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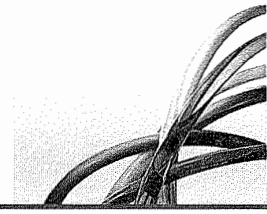

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Consumer Behavior

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Some time ago, General Mills introduced a new breakfast cereal. The new brand, Apple-Cinnamon Cheerios, was a sweetened and more flavorful variant on General Mills' classic Cheerios product. But before Apple-Cinnamon Cheerios could be extensively marketed, the company had to resolve an important problem: *How high a price should it charge?* No matter how good the cereal was, its profitability would depend on the company's pricing decision. Knowing that consumers would pay more for a new product was not enough. The question was *how much more.* General Mills, therefore, had to conduct a careful analysis of consumer preferences to determine the demand for Apple-Cinnamon Cheerios.

General Mills' problem in determining consumer preferences mirrors the more complex problem faced by the U.S. Congress in evaluating the federal Food Stamps program. The goal of the program is to give low-income households coupons that can be exchanged for food. But there has always been a problem in the program's design that complicates its assessment: To what extent do food stamps provide people with *more* food, as opposed to simply subsidizing the purchase of food that they would have bought anyway? In other words, has the program turned out to be little more than an income supplement that people spend largely on nonfood items instead of a solution to the nutritional problems of the poor? As in the cereal example, we need an analysis of consumer behavior. In this case, the federal government must determine how spending on food, as opposed to spending on other goods, is affected by changing income levels and prices.

Solving these two problems—one involving corporate policy and the other public policy—requires an understanding of the **theory of consumer behavior:** the explanation of how consumers allocate incomes to the purchase of different goods and services.

Consumer Behavior

How can a consumer with a limited income decide which goods and services to buy? This is a fundamental issue in microeconomics—one that we address in this chapter and the next. We will see how consumers allocate their incomes across goods and explain how these allocation decisions determine the demands for various goods and

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• **theory of consumer behavior** Description of how consumers allocate incomes among different goods and services to maximize their well-being.

services. In turn, understanding consumer purchasing decisions will help us to understand how changes in income and prices affect the demand for goods and services and why the demand for some products is more sensitive than others to changes in prices and income.

Consumer behavior is best understood in three distinct steps:

1. **Consumer Preferences:** The first step is to find a practical way to describe the reasons people might prefer one good to another. We will see how a consumer's *preferences* for various goods can be described graphically and algebraically.
2. **Budget Constraints:** Of course, consumers also consider *prices*. In Step 2, therefore, we take into account the fact that consumers have limited incomes which restrict the quantities of goods they can buy. What does a consumer do in this situation? We find the answer to this question by putting consumer preferences and budget constraints together in the third step.
3. **Consumer Choices:** Given their preferences and limited incomes, consumers choose to buy combinations of goods that maximize their satisfaction. These combinations will depend on the prices of various goods. Thus, understanding consumer choice will help us understand *demand*—i.e., how the quantity of a good that consumers choose to purchase depends on its price.

These three steps are the basics of consumer theory, and we will go through them in detail in the first three sections of this chapter. Afterward, we will explore a number of other interesting aspects of consumer behavior. For example, we will see how one can determine the nature of consumer preferences from actual observations of consumer behavior. Thus, if a consumer chooses one good over a similarly priced alternative, we can infer that he or she prefers the first good. Similar kinds of conclusions can be drawn from the actual decisions that consumers make in response to changes in the prices of the various goods and services that are available for purchase.

At the end of this chapter, we will return to the discussion of real and nominal prices that we began in Chapter 1. We saw that the Consumer Price Index can provide one measure of how the well-being of consumers changes over time. In this chapter, we delve more deeply into the subject of purchasing power by describing a range of indexes that measure changes in purchasing power over time. Because they affect the benefits and costs of numerous social-welfare programs, these indexes are significant tools in setting government policy in the United States.

WHAT DO CONSUMERS DO? Before proceeding, we need to be clear about our assumptions regarding consumer behavior, and whether those assumptions are realistic. It is hard to argue with the proposition that consumers have preferences among the various goods and services available to them, and that they face budget constraints which put limits on what they can buy. But we might take issue with the proposition that consumers decide which combinations of goods and services to buy so as to maximize their satisfaction. Are consumers as rational and informed as economists often make them out to be?

We know that consumers do not always make purchasing decisions rationally. Sometimes, for example, they buy on impulse, ignoring or not

fully accounting for their budget constraints (and going into debt as a result). Sometimes consumers are unsure about their preferences or are swayed by the consumption decisions of friends and neighbors, or even by changes in mood. And even if consumers do behave rationally, it may not always be feasible for them to account fully for the multitude of prices and choices that they face daily.

Economists have recently been developing models of consumer behavior that incorporate more realistic assumptions about rationality and decision making. This area of research, called *behavioral economics*, has drawn heavily from findings in psychology and related fields. We will discuss some key results from behavioral economics in Chapter 5. At this point we simply want to make it clear that our basic model of consumer behavior necessarily makes some simplifying assumptions. But we also want to emphasize that this model has been extremely successful in explaining much of what we actually observe regarding consumer choice and the characteristics of consumer demand. As a result, this model is a basic "workhorse" of economics. It is used widely, not only in economics, but also in related fields such as finance and marketing.

3.1 Consumer Preferences

Given both the vast number of goods and services that our industrial economy provides for purchase and the diversity of personal tastes, how can we describe consumer preferences in a coherent way? Let's begin by thinking about how a consumer might compare different groups of items available for purchase. Will one group of items be preferred to another group, or will the consumer be indifferent between the two groups?

Market Baskets

We use the term *market basket* to refer to such a group of items. Specifically, a **market basket** is a list with specific quantities of one or more goods. A market basket might contain the various food items in a grocery cart. It might also refer to the quantities of food, clothing, and housing that a consumer buys each month. Many economists also use the word *bundle* to mean the same thing as market basket.

• **market basket** (or **bundle**) List with specific quantities of one or more goods.

How do consumers select market baskets? How do they decide, for example, how much food versus clothing to buy each month? Although selections may occasionally be arbitrary, as we will soon see, consumers usually select market baskets that make them as well off as possible.

Table 3.1 shows several market baskets consisting of various amounts of food and clothing purchased on a monthly basis. The number of food items can be measured in any number of ways: by total number of containers, by number of packages of each item (e.g., milk, meat, etc.), or by number of pounds or grams. Likewise, clothing can be counted as total number of pieces, as number of pieces of each type of clothing, or as total weight or volume. Because the method of measurement is largely arbitrary, we will simply describe the items in a market basket in terms of the total number of *units* of each commodity. Market basket *A*, for example, consists of 20 units of food and 30 units of clothing, basket *B* consists of 10 units of food and 50 units of clothing, and so on.

TABLE 3.1 ALTERNATIVE MARKET BASKETS

MARKET BASKET	UNITS OF FOOD	UNITS OF CLOTHING
A	20	30
B	10	50
D	40	20
E	30	40
G	10	20
H	10	40

Note: We will avoid the use of the letters *C* and *F* to represent market baskets, whenever market baskets might be confused with the number of units of food and clothing.

To explain the theory of consumer behavior, we will ask whether consumers *prefer* one market basket to another. Note that the theory assumes that consumers' preferences are consistent and make sense. We explain what we mean by these assumptions in the next subsection.

Some Basic Assumptions about Preferences

The theory of consumer behavior begins with three basic assumptions about people's preferences for one market basket versus another. We believe that these assumptions hold for most people in most situations.

1. **Completeness:** Preferences are assumed to be *complete*. In other words, consumers can compare and rank all possible baskets. Thus, for any two market baskets *A* and *B*, a consumer will prefer *A* to *B*, will prefer *B* to *A*, or will be indifferent between the two. By *indifferent* we mean that a person will be equally satisfied with either basket. Note that these preferences ignore costs. A consumer might prefer steak to hamburger but buy hamburger because it is cheaper.
2. **Transitivity:** Preferences are *transitive*. Transitivity means that if a consumer prefers basket *A* to basket *B* and basket *B* to basket *C*, then the consumer also prefers *A* to *C*. For example, if a Porsche is preferred to a Cadillac and a Cadillac to a Chevrolet, then a Porsche is also preferred to a Chevrolet. Transitivity is normally regarded as necessary for consumer consistency.
3. **More is better than less:** Goods are assumed to be desirable—i.e., to be *good*. Consequently, *consumers always prefer more of any good to less*. In addition, consumers are never satisfied or satiated; *more is always better, even if just a little better.*[1] This assumption is made for pedagogic reasons; namely, it simplifies the graphical analysis. Of course, some goods, such as air pollution, may be undesirable, and consumers will always prefer less. We ignore these "bads" in the context of our immediate discussion of consumer choice because most consumers would not choose to purchase them. We will, however, discuss them later in the chapter.

These three assumptions form the basis of consumer theory. They do not explain consumer preferences, but they do impose a degree of rationality and reasonableness on them. Building on these assumptions, we will now explore consumer behavior in greater detail.

[1]Thus some economists use the term *nonsatiation* to refer to this third assumption.

Indifference Curves

We can show a consumer's preferences graphically with the use of *indifference curves*. An **indifference curve** *represents all combinations of market baskets that provide a consumer with the same level of satisfaction.* That person is therefore *indifferent* among the market baskets represented by the points graphed on the curve.

• **indifference curve** Curve representing all combinations of market baskets that provide a consumer with the same level of satisfaction.

Given our three assumptions about preferences, we know that a consumer can always indicate either a preference for one market basket over another or indifference between the two. We can then use this information to rank all possible consumption choices. In order to appreciate this principle in graphic form, let's assume that there are only two goods available for consumption: food *F* and clothing *C*. In this case, all market baskets describe combinations of food and clothing that a person might wish to consume. As we have already seen, Table 3.1 provides some examples of baskets containing various amounts of food and clothing.

In order to graph a consumer's indifference curve, it helps first to graph his or her individual preferences. Figure 3.1 shows the same baskets listed in Table 3.1. The horizontal axis measures the number of units of food purchased each week; the vertical axis measures the number of units of clothing. Market basket *A*, with 20 units of food and 30 units of clothing, is preferred to basket *G* because *A* contains more food *and* more clothing (recall our third assumption that more is better than less). Similarly, market basket *E*, which contains even more food and even more clothing, is preferred to *A*. In fact, we can easily compare all market baskets in the two shaded areas (such as *E* and *G*) to *A* because they contain either more or less of both food and clothing. Note, however, that *B* contains more clothing but less food than *A*. Similarly, *D* contains more food but less clothing than *A*. Therefore, comparisons of market basket *A* with baskets *B*, *D*, and *H* are not possible without more information about the consumer's ranking.

This additional information is provided in Figure 3.2, which shows an indifference curve, labeled U_1, that passes through points *A*, *B*, and *D*. This curve indicates that the consumer is indifferent among these three market baskets. It tells us that in moving from market basket *A* to market basket *B*, the consumer feels neither better nor worse off in giving up 10 units of food to obtain 20 additional

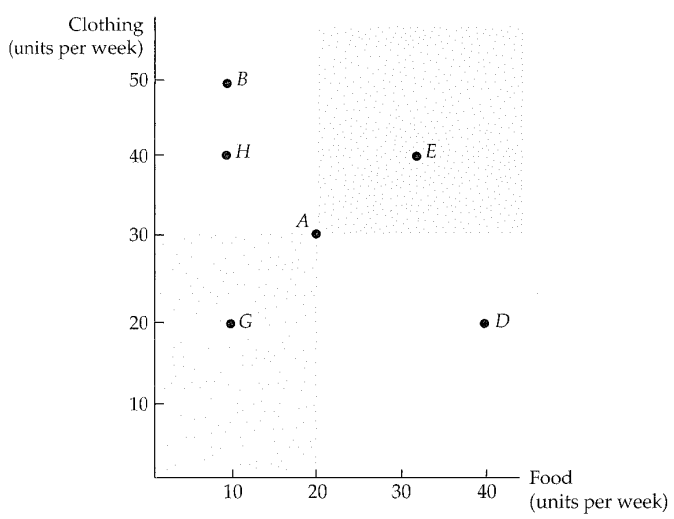
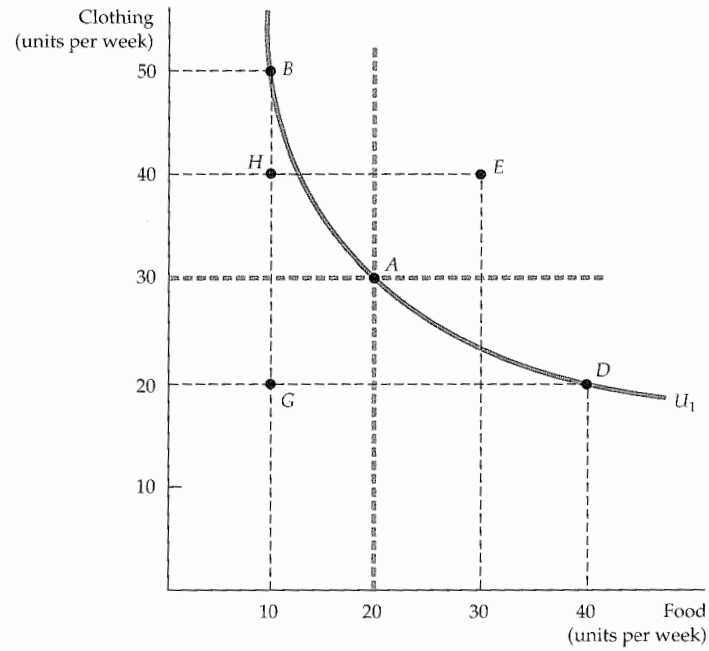


FIGURE 3.1
DESCRIBING INDIVIDUAL PREFERENCES

Because more of each good is preferred to less, we can compare market baskets in the shaded areas. Basket *A* is clearly preferred to basket *G*, while *E* is clearly preferred to *A*. However, *A* cannot be compared with *B*, *D*, or *H* without additional information.

FIGURE 3.2
AN INDIFFERENCE CURVE

The indifference curve U_1 that passes through market basket A shows all baskets that give the consumer the same level of satisfaction as does market basket A; these include baskets B and D. Our consumer prefers basket E, which lies above U_1, to A, but prefers A to H or G, which lie below U_1.



units of clothing. Likewise, the consumer is indifferent between points A and D: He or she will give up 10 units of clothing to obtain 20 more units of food. On the other hand, the consumer prefers A to H, which lies below U_1.

Note that the indifference curve in Figure 3.2 slopes downward from left to right. To understand why this must be the case, suppose instead that it sloped upward from A to E. This would violate the assumption that more of any commodity is preferred to less. Because market basket E has more of both food and clothing than market basket A, it must be preferred to A and therefore cannot be on the same indifference curve as A. In fact, any market basket lying *above and to the right of* indifference curve U_1 in Figure 3.2 is preferred to any market basket on U_1.

Indifference Maps

• **indifference map** Graph containing a set of indifference curves showing the market baskets among which a consumer is indifferent.

To describe a person's preferences for *all* combinations of food and clothing, we can graph a set of indifference curves called an **indifference map.** Each indifference curve in the map shows the market baskets among which the person is indifferent. Figure 3.3 shows three indifference curves that form part of an indifference map (the entire map includes an infinite number of such curves). Indifference curve U_3 generates the highest level of satisfaction, followed by indifference curves U_2 and U_1.

Indifference curves cannot intersect. To see why, we will assume the contrary and see how the resulting graph violates our assumptions about consumer behavior. Figure 3.4 shows two indifference curves, U_1 and U_2, that intersect at A. Because A and B are both on indifference curve U_1, the consumer must be indifferent between these two market baskets. Because both A and D lie on indifference curve U_2, the consumer is also indifferent between these market baskets. Consequently, using the assumption of transitivity, the consumer is also

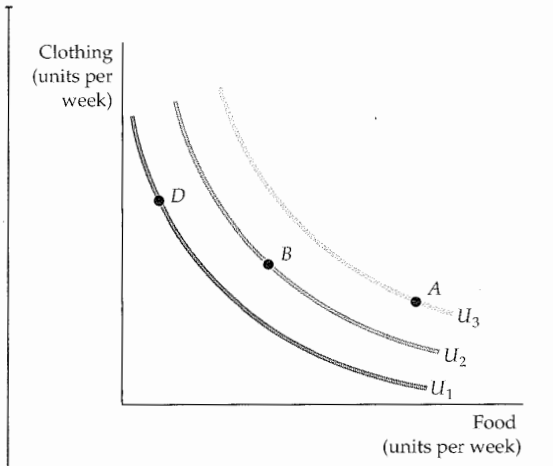


FIGURE 3.3
AN INDIFFERENCE MAP

An indifference map is a set of indifference curves that describes a person's preferences. Any market basket on indifference curve U_3, such as basket *A*, is preferred to any basket on curve U_2 (e.g., basket *B*), which in turn is preferred to any basket on U_1, such as *D*.

