of employment over the long run.

G

Gains from trade. The aggregate increase in welfare accruing from voluntary exchange; equal to the sum of consumer surplus and gains in producer profits.

Galloping inflation. See **inflation.**

Game theory. An analysis of situations involving two or more decision makers with at least partially conflicting interests. It can be applied to the interaction of oligopolistic markets as well as to bargaining situations such as strikes or to conflicts such as games and war.

GDP deflator. The "price" of GDP, i.e., the price index that measures the average price of the components in GDP relative to a base year.

General-equilibrium analysis. Analysis of the equilibrium state for the economy as a whole in which the markets for all goods and services are simultaneously in equilibrium. By contrast, **partial-equilibrium analysis** concerns the equilibrium in a single market.

GNP. See **gross national product.**

Gold standard. A system under which a nation (1) declares its currency unit to be equivalent to some fixed weight of gold, (2) holds gold reserves against its money, and (3) will buy or sell gold freely at the price so proclaimed, with no restrictions on the export or import of gold.

Government debt. The total of government obligations in the form of bonds and shorter-term borrowings. Government debt held by the public excludes bonds held by quasi-governmental agencies such as the central bank.

Government expenditure multiplier. The increase in GDP resulting from an increase of $1 in government purchases.

Gross domestic product, nominal (or nominal GDP). The value, at current market prices, of the total final output produced inside a country during a given year.

Gross domestic product, real (or real GDP). The quantity of goods and services produced in a nation during a year. Real GDP takes nominal GDP and corrects for price increases.

Gross national product, real (or real GNP). Nominal GNP corrected for inflation; i.e., real GNP equals nominal GNP divided by the GNP deflator. This was the central accounting concept in earlier times but has been replaced by **gross domestic product.**

Growth accounting. A technique for estimating the contribution of different factors to economic growth. Using marginal productivity theory, growth accounting decomposes the growth of output into the growth in labor, land, capital, education, technical knowledge, and other miscellaneous sources.

H

Hedging. A technique for avoiding a risk by making a counteracting transaction. For example, if a farmer produces wheat that will be harvested in the fall, the risk of price fluctuations can be offset, or hedged, by selling in the spring or summer the quantity of wheat that will be produced.

Herfindahl-Hirschman Index (HHI). A measure of market power often used in analysis of market structure. It is calculated by summing the squares of the percentage market shares of all participants in a market. Perfect competition would have an HHI of near zero, while complete monopoly has an HHI of 10,000.

High-powered money. Same as **monetary base.**

Horizontal equity vs. vertical equity. *Horizontal equity* refers to the fairness or equity in treatment of persons in similar situations; the principle of horizontal equity states that those who are essentially equal should receive equal treatment. *Vertical equity* refers to the equitable treatment of those who are in different circumstances.

Horizontal integration. See **integration, vertical vs. horizontal.**

Horizontal merger. See **merger.**

Human capital. The stock of technical knowledge and skill embodied in a nation's workforce, resulting from investments in formal education and on-the-job training.

Hyperinflation. See **inflation.**

I

Imperfect competition. Refer to **competition, imperfect.**

Eye Therapies Exhibit 2127, 685 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Imperfect competitor. Any firm that buys or sells a good in large enough quantities to be able to affect the price of that good.

Implicit-cost elements. Costs that do not show up as explicit money costs but nevertheless should be counted as such (such as the labor cost of the owner of a small store). Sometimes called **opportunity cost,** although "opportunity cost" has a broader meaning.

Imports. See **exports.**

Inappropriability. See **inappropriable.**

Inappropriable. Term applied to resources for which the individual cost of use is free or less than the full social costs. These resources are characterized by the presence of externalities, and thus markets will allocate their use inefficiently from a social point of view.

Incidence (or tax incidence). The ultimate economic effect of a tax on the real incomes of producers or consumers (as opposed to the legal requirement for payment). Thus a sales tax may be paid by a retailer, but it is likely that the incidence falls upon the consumer. The exact incidence of a tax depends on the price elasticities of supply and demand.

Income. The flow of wages, interest payments, dividends, and other receipts accruing to an individual or nation during a period of time (usually a year).

Income effect (of a price change)**.** Change in the quantity demanded of a commodity because the change in its price has the effect of changing a consumer's real income. Thus it supplements the **substitution effect** of a price change.

Income elasticity of demand. The demand for any given good is influenced not only by the good's price but by buyers' incomes. Income elasticity measures this responsiveness. Its precise definition is percentage change in quantity demanded divided by percentage change in income. (Compare with **price elasticity of demand.**)

Income statement. A company's statement, covering a specified time period (usually a year), showing sales or revenue earned during that period, all costs properly charged against the goods sold, and the profit (net income) remaining after deduction of such costs. Also called a *profit-and-loss statement.*

Income tax, personal. Tax levied on the income received by individuals in the form of either wages and salaries or income from property, such as rents, dividends, or interest. In the United States, personal income tax is **progressive,** meaning that people with higher incomes pay taxes at a higher average rate than people with lower incomes.

Income velocity of money. See **velocity of money.**

Increasing returns to scale. See **returns to scale.**

Independent goods. Goods whose demands are relatively separate from each other. More precisely, goods A and B are independent when a change in the price of good A has no effect on the quantity demanded of good B, other things equal.

Indexing (or indexation). A mechanism by which wages, prices, and contracts are partially or wholly adjusted to compensate for changes in the general price level.

Indifference curve. A curve drawn on a graph whose two axes measure amounts of different goods consumed. Each point on one curve (indicating different combinations of the two goods) yields exactly the same level of satisfaction for a given consumer.

Indifference map. A graph showing a family of indifference curves for a consumer. In general, curves that lie farther northeast from the graph's origin represent higher levels of satisfaction.

Indirect taxes. See **direct taxes.**

Induced variables. See **exogenous vs. induced variables.**

Industry. A group of firms producing similar or identical products.

Infant industry. In foreign-trade theory, an industry that has not had sufficient time to develop the experience or expertise to exploit the economies of scale needed to compete successfully with more mature industries producing the same commodity in other countries. Infant industries are often thought to need tariffs or quotas to protect them while they develop.

Inferior good. A good whose consumption goes down as income rises.

Inflation (or inflation rate). The inflation rate is the percentage of annual increase in a general price level. *Hyperinflation* is inflation at extremely high rates (say, 1000, 1 million, or even 1 billion percent a year). *Galloping inflation* is a rate of 50 or 100 or 200 percent annually. *Moderate inflation* is a price-level rise that does not distort relative prices or incomes severely.

Inflation targeting. The announcement of official target ranges for the inflation rate along with an explicit statement that low and stable inflation is the overriding goal of monetary policy. Inflation targeting in hard or soft varieties has been adopted in recent years by many industrial countries.

Innovation. A term particularly associated with Joseph Schumpeter, who meant by it (1) the bringing to market of a new and significantly different product, (2) the introduction of a new production technique, or (3) the opening up of a new market. (Contrast with **invention.**)

Inputs. Commodities or services used by firms in their production processes; also called *factors of production.*

Eye Therapies Exhibit 2127, 686 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Insurance. A system by which individuals can reduce their exposure to risk of large losses by spreading the risks among a large number of persons.

Integration, vertical vs. horizontal. The production process is one of stages—e.g., iron ore into steel ingots, steel ingots into rolled steel sheets, rolled steel sheets into an automobile body. *Vertical integration* is the combination in a single firm of two or more different stages of this process (e.g., iron ore with steel ingots). *Horizontal integration* is the combination in a single firm of different units that operate at the same stage of production.

Intellectual property rights. Laws governing patents, copyrights, trade secrets, electronic media, and other commodities comprised primarily of information. These laws generally provide the original creator the right to control and be compensated for reproduction of the work.

Interest. The return paid to those who lend money.

Interest rate. The price paid for borrowing money for a period of time, usually expressed as a percentage of the principal per year. Thus, if the interest rate is 10 percent per year, then $100 would be paid for a loan of $1000 for 1 year.

Intermediate goods. Goods that have undergone some manufacturing or processing but have not yet reached the stage of becoming final products. For example, steel and cotton yarn are intermediate goods.

International monetary system (also international financial system). The institutions under which payments are made for transactions that reach across national boundaries. A central policy issue concerns the arrangement for determining how foreign exchange rates are set and how governments can affect exchange rates.

Intervention. An activity in which a government buys or sells its currency in the foreign exchange market in order to affect its currency's exchange rate.

