Chapter 21

New Electronic Trading Systems in Foreign Exchange Markets

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The foreign exchange market can be divided in two segments: the interbank market and the customer market. Two advances in trading technology, electronic brokers in the interbank market and internet trading for customers, have significantly changed the structure of the foreign exchange market. In this chapter, we explain the functioning of electronic brokers and internet trading and discuss the economic consequences. © 2003, Elsevier Science (USA).

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Bid–ask spread Difference between the best buy price (ask) and best sell price (bid). The initiator of a trade buys at the ask and sells at the lower bid price. The spread is a measure of transaction costs. The buy price is also called the "offer."

Broker Brokers match dealers in the interbank market without being a party to the transactions themselves and without taking positions (cf. dealer).

Call market A market where all traders trade at the same time when called upon.

Counterparty credit risk The risk that the market participant on the other side of a transaction will default. Due to the large trade sizes in foreign exchange markets, credit risk is an important issue.

Dealer A person employed by a bank whose primary business is entering into transactions on both sides of wholesale financial markets and seeking profits by taking risks in these markets (cf. broker).

Dealer market Market where orders for execution pass to an intermediary (dealer) for execution.

Interbank market The market where dealers trade exclusively with each other, either bilaterally or through brokers.

Limit order Order to buy a specified quantity up to a maximum price or sell subject to a minimum price (cf. market order).

Liquidity Characteristic of a market where transactions do not excessively move prices. It is also easy to have a trade effected quickly without a long search for counterparties ("immediacy"). Liquid markets usually have low bid–ask spreads, high volume, and (relatively) low volatility.

Market maker Dealer ready to quote buy and sell prices upon request. The market maker provides immediacy (liquidity services) to the market and receives compensation through the spread. There is no formal obligation to quote tight spreads; rather, market making is governed by reciprocity.

Market order Order to buy (or sell) a specified quantity at the best prevailing price (cf. limit order).

Order-driven market Market where prices are determined by an order execution algorithm from participants sending firm buy and sell orders, which are incorporated into the limit order book (cf. quote-driven or dealer market).

Order flow Signed flow of transactions. The transaction is given a positive (negative) sign if the initiator of the transactions is buying (selling).

Price discovery Determination of prices in a market. Incorporation of information into prices.

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Quote-driven market Refers to a market where market makers post bid and ask quotes upon bilateral request. In the interbank market, these prices are on a take-it-or-leave-it basis (cf. order-driven market).

Transparency Ability of market participants to observe trade information in a timely fashion.

I. INTRODUCTION

The 1990s gave us what might prove to be the two biggest changes in foreign exchange market structure since World War II: electronic brokers were introduced into the interbank market in 1992, and in the late 1990s the Internet became available as a trading channel for customers. What are the consequences for the market of these innovations? Is there any reason to believe that these technological developments have influenced the market in any significant way? Do not dealers in the foreign exchange market still fulfill their function as liquidity providers and aggregate information in their price setting? And, do not basic macroeconomic variables still drive exchange rates, irrespective of trading technology?

In an ideal world with perfect information, these changes to the institutions of trading probably would not matter that much at the macroeconomic level. In such a world, exchange rates would be determined by expectations regarding macroeconomic fundamentals like inflation, productivity growth, and interest rates. Exchange rates will be efficient asset prices when all market participants observe these fundamentals and agree on how they influence exchange rates. Furthermore, provision of liquidity would be much less risky than in a situation with imperfect information. However, as empirical evidence has shown all too clearly, models of an ideal world with perfect information do not hold, at least not for horizons shorter than a year or so.

The microstructure approach to foreign exchange has made some promising steps toward solving some of these puzzles (see Lyons, 2001a). This approach differs from the traditional macroeconomic approach by allowing for imperfect information and heterogeneous agents and, thereby, leaving a role for trading institutions as such. In such a world, technological changes such as the introduction of electronic brokers and Internet trading may be significant because they change the structure of the market. A different market structure changes the game played between the market participants. This may influence information aggregation capabilities and incentives for liquidity provision and, thereby, different aspects of market quality like *efficiency* (price discovery), *liquidity*, and *transac-*

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tion costs. We are interested in understanding market structure because a well-functioning foreign exchange market is important for the macroeconomy. This chapter considers the impact of technological advances on the foreign exchange market by focusing on these properties of market quality.