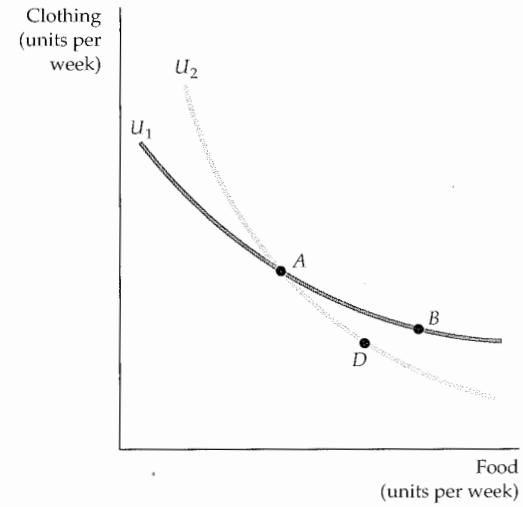


FIGURE 3.4
INDIFFERENCE CURVES CANNOT INTERSECT

If indifference curves U_1 and U_2 intersect, one of the assumptions of consumer theory is violated. According to this diagram, the consumer should be indifferent among market baskets *A*, *B*, and *D*. Yet *B* should be preferred to *D* because *B* has more of both goods.

indifferent between *B* and *D*. But this conclusion can't be true: Market basket *B* must be preferred to *D* because it contains more of both food and clothing. Thus, intersecting indifference curves contradicts our assumption that more is preferred to less.

Of course, there are an infinite number of nonintersecting indifference curves, one for every possible level of satisfaction. In fact, every possible market basket (each corresponding to a point on the graph) has an indifference curve passing through it.

The Shape of Indifference Curves

Recall that indifference curves are all downward sloping. In our example of food and clothing, when the amount of food increases along an indifference curve, the amount of clothing decreases. The fact that indifference curves slope downward follows directly from our assumption that more of a good is better than less. If an indifference curve sloped upward, a consumer would be indifferent between two market baskets even though one of them had more of *both* food and clothing.

As we saw in Chapter 1, people face trade-offs. The shape of an indifference curve describes how a consumer is willing to substitute one good for another. Look, for example, at the indifference curve in Figure 3.5. Starting at market basket *A* and moving to basket *B*, we see that the consumer is willing to give up 6 units of clothing to obtain 1 extra unit of food. However, in moving from *B* to *D*, he is willing to give up only 4 units of clothing to obtain an additional unit of

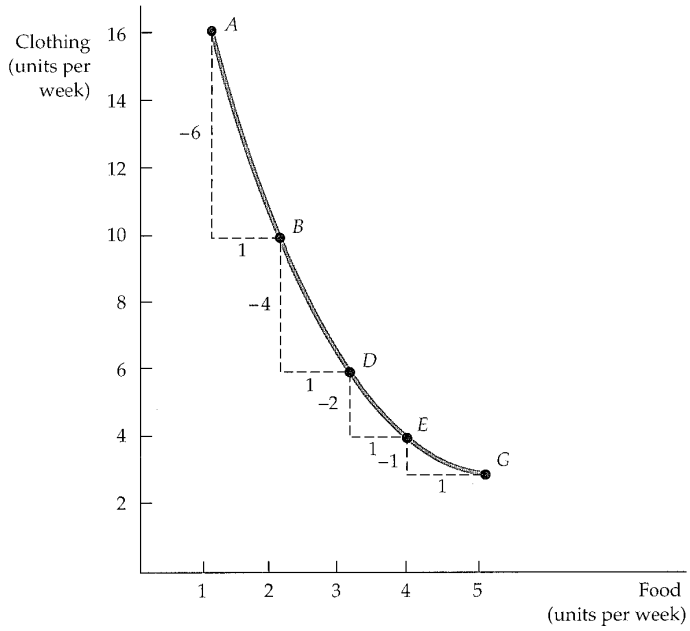


FIGURE 3.5
THE MARGINAL RATE OF SUBSTITUTION

The magnitude of the slope of an indifference curve measures the consumer's marginal rate of substitution (MRS) between two goods. In this figure, the MRS between clothing (*C*) and food (*F*) falls from 6 (between *A* and *B*) to 4 (between *B* and *D*) to 2 (between *D* and *E*) to 1 (between *E* and *G*). When the MRS diminishes along an indifference curve, the curve is convex.

food; in moving from *D* to *E*, he will give up only 2 units of clothing for 1 unit of food. The more clothing and the less food a person consumes, the more clothing he will give up in order to obtain more food. Similarly, the more food that a person possesses, the less clothing he will give up for more food.

The Marginal Rate of Substitution

marginal rate of substitution (MRS) Maximum amount of a good that a consumer is willing to give up in order to obtain one additional unit of another good.

To quantify the amount of one good that a consumer will give up to obtain more of another, we use a measure called the **marginal rate of substitution (MRS).** *The MRS of food F for clothing C is the maximum amount of clothing that a person is willing to give up to obtain one additional unit of food.* Suppose, for example, the MRS is 3. This means that the consumer will give up 3 units of clothing to obtain 1 additional unit of food. If the MRS is 1/2, the consumer is willing to give up only 1/2 unit of clothing. Thus, the MRS measures *the value that the individual places on 1 extra unit of a good in terms of another.*

Look again at Figure 3.5. Note that clothing appears on the vertical axis and food on the horizontal axis. When we describe the MRS, we must be clear about which good we are giving up and which we are getting more of. To be consistent throughout the book, we will define the MRS in terms of *the amount of the good on the vertical axis that the consumer is willing to give up in order to obtain 1 extra unit of the good on the horizontal axis.* Thus, in Figure 3.5 the MRS refers to the amount of clothing that the consumer is willing to give up to obtain an additional unit of food. If we denote the *change* in clothing by ΔC and the change in food by ΔF, the MRS can be written as $-\Delta C/\Delta F$. We add the negative sign to make the marginal rate of substitution a positive number. (Remember that ΔC is always negative; the consumer *gives up* clothing to obtain additional food.)

Thus the MRS at any point is equal in magnitude to the slope of the indifference curve. In Figure 3.5, for example, the MRS between points A and B is 6: The consumer is willing to give up 6 units of clothing to obtain 1 additional unit of food. Between points B and D, however, the MRS is 4: With these quantities of food and clothing, the consumer is willing to give up only 4 units of clothing to obtain 1 additional unit of food.

CONVEXITY Also observe in Figure 3.5 that the MRS falls as we move down the indifference curve. This is not a coincidence. This decline in the MRS reflects an important characteristic of consumer preferences. To understand this, we will add an additional assumption regarding consumer preferences to the three that we discussed earlier in this chapter (see page 70):

4. **Diminishing marginal rate of substitution:** Indifference curves are usually *convex*, or bowed inward. The term *convex* means that the slope of the indifference curve *increases* (i.e., becomes less negative) as we move down along the curve. In other words, *an indifference curve is convex if the MRS diminishes along the curve.* The indifference curve in Figure 3.5 is convex. As we have seen, starting with market basket A in Figure 3.5 and moving to basket B, the MRS of food F for clothing C is $-\Delta C/\Delta F = -(-6)/1 = 6$. However, when we start at basket B and move from B to D, the MRS falls to 4. If we start at basket D and move to E, the MRS is 2. Starting at E and moving to G, we get an MRS of 1. As food consumption increases, the slope of the indifference curve falls in magnitude. Thus the MRS also falls.[2]

Is it reasonable to expect indifference curves to be convex? Yes. As more and more of one good is consumed, we can expect that a consumer will prefer to give up fewer and fewer units of a second good to get additional units of the first one. As we move down the indifference curve in Figure 3.5 and consumption of food increases, the additional satisfaction that a consumer gets from still more food will diminish. Thus, he will give up less and less clothing to obtain additional food.

Another way of describing this principle is to say that consumers generally prefer balanced market baskets to market baskets that contain all of one good and none of another. Note from Figure 3.5 that a relatively balanced market basket containing 3 units of food and 6 units of clothing (basket D) generates as much satisfaction as another market basket containing 1 unit of food and 16 units of clothing (basket A). It follows that a balanced market basket containing, for example, 6 units of food and 8 units of clothing will generate a higher level of satisfaction.

Perfect Substitutes and Perfect Complements

The shape of an indifference curve describes the willingness of a consumer to substitute one good for another. An indifference curve with a different shape implies a different willingness to substitute. To see this principle, look at the two somewhat extreme cases illustrated in Figure 3.6.

In §2.1, we explain that two goods are *substitutes* when an increase in the price of one leads to an increase in the quantity demanded of the other.

[2]With nonconvex preferences, the MRS increases as the amount of the good measured on the horizontal axis increases along any indifference curve. This unlikely possibility might arise if one or both goods are addictive. For example, the willingness to substitute an addictive drug for other goods might increase as the use of the addictive drug increased.

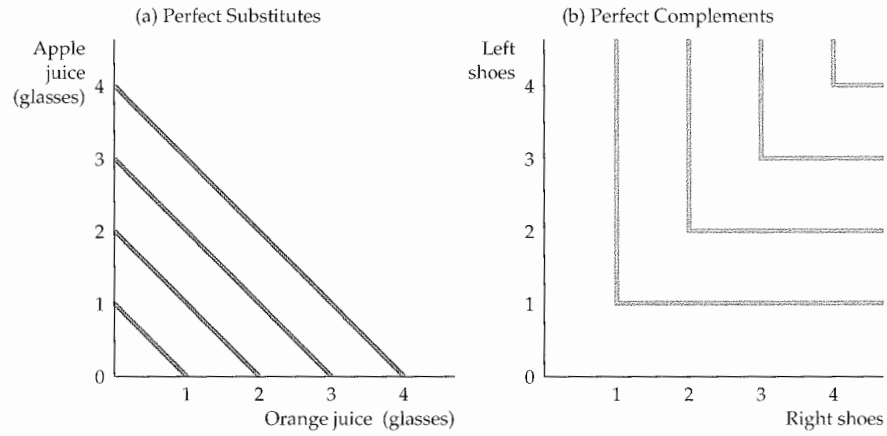


FIGURE 3.6
PERFECT SUBSTITUTES AND PERFECT COMPLEMENTS

In *(a)*, Bob views orange juice and apple juice as perfect substitutes: He is always indifferent between a glass of one and a glass of the other. In *(b)*, Jane views left shoes and right shoes as perfect complements: An additional left shoe gives her no extra satisfaction unless she also obtains the matching right shoe.

Figure 3.6 (a) shows Bob's preferences for apple juice and orange juice. These two goods are perfect substitutes for Bob because he is entirely indifferent between having a glass of one or the other. In this case, the MRS of apple juice for orange juice is 1: Bob is always willing to trade 1 glass of one for 1 glass of the other. In general, we say that two goods are **perfect substitutes** when the marginal rate of substitution of one for the other is a constant. Indifference curves describing the trade-off between the consumption of the goods are straight lines. The slope of the indifference curves need not be −1 in the case of perfect substitutes. Suppose, for example, that Dan believes that one 16-megabyte memory chip is equivalent to two 8-megabyte chips because both combinations have the same memory capacity. In that case, the slope of Dan's indifference curve will be −2 (with the number of 8-megabyte chips on the vertical axis).

• **perfect substitutes** Two goods for which the marginal rate of substitution of one for the other is a constant.

Figure 3.6 (b) illustrates Jane's preferences for left shoes and right shoes. For Jane, the two goods are perfect complements because a left shoe will not increase her satisfaction unless she can obtain the matching right shoe. In this case, the MRS of left shoes for right shoes is zero whenever there are more right shoes than left shoes; Jane will not give up any left shoes to get additional right shoes. Correspondingly, the MRS is infinite whenever there are more left shoes than right because Jane will give up all but one of her excess left shoes in order to obtain an additional right shoe. Two goods are **perfect complements** when the indifference curves for both are shaped as right angles.

In §2.1 we explain that goods are *complements* when an increase in the price of one leads to a decrease in the quantity demanded of the other.

• **perfect complements** Two goods for which the MRS is zero or infinite; the indifference curves are shaped as right angles.

BADS So far, all of our examples have involved products that are "goods"—i.e., cases in which more of a product is preferred to less. However, some things are **bads:** *Less of them is preferred to more.* Air pollution is a bad; asbestos in housing

• **bad** Good for which less is preferred rather than more.

insulation is another. How do we account for bads in the analysis of consumer preferences?

The answer is simple: We redefine the product under study so that consumer tastes are represented as a preference for less of the bad. This reversal turns the bad into a good. Thus, for example, instead of a preference for air pollution, we will discuss the preference for clean air, which we can measure as the degree of reduction in air pollution. Likewise, instead of referring to asbestos as a bad, we will refer to the corresponding good, the removal of asbestos.

With this simple adaptation, all four of the basic assumptions of consumer theory continue to hold, and we are ready to move on to an analysis of consumer budget constraints.

EXAMPLE 3.1 DESIGNING NEW AUTOMOBILES (I)

Suppose you worked for the Ford Motor Company and had to help plan new models to introduce. Should the new models emphasize interior space or handling? Horsepower or gas mileage? To decide, you would want to know how people value the various attributes of a car, such as power, size, handling, gas mileage, interior features, and so on. The more desirable the attributes, the more people would be willing to pay for a car. However, the better the attributes, the more the car will cost to manufacture. A car with a more powerful engine and more interior space, for example, will cost more to produce than a car with a smaller engine and less space. How should Ford trade off these different attributes and decide which ones to emphasize?

The answer depends in part on the cost of production, but it also depends on consumer preferences. To find out how much people are willing to pay for various attributes, economists and marketing experts look at the prices that people actually do pay for a wide range of models with a range of attributes. For example, if the only difference between two cars is interior space, and if the car with 2 additional cubic feet sells for $1000 more than its smaller counterpart, then interior space will be valued at $500 per cubic foot. By evaluating car purchases over a range of buyers and a range of models, one can estimate the values associated with various attributes, while accounting for the fact that these valuations may diminish as more and more of each attribute is included in a car. One way to obtain such information is by conducting surveys in which individuals are asked about their preferences for various automobiles with different combinations of attributes. Another way is to statistically analyze past consumer purchases of cars whose attributes varied.

One recent statistical study looked at a wide range of Ford models with varying attributes.[3] Figure 3.7 describes two sets of indifference curves, derived from an analysis that varies two attributes: *interior size* (measured in cubic feet) and *acceleration* (measured in horsepower) *for typical consumers of Ford automobiles*. Figure 3.7 (a) describes the preferences of typical owners of Ford Mustang coupes. Because they tend to place greater value on acceleration than size, Mustang owners have a high marginal rate of substitution for size versus acceleration; in other words, they are willing to give up quite a bit of size to get better acceleration. Compare these preferences to those of Ford Explorer owners, shown in Figure 3.7 (b). They have a lower MRS and will consequently give up a considerable amount of acceleration to get a car with a roomier interior.

[3]Amil Petrin, "Quantifying the Benefits of New Products: The Case of the Minivan," *Journal of Political Economy* 110 (2002): 705–729. We wish to thank Amil Petrin for providing some of the empirical information in this example.

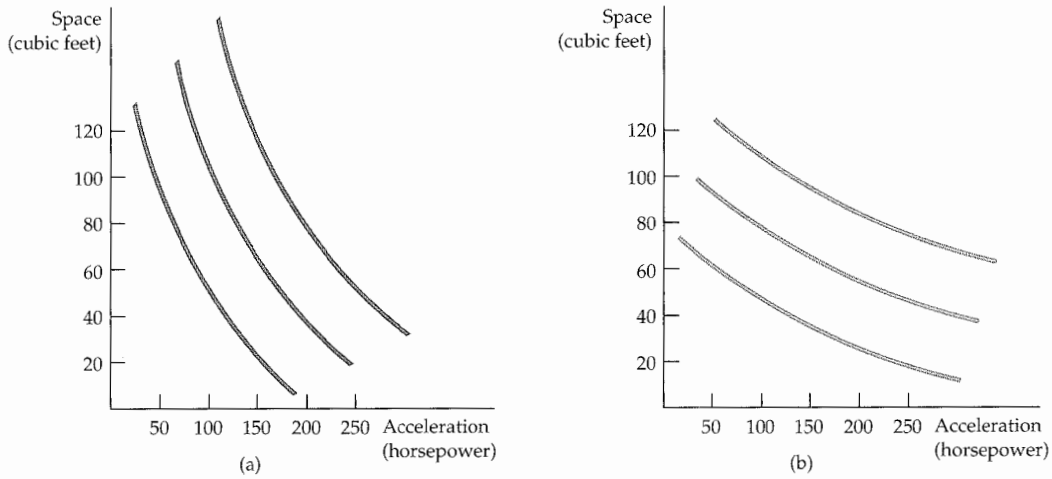


FIGURE 3.7
PREFERENCES FOR AUTOMOBILE ATTRIBUTES

Preferences for automobile attributes can be described by indifference curves. Each curve shows the combination of acceleration and interior space that give the same satisfaction. Owners of Ford Mustang coupes *(a)* are willing to give up considerable interior space for additional acceleration. The opposite is true for owners of Ford Explorers *(b)*.