Intrinsic value (of money)**.** The commodity value of a piece of money (e.g., the market value of the weight of copper in a copper coin).

Invention. The creation of a new product or discovery of a new production technique. (Distinguish from **innovation.**)

Investment. (1) Economic activity that forgoes consumption today with an eye to increasing output in the future. It includes tangible capital such as houses and intangible investments such as education. *Net investment* is the value of total investment after an allowance has been made for depreciation. *Gross investment* is investment without allowance for depreciation. (2) In finance terms, "investment" has an altogether different meaning and denotes the purchase of a security, such as a stock or a bond.

Investment demand (or investment demand curve). The schedule showing the relationship between the level of investment and the cost of capital (or, more specifically, the real interest rate); also, the graph of that relationship.

Invisible hand. A concept introduced by Adam Smith in 1776 to describe the paradox of a laissez-faire market economy. The invisible-hand doctrine holds that, with each participant pursuing his or her own private interest, a market system nevertheless works to the benefit of all as though a benevolent invisible hand were directing the whole process.

Involuntarily unemployed. See **unemployment.**

Isoquant. See **equal-product curve.**

K

Keynesian economics. The body of macroeconomic analysis developed by John Maynard Keynes holding that a market economy does not automatically tend toward a full-employment equilibrium. According to Keynes, the resulting underemployment equilibrium could be cured by fiscal or monetary policies to raise aggregate demand.

Keynesian macroeconomics. A theory of macroeconomic activity used to explain business cycles. It relies on an upward-sloping aggregate supply curve, so that changes in aggregate demand can affect output and employment.

Keynesian school. See **Keynesian economics.**

L

Labor force. In official U.S. statistics, that group of people 16 years of age and older who are either employed or unemployed.

Labor-force participation rate. The ratio of those in the labor force to the entire population 16 years of age or older.

Labor productivity. See **productivity.**

Labor supply. The number of workers (or, more generally, the number of labor-hours) available to an economy. The principal determinants of labor supply are population, real wages, and social traditions.

Labor theory of value. The view, often associated with Karl Marx, that every commodity should be valued solely according to the quantity of labor required for its production.

Laissez-faire ("Leave us alone"). The view that government should interfere as little as possible in economic activity and leave decisions to the marketplace. As expressed by classical economists like Adam Smith, this view held that the role of government should be limited

Eye Therapies Exhibit 2127, 687 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

to maintenance of law and order, national defense, and provision of certain public goods that private business would not undertake (e.g., public health and sanitation).

Land. In classical and neoclassical economics, one of the three basic factors of production (along with labor and capital). More generally, land is taken to include land used for agricultural or industrial purposes as well as natural resources taken from above or below the soil.

Law of diminishing marginal utility. See **diminishing marginal utility, law of.**

Law of diminishing returns. See **diminishing returns, law of.**

Law of downward-sloping demand. The nearly universal observation that when the price of a commodity is raised (and other things are held constant), buyers buy less of the commodity. Similarly, when the price is lowered, other things being constant, quantity demanded increases.

Least-cost rule (of production)**.** The rule that the cost of producing a specific level of output is minimized when the ratio of the marginal revenue product of each input to the price of that input is the same for all inputs.

Legal tender. Money that by law must be accepted as payment for debts. All U.S. coins and currency are legal tender, but checks are not.

Liabilities. In accounting, debts or financial obligations owed to other firms or persons.

Libertarianism. An economic philosophy that emphasizes the importance of personal freedom in economic and political affairs; also sometimes called "liberalism."

Limited liability. The restriction of an owner's loss in a business to the amount of capital that the owner has contributed to the company. Limited liability was an important factor in the rise of large corporations. By contrast, owners in partnerships and individual proprietorships generally have *unlimited liability* for the debts of those firms.

Long run. A term used to denote a period over which full adjustment to changes can take place. In microeconomics, it denotes the time over which firms can enter or leave an industry and the capital stock can be replaced. In macroeconomics, it is often used to mean the period over which all prices, wage contracts, tax rates, and expectations can fully adjust.

Long-run aggregate supply schedule. A schedule showing the relationship between output and the price level after all price and wage adjustments have taken place, and the *AS* curve is therefore vertical.

Lorenz curve. A graph used to show the extent of inequality of income or wealth.

M

M_1. See **money supply.**

Macroeconomic equilibrium. Refer to **equilibrium, macroeconomic.**

Macroeconomics. Analysis dealing with the behavior of the economy as a whole with respect to output, income, the price level, foreign trade, unemployment, and other aggregate economic variables. (Contrast with **microeconomics.**)

Malthusian theory of population growth. The hypothesis, first expressed by Thomas Malthus, that the "natural" tendency of population is to grow more rapidly than the food supply. Per capita food production would thus decline over time, thereby putting a check on population. In general, a view that population tends to grow more rapidly as incomes or living standards of the population rise.

Managed exchange rate. The most prevalent exchange-rate system today. In this system, a country occasionally intervenes to stabilize its currency but there is no fixed or announced parity.

Marginal cost. Refer to **cost, marginal.**

Marginal principle. The fundamental notion that people will maximize their income or profits when the marginal costs and marginal benefits of their actions are equal.

Marginal product (*MP*). The extra output resulting from 1 extra unit of a specified input when all other inputs are held constant. Sometimes called *marginal physical product.*

Marginal product theory of distribution. A theory of the distribution of income proposed by John B. Clark, according to which each productive input is paid according to its **marginal product.**

Marginal propensity to consume (*MPC*). The extra amount that people consume when they receive an extra dollar of disposable income. To be distinguished from the *average propensity to consume,* which is the ratio of total consumption to total disposable income.

Marginal propensity to import (*MPm*). In macroeconomics, the increase in the dollar value of imports resulting from each dollar increase in the value of GDP.

Marginal propensity to save (*MPS*). That fraction of an additional dollar of disposable income that is saved. Note that, by definition, $MRC + MPS = 1$.

Marginal revenue (*MR*). The additional revenue a firm would earn if it sold 1 extra unit of output. In perfect competition, *MR* equals price. Under imperfect competition, *MR* is less than price because, in order to sell the extra unit, the price must be reduced on all prior units sold.

Marginal revenue product (*MRP*) (of an input)**.** Marginal revenue multiplied by marginal product. It is the extra revenue that would

Eye Therapies Exhibit 2127, 688 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

be brought in if a firm were to buy 1 extra unit of an input, put it to work, and sell the extra product it produced.

Marginal tax rate. For an income tax, the percentage of the last dollar of income paid in taxes. If a tax system is progressive, the marginal tax rate is higher than the average tax rate.

Marginal utility (*MU*). The additional or extra satisfaction yielded from consuming 1 additional unit of a commodity, with amounts of all other goods consumed held constant.

Market. An arrangement whereby buyers and sellers interact to determine the prices and quantities of a commodity. Some markets (such as the stock market or a flea market) take place in physical locations; other markets are conducted over the telephone or are organized by computers, and some markets now are organized on the Internet.

Market-clearing price. The price in a supply-and-demand equilibrium. This denotes that all supply and demand orders are filled at that price, so that the books are "cleared" of orders.

Market economy. An economy in which the ***what, how,* and *for whom*** questions concerning resource allocation are primarily determined by supply and demand in markets. In this form of economic organization, firms, motivated by the desire to maximize profits, buy inputs and produce and sell outputs. Households, armed with their factor incomes, go to markets and determine the demand for commodities. The interaction of firms' supply and households' demand then determines the prices and quantities of goods.

Market equilibrium. Same as **competitive equilibrium.**

Market failure. An imperfection in a price system that prevents an efficient allocation of resources. Important examples are **externalities** and **imperfect competition.**

Market power. The degree of control that a firm or group of firms has over the price and production decisions in an industry. In a monopoly, the firm has a high degree of market power; firms in perfectly competitive industries have no market power. **Concentration ratios** are the most widely used measures of market power.

Market share. That fraction of an industry's output accounted for by an individual firm or group of firms.

Marxism. The set of social, political, and economic doctrines developed by Karl Marx in the nineteenth century. As an economic theory, Marxism predicted that capitalism would collapse as a result of its own internal contradictions, especially its tendency to exploit the working classes.

Mean. In statistics, the same thing as "average." Thus for the numbers 1, 3, 6, 10, 20, the mean is 8.