The new economy and foreign exchange markets is a vast subject. We limit ourselves to the two major innovations in trading technology because trading institutions are an important part of a financial market's structure. Furthermore, several studies show that trading is important for the determination of exchange rates. There is particular focus on a property of market structure called *transparency*, i.e., how much of the trading process market participants can observe. Because trading is an important determinant of exchange rates, observation of the trading process is important to enable dealers to set the "correct" exchange rates. On a more general level, transparency relates to how efficiently dealers can aggregate information.

There are of course many other uses of information and communication technology (ICT) that have obviously influenced the markets that we do not address here. These include information providers such as Reuters and Bloomberg, computers' calculation capabilities and the importance for option trading, and of course network technologies and computers in general. Two other technological innovations deserving special attention that we do not consider are the newly started settlement service CLS Bank (Continuous Linked Settlement), which went live on September 9, 2002, and the netting technology FXNet. The former links all participating countries' payment systems for real-time settlement. With such a system in place in 1974, the famous Bankhaus Herstatt default would never had happened. FXNet is a technology for netting out gross liabilities. Both are very important for the handling of counterparty credit risk.

Sections II and III provide the background for the introduction of electronic brokers and Internet trading. A brief description and history are given of the structure of the market prior to these innovations, followed by some considerations that dealers take into account in their trading. The trading institutions of the 1980s are referenced to clarify the differences. Section IV discusses electronic brokers, whereas Section V discusses Internet trading. Section VI provides a summary.

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II. THE STRUCTURE OF FOREIGN EXCHANGE MARKETS

Before we discuss electronic brokers and Internet trading, we need an overview of the general structure of the foreign exchange market so as to be able to understand the impact of these new trading institutions. Although electronic brokers were undoubtedly the most significant structural change in the 1990s, the general description given here is valid for the structure both before and after the introduction of electronic brokers. The reason is that brokers were present in the market before electronic brokers were introduced. The introduction of Internet trading, on the other hand, is still very recent, but it may prove to be the most significant structural shift of the first decade of the twenty-first century. This shift has the potential to overthrow the general structure of the market completely, a point that we come back to in Section V.

A. Information and Agents

The foreign exchange market is the oldest and largest financial market in the world, with $1200 billion changing hands every day (April 2001).[1] These trades can be divided into interbank trades and customer trades, representing the two segments of the market. In the interbank market, trading is either direct (bilateral or taking place between dealers) or brokered (interdealer trades). Prior to the advent of the Internet, customers traded only with banks. We could have added customer-to-customer Internet-based trading sites, but we feel it is too early to pay them the same attention as the three methods already mentioned (interbank, both direct and brokered, and customer–bank). In the 1990s, the market was often divided into three groups: customers, dealers, and brokers. However, as brokering becomes more and more electronic and also is open to customers through the Internet, we feel that it is more natural to focus on two main groups of traders: customers and dealers. The customers are the ultimate end-users of currency, and they typically make the largest single trades. Customers may be central banks, governments, importers and exporters of goods, and financial institutions like hedge funds.

Important characteristics of the foreign exchange market are that customers do not have access to the interbank market and that they do not trade with each other (except on the customer-to-customer sites mentioned

[1]This number includes spot, forward, and swap volumes. In the following, we will focus on spot trading because spot is the most fundamental.

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earlier, which we return to later). The trading that takes place with customers is private information for the banks, and dealers stress the importance of seeing customer flows. An interesting question is what kind of information this trading may reveal. For understanding the concept of information in the foreign exchange market, we need to add some details to what we mean by information, and Lyons (2002) suggests the description given in Table 1. The starting point is the expression of an asset price as the discounted expected value. Information may concern the expected value, the payoff-relevant part, or the discount rate (including the risk premium).

In the upper left corner of Table 1, concentrated payoff-relevant information, or information on risk-neutral valuations, is the kind of private information that is typical in equity markets. In the case of foreign exchange, it probably does not constitute the main motivation for information-based trading. Changes in central banks' interest rates are too infrequent and too shrouded in secrecy for private information about these rates to be a major driver of trading. However, private information about interventions is a possible candidate because central banks sometimes perform their interventions through particular banks. Bettina Peiers found that the exchange rate changes made by Deutsche Bank were leading the rates of other banks through rumors of interventions.