UTILITY You may have noticed a convenient feature of the theory of consumer behavior as we have described it so far: *It has not been necessary to associate a numerical level of satisfaction with each market basket consumed.* For example, with respect to the three indifference curves in Figure 3.3 (page 73), we know that market basket A (or any other basket on indifference curve U_3) gives more satisfaction than any market basket on U_2, such as B. Likewise, we know that the market baskets on U_2 are preferred to those on U_1. The indifference curves simply allow us to describe consumer preferences graphically, building on the assumption that consumers can rank alternatives.

We will see that consumer theory relies only on the assumption that consumers can provide relative rankings of market baskets. Nonetheless, it is often useful to assign *numerical values* to individual baskets. Using this numerical approach, we can describe consumer preferences by assigning scores to the levels of satisfaction associated with each indifference curve. The concept is known as utility. In everyday language, the word *utility* has rather broad connotations, meaning, roughly, "benefit" or "well-being." Indeed, people obtain "utility" by getting things that give them pleasure and by avoiding things that give them pain. In the language of economics, the concept of **utility** refers to *the numerical score representing the satisfaction that a consumer gets from a market basket.* In other words, utility is a device used to simplify the ranking of market baskets. If buying three copies of this textbook makes you happier than buying one shirt, then we say that the three books give you more utility than the shirt.

• **utility** Numerical score representing the satisfaction that a consumer gets from a given market basket.

UTILITY FUNCTIONS A **utility function** is a formula that assigns a level of utility to each market basket. Suppose, for example, that Phil's utility function for food (F) and clothing (C) is $u(F,C) = F + 2C$. In that case, a market basket consisting of 8 units of food and 3 units of clothing generates a utility of $8 + (2)(3) = 14$. Phil is therefore indifferent between this market basket and a market basket containing 6 units of food and 4 units of clothing [$6 + (2)(4) = 14$]. On the other hand, either market basket is preferred to a third containing 4 units of food and 4 units of clothing. Why? Because this last market basket has a utility level of only $4 + (4)(2) = 12$.

utility function Formula that assigns a level of utility to individual market baskets.

We assign utility levels to market baskets so that if market basket A is preferred to basket B, the number will be higher for A than for B. For example, market basket A on the highest of three indifference curves U_3 might have a utility level of 3, while market basket B on the second-highest indifference curve U_2 might have a utility level of 2; on the lowest indifference curve U_1, basket D has a utility level of 1. Thus the utility function provides the same information about preferences that an indifference map does: Both order consumer choices in terms of levels of satisfaction.

Let's examine one particular utility function in some detail. The *utility function* $u(F,C) = FC$ tells us that the level of satisfaction obtained from consuming F units of food and C units of clothing is the product of F and C. Figure 3.8 shows indifference curves associated with this function. The graph was drawn by initially choosing one particular market basket—say, $F = 5$ and $C = 5$ at point A. This market basket generates a utility level U_1 of 25. Then the indifference curve (also called an *isoutility curve*) was drawn by finding all market baskets for which $FC = 25$ (e.g., $F = 10$, $C = 2.5$ at point B; $F = 2.5$, $C = 10$ at point D). The second indifference curve, U_2, contains all market baskets for which $FC = 50$ and the third, U_3, all market baskets for which $FC = 100$.

It is important to note that the numbers attached to the indifference curves are for convenience only. Suppose the utility function were changed to $u(F,C) = 4FC$. Consider any market basket that previously generated a utility level of 25—say, $F = 5$ and $C = 5$. Now the level of utility has increased, by a factor of 4, to 100. Thus the indifference curve labeled 25 looks the same, although it should now be labeled 100 rather than 25. In fact, the only difference between the indifference curves associated with the utility function $4FC$ and the utility

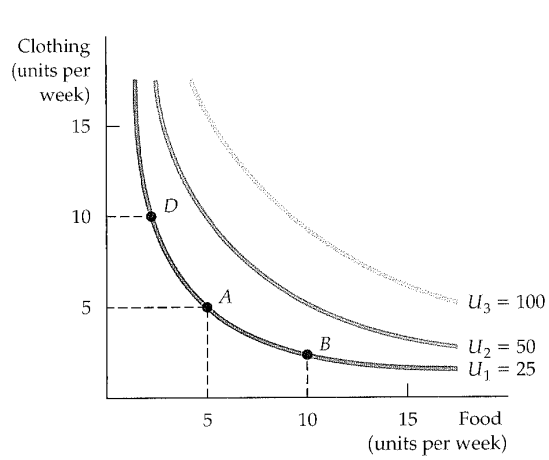


FIGURE 3.8
UTILITY FUNCTIONS AND INDIFFERENCE CURVES

A utility function can be represented by a set of indifference curves, each with a numerical indicator. This figure shows three indifference curves (with utility levels of 25, 50, and 100, respectively) associated with the utility function FC.

function FC is that the curves are numbered 100, 200, and 400, rather than 25, 50, and 100. It is important to stress that the utility function is simply a way of *ranking* different market baskets; the *magnitude* of the utility difference between any two market baskets does not really tell us anything. The fact that U_3 has a level of utility of 100 and U_2 has a level of 50 does not mean that market baskets on U_3 generate twice as much satisfaction as those on U_2. This is so because we have no means of objectively measuring a person's satisfaction or level of well-being from the consumption of a market basket. Thus whether we use indifference curves or a measure of utility, we know only that U_3 is better than U_2 and that U_2 is better than U_1. We do not, however, know by *how much* one is preferred to the other.

ORDINAL VERSUS CARDINAL UTILITY The three indifference curves in Figure 3.3 (page 73) provide a ranking of market baskets that is ordered, or *ordinal*. For this reason, a utility function that generates a ranking of market baskets is called an **ordinal utility function.** The ranking associated with the ordinal utility function places market baskets in the order of most to least preferred. However, as explained above, it does not indicate by *how much* one is preferred to another. We know, for example, that any market basket on U_3, such as A, is preferred to any on U_2, such as B. However, the *amount* by which A is preferred to B (and B to D) is not revealed by the indifference map or by the ordinal utility function that generates it.

• **ordinal utility function** Utility function that generates a ranking of market baskets in order of most to least preferred.

When working with ordinal utility functions, we must be careful to avoid a trap. Suppose that Juan's ordinal utility function attaches a utility level of 5 to a copy of this textbook; meanwhile Maria's utility function attaches a level of 10. Will Maria be happier than Juan if each of them gets a copy of this book? We don't know. Because these numerical values are arbitrary, interpersonal comparisons of utility are impossible.

When economists first studied utility and utility functions, they hoped that individual preferences could be quantified or measured in terms of basic units and could therefore provide a ranking that allowed for interpersonal comparisons. Using this approach, we could say that Maria gets twice as much satisfaction as Juan from a copy of this book. Or if we found that having a second copy increased Juan's utility level to 10, we could say that his happiness has doubled. If the numerical values assigned to market baskets did have meaning in this way, we would say that the numbers provided a *cardinal* ranking of alternatives. A utility function that describes *by how much* one market basket is preferred to another is called a **cardinal utility function.** Unlike ordinal utility functions, a cardinal utility function attaches to market baskets numerical values that cannot arbitrarily be doubled or tripled without altering the differences between the values of various market baskets.

• **cardinal utility function** Utility function describing by how much one market basket is preferred to another.

Unfortunately, we have no way of telling whether a person gets twice as much satisfaction from one market basket as from another. Nor do we know whether one person gets twice as much satisfaction as another from consuming the same basket. (Could *you* tell whether you get twice as much satisfaction from consuming one thing versus another?) Fortunately, this constraint is unimportant. Because our objective is to understand consumer behavior, all that matters is knowing how consumers rank different baskets. Therefore, we will work only with ordinal utility functions. This approach is sufficient for understanding both how individual consumer decisions are made and what this knowledge implies about the characteristics of consumer demand.

EXAMPLE 3.2 CAN MONEY BUY HAPPINESS?

Economists use the term *utility* to represent a measure of the satisfaction or happiness that individuals get from the consumption of goods and services. Because a higher income allows one to consume more goods and services, we say that utility increases with income. But does greater income and consumption really translate into greater happiness? Research comparing various measures of happiness suggests that the answer is a qualified yes.[4]

In one study, an ordinal scale for happiness was derived from the answer to the following question. "How satisfied are you at present with your life, all things considered?"[5] Possible responses ran on a scale from 0 (completely dissatisfied) to 10 (completely satisfied). Income was found to be a very strong predictor of happiness (another strong predictor was whether a person was employed or not). On average, as income increased by one percent, the satisfaction score increased one half a point. Knowing that there is a positive relationship between utility or satisfaction and income, it is reasonable to assign utility values to the baskets of goods and services that consumers buy. Whether that relationship is cardinal or ordinal remains an ongoing debate.

Let's take this inquiry one step further. Can one compare levels of happiness *across* as well as *within* countries? Once again, the evidence says yes. In a separate survey of individuals in 67 countries, a team of researchers asked: "All things considered, how satisfied are you with your life as a whole these days?" Responses were given on a ten-point scale, with 1 representing the most dissatisfied and 10 the most satisfied.[6] Income was measured by each country's per-capita gross domestic product in U.S. dollars. Figure 3.9 shows the results, with each data point representing a different country. You can see that as we move from poor countries with incomes below $5000 per capita to those with incomes closer to $10,000 per capita, satisfaction increases substantially. Once we move past the $10,000 level, the index scale of satisfaction increases at a lower rate.

Comparisons across countries are difficult because there are likely to be many other factors that explain satisfaction besides income (e.g., health, climate, political environment, human rights, etc.). Interestingly, a recent survey of 136,000 individuals over 132 countries shows that the United States, which had the highest GDP per capita, was ranked 16th overall in happiness. The number 1 rated country was Denmark. Generally, countries in Northern Europe and English-speaking countries did well overall, as did a number of Latin American countries. However, South Korea and Russia were not rated as high as their incomes would predict. Does location affect feelings of well-being within the United States? The answer is apparently yes, with the top-ranked states (in order) being Utah, Hawaii, Wyoming, and Colorado, all west of the Mississippi River. (The lowest four, in reverse order, were West Virginia, Kentucky, Mississippi, and Ohio, all east of the Mississippi.) Moreover, it is possible that the relationship between income and satisfaction goes two ways: Although higher incomes generate more satisfaction, greater satisfaction offers greater motivation for individuals to work hard and generate higher incomes. Interestingly, even when studies account for other factors, the positive relationship between income and satisfaction remains.

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[4]For a review of the relevant literature which underlies this example, see Raphael DiTella and Robert MacCulloch, "Some Uses of Happiness Data in Economics," *Journal of Economic Perspectives* 20 (Winter 2006): 25–46.

[5]Paul Frijters, John P. Haisken-Denew, and Michael A. Shields, "Money Does Matter! Evidence from Increasing Real Income and Life Satisfaction in East Germany Following Reunification," *American Economic Review* 94 (June 2004): 730–40.

[6]Ronald Inglehart et al., *European and World Values Surveys Four-Wave Integrated Data File, 1981–2004 (2006)*. Available online: **http://www.worldvaluessurvey.org.**

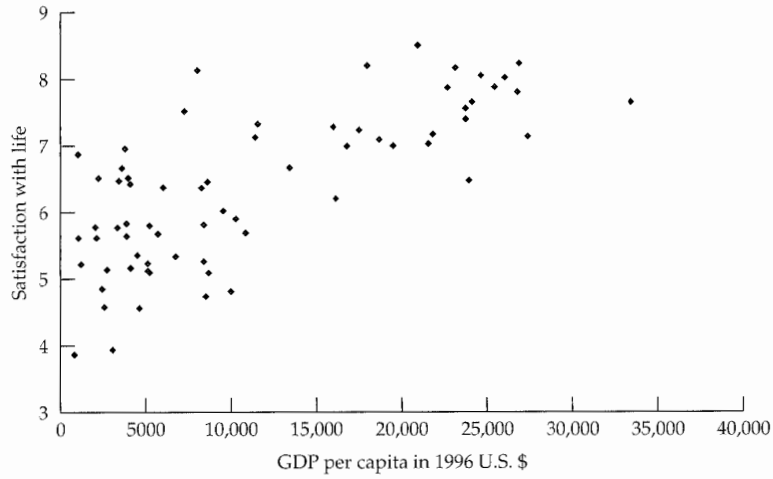


FIGURE 3.9
INCOME AND HAPPINESS

A cross-country comparison shows that individuals living in countries with higher GDP per capita are on average happier than those living in countries with lower per-capita GDP.

3.2 Budget Constraints

So far, we have focused only on the first element of consumer theory—consumer preferences. We have seen how indifference curves (or, alternatively, utility functions) can be used to describe how consumers value various baskets of goods. Now we turn to the second element of consumer theory: the **budget constraints** that consumers face as a result of their limited incomes.

• **budget constraints** Constraints that consumers face as a result of limited incomes.

The Budget Line

To see how a budget constraint limits a consumer's choices, let's consider a situation in which a woman has a fixed amount of income, I, that can be spent on food and clothing. Let F be the amount of food purchased and C be the amount of clothing. We will denote the prices of the two goods P_F and P_C. In that case, $P_F F$ (i.e., price of food times the quantity) is the amount of money spent on food and $P_C C$ the amount of money spent on clothing.

• **budget line** All combinations of goods for which the total amount of money spent is equal to income.

The **budget line** indicates *all combinations of F and C for which the total amount of money spent is equal to income.* Because we are considering only two goods (and ignoring the possibility of saving), our hypothetical consumer will spend her entire income on food and clothing. As a result, the combinations of food and clothing that she can buy will all lie on this line:

$$P_F F + P_C C = I \tag{3.1}$$

TABLE 3.2 MARKET BASKETS AND THE BUDGET LINE

MARKET BASKET	FOOD (*F*)	CLOTHING (*C*)	TOTAL SPENDING
A	0	40	$80
B	20	30	$80
D	40	20	$80
E	60	10	$80
G	80	0	$80

Suppose, for example, that our consumer has a weekly income of $80, the price of food is $1 per unit, and the price of clothing is $2 per unit. Table 3.2 shows various combinations of food and clothing that she can purchase each week with her $80. If her entire budget were allocated to clothing, the most that she could buy would be 40 units (at a price of $2 per unit), as represented by market basket *A*. If she spent her entire budget on food, she could buy 80 units (at $1 per unit), as given by market basket *G*. Market baskets *B*, *D*, and *E* show three additional ways in which her $80 could be spent on food and clothing.

Figure 3.10 shows the budget line associated with the market baskets given in Table 3.2. Because giving up a unit of clothing saves $2 and buying a unit of food costs $1, the amount of clothing given up for food along the budget line must be the same everywhere. As a result, the budget line is a straight line from point *A* to point *G*. In this particular case, the budget line is given by the equation $F + 2C = \$80$.

The intercept of the budget line is represented by basket *A*. As our consumer moves along the line from basket *A* to basket *G*, she spends less on clothing and more on food. It is easy to see that the extra clothing which must be given up to consume an additional unit of food is given by the ratio of the price of food to the price of clothing ($\$1/\$2 = 1/2$). Because clothing costs $2 per unit and food only $1 per unit, 1/2 unit of clothing must be given up to get 1 unit of food. In Figure 3.10, the slope of the line, $\Delta C/\Delta F = -1/2$, measures the relative cost of food and clothing.

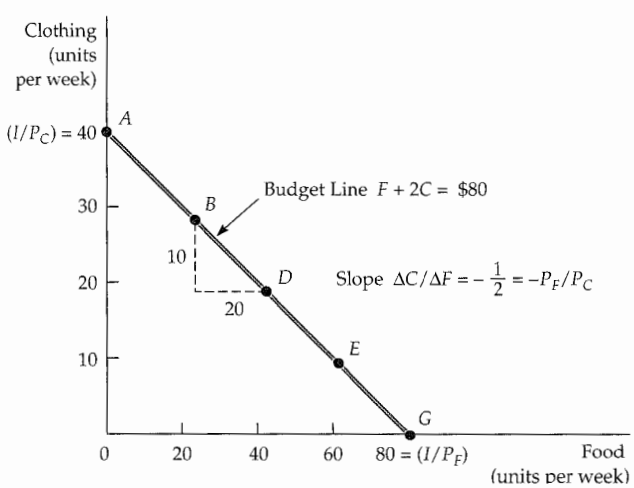


FIGURE 3.10
A BUDGET LINE

A budget line describes the combinations of goods that can be purchased given the consumer's income and the prices of the goods. Line *AG* (which passes through points *B*, *D*, and *E*) shows the budget associated with an income of $80, a price of food of $P_F = \$1$ per unit, and a price of clothing of $P_C = \$2$ per unit. The slope of the budget line (measured between points *B* and *D*) is $-P_F/P_C = -10/20 = -1/2$.