Median. In statistics, the figure exactly in the middle of a series of numbers ordered or ranked from lowest to highest (e.g., incomes or examination grades). Thus for the numbers 1, 3, 6, 10, 20, the median is 6.

Mercantilism. A political doctrine emphasizing the importance of balance-of-payments surpluses as a device to accumulate gold. Proponents therefore advocated tight government control of economic policies, believing that laissez-faire policies might lead to a loss of gold.

Merchandise trade balance. See **balance of trade.**

Merger. The acquisition of one corporation by another, which usually occurs when one firm buys the stock of another. Important examples are (1) *vertical mergers,* which occur when the two firms are at different stages of a production process (e.g., iron ore and steel), (2) *horizontal mergers,* which occur when the two firms produce in the same market (e.g., two automobile manufacturers), and (3) *conglomerate mergers,* which occur when the two firms operate in unrelated markets (e.g., shoelaces and oil refining).

Microeconomics. Analysis dealing with the behavior of individual elements in an economy—such as the determination of the price of a single product or the behavior of a single consumer or business firm. (Contrast with **macroeconomics.**)

Minimum cost. Refer to **cost, minimum.**

Mixed economy. The dominant form of economic organization in noncommunist countries. Mixed economies rely primarily on the price system for their economic organization but use a variety of government interventions (such as taxes, spending, and regulation) to handle macroeconomic instability and market failures.

Model. A formal framework for representing the basic features of a complex system by a few central relationships. Models take the form of graphs, mathematical equations, and computer programs.

Momentary run. A period of time that is so short that production is fixed.

Monetarism. A school of thought holding that changes in the money supply are the major cause of macroeconomic fluctuations.

Monetary base. The net monetary liabilities of the government that are held by the public. In the United States, the monetary base is equal to currency and bank reserves. Sometimes called *high-powered money.*

Monetary economy. An economy in which the trade takes place through a commonly accepted medium of exchange.

Eye Therapies Exhibit 2127, 689 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Monetary policy. The objectives of the central bank in exercising its control over money, interest rates, and credit conditions. The instruments of monetary policy are primarily open-market operations, reserve requirements, and the discount rate.

Monetary rule. The cardinal tenet of monetarist economic philosophy is the monetary rule which asserts that optimal monetary policy sets the growth of the money supply at a fixed rate and holds to that rate through thick and thin.

Monetary transmission mechanism. In macroeconomics, the route by which changes in the supply of money are translated into changes in output, employment, prices, and inflation.

Monetary union. An arrangement by which several nations adopt a common currency as a unit of account and medium of exchange. The European Monetary Union adopted the Euro as the common currency in 1999.

Money. The means of payment or medium of exchange. For the items constituting money, see **money supply.**

Money, velocity of. Refer to **velocity of money.**

Money demand schedule. The relationship between holdings of money and interest rates. As interest rates rise, bonds and other securities become more attractive, lowering the quantity of money demanded. See also **demand for money.**

Money funds. Shorthand expression for very liquid short-term financial instruments whose interest rates are not regulated. The major examples are money market mutual funds and commercial-bank money market deposit accounts.

Money market. A term denoting the set of institutions that handle the purchase or sale of short-term credit instruments like Treasury bills and commercial paper.

Money supply. The narrowly defined money supply (narrow money, or M_1) consists of coins, paper currency, and all demand or checking deposits; this is transactions money. The broadly defined supply (broad money) includes all items in M_1 plus certain liquid assets or near-monies—savings deposits, money market funds, and the like.

Money-supply effect. The relationship whereby a price rise operating on a fixed nominal money supply produces tight money and lowers aggregate spending.

Money-supply multiplier. The ratio of the increase in the money supply (or in deposits) to the increase in bank reserves. Generally, the money-supply multiplier is equal to the inverse of the required reserve ratio. For example, if the required reserve ratio is 0.125, then the money-supply multiplier is 8.

Monopolistic competition. A market structure in which there are many sellers supplying goods that are close, but not perfect, substitutes. In such a market, each firm can exercise some effect on its product's price.

Monopoly. A market structure in which a commodity is supplied by a single firm. Also see **natural monopoly.**

Monopsony. The mirror image of monopoly: a market in which there is a single buyer; a "buyer's monopoly."

Moral hazard. A type of market failure in which the presence of insurance against an insured risk increases the likelihood that the risky event will occur. For example, a car owner insured 100 percent against auto theft may be careless about locking the car because the presence of insurance reduces the incentive to prevent the theft.

MPC. See **marginal propensity to consume.**

MPS. See **marginal propensity to save.**

Multiplier. A term in macroeconomics denoting the change in an induced variable (such as GDP or money supply) per unit of change in an external variable (such as government spending or bank reserves). The *expenditure multiplier* denotes the increase in GDP that would result from a $1 increase in expenditure (say, on investment).

Multiplier model. In macroeconomics, a theory developed by J. M. Keynes that emphasizes the importance of changes in autonomous expenditures (especially investment, government spending, and net exports) in determining changes in output and employment. Also see **multiplier.**

N

NAIRU. See **nonaccelerating inflation rate of unemployment.**

Nash equilibrium. In game theory, a set of strategies for the players where no player can improve his or her payoff given the other player's strategy. That is, given player A's strategy, player B can do no better, and given B's strategy, A can do no better. The Nash equilibrium is also sometimes called the *noncooperative equilibrium.*

National debt. Same as **government debt.**

National income and product accounts (NIPA). A set of accounts that measures the spending, income, and output of the entire nation for a quarter or a year.

National saving rate. Total saving, private and public, divided by net domestic product.

Natural monopoly. A firm or industry whose average cost per unit of production falls sharply over the entire range of its output, as, e.g., in local electricity distribution.

Eye Therapies Exhibit 2127, 690 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Thus a single firm, a monopoly, can supply the industry output more efficiently than can multiple firms.

Natural rate of unemployment. The same concept as the **nonaccelerating inflation rate of unemployment (NAIRU).**

Neoclassical model of growth. A theory or model used to explain long-term trends in the economic growth of industrial economies. This model emphasizes the importance of capital deepening (i.e., a growing capital-labor ratio) and technological change in explaining the growth of potential real GDP.

Net domestic product (NDP). GDP less an allowance for depreciation of capital goods.

Net exports. In the national product accounts, the value of exports of goods and services minus the value of imports of goods and services.

Net foreign investment. Net saving by a country abroad; approximately equal to net exports.

Net investment. Gross investment minus depreciation of capital goods.

Net worth. In accounting, total assets minus total liabilities.

New classical macroeconomics. A theory which holds that (1) prices and wages are flexible and (2) people make forecasts in accordance with the **rational-expectations hypothesis.**

Nominal GDP. See **gross domestic product, nominal.**

Nominal (or money) interest rate. The **interest rate** paid on different assets. This represents a dollar return per year per dollar invested. Compare with the **real interest rate,** which represents the return per year in goods per unit of goods invested.

Nonaccelerating inflation rate of unemployment (NAIRU). An unemployment rate that is consistent with a constant inflation rate. At the NAIRU, upward and downward forces on price and wage inflation are in balance, so there is no tendency for inflation to change. The NAIRU is the unemployment rate at which the long-run Phillips curve is vertical.

Noncooperative equilibrium. See **Nash equilibrium.**

Nonrenewable resources. Those natural resources, like oil and gas, that are essentially fixed in supply and whose regeneration is not quick enough to be economically relevant.

Normative vs. positive economics. *Normative economics* considers "what ought to be"—value judgments, or goals, of public policy. *Positive economics,* by contrast, is the analysis of facts and behavior in an economy, or "the way things are."

Not in the labor force. That part of the adult population that is neither working nor looking for work.

O

Okun's Law. The empirical relationship, discovered by Arthur Okun, between cyclical movements in GDP and unemployment. The law states that when actual GDP declines 2 percent relative to potential GDP, the unemployment rate increases by about 1 percentage point. (Earlier estimates placed the ratio at 3 to 1.)

Oligopoly. A situation of imperfect competition in which an industry is dominated by a small number of suppliers.

Open economy. An economy that engages in international trade (i.e., imports and exports) of goods and capital with other countries. A *closed economy* is one that has no imports or exports.

Open-economy multiplier. Multiplier analysis as applied to economies that have foreign trade. The open-economy multiplier is smaller than the closed-economy multiplier because there is a leakage of spending into imports as well as into saving.