Rather, Lyons (2002) suggests that it is the lower row in Table 1 that is most relevant in foreign exchange markets. The information that needs to be aggregated by the market is not concentrated on a few people, but rather dispersed among many. In their 2002 paper, Martin D. D. Evans and Lyons present a model where customer trading represents portfolio shifts and signals changes in risk premiums (information of the type in the lower right cell of Table 1). A risk premium arises as the compensation necessary to induce others to take the other side of the portfolio shift. This risk premium must be a permanent change in exchange rates because the new holders of currency must want to continue holding the currency. Their empirical results confirm this.

Table 1

Sources of Private Information[a]

	Payoffs	Discount rates
Concentrated	Interest rate changes, interventions	
Dispersed	Expectations, information interpretation ("market sentiment")	Risk premiums (risk aversion, portfolio shift)

[a]Lyons (2002) suggests that information in the upper left corner is unlikely in foreign exchange markets and that the lower right corner is the more relevant.

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We can also make an argument for the lower left cell. Because no model so far has proven to be the correct model for exchange rates, agents are likely to have different views on exchange rates. Customers' trading counts the "votes" of the customers on where the exchange rate is heading. The hypothesis that information is dispersed has implications for optimal market structure: what kind of trading institutions are best fit for aggregating dispersed information? We come back to this in Section IV.

B. Institutions

The market structure has not always been like the present structure. Prior to telecommunications, trading in foreign exchange markets could be described as a centralized call market. Trading in foreign exchange can be traced back to ancient times, when foreign exchange trading was a way to circumvent the ban on usury. In the sixteenth century, trading in foreign exchange occurred every third month at fairs in the Genoa area, each of which lasted for 8 days.[2] However, telecommunications changed the general structure of the foreign exchange market, and it has been more or less unaltered from the early 1930s up to the present.[3] Drawing on the theory of the microstructure of financial markets, we can describe the current interbank foreign exchange market as follows:

1. Trading is *decentralized* across several locations, as opposed to *centralized* on an exchange as is the case in many equity markets.
2. There is *continuous* trading around the clock, as opposed to only when called upon as in a *call* market.
3. There are *several* dealers that provide liquidity, as opposed to the specialist on the NYSE floor in earlier days, for example.
4. Liquidity is both *quote-driven*, i.e., created by quoting bid and ask prices in response to trading initiatives (market making or dealer market), and *order-driven*, i.e., by entering limit orders with brokers (auction market).
5. The market is relatively *opaque*, i.e., has low transparency compared with many equity markets.

[2]The Genoa fairs lasted from 1532 to 1763 [see chapters by M. de Cecco in Newman *et al.* (1992)]. After this, Amsterdam and then London took over as the main location for currency trading.

[3]It is difficult to find information on market structure from earlier periods. Several brokers started up in London in the 1930s with brokering over the telephone. Really active trading in foreign exchange, however, did not start until the mid-1960s, when regulations were eased in several European countries.

The introduction of telecommunications allowed decentralized trade of the asset foreign exchange, as is most natural. Banks want to be present where the customers are, and because an exchange rate is the relative price of two assets from two different countries, it is natural to have a decentralized market. Given that customers are in different time zones and may have an interest in the same asset, say $, trading must also be continuous around the clock. Finally, given the geographical pattern of customers and the fact that several banks serve them, it is natural to have a number of dealers acting as liquidity providers in each currency pair. The decentralized structure also makes it very difficult to regulate foreign exchange trading, and the market structure has therefore evolved endogenously. These factors, together with the lack of regulatory disclosure requirements, mean that the foreign exchange markets are characterized by low transparency.

All of this has economic consequences. Low transparency means that few of the dispersed signals that order flow may reveal will be observed by a single dealer. In a centralized call market, which is more transparent, information aggregation will typically be faster and more accurate. The lack of regulation is also important. Disclosure requirements are imposed on equity markets so that more trading, and hence more information, is observed by the market participants. As will be discussed later, the trading institutions also have implications for risk sharing.

C. Interbank Trading Options

Foreign exchange trading typically follows a sequence. Customers' trading is the primary source of currency demand, and the sequence starts with a customer contacting her bank with a wish to trade (dealers never take the initiative). The bank acts as market maker and gives quotes to the customer. Customers do not have access to the interbank market, so an exporter cannot contact his counterparty or the counterparty's bank directly. For a customer, trading with the counterparty directly involves credit risk, which could be handled more efficiently by a bank. A dealer in the bank then turns to the interbank market to cover the customer trade. Interbank trading actually accounts for between 60% and 80% of the total volume of foreign exchange trading, and we will come back to this issue in the next section because it is closely related to trading institutions.