Using equation (3.1), we can see how much of C must be given up to consume more of *F*. We divide both sides of the equation by P_C and then solve for C:

$$C = (I/P_C) - (P_F/P_C)F \tag{3.2}$$

Equation (3.2) is the equation for a straight line; it has a vertical intercept of I/P_C and a slope of $-(P_F/P_C)$.

The slope of the budget line, $-(P_F/P_C)$, is *the negative of the ratio of the prices of the two goods*. The magnitude of the slope tells us the rate at which the two goods can be substituted for each other without changing the total amount of money spent. The vertical intercept (I/P_C) represents the maximum amount of C that can be purchased with income *I*. Finally, the horizontal intercept (I/P_F) tells us how many units of *F* can be purchased if all income were spent on *F*.

The Effects of Changes in Income and Prices

We have seen that the budget line depends both on income and on the prices of the goods, P_F and P_C. But of course prices and income often change. Let's see how such changes affect the budget line.

INCOME CHANGES What happens to the budget line when income changes? From the equation for the straight line (3.2), we can see that a change in income alters the vertical intercept of the budget line but does not change the slope (because the price of neither good changed). Figure 3.11 shows that if income is doubled (from \$80 to \$160), the budget line shifts outward, from budget line L_1 to budget line L_2. Note, however, that L_2 remains parallel to L_1. If she desires, our consumer can now double her purchases of both food and clothing. Likewise, if her income is cut in half (from \$80 to \$40), the budget line shifts inward, from L_1 to L_3.

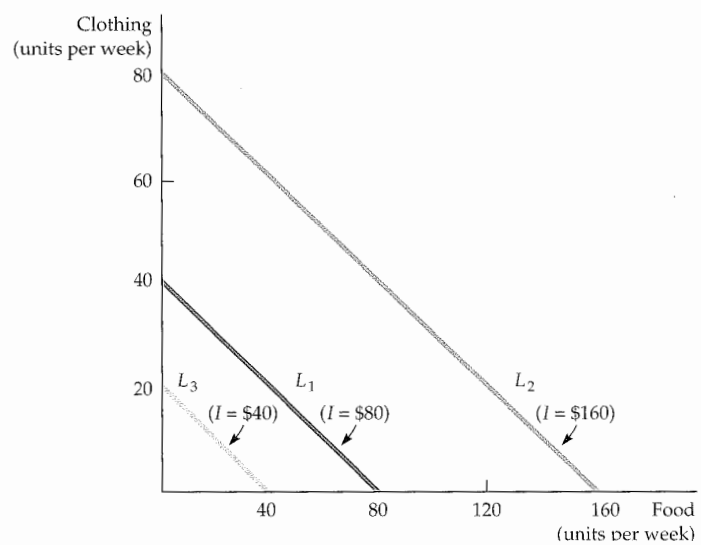


FIGURE 3.11
EFFECTS OF A CHANGE IN INCOME ON THE BUDGET LINE

A change in income (with prices unchanged) causes the budget line to shift parallel to the original line (L_1). When the income of \$80 (on L_1) is increased to \$160, the budget line shifts outward to L_2. If the income falls to \$40, the line shifts inward to L_3.

PRICE CHANGES What happens to the budget line if the price of one good changes but the price of the other does not? We can use the equation $C = (I/P_C) - (P_F/P_C)F$ to describe the effects of a change in the price of food on the budget line. Suppose the price of food falls by half, from \$1 to \$0.50. In that case, the vertical intercept of the budget line remains unchanged, although the slope changes from $-P_F/P_C = -\$1/\$2 = -\$1/2$ to $-\$0.50/\$2 = -\$1/4$. In Figure 3.12, we obtain the new budget line L_2 by rotating the original budget line L_1 outward, pivoting from the C-intercept. This rotation makes sense because a person who consumes only clothing and no food is unaffected by the price change. However, someone who consumes a large amount of food will experience an increase in his purchasing power. Because of the decline in the price of food, the maximum amount of food that can be purchased has doubled.

On the other hand, when the price of food doubles from \$1 to \$2, the budget line rotates inward to line L_3 because the person's purchasing power has diminished. Again, a person who consumed only clothing would be unaffected by the food price increase.

What happens if the prices of both food and clothing change, but in a way that leaves the *ratio* of the two prices unchanged? Because the slope of the budget line is equal to the ratio of the two prices, the slope will remain the same. The intercept of the budget line must shift so that the new line is parallel to the old one. For example, if the prices of both goods fall by half, then the slope of the budget line does not change. However, both intercepts double, and the budget line is shifted outward.

This exercise tells us something about the determinants of a consumer's *purchasing power*—her ability to generate utility through the purchase of goods and services. Purchasing power is determined not only by income, but also by prices. For example, our consumer's purchasing power can double either because her income doubles *or* because the prices of all the goods that she buys fall by half.

Finally, consider what happens if everything doubles—the prices of both food and clothing *and* the consumer's income. (This can happen in an inflationary economy.) Because both prices have doubled, the ratio of the prices has not changed; neither, therefore, has the slope of the budget line. Because the price of clothing has doubled along with income, the maximum amount of clothing that can be purchased (represented by the vertical intercept of the budget

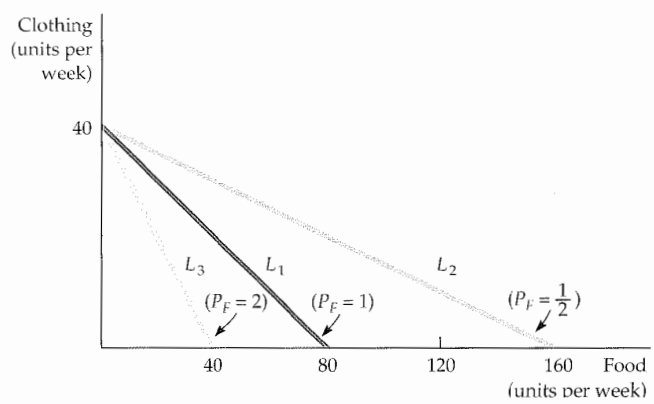


FIGURE 3.12
EFFECTS OF A CHANGE IN PRICE ON THE BUDGET LINE

A change in the price of one good (with income unchanged) causes the budget line to rotate about one intercept. When the price of food falls from \$1.00 to \$0.50, the budget line rotates outward from L_1 to L_2. However, when the price increases from \$1.00 to \$2.00, the line rotates inward from L_1 to L_3.

line) is unchanged. The same is true for food. Therefore, inflationary conditions in which all prices and income levels rise proportionately will not affect the consumer's budget line or purchasing power.

3.3 Consumer Choice

Given preferences and budget constraints, we can now determine how individual consumers choose how much of each good to buy. We assume that consumers make this choice in a rational way—that they choose goods to *maximize the satisfaction they can achieve, given the limited budget available to them.* The maximizing market basket must satisfy two conditions:

1. ***It must be located on the budget line.*** To see why, note that any market basket to the left of and below the budget line leaves some income unallocated—income which, if spent, could increase the consumer's satisfaction. Of course, consumers can—and often do—save some of their incomes for future consumption. In that case, the choice is not just between food and clothing, but between consuming food or clothing now and consuming food or clothing in the future. At this point, however, we will keep things simple by assuming that all income is spent now. Note also that any market basket to the right of and above the budget line cannot be purchased with available income. Thus, the only rational and feasible choice is a basket on the budget line.
2. ***It must give the consumer the most preferred combination of goods and services.***

These two conditions reduce the problem of maximizing consumer satisfaction to one of picking an appropriate point on the budget line.

In our food and clothing example, as with any two goods, we can graphically illustrate the solution to the consumer's choice problem. Figure 3.13 shows how

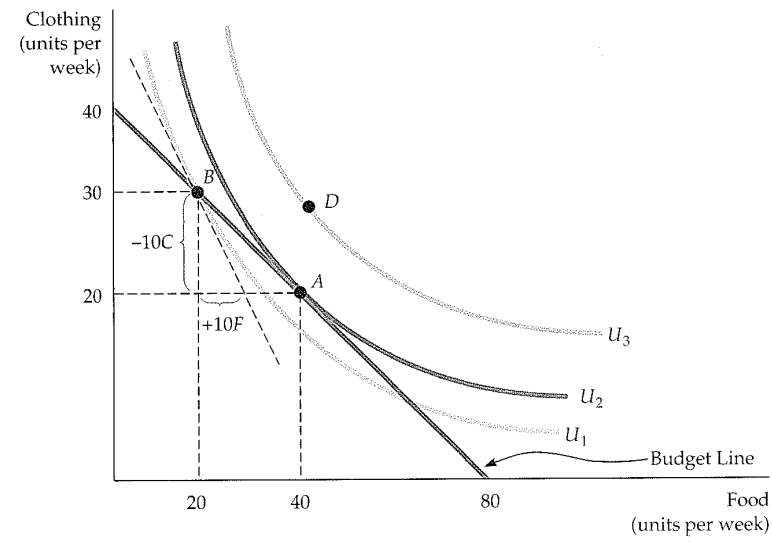


FIGURE 3.13
MAXIMIZING CONSUMER SATISFACTION

A consumer maximizes satisfaction by choosing market basket *A*. At this point, the budget line and indifference curve U_2 are tangent, and no higher level of satisfaction (e.g., market basket *D*) can be attained. At *A*, the point of maximization, the MRS between the two goods equals the price ratio. At *B*, however, because the MRS [−(−10/10) = 1] is greater than the price ratio (1/2), satisfaction is not maximized.

the problem is solved. Here, three indifference curves describe a consumer's preferences for food and clothing. Remember that of the three curves, the outermost curve, U_3, yields the greatest amount of satisfaction, curve U_2 the next greatest amount, and curve U_1 the least.

Note that point B on indifference curve U_1 is not the most preferred choice, because a reallocation of income in which more is spent on food and less on clothing can increase the consumer's satisfaction. In particular, by moving to point A, the consumer spends the same amount of money and achieves the increased level of satisfaction associated with indifference curve U_2. In addition, note that baskets located to the right and above indifference curve U_2, like the basket associated with D on indifference curve U_3, achieve a higher level of satisfaction but cannot be purchased with the available income. Therefore, A maximizes the consumer's satisfaction.

We see from this analysis that the basket which maximizes satisfaction must lie on the highest indifference curve that touches the budget line. Point A is the point of tangency between indifference curve U_2 and the budget line. At A, the slope of the budget line is exactly equal to the slope of the indifference curve. Because the MRS ($-\Delta C/\Delta F$) is the negative of the slope of the indifference curve, we can say that satisfaction is maximized (given the budget constraint) at the point where

$$\text{MRS} = P_F/P_C \tag{3.3}$$

This is an important result: Satisfaction is maximized when *the marginal rate of substitution* (of F for C) *is equal to the ratio of the prices* (of F to C). Thus the consumer can obtain maximum satisfaction by adjusting his consumption of goods F and C so that the MRS equals the price ratio.

The condition given in equation (3.3) illustrates the kinds of optimization conditions that arise in economics. In this instance, satisfaction is maximized when the **marginal benefit**—the benefit associated with the consumption of one additional unit of food—is equal to the **marginal cost**—the cost of the additional unit of food. The marginal benefit is measured by the MRS. At point A, it equals 1/2 (the magnitude of the slope of the indifference curve), which implies that the consumer is willing to give up 1/2 unit of clothing to obtain 1 unit of food. At the same point, the marginal cost is measured by the magnitude of the slope of the budget line; it too equals 1/2 because the cost of getting one unit of food is giving up 1/2 unit of clothing ($P_F = 1$ and $P_C = 2$ on the budget line).

• **marginal benefit** Benefit from the consumption of one additional unit of a good.

• **marginal cost** Cost of one additional unit of a good.

If the MRS is less or greater than the price ratio, the consumer's satisfaction has not been maximized. For example, compare point B in Figure 3.13 to point A. At point B, the consumer is purchasing 20 units of food and 30 units of clothing. The price ratio (or marginal cost) is equal to 1/2 because food costs \$1 and clothing \$2. However, the MRS (or marginal benefit) is greater than 1/2; it is approximately 1. As a result, the consumer is able to substitute 1 unit of food for 1 unit of clothing without loss of satisfaction. Because food is cheaper than clothing, it is in her interest to buy more food and less clothing. If our consumer purchases 1 less unit of clothing, for example, the \$2 saved can be allocated to two units of food, even though only one unit is needed to maintain her level of satisfaction.

The reallocation of the budget continues in this manner (moving along the budget line), until we reach point A, where the price ratio of 1/2 just equals the MRS of 1/2. This point implies that our consumer is willing to trade one unit of clothing for two units of food. Only when the condition MRS = $1/2 = P_F/P_C$ holds is she maximizing her satisfaction.

The result that the MRS equals the price ratio is deceptively powerful. Imagine two consumers who have just purchased various quantities of food and

clothing. If both are maximizing, you can tell the value of each person's MRS by looking at the prices of the two goods. What you cannot tell, however, is the quantity of each good purchased, because that decision is determined by their individual preferences. If the two consumers have different tastes, they will consume different quantities of food and clothing, even though each MRS is the same.

EXAMPLE 3.3 DESIGNING NEW AUTOMOBILES (II)

Our analysis of consumer choice allows us to see how different preferences of consumer groups for automobiles can affect their purchasing decisions. Following up on Example 3.1 (page 77), we consider two groups of consumers planning to buy new cars. Suppose that each consumer has an overall car budget of $20,000, but has decided to allocate $10,000 to interior size and acceleration and $10,000 to all the other attributes of a new car. Each group, however, has different preferences for size and acceleration.

Figure 3.14 shows the car-buying budget constraint faced by individuals in each group. Those in the first group, who are typical of Ford Mustang coupe owners with preferences similar to those in Figure 3.7 (page 78), prefer acceleration to size. By finding the point of tangency between a typical individual's indifference curve and the budget constraint, we see that consumers in this group would prefer to buy a car whose acceleration was worth $7000 and whose size was worth $3000. Individuals in the second group, who are typical of Ford

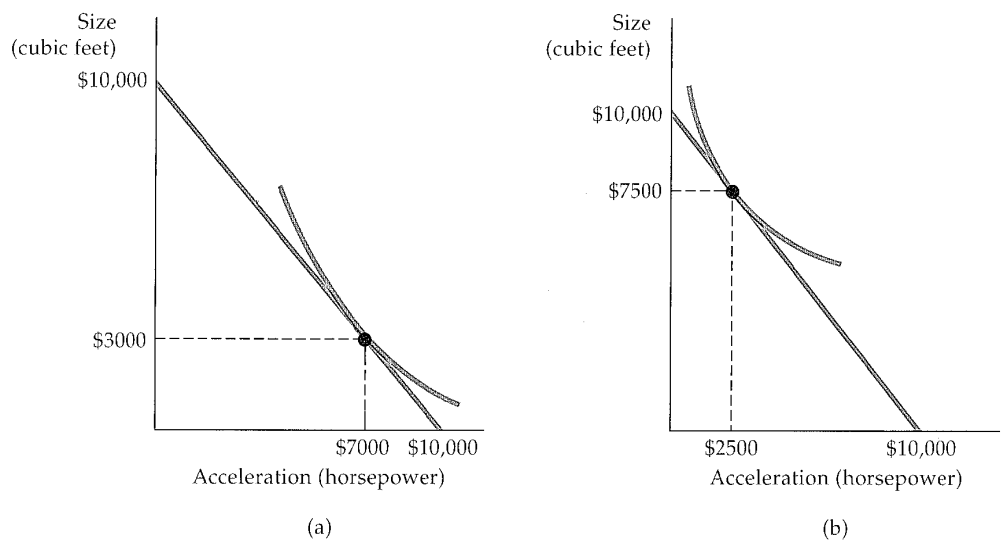


FIGURE 3.14
CONSUMER CHOICE OF AUTOMOBILE ATTRIBUTES

The consumers in *(a)* are willing to trade off a considerable amount of interior space for some additional acceleration. Given a budget constraint, they will choose a car that emphasizes acceleration. The opposite is true for consumers in *(b)*.

Explorer users, would prefer cars with $2500 worth of acceleration and $7500 worth of size.[7]

We have simplified matters for this example by considering only two attributes. In practice, an automobile company will use marketing and statistical studies to learn how different groups of consumers value a broad set of attributes. Combined with information about how these attributes will affect manufacturing costs, the company can design a production and marketing plan.