Open-market operations. The activity of a central bank in buying or selling government bonds to influence bank reserves, the money supply, and interest rates. If securities are bought, the money paid out by the central bank increases commercial-bank reserves, and the money supply increases. If securities are sold, the money supply contracts.

Opportunity cost. The value of the best alternative use of an economic good. Thus, say that the best alternative use of the inputs employed to mine a ton of coal was to grow 10 bushels of wheat. The opportunity cost of a ton of coal is thus the 10 bushels of wheat that *could* have been produced but were not. Opportunity cost is particularly useful for valuing nonmarketed goods such as environmental health or safety.

Optimal currency area. A grouping of regions or countries which have high labor mobility or have common and synchronous aggregate supply or demand shocks. Under such conditions, significant changes in exchange rates are not necessary to ensure rapid macroeconomic adjustment, and the countries can have fixed exchange rates or a common currency.

Ordinal utility. A dimensionless utility measure used in demand theory. Ordinal utility enables one to state that A is preferred to B, but we cannot say by how much. That is, any two bundles of goods can be ranked relative to each other, but the absolute difference between bundles cannot be measured. This contrasts with *cardinal utility,* or dimensional utility, which is sometimes used in the analysis of behavior toward risk. An example of a cardinal measure comes when we say that a substance at 100 K (kelvin) is twice as hot as one at 50 K.

Eye Therapies Exhibit 2127, 691 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Other things constant. A phrase (sometimes stated "*ceteris paribus*") which signifies that a factor under consideration is changed while all other factors are held constant or unchanged. For example, a downward-sloping demand curve shows that the quantity demanded will decline as the price rises, as long as other things (such as incomes) are held constant.

Outputs. The various useful goods or services that are either consumed or used in further production.

P

Paradox of thrift. The principle, first proposed by John Maynard Keynes, that an attempt by a society to increase its saving may result in a reduction in the amount which it actually saves.

Paradox of value. The paradox that many necessities of life (e.g., water) have a low "market" value while many luxuries (e.g., diamonds) with little "use" value have a high market price. It is explained by the fact that a price reflects not the total utility of a commodity but its marginal utility.

Pareto efficiency (or Pareto optimality). A situation in which no reorganization or trade could raise the utility or satisfaction of one individual without lowering the utility or satisfaction of another individual. Under certain limited conditions, perfect competition leads to allocative efficiency. Also called *allocative efficiency.*

Partial-equilibrium analysis. Analysis concentrating on the effect of changes in an individual market, holding other things equal (e.g., disregarding changes in income).

Partnership. An association of two or more persons to conduct a business which is not in corporate form and does not enjoy limited liability.

Patent. An exclusive right granted to an inventor to control the use of an invention for, in the United States, a period of 20 years. Patents create temporary monopolies as a way of rewarding inventive activity and, like other intellectual property rights, are a tool for promoting invention among individuals or small firms.

Payoff table. In game theory, a table used to describe the strategies and payoffs of a game with two or more players. The profits or utilities of the different players are the *payoffs.*

Payoffs. See **payoff table.**

Perfect competition. Refer to **competition, perfect.**

Personal disposable income. Personal income minus taxes plus transfers. The amount households have for consumption and saving.

Personal income. A measure of income before taxes have been deducted. More precisely, it equals disposable personal income plus net taxes.

Personal saving. That part of income which is not consumed; in other words, the difference between disposable income and consumption.

Personal saving rate. The ratio of personal saving to personal disposable income, in percent.

Phillips curve. A graph, first devised by A. W. Phillips, showing the tradeoff between unemployment and inflation. In modern mainstream macroeconomics, the downward-sloping "tradeoff" Phillips curve is generally held to be valid only in the short run; in the long run, the Phillips curve is usually thought to be vertical at the nonaccelerating inflation rate of unemployment (NAIRU).

Policy-ineffectiveness theorem. A theorem which asserts that, with rational expectations and flexible prices and wages, anticipated government monetary or fiscal policy cannot affect real output or unemployment.

Portfolio theory. An economic theory that describes how rational investors allocate their wealth among different financial assets—that is, how they put their wealth into a "portfolio."

Positive economics. See **normative vs. positive economics.**

Post hoc fallacy. From the Latin, *post hoc, ergo propter hoc,* which translates as "after this, therefore because of this." This fallacy arises when it is assumed that because event A precedes event B, it follows that A *causes* B.

Potential GDP. High-employment GDP; more precisely, the maximum level of GDP that can be sustained with a given state of technology and population size without accelerating inflation. Today, it is generally taken to be equivalent to the level of output corresponding to the **nonaccelerating inflation rate of unemployment (NAIRU).** Potential output is not necessarily maximum output.

Potential output. Same as **potential GDP.**

Poverty. Today, the U.S. government defines the "poverty line" to be the minimum adequate standard of living.

PPF. See **production-possibility frontier.**

Present value (of an asset). Today's value for an asset that yields a stream of income over time. Valuation of such time streams of returns requires calculating the present worth of each component of the income, which is done by applying a discount rate (or interest rate) to future incomes.

Price. The money cost of a good, service, or asset. Price is measured in monetary units per unit of the good (as in 3 dollars per 1 hamburger).

Price discrimination. A situation where the same product is sold to different consumers for different prices.

Eye Therapies Exhibit 2127, 692 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Price-elastic demand (or elastic demand). The situation in which price elasticity of demand exceeds 1 in absolute value. This signifies that the percentage change in quantity demanded is greater than the percentage change in price. In addition, elastic demand implies that total revenue (price times quantity) rises when price falls because the increase in quantity demanded is so large. (Contrast with **price-inelastic demand.**)

Price elasticity of demand. A measure of the extent to which quantity demanded responds to a price change. The elasticity coefficient (price elasticity of demand E_p) is the percentage change in quantity demanded divided by percentage change in price. In figuring percentages, use the averages of old and new quantities in the numerator and of old and new prices in the denominator; disregard the minus sign. Refer also to **price-elastic demand, price-inelastic demand,** and **unit-elastic demand.**

Price elasticity of supply. Conceptually similar to **price elasticity of demand,** except that it measures the supply responsiveness to a price change. More precisely, the price elasticity of supply measures the percentage change in quantity supplied divided by the percentage change in price. Supply elasticities are most useful in perfect competition.

Price flexibility. Price behavior in "auction" markets (e.g., for many raw commodities or the stock market), in which prices immediately respond to changes in demand or in supply.

Price index. An index number that shows how the average price of a bundle of goods changes over time. In computation of the average, the prices of the different goods are generally weighted by their economic importance (e.g., by each commodity's share of total consumer expenditures in the **consumer price index**).

Price-inelastic demand (or inelastic demand). The situation in which price elasticity of demand is below 1 in absolute value. In this case, when price declines, total revenue declines, and when price is increased, total revenue goes up. Perfectly inelastic demand means that there is no change at all in quantity demanded when price goes up or down. (Contrast with **price-elastic demand** and **unit-elastic demand.**)

Price of GDP. See **GDP deflator.**

Private good. See **public good.**

Producer price index. The price index of goods sold at the wholesale level (such as steel, wheat, oil).

Producer surplus. The difference between the producer sales revenue and the producer cost. The producer surplus is generally measured as the area above the supply curve but under the price line up to the amount sold.

Product, average. Refer to **average product.**

Product, marginal. Refer to **marginal product.**

Product differentiation. The existence of characteristics that make similar goods less-than-perfect substitutes. Thus locational differences make similar types of gasoline sold at separate points imperfect substitutes. Firms enjoying product differentiation face a downward-sloping demand curve instead of the horizontal demand curve of the perfect competitor.

Production function. A relation (or mathematical function) specifying the maximum output that can be produced with given inputs for a given level of technology; applies to a firm or, as an aggregate production function, to the economy as a whole.

Production-possibility frontier (*PPF*). A graph showing the menu of goods that can be produced by an economy. In a frequently cited case, the choice is reduced to two goods, guns and butter. Points outside the *PPF* (to the northeast of it) are unattainable. Points inside it are inefficient since resources are not being fully employed, resources are not being used properly, or outdated production techniques are being utilized.

Productive efficiency. A situation in which an economy cannot produce more of one good without producing less of another good; this implies that the economy is on its production-possibility frontier.

Productivity. A term referring to the ratio of output to inputs (total output divided by labor inputs is *labor productivity*). Productivity increases if the same quantity of inputs produces more output. Labor productivity increases because of improved technology, improvements in labor skills, or capital deepening.