In the interbank market, the dealer has several options, as illustrated by the 2×2 matrix in Table 2. In a multiple-dealer market, the dealer may choose to provide liquidity as a market maker and give quotes when contacted by other dealers (incoming trade), or he may trade on other market

Table 2
Interbank Trading Options[a]

	Incoming (nonaggressor)	Outgoing (aggressor)
Direct	Give quotes on request (market making)	Trade at other dealers' quotes ("taker")
Indirect	Dealer gives quote(s) to a broker (limit order)	Dealer trades at quotes given by a broker (market order)

[a]A market maker gives quotes (buy and sell prices) on request from other dealers. The dealer that takes the initiative and asks for quotes is called the "aggressor." Direct trading is bilateral trade over the D2000-1 computer system or the telephone. Indirect trading is trading through a broker, either a traditional "voice" broker (closed telephone network) or the electronic brokers D2000-2 and EBS.

makers' quotes (outgoing trade). Because this is bilateral, it is often called *direct* trading. Furthermore, the interbank market is a hybrid market in the sense that liquidity can be provided both through making markets and by entering limit orders with brokers. The brokers announce the best bid and ask prices, and trading on these is a market order. Brokered trades are often called *indirect* trading.

The information signal in trading is connected to the action of the most active part in the trade, often called the initiator or aggressor (outgoing trade). If the aggressor buys (sells), we say that it is a positive (negative) *order flow*, so order flow is just a transaction with a sign. How is this informative? Think of the portfolio shift model of Evans and Lyons mentioned in the discussion of Table 1. If the aggressor buys, that could be because she is covering a position after a customer purchase (portfolio shift into that currency). Alternatively, think of the proposition that order flow reveals information about other dealers' expectations. Then a purchase on behalf of the aggressor could be a signal, with noise, that the aggressor believes the currency is undervalued. In both cases, the positive order flow signals that the exchange rate should appreciate.

D. Transparency

As mentioned earlier, transparency is low in foreign exchange markets compared to most equity markets. There are many forms of transparency: pretrade and posttrade transparency, transparency of prices or trades, and transparency with respect to whether the customers or only the dealers can observe the trading process. To start with the last of these, in the foreign

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exchange markets only the dealers can observe anything other than their own trading. The trades with customers that initiate the trading sequence are only observed by the bank that receives the order and, hence, are private information for the banks. In the interbank market, trades that are made directly between two dealers are only observed by the two dealers. The lack of disclosure requirements also ensures that these trades will not be observed by other dealers after the trade is made. Indirect trading is more transparent because the price and sign (buying or selling by the aggressor) of the last trades are observable. In this sense, trading through brokers is what determines the level of trade transparency. This level has evolved endogenously as a result of dealers' indirect trading.

Price transparency is higher than trade transparency, but until recently customers' ability to see prices was less than that of dealers. However, compared to many equity markets with indirect trading, transparency is still low. In many equity markets a trader may be able to see the identity of the best bid and ask and often also a part of or the entire order book (all the other limit orders). In the case of a trade, both the size and the identity of the counterparties are revealed in many equity markets.

III. DIRECT TRADING AND VOICE BROKERS

In this section, we provide a further elaboration on the working of the interbank market prior to the electronic brokers by discussing how indirect and direct trading actually functions and affects dealers' behavior. As mentioned earlier, the trading institutions have been more or less unaltered for a long time, perhaps since the early 1930s when the first telephone brokers started. The composition of direct versus indirect trading has changed over time, however. For telephone brokers, the main innovation came in the 1960s when brokers started operating through private telephone networks. These are installed free of charge in banks by brokers. The broker announces the best (limit order) bid and ask prices over intercoms at the dealers' desk. If the dealer wants to trade at a limit order, i.e., submit a market order, he picks up the phone with the direct line and just says "mine" if he is buying (at the ask price) and "yours" if he is selling (at the bid price). The voice broker then knows which of the two announced prices at which he is trading. After a trade the broker announces the price and whether it was traded on the bid or the ask price. The size of the trade is not announced, but standard sizes are 1 and 5 million. This announcement was the only signal on marketwide order flow that the dealer received. Telephone brokers are often called voice brokers due to the announcements over intercom systems. Voice brokers were very popular up to the mid-

1980s at least. The main advantage for the dealers is that the dealer stays anonymous until the trade is made.