In the context of our example, one potentially profitable option is to appeal to both groups of consumers by manufacturing a model emphasizing acceleration to a slightly lesser degree than preferred by those in Figure 3.14 (a). A second option is to produce a relatively large number of cars that emphasize size and a smaller number emphasizing acceleration.

Knowledge about the preferences of each group (i.e., the actual indifference curves), along with information about the number of consumers in each, would help the firm make a sensible business decision. In fact, an exercise similar to the one we've described here was carried out by General Motors in a survey of a large number of automobile buyers.[8] Some of the results were expected. For example, households with children tended to prefer functionality over style and so tended to buy minivans rather than sedans and sporty cars. Rural households, on the other hand, tended to purchase pickups and all-wheel drives. More interesting was the strong correlation between age and attribute preferences. Older consumers tended to prefer larger and heavier cars with more safety features and accessories (e.g., power windows and steering). Further, younger consumers preferred greater horsepower and more stylish cars.

Corner Solutions

Sometimes consumers buy in extremes, at least within categories of goods. Some people, for example, spend no money on travel and entertainment. Indifference curve analysis can be used to show conditions under which consumers choose not to consume a particular good.

In Figure 3.15, a man faced with budget line *AB* for snacks chooses to purchase only ice cream (*IC*) and no frozen yogurt (*Y*). This decision reflects what is called a **corner solution.** When one of the goods is not consumed, the consumption bundle appears at the corner of the graph. At *B*, which is the point of maximum satisfaction, the MRS of ice cream for frozen yogurt is greater than the slope of the budget line. This inequality suggests that if the consumer had more frozen yogurt to give up, he would gladly trade it for additional ice cream. At this point, however, our consumer is already consuming all ice cream and no frozen yogurt, and it is impossible to consume *negative* amounts of frozen yogurt.

corner solution Situation in which the marginal rate of substitution of one good for another in a chosen market basket is not equal to the slope of the budget line.

When a corner solution arises, the consumer's MRS does not necessarily equal the price ratio. Unlike the condition expressed in equation (3.3), the necessary condition for satisfaction to be maximized when choosing between ice cream and frozen yogurt in a corner solution is given by the following inequality.[9]

$$\text{MRS} \geq P_{IC}/P_Y \qquad \textbf{(3.4)}$$

[7]The first set of indifference curves for the Ford Mustang coupe will be of the following form: U (level of utility) = b_0 (constant) + b_1 *S (space in cubic feet) * b_2*S^2 + b_3*H (horsepower) + b_4*H^2 + b_5*O (a list of other attributes). Each indifference curve represents the combinations of S and H that generate the same level of utility. The comparable relationship for the Ford Explorer will have the same form, but different b's.

[8]The survey design and the results are described in Steven Berry, James Levinsohn, and Ariel Pakes, "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Car Market," *Journal of Political Economy*, 112 (February 2004): 68–105.

[9]Strict equality could hold if the slope of the budget constraint happened to equal the slope of the indifference curve—a condition that is unlikely.

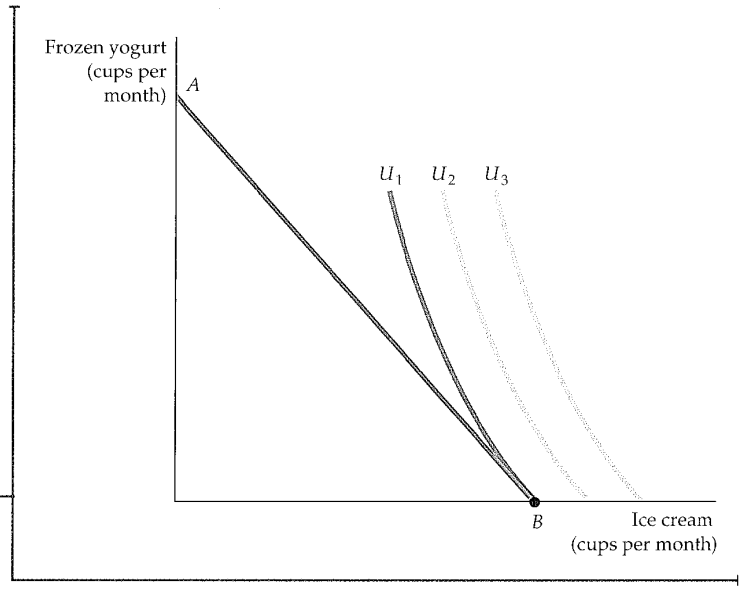


FIGURE 3.15
A CORNER SOLUTION

When the consumer's marginal rate of substitution is not equal to the price ratio for all levels of consumption, a corner solution arises. The consumer maximizes satisfaction by consuming only one of the two goods. Given budget line *AB*, the highest level of satisfaction is achieved at *B* on indifference curve U_1, where the MRS (of ice cream for frozen yogurt) is greater than the ratio of the price of ice cream to the price of frozen yogurt.

This inequality would, of course, be reversed if the corner solution were at point *A* rather than *B*. In either case, we can see that the marginal benefit–marginal cost equality that we described in the previous section holds only when positive quantities of all goods are consumed.

An important lesson here is that predictions about how much of a product consumers will purchase when faced with changing economic conditions depend on the nature of consumer preferences for that product and related products and on the slope of the consumer's budget line. If the MRS of ice cream for frozen yogurt is substantially greater than the price ratio, as in Figure 3.15, then a small decrease in the price of frozen yogurt will not alter the consumer's choice; he will still choose to consume only ice cream. But if the price of frozen yogurt falls far enough, the consumer could quickly choose to consume a lot of frozen yogurt.

EXAMPLE 3.4 CONSUMER CHOICE OF HEALTH CARE

Expenditures on health care in the United States have risen dramatically over the past few decades, a phenomenon that some people find alarming. Some economists have argued that these expenditures have increased so much because our health care system is

inefficient. That may well be, but there could also be another reason: As consumers become better off economically, their preferences shift toward health care and away from other goods. After all, if you already own a nice home and two cars, what would give you more satisfaction—a third

car, or additional medical care that might extend your life by a year? Many would choose the extra health care.

The preferences for health care are illustrated in Figure 3.16, which shows a series of indifference curves and budget lines that characterize the trade-off between consumption of health care (H) versus other goods (O). Indifference curve U_1 applies to a consumer with low income; the consumer's budget line is tangent at point A, so that the consumption of health care and consumption of other goods that maximize the consumer's satisfaction are H_1 and O_1. Indifference curve U_2 yields a greater amount of satisfaction, but is only feasible for a consumer with higher income. In this case utility is maximized at point B. Curve U_3 applies to a high-income consumer, and implies less willingness to give up health care for other goods. Moving from point B to point C, the consumer's consumption of health care increases considerably (from H_2 to H_3), while her consumption of other goods increases only modestly (from O_2 to O_3).

Does Figure 3.16 correctly characterize the preferences of consumers? At least one recent statistical study indicates that it does.[10] So does common sense. If your income were high enough so that you could have most of the things you wanted, would you prefer to spend additional income on life-extending health care or on another car?

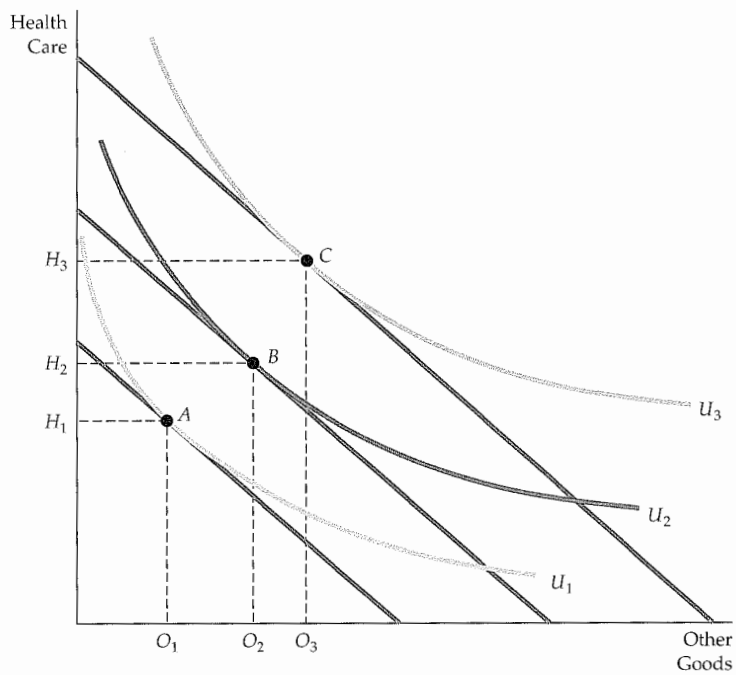


FIGURE 3.16
CONSUMER PREFERENCES FOR HEALTH CARE VERSUS OTHER GOODS

These indifference curves show the trade-off between consumption of health care (H) versus other goods (O). Curve U_1 applies to a consumer with low income; given the consumer's budget constraint, satisfaction is maximized at point A. As income increases the budget line shifts to the right, and curve U_2 becomes feasible. The consumer moves to point B, with greater consumption of both health care and other goods. Curve U_3 applies to a high-income consumer, and implies less willingness to give up health care for other goods. Moving from point B to point C, the consumer's consumption of health care increases considerably (from H_2 to H_3), while her consumption of other goods increases only modestly (from O_2 to O_3).

[10]See the interesting article by Robert E. Hall and Charles I. Jones, "The Value of Life and the Rise in Health Spending," *Quarterly Journal of Economics*, February 2007, pp. 39–72. The authors explain that the optimal composition of total spending shifts toward health as income increases. They predict that the optimal heath share of spending is likely to exceed 30 percent by 2050.

EXAMPLE 3.5 A COLLEGE TRUST FUND

Jane Doe's parents have provided a trust fund for her college education. Jane, who is 18, can receive the entire trust fund on the condition that she spend it only on education. The fund is a welcome gift but perhaps not as welcome as an unrestricted trust. To see why Jane feels this way, consider Figure 3.17, in which dollars per year spent on education are shown on the horizontal axis and dollars spent on other forms of consumption on the vertical.

The budget line that Jane faces before being awarded the trust is given by line *PQ*. The trust fund expands the budget line outward as long as the full amount of the fund, shown by distance *PB*, is spent on education. By accepting the trust fund and going to college, Jane increases her satisfaction, moving from *A* on indifference curve U_1 to *B* on indifference curve U_2.

Note that *B* represents a corner solution because Jane's marginal rate of substitution of education for other consumption is lower than the relative price of other consumption. Jane would prefer to spend a portion of the trust fund on other goods in addition to education. Without restriction on the trust fund, she would move to *C* on indifference curve U_3, decreasing her spending on education (perhaps going to a junior college rather than a four-year college) but increasing her spending on items that she enjoys more than education.

Recipients usually prefer unrestricted to restricted trusts. Restricted trusts are popular, however, because they allow parents to control children's expenditures in ways that they believe are in the children's long-run best interests.

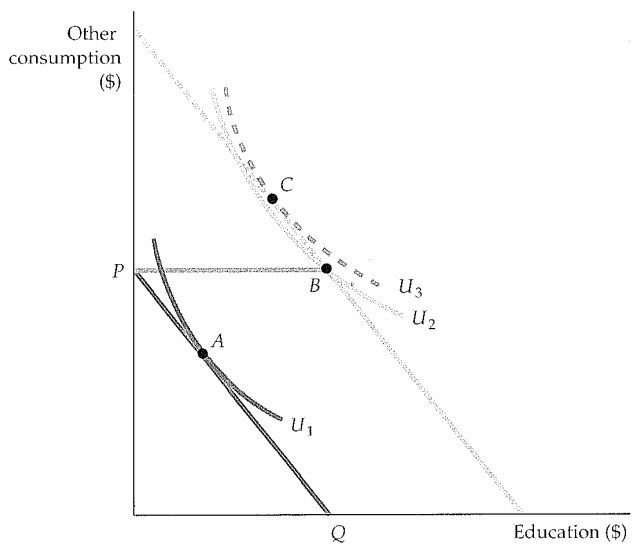


FIGURE 3.17
A COLLEGE TRUST FUND

When given a college trust fund that must be spent on education, the student moves from *A* to *B*, a corner solution. If, however, the trust fund could be spent on other consumption as well as education, the student would be better off at *C*.

3.4 Revealed Preference

In Section 3.1, we saw how an individual's preferences could be represented by a series of indifference curves. Then in Section 3.3, we saw how preferences, given budget constraints, determine choices. Can this process be reversed? If we know the choices that a consumer has made, can we determine his or her preferences?

We can if we have information about a sufficient number of choices that have been made when prices and income levels varied. The basic idea is simple. *If a consumer chooses one market basket over another, and if the chosen market basket is more expensive than the alternative, then the consumer must prefer the chosen market basket.*

Suppose that an individual, facing the budget constraint given by line l_1 in Figure 3.18, chooses market basket *A*. Let's compare *A* to baskets *B* and *D*. Because the individual could have purchased basket *B* (and all baskets below line l_1) and did not, we say that *A is preferred to B*.

It might seem at first glance that we cannot make a direct comparison between baskets *A* and *D* because *D* is not on l_1. But suppose the relative prices of food and clothing change, so that the new budget line is l_2 and the individual then chooses market basket *B*. Because *D* lies on budget line l_2 and was not chosen, *B* is preferred to *D* (and to all baskets below line l_2). Because *A* is preferred to *B* and *B* is preferred to *D*, we conclude that *A* is preferred to *D*. Furthermore, note in Figure 3.18 that basket *A* is preferred to all of the baskets that appear in the green-shaded areas. However, because food and clothing are "goods" rather than "bads," all baskets that lie in the pink-shaded area in the rectangle above and to the right of *A* are preferred to *A*. Thus, the indifference curve passing through *A* must lie in the unshaded area.

Given more information about choices when prices and income levels vary, we can get a better fix on the shape of the indifference curve. Consider Figure 3.18. Suppose that facing line l_3 (which was chosen to pass through *A*), the individual chooses market basket *E*. Because *E* was chosen even though *A* was equally expensive (it lies on the same budget line), *E* is preferred to *A*, as are all points in the rectangle above and to the right of *E*. Now suppose that facing line l_4 (which passes through *A*), the individual chooses market basket *G*. Because *G* was chosen and *A* was not, *G* is preferred to *A*, as are all market baskets above and to the right of *G*.

We can go further by making use of the assumption that indifference curves are convex. In that case, because *E* is preferred to *A*, all market baskets above and to the right of line *AE* in Figure 3.19 must be preferred to *A*. Otherwise, the indifference curve passing through *A* would have to pass through a point above

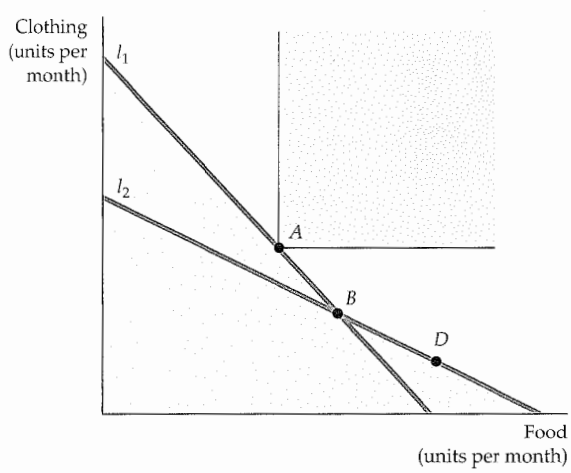


FIGURE 3.18
REVEALED PREFERENCE: TWO BUDGET LINES

If an individual facing budget line l_1 chose market basket *A* rather than market basket *B*, *A* is revealed to be preferred to *B*. Likewise, the individual facing budget line l_2 chooses market basket *B*, which is then revealed to be preferred to market basket *D*. Whereas *A* is preferred to all market baskets in the green-shaded area, all baskets in the pink-shaded area are preferred to *A*.

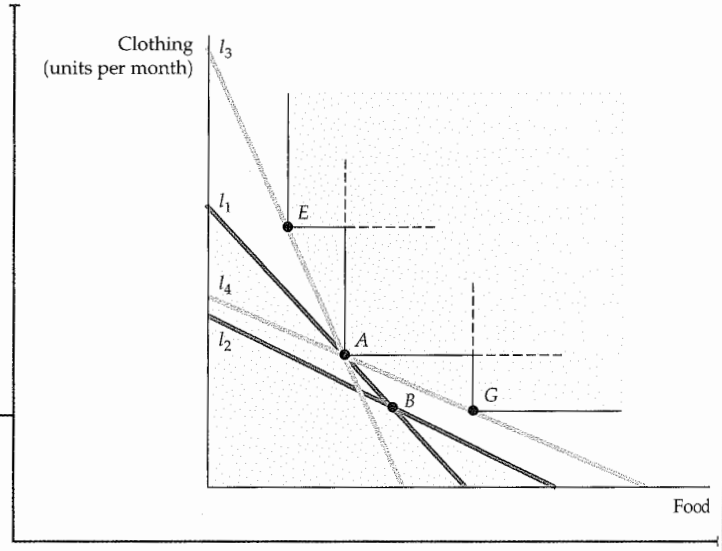


FIGURE 3.19
REVEALED PREFERENCE: FOUR BUDGET LINES

Facing budget line l_3 the individual chooses E, which is revealed to be preferred to A (because A could have been chosen). Likewise, facing line l_4, the individual chooses G which is also revealed to be preferred to A. Whereas A is preferred to all market baskets in the green-shaded area, all market baskets in the pink-shaded area are preferred to A.

and to the right of AE and then fall below the line at E—in which case the indifference curve would not be convex. By a similar argument, all points on AG or above are also preferred to A. Therefore, the indifference curve must lie within the unshaded area.