Productivity growth. The rate of increase in **productivity** from one period to another. For example, if an index of labor productivity is 100 in 2004 and 101.7 in 2005, the rate of productivity growth is 1.7 percent per year for 2005 over 2004.

Productivity of capital, net. See **rate of return on capital.**

Profit. (1) In accounting terms, total revenue minus costs properly chargeable against the goods sold (see **income statement**). (2) In economic theory, the difference between sales revenue and the full opportunity cost of resources involved in producing the goods.

Profit-and-loss statement. See **income statement.**

Progressive, proportional, and regressive taxes. A progressive tax weighs more heavily upon the rich; a regressive tax does the opposite. More precisely, a tax is *progressive* if the average tax rate (i.e., taxes divided by income) is higher for

Eye Therapies Exhibit 2127, 693 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

those with higher incomes; it is a *regressive* tax if the average tax rate declines with higher incomes; it is a *proportional* tax if the average tax rate is equal at all income levels.

Property rights. Rights that define the ability of individuals or firms to own, buy, sell, and use the capital goods and other property in a market economy.

Proportional tax. See **progressive, proportional, and regressive taxes.**

Proprietorship, individual. A business firm owned and operated by one person.

Protectionism. Any policy adopted by a country to protect domestic industries against competition from imports (most commonly, a tariff or quota imposed on such imports).

Public choice (also public-choice theory). Branch of economics and political science dealing with the way that governments make choices and direct the economy. This theory differs from the theory of markets in emphasizing the influence of vote maximizing for politicians, which contrasts to profit maximizing by firms.

Public debt. See **government debt.**

Public good. A commodity whose benefits are indivisibly spread among the entire community, whether or not particular individuals desire to consume the public good. For example, a public-health measure that eradicates polio protects all, not just those paying for the vaccinations. To be contrasted with *private goods,* such as bread, which, if consumed by one person, cannot be consumed by another person.

Pure economic rent. See **rent, economic.**

Q

Quantity demanded. See **change in demand vs. change in quantity demanded.**

Quantity equation of exchange. A tautology, $MV \equiv PQ$, where M is the money supply, V is the income velocity of money, and PQ (price times quantity) is the money value of total output (nominal GDP). The equation must always hold exactly since V is defined as PQ/M.

Quantity supplied. See **change in supply vs. change in quantity supplied.**

Quantity theory of money and prices. A theory of the determination of output and the overall price level holding that prices move proportionately with the money supply. A more cautious approach put forth by monetarists holds that the money supply is the most important determinant of changes in nominal GDP (see **monetarism**).

Quota. A form of import protectionism in which the total quantity of imports of a particular commodity (e.g., sugar or cars) during a given period is limited.

R

Random-walk theory (of stock market prices). See **efficient market.**

Rate of inflation. See **inflation.**

Rate of return (or return) on capital. The yield on an investment or on a capital good. Thus, an investment costing $100 and yielding $12 annually has a rate of return of 12 percent per year.

Rate of return on investment. The net dollar return per year for every dollar of invested capital. For example, if $100 of investment yields $12 per year of return, the rate of return on investment is 12 percent per year.

Rational expectations. See **expectations.**

Rational-expectations hypothesis. A hypothesis which holds that people make unbiased forecasts and, further, that people use all available information and economic theory to make these forecasts.

Rational-expectations macroeconomics. A school holding that markets clear quickly and that expectations are rational. Under these and other conditions it can be shown that predictable macroeconomic policies have no effect on real output or unemployment. Sometimes called **new classical macroeconomics.**

Real-business-cycle (RBC) theory. A theory that explains business cycles purely as shifts in aggregate supply, primarily due to technological disturbances, without any reference to monetary or other demand-side forces.

Real GDP. See **gross domestic product, real.**

Real interest rate. The interest rate measured in terms of goods rather than money. It is thus equal to the money (or nominal) interest rate less the rate of inflation.

Real wages. The purchasing power of a worker's wages in terms of goods and services. It is measured by the ratio of the money wage rate to the consumer price index.

Recession. A period of significant decline in total output, income, and employment, usually lasting from 6 months to a year and marked by widespread contractions in many sectors of the economy. See also **depression.**

Regressive tax. See **progressive, proportional, and regressive taxes.**

Regulation. Government laws or rules designed to control the behavior of firms. The major kinds are *economic regulation* (which affects the prices, entry, or service of a single industry, such as telephone service) and *social regulation* (which attempts to correct externalities that prevail across a number of industries, such as air or water pollution).

Renewable resources. Natural resources (like agricultural land) whose services replenish regularly and which, if properly managed, can yield useful services indefinitely.

Eye Therapies Exhibit 2127, 694 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Rent, economic (or pure economic rent). Term applied to income earned from land. The total supply of land available is (with minor qualifications) fixed, and the return paid to the landowner is rent. The term is often extended to the return paid to any factor in fixed supply—i.e., to any input having a perfectly inelastic or vertical supply curve.

Required reserve ratio. See **reserves, bank.**

Reserves, bank. That portion of deposits that a bank sets aside in the form of vault cash or non-interest-earning deposits with Federal Reserve Banks. In the United States, banks are required to hold 10 percent of checking deposits (or transactions accounts) in the form of reserves.

Reserves, international. International money held by a nation to stabilize or "peg" its foreign exchange rate or provide financing when the nation faces balance-of-payments difficulties. Today, the bulk of reserves are U.S. dollars, with Euros and Japanese yen the other major reserve currencies.

Resource allocation. The manner in which an economy distributes its resources (its factors of production) among the potential uses so as to produce a particular set of final goods.

Returns to scale. The rate at which output increases when all inputs are increased proportionately. For example, if all the inputs double and output is exactly doubled, that process is said to exhibit *constant returns to scale.* If, however, output grows by less than 100 percent when all inputs are doubled, the process shows *decreasing returns to scale;* if output more than doubles, the process demonstrates *increasing returns to scale.*

Revaluation. An increase in the official foreign exchange rate of a currency. See also **devaluation.**

Ricardian view of fiscal policy. A theory developed by Harvard's Robert Barro which holds that changes in tax rates have no impact upon consumption spending because households foresee, say, that tax cuts today will require tax increases tomorrow to finance the government's financing requirements.

Risk. In financial economics, refers to the variability of the returns on an investment.

Risk averse. A person is risk-averse when, faced with an uncertain situation, the displeasure from losing a given amount of income is greater than the pleasure from gaining the same amount of income.

Risk spreading. The process of taking large risks and spreading them around so that they are but small risks for a large number of people. The major form of risk spreading is **insurance,** which is a kind of gambling in reverse.

Rule of 70. A useful shortcut for approximating compound interest. A quantity that grows at r percent per year will double in about $70/r$ years.

S

Sacrifice ratio. The sacrifice ratio is the cumulative loss in output, measured as a percent of one year's GDP, associated with a one-percentage-point permanent reduction in inflation.

Sales tax. See **excise tax vs. sales tax.**

Saving function. The schedule showing the amount of saving that households or a nation will undertake at each level of income.

Say's Law of Markets. The theory that "supply creates its own demand." J. B. Say argued in 1803 that, because total purchasing power is exactly equal to total incomes and outputs, excess demand or supply is impossible. Keynes attacked Say's Law, pointing out that an extra dollar of income need not be spent entirely (i.e., the marginal propensity to spend is not necessarily unity).

Scarcity. The distinguishing characteristic of an economic good. That an economic good is scarce means not that it is rare but only that it is not freely available for the taking. To obtain such a good, one must either produce it or offer other economic goods in exchange.

Scarcity, law of. The principle that most things that people want are available only in limited supply (the exception being **free goods**). Thus goods are generally scarce and must somehow be rationed, whether by price or some other means.

Schedule (demand, supply, aggregate demand, aggregate supply). Term used interchangeably with "curve," as in demand curve, supply curve, etc.

Securities. A term used to designate a wide variety of financial assets, such as stocks, bonds, options, and notes; more precisely, the documents used to establish ownership of these assets.

Short run. A period in which not all factors can adjust fully. In microeconomics, the capital stock and other "fixed" inputs cannot be adjusted and entry is not free in the short run. In macroeconomics, prices, wage contracts, tax rates, and expectations may not fully adjust in the short run.

Short-run aggregate supply schedule. The schedule showing the relationship between output and prices in the short run wherein changes in aggregate demand can affect output; represented by an upward-sloping or horizontal *AS* curve.