Direct trading was made by telephone or telex in the 1970s. In February 1981, Reuters introduced the Reuters Market Data Service (RMDS), which was like a bilateral bulletin board for conveying trading interest, for subsequent trading over the telephone. This system was replaced in 1987 by Reuters Dealing 2000-1, a closed network for bilateral electronic communication. Although a system for electronic trading, it did not revolutionize the market. The D2000-1 is more like an advanced telephone and made the direct trading that used to take place over the telephone more efficient. D2000-1 quickly became the dominant tool for trading bilaterally. The dealers "chat" in much the same manner as with "instant messengers" on the Internet. Furthermore, trade tickets, needed to check trades and for settlement with counterparties, were sent automatically to the back office, and the dealer could trade faster and more efficiently with up to four conversations going simultaneously. With this system in place, direct trading started to take market share from voice brokers, and in the late 1980s to early 1990s, interbank volume was split 50/50 between direct trading and voice brokers.

Table 3 reports some volume numbers from the United Kingdom, United States, and Japan, the three largest single markets, to help us get an idea of the size of the market. First we notice that in London alone there is trading for over $500 billion each day, down from over $630 in 1998. The foreign exchange market had grown rapidly from the collapse of Bretton Woods in the early 1970s, until the downturn in volume that we see from 1998. Total volume has decreased similarly, down to $1200 billion in 2001 from $1490 billion in 1998. We will come back to the downturn in the next section. The increase in volume through the 1980s and 1990s was primarily driven by increased globalization, a dramatic increase in trading with customers in the late 1980s, and more banks entering the foreign exchange market. The introduction of D2000-1 might, however, have been a useful trading tool in this process. Not only could the system handle more trades simultaneously (the dealer could contact four market makers simultaneously) but D2000-1 also made cross-border trading easier. Voice brokers are quite regional. There are New York-based, London-based, Frankfurt-based, and Tokyo-based brokers, brokers serving Scandinavia, etc. Chatting electronically seems to be less hampered by borders.

Notice also the high interbank share of foreign exchange volume in Table 3. During the 1990s, the interbank share was between 60% and 80%, possibly at the high end for financial centers. This has been interpreted as speculative trading on the part of the banks, because it cannot be related to goods trading, etc. However, within this trading structure with a high

Table 3
Daily Trading Volumes[a]

		United Kingdom		United States		Japan	
		Volume	Share (%)	Volume	Share (%)	Volume	Share (%)
2001	Total volume	504		254		147	
	Total interbank	341	68	143	56	123	83
	Total spot	151	30	104	41	37	25
1998	Total volume	637		351		136	
	Total interbank	530	83	171	49	109	80
	Total spot	217	34	148	42	57	42
1995	Total volume	464		244		161	
	Total interbank	349	75	138	57	118	74
	Total spot	186	40	134	55	55	34
1992	Total volume	290		167		120	
	Total interbank	230	79	122	73	92	76
	Total spot	148	51	95	57	48	40
1989	Total volume	184		125		111	
	Total interbank	161	88	116	93	78	70
	Total spot	119	65	81	65	46	41
1986	Total volume	90		59		48	
	Total interbank	82	91	54	93	32	67
	Total spot	66	55	34	42	19	41

[a]Source: Average daily volumes as reported in BIS (1990, 1993, 1996, 1999, 2002). All volumes are corrected for local double-counting. Total volume and total interbank volume in each country is the sum of spot, forward, and swap volumes in the overall and interbank markets, respectively. Interbank share and spot share are calculated as the share of total interbank volume.

share of direct trading, a high interbank share may be the result of risk sharing between the banks after receiving large customer orders. Imagine that a large customer order, for example €100 million, ends up at the desk of an interbank dealer. Let us assume that the dealer wants to get rid of it. The dealer has relationships with 10 other dealers (market makers) and sells €10 million to each through (outgoing) direct trading. For the sake of the argument, assume that none of these dealers are particularly interested in the position. They accept the trade because they get compensation through the bid–ask spread (incoming trade on their behalf). Each of them turns to two of their contacts and sells €5 million to each. The interbank volume is now €200 million, and it continues to grow. The €5 million that 20 dealers have received are sold to other dealers again, and the volume

reaches €300 million! The customer trade is passed on like a "hot potato." When the process comes to an end, all dealers, including our initial dealer, hold a share of the initial customer order. Large interbank trading flows could, in other words, be a consequence of a market structure with a high share of direct trading.