The revealed preference approach is valuable as a means of checking whether individual choices are consistent with the assumptions of consumer theory. As Example 3.6 shows, revealed preference analysis can help us understand the implications of choices that consumers must make in particular circumstances.

EXAMPLE 3.6 REVEALED PREFERENCE FOR RECREATION

A health club has been offering the use of its facilities to anyone who is willing to pay an hourly fee. Now the club decides to alter its pricing policy by charging both an annual membership fee and a lower hourly fee. Does this new financial arrangement make individuals better off or worse off than they were under the old arrangement? The answer depends on people's preferences.

Suppose that Roberta has $100 of income available each week for recreational activities, including exercise, movies, restaurant meals, and so on. When the health club charged a fee of $4 per hour, Roberta used the facility 10 hours per week. Under the new arrangement, she is required to pay $30 per week but can use the club for only $1 per hour.

Is this change beneficial for Roberta? Revealed preference analysis provides the answer. In Figure 3.20, line l_1 represents the budget constraint that Roberta faced under the original pricing arrangement. In this case, she maximized her satisfaction by choosing market basket A, with 10 hours of exercise and $60 of other recreational activities. Under the new arrangement, which shifts the budget line to l_2, she could still choose market basket A. But because U_1 is clearly not tangent to l_2, Roberta will be better off choosing another basket, such as B, with 25 hours of exercise and $45 worth of other recreational activities. Because she would choose B when she could still choose A, she prefers B to A. The new pricing arrangement

therefore makes Roberta better off. (Note that *B* is also preferred to *C*, which represents the option of not using the health club at all.)

We could also ask whether this new pricing system—called a *two-part tariff*—will increase the club's profits. If all members are like Roberta and more use generates more profit, then the answer is yes. In general, however, the answer depends on two factors: the preferences of all members and the costs of operating the facility. We discuss the two-part tariff in detail in Chapter 11, where we study ways in which firms with market power set prices.

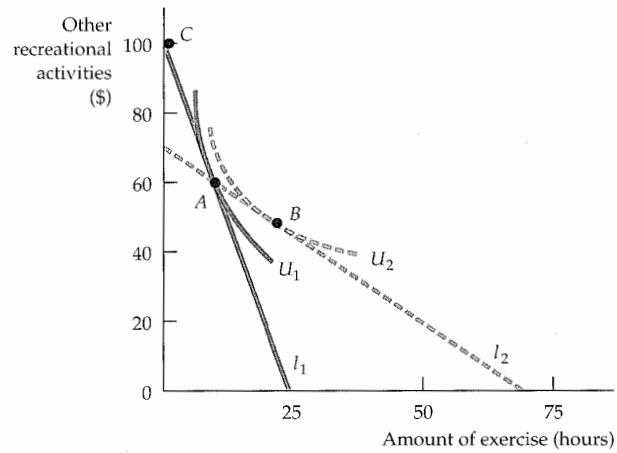


FIGURE 3.20
REVEALED PREFERENCE FOR RECREATION

When facing budget line I_1, an individual chooses to use a health club for 10 hours per week at point *A*. When the fees are altered, she faces budget line I_2. She is then made better off because market basket *A* can still be purchased, as can market basket *B*, which lies on a higher indifference curve.

3.5 Marginal Utility and Consumer Choice

In Section 3.3, we showed graphically how a consumer can maximize his or her satisfaction, given a budget constraint. We do this by finding the highest indifference curve that can be reached, given that budget constraint. Because the highest indifference curve also has the highest attainable level of utility, it is natural to recast the consumer's problem as one of maximizing utility subject to a budget constraint.

The concept of utility can also be used to recast our analysis in a way that provides additional insight. To begin, let's distinguish between the total utility obtained by consumption and the satisfaction obtained from the last item consumed. **Marginal utility (MU)** measures *the additional satisfaction obtained from consuming one additional unit of a good.* For example, the marginal utility associated with a consumption increase from 0 to 1 unit of food might be 9; from 1 to 2, it might be 7; from 2 to 3, it might be 5.

• **marginal utility (MU)** Additional satisfaction obtained from consuming one additional unit of a good.

These numbers imply that the consumer has **diminishing marginal utility:** As more and more of a good is consumed, consuming additional amounts will yield smaller and smaller additions to utility. Imagine, for example, the consumption of television: Marginal utility might fall after the second or third hour and could become very small after the fourth or fifth hour of viewing.

• **diminishing marginal utility** Principle that as more of a good is consumed, the consumption of additional amounts will yield smaller additions to utility.

We can relate the concept of marginal utility to the consumer's utility-maximization problem in the following way. Consider a small movement

down an indifference curve in Figure 3.8 (page 79). The additional consumption of food, ΔF, will generate marginal utility MU_F. This shift results in a total increase in utility of $MU_F \Delta F$. At the same time, the reduced consumption of clothing, ΔC, will lower utility per unit by MU_C, resulting in a total loss of $MU_C \Delta C$.

Because all points on an indifference curve generate the same level of utility, the total gain in utility associated with the increase in F must balance the loss due to the lower consumption of C. Formally,

$$0 = MU_F(\Delta F) + MU_C(\Delta C)$$

Now we can rearrange this equation so that

$$-(\Delta C/\Delta F) = MU_F/MU_C$$

But because $-(\Delta C/\Delta F)$ is the MRS of F for C, it follows that

$$MRS = MU_F/MU_C \tag{3.5}$$

Equation (3.5) tells us that the MRS is the ratio of the marginal utility of F to the marginal utility of C. As the consumer gives up more and more of C to obtain more of F, the marginal utility of F falls and that of C increases, so MRS decreases.

We saw earlier in this chapter that when consumers maximize their satisfaction, the MRS of F for C is equal to the ratio of the prices of the two goods:

$$MRS = P_F/P_C \tag{3.6}$$

Because the MRS is also equal to the ratio of the marginal utilities of consuming F and C (from equation 3.5), it follows that

$$MU_F/MU_C = P_F/P_C$$

or

$$MU_F/P_F = MU_C/P_C \tag{3.7}$$

Equation (3.7) is an important result. It tells us that utility maximization is achieved when the budget is allocated so that *the marginal utility per dollar of expenditure is the same for each good.* To see why this principle must hold, suppose that a person gets more utility from spending an additional dollar on food than on clothing. In this case, her utility will be increased by spending more on food. As long as the marginal utility of spending an extra dollar on food exceeds the marginal utility of spending an extra dollar on clothing, she can increase her utility by shifting her budget toward food and away from clothing. Eventually, the marginal utility of food will decrease (because there is diminishing marginal utility in its consumption) and the marginal utility of clothing will increase (for the same reason). Only when the consumer has satisfied the **equal marginal principle**—i.e., *has equalized the marginal utility per dollar of expenditure across all goods*—will she have maximized utility. The equal marginal principle is an important concept in microeconomics. It will reappear in different forms throughout our analysis of consumer and producer behavior.

• **equal marginal principle** Principle that utility is maximized when the consumer has equalized the marginal utility per dollar of expenditure across all goods.

EXAMPLE 3.7 MARGINAL UTILITY AND HAPPINESS

In Example 3.2 (page 81), we saw that money (i.e., a higher income) can buy happiness, at least to a degree. But what, if anything, does research on consumer satisfaction tell us about the relationship between happiness and the concepts of utility and marginal utility? Interestingly, that research is consistent with a pattern of diminishing marginal utility of income, both in the U.S. and across countries. To see why, let's re-examine Figure 3.9 (page 82) in Example 3.2. The data suggest that as incomes increase from one country to the next, satisfaction, happiness, or utility (we are using the three words interchangeably) all increase as per-capita income increases. The *incremental* increase in satisfaction, however, declines as income increases. If one is willing to accept that the satisfaction index resulting from the survey is a cardinal index, then the results are consistent with a diminishing marginal utility of income.

The results for the U.S. are qualitatively very similar to those for the 67 countries that make up the data for Figure 3.9. Figure 3.21 calculates the mean level of life satisfaction for nine separate income groups in the population; the lowest has a mean income of $6,250, the next a mean income of $16,250, and so on until the highest group, whose mean income is $87,500. The solid curve is the one that best fits the data. Once again, we can see that reported happiness increases with income, but at a diminishing rate. For those students concerned about future income prospects, a recent survey by psychologist Daniel Kahneman and economist Angus Deaton shows that

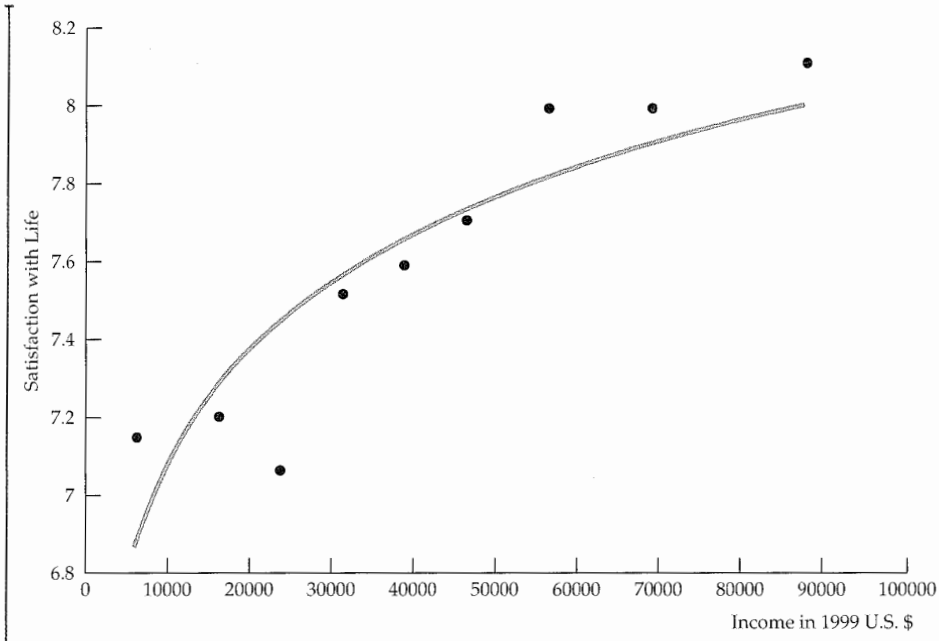


FIGURE 3.21
MARGINAL UTILITY AND HAPPINESS

A comparison of mean levels of satisfaction with life across income classes in the United States shows that happiness increases with income, but at a diminishing rate.

for this relatively high income group, making additional money does not improve a person's ability to enjoy leisure time and good health—all of which factor into one's overall well-being.[11]

These results offer strong support for the modern theory of economic decision making that underlies this text, but they are still being carefully scrutinized. For example, they do not account for the fact that satisfaction tends to vary with age, with younger people often expressing less satisfaction than older folks. Or we can look at this a different way. Students have something positive to look forward to as they get older and wiser.

A second issue arises when we compare the results of happiness studies over time. Per-capita incomes in the U.S., U.K., Belgium, and Japan have all risen substantially over the past 20 years. Average happiness, however, has remained relatively unchanged. (Denmark, Germany, and Italy did show some increased satisfaction.) One plausible interpretation is that happiness is a relative, not absolute, measure of well-being. As a country's income increases over time, its citizens increase their expectations; in other words, they aspire to having higher incomes. To the extent that satisfaction is tied to whether those aspirations are met, satisfaction may not increase as income grows over time.

Rationing

In times of war and other crises, governments sometimes ration food, gasoline, and other products, rather than allow prices to increase to competitive levels. During World War II, for example, individual households in the United States were limited to twelve ounces of sugar per week, one pound of coffee every five weeks, and three gallons of gasoline per week. Rationing has often been used with respect to water in periods of drought. Within the United States, California has often faced water rationing for both household consumption and agricultural production. Outside the United States, countries such as Rwanda, India, Pakistan, and Egypt have imposed water rationing as recently as 2010.

Nonprice rationing is an alternative that some consider more equitable than relying on uncontested market forces. Under a market system, those with higher incomes can outbid those with lower incomes to obtain goods that are in scarce supply. However, if products are rationed through a mechanism such as the allocation of coupons to households or businesses, everyone will have an equal chance to purchase a rationed good.

To understand how we can analyze rationing using the basic consumer model, let's use the gasoline rationing that occurred during 1979 as an example. Following the 1979 Iranian Revolution, oil prices jumped, but the United States imposed price controls that prevented increases in the price of gasoline, resulting in shortages. Gasoline was allocated by long lines at the gas pump: While those who were willing to give up their time waiting got the gas they wanted, others did not. By guaranteeing every eligible person a minimum amount of gasoline, rationing can provide some people with access to a product that they could not otherwise afford. But rationing hurts others by limiting the amount of gasoline that they can buy.[12]

We can see this principle clearly in Figure 3.22, which applies to a woman with an annual income of $20,000. The horizontal axis shows her annual consumption of gasoline, the vertical axis her remaining income after purchasing

[11]Daniel Kahneman and Angus Deaton, "High Income Improves Evaluation of Life But not Emotional Well-Being," *PNAS*, Vol. 107 (September 21, 2010): 16489–16493.

[12]For a more extensive discussion of gasoline rationing, see H. E. Frech III and William C. Lee, "The Welfare Cost of Rationing-by-Queuing Across Markets: Theory and Estimates from the U.S. Gasoline Crises," *Quarterly Journal of Economics* (1987): 97–108.

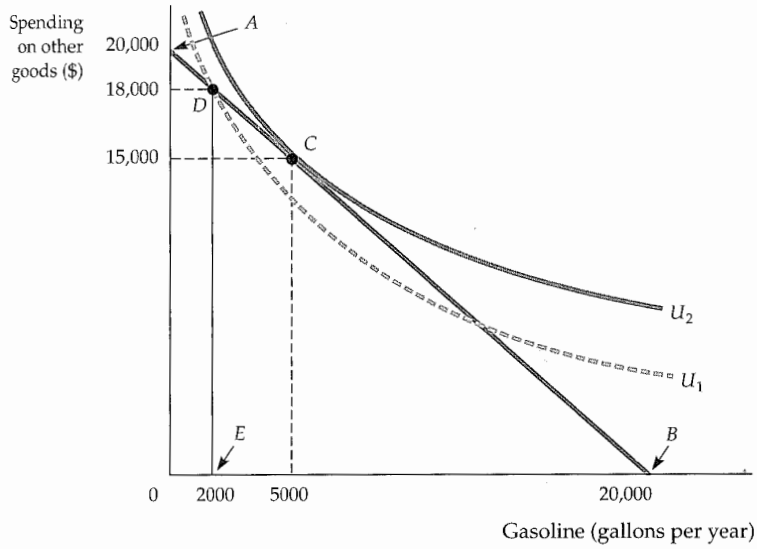


FIGURE 3.22
INEFFICIENCY OF GASOLINE RATIONING

When a good is rationed, less is available than consumers would like to buy. Consumers may be worse off. Without gasoline rationing, up to 20,000 gallons of gasoline are available for consumption (at point *B*). The consumer chooses point *C* on indifference curve U_2, consuming 5000 gallons of gasoline. However, with a limit of 2000 gallons of gasoline under rationing (at point *E*), the consumer moves to *D* on the lower indifference curve U_1.