Shutdown price (or point or rule). In the theory of the firm, the shutdown point comes at that point where the market price is just sufficient to cover average variable cost

Eye Therapies Exhibit 2127, 695 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

and no more. Hence, the firm's losses per period just equal its fixed costs; it might as well shut down.

Single-tax movement. A nineteenth-century movement, originated by Henry George, holding that continued poverty in the midst of steady economic progress was attributable to the scarcity of land and the large rents flowing to landowners. The "single tax" was to be a tax on economic rent earned from landownership.

Slope. In a graph, the change in the variable on the vertical axis per unit of change in the variable on the horizontal axis. Upward-sloping lines have positive slopes, downward-sloping curves (like demand curves) have negative slopes, and horizontal lines have slopes of zero.

Social insurance. Mandatory insurance provided by government to improve social welfare by preventing the losses created by market failures such as moral hazard or adverse selection.

Social overhead capital. The essential investments on which economic development depends, particularly for sanitation and drinking water, transportation, and communications; sometimes called *infrastructure.*

Social regulation. See **regulation.**

Socialism. A political theory which holds that all (or almost all) the means of production, other than labor, should be owned by the community. This allows the return on capital to be shared more equally than under capitalism.

Speculator. Someone engaged in speculation, i.e., someone who buys (or sells) a commodity or financial asset with the aim of profiting from later selling (or buying) the item at a higher (or lower) price.

Spillovers. Same as **externalities.**

Stagflation. A term, coined in the early 1970s, describing the coexistence of high unemployment, or *stag*nation, with persistent in*flation.* Its explanation lies primarily in the inertial nature of the inflationary process.

Statistical discrimination. Treatment of individuals on the basis of the average behavior or characteristics of members of the group to which they belong. Statistical discrimination can be self-fulfilling by reducing incentives for individuals to overcome the stereotype.

Stock, common. Refer to **common stock.**

Stock market. An organized marketplace in which common stocks are traded. In the United States, the largest stock market is the New York Stock Exchange, on which are traded the stocks of the largest U.S. companies.

Stock vs. flow. See **flow vs. stock.**

Strategic interaction. A situation in oligopolistic markets in which each firm's business strategies depend upon its rival's plans. A formal analysis of strategic interaction is given in **game theory.**

Structural budget. See **actual, cyclical, and structural budget.**

Structural unemployment. Unemployment resulting because the regional or occupational pattern of job vacancies does not match the pattern of worker availability. There may be jobs available, but unemployed workers may not have the required skill or the jobs may be in different regions from where the unemployed workers live.

Subsidy. A payment by a government to a firm or household that provides or consumes a commodity. For example, governments often subsidize food by paying for part of the food expenditures of low-income households.

Substitutes. Goods that compete with each other (as do gloves and mittens). By contrast, goods that go together in the eyes of consumers (such as left shoes and right shoes) are *complements.*

Substitution effect (of a price change)**.** The tendency of consumers to consume more of a good when its relative price falls (to "substitute" in favor of that good) and to consume less of the good when its relative price increases (to "substitute" away from that good). This substitution effect of a price change leads to a downward-sloping demand curve. (Compare with **income effect.**)

Substitution rule. A rule which asserts that if the price of one factor falls while all other factor prices remain the same, firms will profit by substituting the now-cheaper factor for all the other factors. The rule is a corollary of the **least-cost rule.**

Supply curve (or supply schedule). A schedule showing the quantity of a good that suppliers in a given market desire to sell at each price, holding other things equal.

Supply shock. In macroeconomics, a sudden change in production costs or productivity that has a large and unexpected impact upon aggregate supply. As a result of a supply shock, real GDP and the price level change unexpectedly.

Supply-shock inflation. Inflation originating on the supply side of markets from a sharp increase in costs. In the aggregate supply-and-demand framework, cost-push is illustrated as an upward shift of the *AS* curve. Also called *cost-push inflation.*

Supply-side economics. A view emphasizing policy measures to affect aggregate supply or potential output. This approach holds that high marginal tax rates on labor and capital incomes reduce work effort and saving.

T

Tangible assets. Those assets, such as land or capital goods like computers, buildings, and automobiles, that are used to produce further goods and services.

Tariff. A levy or tax imposed upon each unit of a commodity imported into a country.

Eye Therapies Exhibit 2127, 696 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Tax incidence. See **incidence.**

Technological change. A change in the process of production or an introduction of a new product such that more or improved output can be obtained from the same bundle of inputs. It results in an outward shift in the production-possibility curve. Often called *technological progress.*

Technological progress. See **technological change.**

Terms of trade (in international trade)**.** The "real" terms at which a nation sells its export products and buys its import products. This measure equals the ratio of an index of export prices to an index of import prices.

Theory of income distribution. A theory explaining the manner in which personal income and wealth are distributed in a society.

Time deposit. Funds, held in a bank, that have a minimum "time of withdrawal"; included in broad money but not in M_1 because they are not accepted as a means of payment. Similar to *savings deposits.*

Total cost. Refer to **cost, total.**

Total factor productivity. An index of productivity that measures total output per unit of total input. The numerator of the index is total output (say, GDP), while the denominator is a weighted average of inputs of capital, labor, and resources. The growth of total factor productivity is often taken as an index of the rate of technological progress. Also sometimes called *multifactor productivity.*

Total product (or output). The total amount of a commodity produced, measured in physical units such as bushels of wheat, tons of steel, or number of haircuts.

Total revenue (*TR*). Price times quantity, or total sales.

Trade balance or **merchandise trade balance.** See **balance of trade.**

Trade barrier. Any of a number of protectionist devices by which nations discourage imports. Tariffs and quotas are the most visible barriers, but in recent years nontariff barriers (or NTBs), such as burdensome regulatory proceedings, have replaced more traditional measures.

Transactions demand for money. See **demand for money.**

Transactions money (M_1). A measure of the **money supply** which consists of items that are actually for transactions, namely, currency and checking accounts.

Transfer payments, government. Payments made by a government to individuals, for which the individual performs no current service in return. Examples are social security payments and unemployment insurance.

Treasury bills (T-bills). Short-term bonds or securities issued by the federal government.

U

Unemployed. People who are not employed but are actively looking for work or waiting to return to work.

Unemployment. (1) In economic terms, *involuntary unemployment* occurs when there are qualified workers who are willing to work at prevailing wages but cannot find jobs. (2) In the official (U.S. Bureau of Labor Statistics) definition, a worker is unemployed if he or she (*a*) is not working and (*b*) either is waiting for recall from layoff or has actively looked for work in the last 4 weeks. See also **frictional unemployment** and **structural unemployment.**

Unemployment rate. The percentage of the labor force that is unemployed.

Unit-elastic demand. The situation, between **price-elastic demand** and **price-inelastic demand,** in which price elasticity is just equal to 1 in absolute value. See also **price elasticity of demand.**

Unlimited liability. See **limited liability.**

Usury. The charging of an interest rate above a legal maximum on borrowed money.

Utility (also total utility). The total satisfaction derived from the consumption of goods or services. To be contrasted with *marginal utility,* which is the additional utility arising from consumption of an additional unit of the commodity.

V

Value, paradox of. Refer to **paradox of value.**

Value added. The difference between the value of goods produced and the cost of materials and supplies used in producing them. In a $1 loaf of bread embodying $0.60 worth of wheat and other materials, the value added is $0.40. Value added consists of the wages, interest, and profit components added to the output by a firm or industry.

Value-added tax (VAT). A tax levied upon a firm as a percentage of its value added.

Variable. A magnitude of interest that can be defined and measured. Important variables in economics include prices, quantities, interest rates, exchange rates, dollars of wealth, and so forth.

Variable cost. Refer to **cost, variable.**

Velocity of money. In serving its function as a medium of exchange, money moves from buyer to seller to new buyer and so on. Its "velocity" refers to the speed of this movement.

Vertical equity. See **horizontal equity vs. vertical equity.**

Vertical integration. See **integration, vertical vs. horizontal.**

Vertical merger. See **merger.**

W

Wealth. The net value of tangible and financial items owned by a nation or person at a point in time. It equals all assets less all liabilities.

Eye Therapies Exhibit 2127, 697 of 702
Dr. Reddy's v. Eye Therapies - IPR2024-00563

Welfare economics. The normative analysis of economic systems, i.e., the study of what is "wrong" or "right" about the economy's functioning.