A. Dealer Behavior

How do the dealers behave in such a hybrid market? We can use the dealer studied by Lyons in 1992 (see Lyons, 2001a) as an example of how a market maker works. The dealer operated as a market maker in a New York investment bank in 1992 and traded almost entirely by giving quotes on the D2000-1 system (market making e.g., direct incoming trading).

A market maker sets bid and ask prices, the difference being the spread and the midpoint typically being her expectation. The spread is a function of three components: (i) adverse selection protection; (ii) risk management; and (iii) order processing costs and rents. To discourage informed traders and make money from the uninformed (she always loses to the better informed), the market maker increases the spread with trade size, hence, making it more expensive to trade. Similarly, the spread increases with size as compensation for taking on the risk in the trade. The part of the spread due to order processing costs and rents is usually modeled as a constant.

The spread is measured in "pips," with one pip being the fourth decimal in most exchange rates (the fifth in £ exchange rates). The median spread for the dmark/$ dealer studied by Lyons (2001a) was three pips, and the median trade size was $3 million. Geir Bjønnes and Dagfinn Rime find, in similar data for direct trading from 1998, a median spread of two pips, with a median trade size of $1 million. The spread was relatively constant up to $5 million. This may seem like a tiny transaction cost. If the dmark/$ was trading at 1.8, then a two-pip spread is only slightly more than one basis point (1%/100), and buying $1 million would cost approximately $55. When one realizes that, in April 1998, dmark/$ was traded for almost $100 billion daily in the interbank market alone (corrected for double counting), the risk sharing process mentioned earlier becomes quite expensive ($5.5 million daily in interbank dmark/$ trading alone).

The dealer that makes the contact (aggressor) asks for bid and ask prices for a given size without revealing his trading intentions. In "direct" trading, market makers are expected to give tight quotes promptly on request, and the aggressor is similarly expected to reply quickly. The quotes are on a take-it-or-leave-it basis. If there is a trade, the server analyzes the conver-

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sation to make precise transaction tickets. An example of a ticket with a conversation can be seen in Fig. 1 and in the middle panel of Fig. 2a.

The "Lyons dealer" increased his spread with the size of the trade to protect himself against better informed dealers. After observing the direction of the trade, he also adjusted the midpoint to take into account the information contained in the trade. Furthermore, he reduced/increased ("shaded") both his prices when his inventory of currency was higher/lower

```
From \CODE" \FULL NAME HERE" *0728GMT 160398 */7576
Our Terminal:  \CODE"      Our user:  \FULL NAME HERE"
   DEM 1
#  45.47
   BA> I BUY
#  TO CONFIRM AT 1,8147 I SELL 1 MIO USD
#  VAL 180398
#  MY DEM TO \FULL NAME HERE"
#  THANKS AND BYE
   TO CONFIRM AT 1,8147 I BUY 1 MIO USD
   VAL 180398
   MY USD TO \FULL NAME HERE"
   THANKS FOR DEAL FRDS. CHEERS
#
   # END REMOTE #

^  ## TKT EDIT OF CNV 7576 BY \CODE" 0728GMT 180398
^  STATUS CONFIRMED
^  ##ENDED AT 07:27 GMT#
```

Figure 1 D2000-1 conversation. An example of a transaction ticket with a D2000-1 conversation made March 16, 1998. The first word means that the call came "from" another dealer. There is information regarding the institution code and the name of the counterpart, the time (Greenwich Mean) of the printing of the ticket, the date, and the number assigned to the communication. DEM 1 means that this is a request for a spot DEM/USD quote for up to USD 1 million, because it is implicitly understood that it is DEM against USD. On line 4 we find the quoted bid and ask prices. Only the last two digits of the four decimals are quoted. In this case, the bid quote is 1.8145 and the ask quote is 1.8147. When confirming the transaction, the communication record provides the first three digits. In this case, the calling dealer buys USD 1 million at the price 1.8147. The record confirms the exact price, quantity, and valuation (delivery) date (two days later for spot). The transaction price always equals the bid or the ask. There is also information regarding the settlement bank. "My DEM to settlement bank" identifies the settlement bank of "our bank," whereas "my USD to settlement bank" identifies the settlement bank of the other bank. It is usual to end a conversation with standard phrases, such as "thanks and bye" or, "thanks for deals friends." The conversation ended 1 minute prior to printing of the transaction ticket, as seen from the last line.