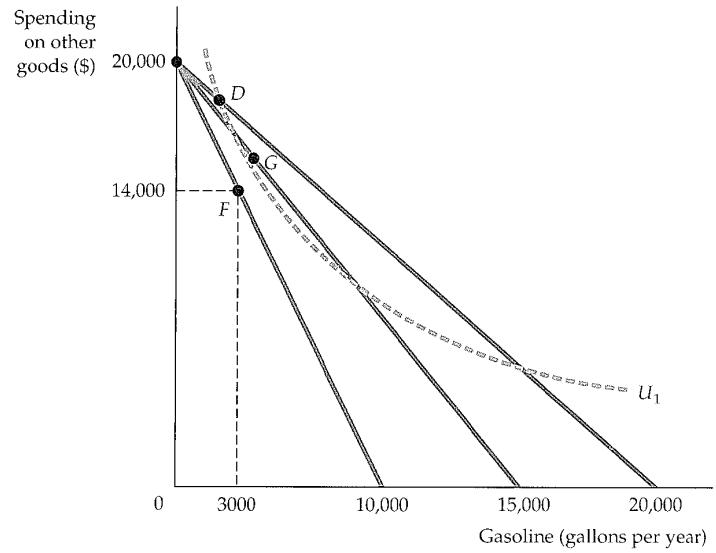
gasoline. Suppose the controlled gasoline price is $1 per gallon. Because her income is $20,000, she is limited to the points on budget line *AB*, which has a slope of −1. Point *A* represents her total income of $20,000. (If no gasoline were purchased, she would have $20,000 to spend on other goods.) At point *B* she would be spending her entire income on gasoline. At $1 per gallon, she might wish to buy 5000 gallons of gasoline per year and spend $15,000 on other goods, represented by *C*. At this point, she would have maximized her utility (by being on the highest possible indifference curve U_2), given her budget constraint of $20,000.

Let's assume that with rationing, our consumer can purchase up to a maximum of 2000 gallons of gasoline. Thus, she now faces budget line *ADE*, which is not a straight line because purchases above 2000 gallons are not possible. Point *D* represents the point of consumption of 2000 gallons per year. At that point, the budget line become vertical, declining to point *E*, since rationing has limited gasoline consumption. The figure shows that her choice to consume at *D* involves a lower level of utility, U_1, than would be achieved without rationing, U_2, because she is consuming less gasoline and more of other goods than she would otherwise prefer.

It is clear that at the rationed price the woman would be better off if her consumption were not constrained. But is she better off under a rationing system than she would be if there were no rationing at all? The answer, not surprisingly, depends on what the competitive market price of gasoline would have been without rationing. Figure 3.23 illustrates this point. Recall that had the price of gasoline been determined by the market to be $1 per gallon, our consumer would have been able to buy up to 20,000 gallons of gasoline per year—hence the original budget line. With rationing, she chooses to buy the maximum allowable 2000 gallons per year, putting her on indifference curve U_1. Now suppose that the competitive market price had been $2.00 per gallon rather than $1.00. Now the relevant budget line would be the line that was associated with a maximum gasoline consumption of only 10,000 gallons per year, and with no rationing she

FIGURE 3.23
COMPARING GASOLINE RATIONING TO THE FREE MARKET

Some consumers will be worse off, but others may be better off with rationing. With rationing and a gasoline price of $1.00 she buys the maximum allowable 2000 gallons per year, putting her on indifference curve U_1. Had the competitive market price been $2.00 per gallon with no rationing, she would have chosen point *F*, which lies below indifference curve U_1. However, had the price of gasoline been only $1.33 per gallon, she would have chosen point *G*, which lies above indifference curve U_1.



would choose point *F*, which lies below indifference curve U_1. (At point *F*, she purchases 3,000 gallons of gasoline and has $14,000 to spend on other goods.)

But, consider what would happen if the price of gasoline were only $1.33 per gallon. Then the relevant budget line would be the line associated with a maximum gasoline consumption of about 15,000 gallons per year ($20,000/$1.33). She would choose a point such as *G*, where she purchases more than 3,000 galls of gasoline and has more than $14,000 to spend on other goods. In this case, she would be better off without rationing, since point G lies above indifference curve U_1. We can conclude, therefore, that while rationing is a less efficient means of allocating goods and serves, under any particular rationing scheme some individuals may well be better off, even though others will necessarily be worse off.

In §1.3, we introduced the *Consumer Price Index* as a measure of the cost of a "typical" consumer's entire market basket. As such, changes in the CPI also measure the rate of inflation.

• **cost-of-living index** Ratio of the present cost of a typical bundle of consumer goods and services compared with the cost during a base period.

In §1.3, we explained that the *Producer Price Index* provides a measure of the aggregate price level for intermediate products and wholesale goods.

*3.6 Cost-of-Living Indexes

The Social Security system has been the subject of heated debate for some time now. Under the present system, a retired person receives an annual benefit that is initially determined at the time of retirement and is based on his or her work history. The benefit then increases from year to year at a rate equal to the rate of increase of the Consumer Price Index (CPI). Does the CPI accurately reflect the cost of living for retirees? Is it appropriate to use the CPI as we now do—as a **cost-of-living index** for other government programs, for private union pensions, and for private wage agreements? On a similar note, we might ask whether the Producer Price Index (PPI) accurately measures the change over time in the cost of production. The answers to these questions lie in the economic theory of consumer behavior. In this section, we describe the theoretical underpinnings of cost indexes such as the CPI, using an example that describes the hypothetical price changes that students and their parents might face.

TABLE 3.3 IDEAL COST-OF-LIVING INDEX

	2000 (*SARAH*)	2010 (*RACHEL*)
Price of books	$20/book	$100/book
Number of books	15	6
Price of food	$2.00/lb.	$2.20/lb.
Pounds of food	100	300
Expenditure	$500	$1260

Ideal Cost-of-Living Index

Let's look at two sisters, Rachel and Sarah, whose preferences are identical. When Sarah began her college education in 2000, her parents gave her a "discretionary" budget of $500 per quarter. Sarah could spend the money on food, which was available at a price of $2.00 per pound, and on books, which were available at a price of $20 each. Sarah bought 100 pounds of food (at a cost of $200) and 15 books (at a cost of $300). Ten years later, in 2010, when Rachel (who had worked during the interim) is about to start college, her parents promise her a budget that is equivalent in buying power to the budget given to her older sister. Unfortunately, prices in the college town have increased, with food now $2.20 per pound and books $100 each. By how much should the discretionary budget be increased to make Rachel as well off in 2010 as her sister Sarah was in 2000? Table 3.3 summarizes the relevant data and Figure 3.24 provides the answer.

The initial budget constraint facing Sarah in 2000 is given by line l_1 in Figure 3.24; her utility-maximizing combination of food and books is at point A on indifference curve U_1. We can check that the cost of achieving this level of utility is $500, as stated in the table:

$$\$500 = 100\,\text{lbs. of food} \times \$2.00/\text{lb.} + 15\,\text{books} \times \$20/\text{book}$$

As Figure 3.24 shows, to achieve the same level of utility as Sarah while facing the new higher prices, Rachel requires a budget sufficient to purchase the food-book

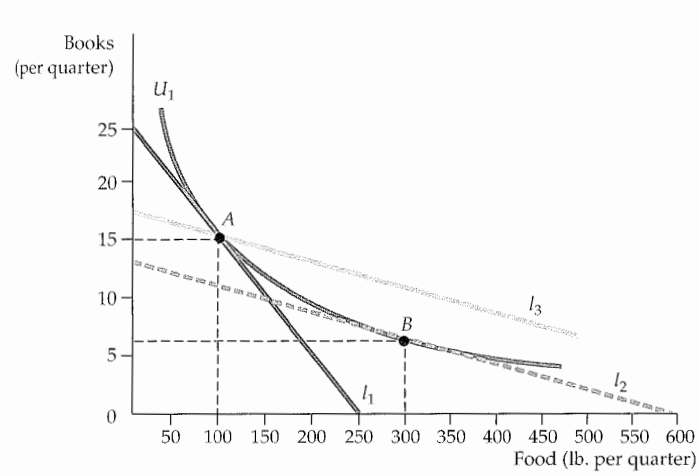


FIGURE 3.24
COST-OF-LIVING INDEXES

A price index, which represents the cost of buying bundle A at current prices relative to the cost of bundle A at base-year prices, overstates the ideal cost-of-living index.

consumption bundle given by point B on line l_2 (and tangent to indifference curve U_1), where she chooses 300 lbs. of food and 6 books. Note that in doing so, Rachel has taken into account the fact that the price of books has increased relative to food. Therefore, she has substituted toward food and away from books.

The cost to Rachel of attaining the same level of utility as Sarah is given by

$$\$1260 = 300\,\text{lbs. of food} \times \$2.20/\text{lb.} + 6\,\text{books} \times \$100/\text{book}$$

The ideal *cost-of-living adjustment* for Rachel is therefore \$760 (which is \$1260 minus the \$500 that was given to Sarah). The ideal cost-of-living index is

$$\$1260/\$500 = 2.52$$

Our index needs a base year, which we will set at 2000 = 100, so that the value of the index in 2010 is 252. A value of 252 implies a 152 percent increase in the cost of living, whereas a value of 100 would imply that the cost of living has not changed. This **ideal cost-of-living index** represents *the cost of attaining a given level of utility at current (2010) prices relative to the cost of attaining the same utility at base (2010) prices.*

• **ideal cost-of-living index** Cost of attaining a given level of utility at current prices relative to the cost of attaining the same utility at base-year prices.

Laspeyres Index

Unfortunately, such an ideal cost-of-living index would entail large amounts of information. We would need to know individual preferences (which vary across the population) as well as prices and expenditures. Actual price indexes are therefore based on consumer *purchases*, not preferences. A price index that uses a *fixed consumption bundle in the base period* is called a Laspeyres price index. The **Laspeyres price index** answers the question: *What is the amount of money at current-year prices that an individual requires to purchase the bundle of goods and services that was chosen in the base year divided by the cost of purchasing the same bundle at base-year prices?*

• **Laspeyres price index** Amount of money at current year prices that an individual requires to purchase a bundle of goods and services chosen in a base year divided by the cost of purchasing the same bundle at base-year prices.

The Laspeyres price index was illustrated in Figure 3.24. Calculating a Laspeyres cost-of-living index for Rachel is a straightforward process. Buying 100 pounds of food and 15 books in 2010 would require an expenditure of \$1720 (100 × \$2.20 + 15 × \$100). This expenditure allows Rachel to choose bundle A on budget line l_3 (or any other bundle on that line). Line l_3 was constructed by shifting line l_2 outward until it intersected point A. Note that l_3 is the budget line that allows Rachel to purchase, at current 2010 prices, the same consumption bundle that her sister purchased in 2000. To compensate Rachel for the increased cost of living, we must increase her discretionary budget by \$1220. Using 100 as the base in 2000, the Laspeyres index is therefore

$$100 \times \$1720/\$500 = 344$$

COMPARING IDEAL COST-OF-LIVING AND LASPEYRES INDEXES In our example, the Laspeyres price index is clearly much higher than the ideal price index. Does a Laspeyres index always overstate the true cost-of-living index? The answer is yes, as you can see from Figure 3.24. Suppose that Rachel was given the budget associated with line l_3 during the base year of 2000. She could choose bundle A, but clearly she could achieve a higher level of utility if she purchased more food and fewer books (by moving to the right on line l_3). Because A and B generate equal utility, it follows that Rachel is better off receiving a Laspeyres cost-of-living adjustment rather than an ideal adjustment. The Laspeyres index overcompensates Rachel for the higher cost of living, and the Laspeyres cost-of-living index is, therefore, greater than the ideal cost-of-living index.

This result holds generally. Why? Because *the Laspeyres price index assumes that consumers do not alter their consumption patterns as prices change.* By changing consumption, however—increasing purchases of items that have become relatively cheaper and decreasing purchases of relatively more expensive items—consumers can achieve the same level of utility without having to consume the same bundle of goods that they did before the price change.

Paasche Index

Another commonly used cost-of-living index is the **Paasche index.** Unlike the Laspeyres index, which focuses on the cost of buying a base-year bundle, the Paasche index focuses on the cost of buying the *current year's bundle.* In particular, the Paasche index answers another question: *What is the amount of money at current-year prices that an individual requires to purchase the current bundle of goods and services divided by the cost of purchasing the same bundle in the base year?*

• **Paasche index** Amount of money at current-year prices that an individual requires to purchase a current bundle of goods and services divided by the cost of purchasing the same bundle in a base year.

COMPARING THE LASPEYRES AND PAASCHE INDEXES It is helpful to compare the Laspeyres and the Paasche cost-of-living indexes.

- **Laspeyres index:** The amount of money at current-year prices that an individual requires to purchase the bundle of goods and services that was *chosen in the base year* divided by the cost of purchasing the same bundle at base-year prices.
- **Paasche index:** The amount of money at current-year prices that an individual requires to purchase the bundle of goods and services *chosen in the current year* divided by the cost of purchasing the same bundle in the base year.

Both the Laspeyres (LI) and Paasche (PI) indexes are **fixed-weight indexes:** The quantities of the various goods and services in each index remain unchanged. For the Laspeyres index, however, the quantities remain unchanged at *base-year* levels; for the Paasche they remain unchanged at *current-year* levels. Suppose generally that there are two goods, food (F) and clothing (C). Let:

• **fixed-weight index** Cost-of-living index in which the quantities of goods and services remain unchanged.

P_{Ft} and P_{Ct} be current-year prices
P_{Fb} and P_{Cb} be base-year prices
F_t and C_t be current-year quantities
F_b and C_b be base-year quantities

We can write the two indexes as:

$$\text{LI} = \frac{P_{Ft}F_b + P_{Ct}C_b}{P_{Fb}F_b + P_{Cb}C_b}$$

$$\text{PI} = \frac{P_{Ft}F_t + P_{Ct}C_t}{P_{Fb}F_t + P_{Cb}C_t}$$

Just as the Laspeyres index will overstate the ideal cost of living, the Paasche will understate it because it assumes that the individual will buy the current-year bundle in the base period. In actuality, facing base-year prices, consumers would have been able to achieve the same level of utility at a lower cost by changing their consumption bundles. Because the Paasche index is a ratio of the cost of

buying the current bundle divided by the cost of buying the current bundle at base-year prices, overstating the cost of the base-year bundle (the denominator in the ratio) will cause the Paasche index itself to be understated.

To illustrate the Laspeyres-Paasche comparison, let's return to our earlier example and focus on Sarah's choices of books and food. For Sarah (who went to college in 2000), the cost of buying the base-year bundle of books and food at current-year prices is \$1720 (100 lbs. × \$2.20/lb. + 15 books × \$100/book). The cost of buying the same bundle at base-year prices is \$500 (100 lbs × \$2/lb. + 15 books × \$20/book). The Laspeyres price index, LI, is therefore 100 × \$1720/\$500 = 344, as reported previously. In contrast, the cost of buying the current-year bundle at current-year prices is \$1260 (300 lbs. × \$2.20/lb. + 6 books × \$100/book). The cost of buying the same bundle at base-year prices is \$720 (300 lbs × \$2/lb. + 6 books × \$20/book). Consequently, the Paasche price index, PI, is 100 × \$1260/\$720 = 175. As expected, the Paasche index is lower than the Laspeyres index and lower than the ideal index of 252.

Price Indexes in the United States: Chain Weighting

Historically, both the CPI and the PPI were measured as Laspeyres price indexes. The overall CPI was calculated each month by the U.S. Bureau of Labor Statistics as the ratio of the cost of a typical bundle of consumer goods and services to the cost during a base period. A CPI for a particular category of goods and services (e.g., housing) would utilize a bundle of goods and services from that category. Similar calculations were done for the PPI using bundles of intermediate and wholesale goods.

We have seen that the Laspeyres index overstates the amount needed to compensate individuals for price increases. With respect to Social Security and other government programs, this means that using the CPI with base weights to adjust retirement benefits would tend to overcompensate most recipients and would thus require greater government expenditure.

While economists have known of this problem for years, it was not until the energy-price shocks of the 1970s, more recent fluctuations in food prices, and concerns surrounding federal deficits that dissatisfaction with the Laspeyres index grew. It was estimated, for example, that a failure to account for changes in computer-buying patterns in response to a sharp decrease in computer prices had caused the CPI to overstate the cost of living substantially.

For this reason, the U.S. government changed the construction of the CPI and the PPI, switching from a simple Laspeyres index to an index in which the base weights are updated every few years. A **chain-weighted price index** is a cost-of-living index that accounts for changes in quantities of goods and services over time. Chain weighting was not new to the U.S. It had been adopted in 1995 as an improvement to the GDP deflator, a Paasche price index used to deflate measures of gross domestic product (GDP) in order to obtain an estimate of real GDP (GDP adjusted for inflation).[13] Using chain-weighted versions of the CPI, PPI, and GDP deflator has reduced the biases associated with the use of simple Laspeyres and Paasche indexes, but because the weights are changed only infrequently, the biases have not been eliminated.[14]

• **chain-weighted price index** Cost-of-living index that accounts for changes in quantities of goods and services.

[13]For the latest changes in the CPI and PPI, see **http://www.bls.gov/cpi** and **http://www.bls.gov/ppi**. For information about the calculation of real GDP, see **http://www.bea.gov**.

[14]Failures to account adequately for the appearance of new goods and improvements in the quality of exisiting goods are additional sources of bias with respect to the CPI and PPI.

EXAMPLE 3.8 THE BIAS IN THE CPI

In the past decade, there has been growing public concern about the solvency of the Social Security system. At issue is the fact that retirement benefits are linked to the Consumer Price Index. Because the CPI was a Laspeyres index that could overstate the cost of living substantially, Congress has asked several economists to look into the matter.