Welfare state. A concept of the mixed economy arising in Europe in the late nineteenth century and introduced in the United States in the 1930s. In the modern conception of the welfare state, markets direct the detailed activities of day-to-day economic life while governments regulate social conditions and provide pensions, health care, and other aspects of the social safety net.

***What, how,* and *for whom*.** The three fundamental problems of economic organization. *What* is the problem of how much of each possible good and service will be produced with the society's limited stock of resources or inputs. *How* is the choice of the particular technique by which each good shall be produced. *For whom* refers to the distribution of consumption goods among the members of that society.

Y

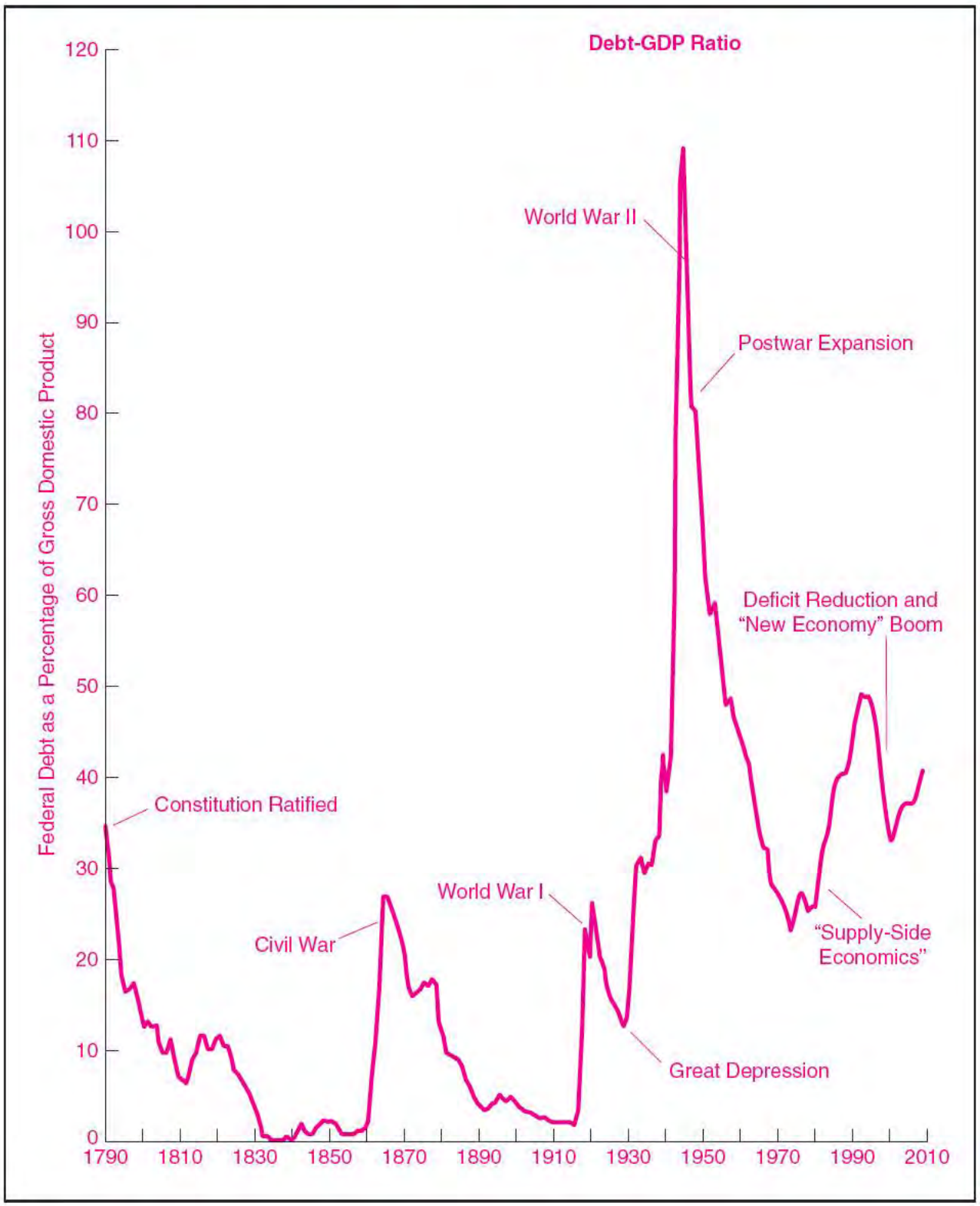
Yield. Same as the **interest rate** or **rate of return** on an asset.

Z

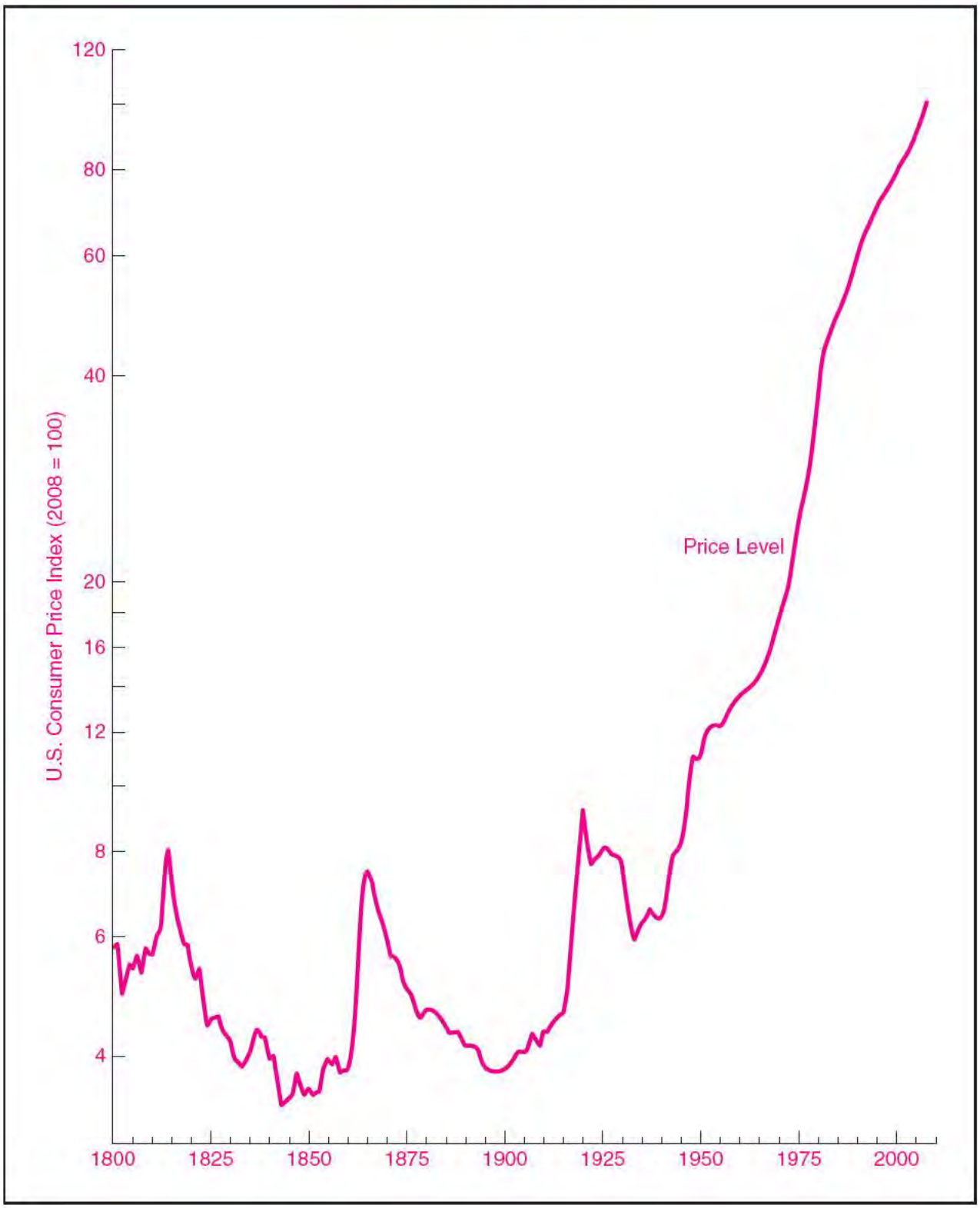
Zero economic profit. In a perfectly competitive industry in long-run equilibrium, there will be zero economic profit. This definition pertains to all revenues less all costs, including the implicit costs of factors owned by the firms.