A commission chaired by Stanford University professor Michael Boskin concluded that the CPI overstated inflation by approximately 1.1 percentage points—a significant amount given the relatively low rate of inflation in the United States in recent years.[15] According to the commission, approximately 0.4 percentage points of the 1.1-percentage-point bias was due to the failure of the Laspeyres price index to account for changes in the current year mix of consumption of the products in the base-year bundle. The remainder of the bias was due to the failure of the index to account for the growth of discount stores (approximately 0.1 percentage points), for improvements in the quality of existing products, and, most significantly, for the introduction of new products (0.6 percentage points).

The bias in the CPI was particularly acute when evaluating the costs of medical care. From 1986 to 1996, the average increase in the CPI was 3.6 percent, but the medical component of the CPI increased at an average annual rate of 6.5 percent per year. Thus, one estimate placed the total bias of the medical insurance part of the CPI at approximately 3.1 percentage points annually. This bias has enormous policy implications as the nation struggles to contain medical-care costs and provide health care to an aging population.[16]

If any remaining bias in the CPI were to be eliminated, in whole or in part, the cost of a number of federal programs would decrease substantially (as would, of course, the corresponding benefits to eligible recipients in the programs). In addition to Social Security, affected programs would include federal retirement programs (for railroad employees and military veterans), Supplemental Security Income (income support for the poor), food stamps, and child nutrition. According to one study, a 1-percentage-point reduction in the CPI would increase national savings and thereby reduce the national debt by approximately $95 billion per year in year 2000 dollars.[17]

In addition, the effect of any CPI adjustments would not be restricted to the expenditure side of the federal budget. Because personal income tax brackets are inflation-adjusted, a CPI adjustment decreasing the rate of measured price increase would necessitate a smaller upper adjustment in tax brackets and, consequently, increase federal tax revenues.

SUMMARY

1. The theory of consumer choice rests on the assumption that people behave rationally in an attempt to maximize the satisfaction that they can obtain by purchasing a particular combination of goods and services.
2. Consumer choice has two related parts: the study of the consumer's preferences and the analysis of the budget line that constrains consumer choices.
3. Consumers make choices by comparing market baskets or bundles of commodities. Preferences are assumed to be complete (consumers can compare all possible market baskets) and transitive (if they prefer basket *A* to *B*, and *B* to *C*, then they prefer *A* to *C*). In addition, economists assume that more of each good is always preferred to less.

[15]Michael J. Boskin, Ellen R. Dulberger, Robert J. Gordon, Zvi Griliches, and Dale W. Jorgenson, "The CPI Commission: Findings and Recommendations," *American Economic Review* 87 (May 1997): 78–93. The Bureau of Labor Statistics adopted changes in the measurement of the CPI, but these changes reduced the bias to only 0.8 or 0.9 percentage points. See, Michael J. Boskin, "Causes and Consequences of Bias in the Consumer Price Index as a Measure of the Cost of Living," *Atlantic Economic Journal* 33 (March 2005): 1–13.

[16]For more information, see Chapters 1 and 2 of *Measuring the Prices of Medical Treatments*, Jack E. Triplett, Editor; Washington, D.C.: Brookings Institution Press, 1999 (**http://brookings.nap.edu/**).

[17]Michael F. Bryan and Jagadeesh Gokhale, "The Consumer Price Index and National Savings," *Economic Commentary* (October 15, 1995) at **http://www.clev.frb.org/**. The data have been adjusted upward using the GDP deflator.

4. Indifference curves, which represent all combinations of goods and services that give the same level of satisfaction, are downward-sloping and cannot intersect one another.
5. Consumer preferences can be completely described by a set of indifference curves known as an indifference map. An indifference map provides an ordinal ranking of all choices that the consumer might make.
6. The marginal rate of substitution (MRS) of *F* for *C* is the maximum amount of *C* that a person is willing to give up to obtain 1 additional unit of *F*. The MRS diminishes as we move down along an indifference curve. When there is a diminishing MRS, indifference curves are convex.
7. Budget lines represent all combinations of goods for which consumers expend all their income. Budget lines shift outward in response to an increase in consumer income. When the price of one good (on the horizontal axis) changes while income and the price of the other good do not, budget lines pivot and rotate about a fixed point (on the vertical axis).
8. Consumers maximize satisfaction subject to budget constraints. When a consumer maximizes satisfaction by consuming some of each of two goods, the marginal rate of substitution is equal to the ratio of the prices of the two goods being purchased.
9. Maximization is sometimes achieved at a corner solution in which one good is not consumed. In such cases, the marginal rate of substitution need not equal the ratio of the prices.
10. The theory of revealed preference shows how the choices that individuals make when prices and income vary can be used to determine their preferences. When an individual chooses basket *A* even though he or she could afford *B*, we know that *A* is preferred to *B*.
11. The theory of the consumer can be presented by two different approaches. The indifference curve approach uses the ordinal properties of utility (that is, it allows for the ranking of alternatives). The utility function approach obtains a utility function by attaching a number to each market basket; if basket *A* is preferred to basket *B*, *A* generates more utility than *B*.
12. When risky choices are analyzed or when comparisons must be made among individuals, the cardinal properties of the utility function can be important. Usually the utility function will show diminishing marginal utility: As more and more of a good is consumed, the consumer obtains smaller and smaller increments of utility.
13. When the utility function approach is used and both goods are consumed, utility maximization occurs when the ratio of the marginal utilities of the two goods (which is the marginal rate of substitution) is equal to the ratio of the prices.
14. In times of war and other crises, governments sometimes ration food, gasoline, and other products, rather than allow prices to increase to competitive levels. Some consider nonprice rationing to be more equitable than relying on uncontested market forces.
15. An ideal cost-of-living index measures the cost of buying, at current prices, a bundle of goods that generates the same level of *utility* as was provided by the bundle of goods consumed at base-year prices. The Laspeyres price index, however, represents the cost of buying the bundle of goods chosen in the base year at current prices relative to the cost of buying *the same bundle* at base-year prices. The CPI, even with chain weighting, overstates the ideal cost-of-living index. By contrast, the Paasche index measures the cost at current-year prices of buying a bundle of goods chosen in the current year divided by the cost of buying the same bundle at base-year prices. It thus understates the ideal cost-of-living index.

QUESTIONS FOR REVIEW

1. What are the four basic assumptions about individual preferences? Explain the significance or meaning of each.
2. Can a set of indifference curves be upward sloping? If so, what would this tell you about the two goods?
3. Explain why two indifference curves cannot intersect.
4. Jon is always willing to trade one can of Coke for one can of Sprite, or one can of Sprite for one can of Coke.
   a. What can you say about Jon's marginal rate of substitution?
   b. Draw a set of indifference curves for Jon.
   c. Draw two budget lines with different slopes and illustrate the satisfaction-maximizing choice. What conclusion can you draw?
5. What happens to the marginal rate of substitution as you move along a convex indifference curve? A linear indifference curve?
6. Explain why an MRS between two goods must equal the ratio of the price of the goods for the consumer to achieve maximum satisfaction.
7. Describe the indifference curves associated with two goods that are perfect substitutes. What if they are perfect complements?
8. What is the difference between ordinal utility and cardinal utility? Explain why the assumption of cardinal utility is not needed in order to rank consumer choices.
9. Upon merging with the West German economy, East German consumers indicated a preference for

Mercedes-Benz automobiles over Volkswagens. However, when they converted their savings into deutsche marks, they flocked to Volkswagen dealerships. How can you explain this apparent paradox?

10. Draw a budget line and then draw an indifference curve to illustrate the satisfaction-maximizing choice associated with two products. Use your graph to answer the following questions.
    a. Suppose that one of the products is rationed. Explain why the consumer is likely to be worse off.
    b. Suppose that the price of one of the products is fixed at a level below the current price. As a result, the consumer is not able to purchase as much as she would like. Can you tell if the consumer is better off or worse off?
11. Describe the equal marginal principle. Explain why this principle may not hold if increasing marginal utility is associated with the consumption of one or both goods.
12. The price of computers has fallen substantially over the past two decades. Use this drop in price to explain why the Consumer Price Index is likely to overstate substantially the cost-of-living index for individuals who use computers intensively.
13. Explain why the Paasche index will generally understate the ideal cost-of-living index.

EXERCISES

1. In this chapter, consumer preferences for various commodities did not change during the analysis. In some situations, however, preferences do change as consumption occurs. Discuss why and how preferences might change over time with consumption of these two commodities:
    a. cigarettes.
    b. dinner for the first time at a restaurant with a special cuisine.
2. Draw indifference curves that represent the following individuals' preferences for hamburgers and soft drinks. Indicate the direction in which the individuals' satisfaction (or utility) is increasing.
    a. Joe has convex indifference curves and dislikes both hamburgers and soft drinks.
    b. Jane loves hamburgers and dislikes soft drinks. If she is served a soft drink, she will pour it down the drain rather than drink it.
    c. Bob loves hamburgers and dislikes soft drinks. If he is served a soft drink, he will drink it to be polite.
    d. Molly loves hamburgers and soft drinks, but insists on consuming exactly one soft drink for every two hamburgers that she eats.
    e. Bill likes hamburgers, but neither likes nor dislikes soft drinks.
    f. Mary always gets twice as much satisfaction from an extra hamburger as she does from an extra soft drink.
3. If Jane is currently willing to trade 4 movie tickets for 1 basketball ticket, then she must like basketball better than movies. True or false? Explain.
4. Janelle and Brian each plan to spend $20,000 on the styling and gas mileage features of a new car. They can each choose all styling, all gas mileage, or some combination of the two. Janelle does not care at all about styling and wants the best gas mileage possible. Brian likes both equally and wants to spend an equal amount on each. Using indifference curves and budget lines, illustrate the choice that each person will make.
5. Suppose that Bridget and Erin spend their incomes on two goods, food (F) and clothing (C). Bridget's preferences are represented by the utility function $U(F,C) = 10FC$, while Erin's preferences are represented by the utility function $U(F,C) = .20F^2C^2$.
    a. With food on the horizontal axis and clothing on the vertical axis, identify on a graph the set of points that give Bridget the same level of utility as the bundle (10, 5). Do the same for Erin on a separate graph.
    b. On the same two graphs, identify the set of bundles that give Bridget and Erin the same level of utility as the bundle (15, 8).
    c. Do you think Bridget and Erin have the same preferences or different preferences? Explain.
6. Suppose that Jones and Smith have each decided to allocate $1000 per year to an entertainment budget in the form of hockey games or rock concerts. They both like hockey games and rock concerts and will choose to consume positive quantities of both goods. However, they differ substantially in their preferences for these two forms of entertainment. Jones prefers hockey games to rock concerts, while Smith prefers rock concerts to hockey games.
    a. Draw a set of indifference curves for Jones and a second set for Smith.
    b. Using the concept of marginal rate of substitution, explain why the two sets of curves are different from each other.
7. The price of DVDs (D) is $20 and the price of CDs (C) is $10. Philip has a budget of $100 to spend on the two goods. Suppose that he has already bought one DVD and one CD. In addition, there are 3 more DVDs and 5 more CDs that he would really like to buy.
    a. Given the above prices and income, draw his budget line on a graph with CDs on the horizontal axis.
    b. Considering what he has already purchased and what he still wants to purchase, identify the three

different bundles of CDs and DVDs that he could choose. For this part of the question, assume that he cannot purchase fractional units.

8. Anne has a job that requires her to travel three out of every four weeks. She has an annual travel budget and can travel either by train or by plane. The airline on which she typically flies has a frequent-traveler program that reduces the cost of her tickets according to the number of miles she has flown in a given year. When she reaches 25,000 miles, the airline will reduce the price of her tickets by 25 percent for the remainder of the year. When she reaches 50,000 miles, the airline will reduce the price by 50 percent for the remainder of the year. Graph Anne's budget line, with train miles on the vertical axis and plane miles on the horizontal axis.
9. Debra usually buys a soft drink when she goes to a movie theater, where she has a choice of three sizes: the 8-ounce drink costs $1.50, the 12-ounce drink $2.00, and the 16-ounce drink $2.25. Describe the budget constraint that Debra faces when deciding how many ounces of the drink to purchase. (Assume that Debra can costlessly dispose of any of the soft drink that she does not want.)
10. Antonio buys five new college textbooks during his first year at school at a cost of $80 each. Used books cost only $50 each. When the bookstore announces that there will be a 10 percent increase in the price of new books and a 5 percent increase in the price of used books, Antonio's father offers him $40 extra.
    a. What happens to Antonio's budget line? Illustrate the change with new books on the vertical axis.
    b. Is Antonio worse or better off after the price change? Explain.
11. Consumers in Georgia pay twice as much for avocados as they do for peaches. However, avocados and peaches are the same price in California. If consumers in both states maximize utility, will the marginal rate of substitution of peaches for avocados be the same for consumers in both states? If not, which will be higher?
12. Ben allocates his lunch budget between two goods, pizza and burritos.
    a. Illustrate Ben's optimal bundle on a graph with pizza on the horizontal axis.
    b. Suppose now that pizza is taxed, causing the price to increase by 20 percent. Illustrate Ben's new optimal bundle.
    c. Suppose instead that pizza is rationed at a quantity less than Ben's desired quantity. Illustrate Ben's new optimal bundle.
13. Brenda wants to buy a new car and has a budget of $25,000. She has just found a magazine that assigns each car an index for styling and an index for gas mileage. Each index runs from 1 to 10, with 10 representing either the most styling or the best gas mileage. While looking at the list of cars, Brenda observes that on average, as the style index increases by one unit, the price of the car increases by $5000. She also observes that as the gas-mileage index rises by one unit, the price of the car increases by $2500.
    a. Illustrate the various combinations of style (S) and gas mileage (G) that Brenda could select with her $25,000 budget. Place gas mileage on the horizontal axis.
    b. Suppose Brenda's preferences are such that she always receives three times as much satisfaction from an extra unit of styling as she does from gas mileage. What type of car will Brenda choose?
    c. Suppose that Brenda's marginal rate of substitution (of gas mileage for styling) is equal to $S/(4G)$. What value of each index would she like to have in her car?
    d. Suppose that Brenda's marginal rate of substitution (of gas mileage for styling) is equal to $(3S)/G$. What value of each index would she like to have in her car?
14. Connie has a monthly income of $200 that she allocates between two goods: meat and potatoes.
    a. Suppose meat costs $4 per pound and potatoes $2 per pound. Draw her budget constraint.
    b. Suppose also that her utility function is given by the equation $U(M, P) = 2M + P$. What combination of meat and potatoes should she buy to maximize her utility? (*Hint:* Meat and potatoes are perfect substitutes.)
    c. Connie's supermarket has a special promotion. If she buys 20 pounds of potatoes (at $2 per pound), she gets the next 10 pounds for free. This offer applies only to the first 20 pounds she buys. All potatoes in excess of the first 20 pounds (excluding bonus potatoes) are still $2 per pound. Draw her budget constraint.
    d. An outbreak of potato rot raises the price of potatoes to $4 per pound. The supermarket ends its promotion. What does her budget constraint look like now? What combination of meat and potatoes maximizes her utility?
15. Jane receives utility from days spent traveling on vacation domestically (D) and days spent traveling on vacation in a foreign country (F), as given by the utility function $U(D,F) = 10DF$. In addition, the price of a day spent traveling domestically is $100, the price of a day spent traveling in a foreign country is $400, and Jane's annual travel budget is $4000.
    a. Illustrate the indifference curve associated with a utility of 800 and the indifference curve associated with a utility of 1200.
    b. Graph Jane's budget line on the same graph.
    c. Can Jane afford any of the bundles that give her a utility of 800? What about a utility of 1200?
    *d. Find Jane's utility-maximizing choice of days spent traveling domestically and days spent in a foreign country.
16. Julio receives utility from consuming food (F) and clothing (C) as given by the utility function $U(F,C) = FC$.

In addition, the price of food is $2 per unit, the price of clothing is $10 per unit, and Julio's weekly income is $50.

a. What is Julio's marginal rate of substitution of food for clothing when utility is maximized? Explain.

b. Suppose instead that Julio is consuming a bundle with more food and less clothing than his utility maximizing bundle. Would his marginal rate of substitution of food for clothing be greater than or less than your answer in part a? Explain.

17. The utility that Meredith receives by consuming food F and clothing C is given by $U(F,C) = FC$. Suppose that Meredith's income in 1990 is $1200 and that the prices of food and clothing are $1 per unit for each. By 2000, however, the price of food has increased to $2 and the price of clothing to $3. Let 100 represent the cost of living index for 1990. Calculate the ideal and the Laspeyres cost-of-living index for Meredith for 2000. (*Hint:* Meredith will spend equal amounts on food and clothing with these preferences.)