Zero-profit point. For a business firm, that level of price at which the firm breaks even, covering all costs but earning zero profit.

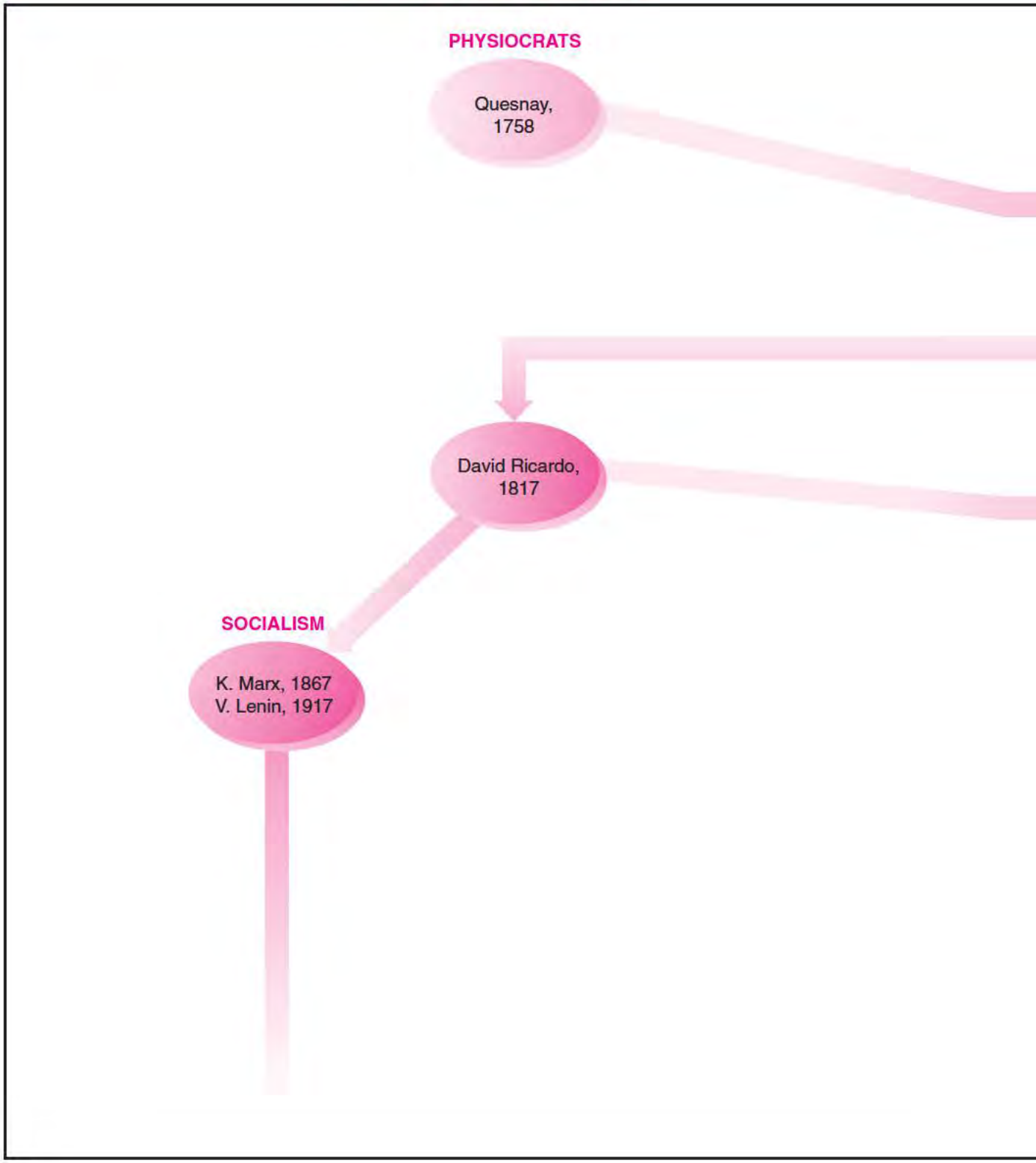
GOVERNMENT DEBT SINCE THE AMERICAN REVOLUTION

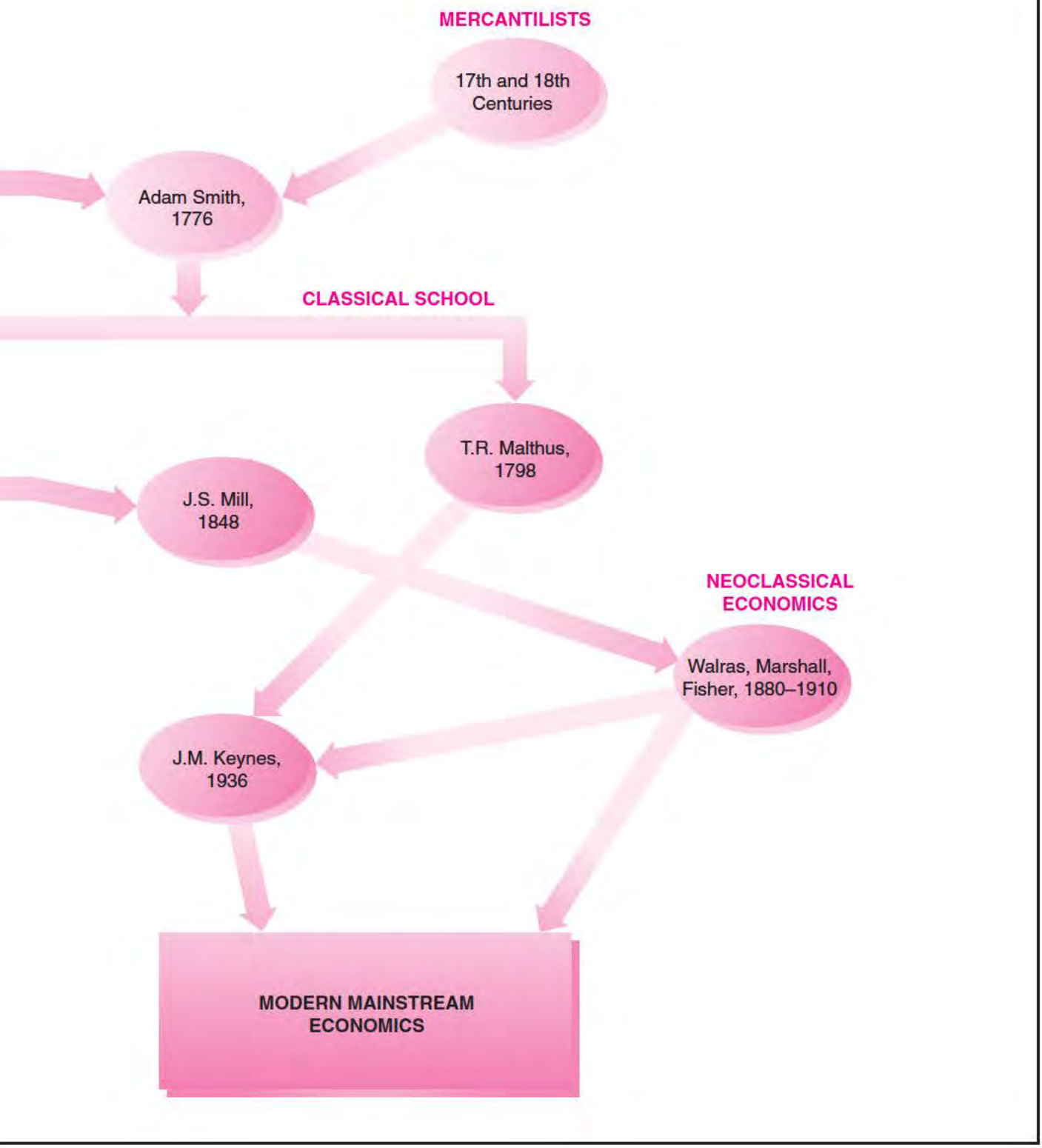


U.S. PRICE LEVEL SINCE 1800



FAMILY TREE OF ECONOMICS




MERCANTILISTS
17th and 18th Centuries
Adam Smith, 1776
CLASSICAL SCHOOL
T.R. Malthus, 1798
J.S. Mill, 1848
NEOCLASSICAL ECONOMICS
Walras, Marshall, Fisher, 1880–1910
J.M. Keynes, 1936
MODERN MAINSTREAM ECONOMICS