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than preferred so as to induce trade in his preferred direction in order to control his inventory risk. If he was "long" (positive holdings of, for example, $ against dmark), he wanted to make it attractive for others to buy from him.

This strategy makes perfect sense for this kind of dealer. The dealer, working in an investment bank, did not see any customer order flow and was consequently uninformed about events like portfolio or sentiment shift. Given that he did not have any superior information, there was little reason for him to trade at others' quotes, which would cost him half the spread. Instead, he made money by making markets, selling on the high ask price and buying at the lower bid price. This explains his high incoming trade share. Furthermore, to make money on the spread, it is necessary to price competitively in order to attract trades, so he controlled his inventory by shading his quote instead of submitting market orders to brokers, for example. Finally, as he attracted large dealers with his competitive pricing, he also had to make sure to protect himself against an unfavorable information position.

This strategy would not necessarily work for a well-informed dealer with large customer flow. First, she would be willing to pay half the spread to make use of the customer's information quickly. Second, because she had a relationship with the Lyons dealer, she was probably happy trading with a competitive and (relatively) uninformed market maker.

Other dealers could, of course, have chosen to trade with the voice brokers. With the broker the dealer had more options. She could have placed a market order with the broker, but if she was well-informed there was always a risk of information leakage. Besides, direct trading was often the preferred channel when trading either very large or odd sizes. An alternative could be to post a limit order with the broker. First, she could choose whether she wanted to give two-way quotes (bid and ask) or only one-way quotes (bid or ask). If she knew whether she wanted to buy or sell, for example, because she was well-informed or for inventory control, she would give a one-way quote. Furthermore, timing is another important distinction between direct and indirect trades. In an incoming direct trade, the dealer does not decide when to trade. In an incoming *in*direct trade, there is a timing decision because the dealer decides when to place the limit order with the broker.

On the other hand, voice brokers are quite expensive to trade with. With many voice brokers, both the liquidity provider (the limit order dealer) and the aggressor have to pay commission, whereas with direct trading on the D2000-1 the only cost incurred is the fixed rental cost to Reuters for the keystation.

What were the consequences of the introduction of electronic direct trading through D2000-1? Probably not very extensive. As mentioned earlier, D2000-1 merely replaced the telephone as the tool for direct trading. The fact that it was more efficient, both for the dealer and for the back office, *might* have led to a decrease in the order processing cost of the spread and, hence, lower spreads. More efficient trading could also have allowed more trading, which again could have resulted in a more liquid market. In a more liquid market, meaning one in which it is easier to trade without a price impact, the risk of taking on a trade is lower because it is easier to get rid of as well, and the inventory part of the spread may also have decreased. There is insufficient foreign exchange spread data available to allow anything precise to be said about this. We do know from market participants that spreads decreased during the late 1980s, but the main reason might have been increased competition between the banks and a more liquid market due to more active customers.

IV. ELECTRONIC BROKERS

Electronic brokers collect orders from screens connected together in a network and match the orders, hence letting the screens represent a more centralized marketplace. As such they are perfectly suited to a decentralized market in need of efficient matching. The foreign exchange market, with its decentralized structure and quickly growing volumes, was also among the early adopters of electronic brokers.[4] Subsequently, many equity markets also adopted electronic brokers.

Today there are two electronic brokers in the interbank market. The first, Dealing 2000-2, was introduced by Reuters in April 1992. The D2000-2 system comes bundled together with the previously mentioned direct system, D2000-1. A year later, in April 1993, Minex was launched by Japanese banks, with EBS (Electronic Broking Services) following in September 1993. The EBS Partnership was established by several major market making banks to counter the dominant role of Reuters, and EBS acquired Minex in December 1995 and thereby gained a significant market share in Asia. Figure 2a shows the Dealing 2000 screen, which consists of both D2000-1 and D2000-2,[5] whereas Figure 2b shows the EBS screen.

[4]The government bond markets, another decentralized market sharing many properties with foreign exchange markets, was even earlier in adopting electronic brokers.

[5]Reuters Dealing 2000 was replaced by Dealing 3000 in 2000.

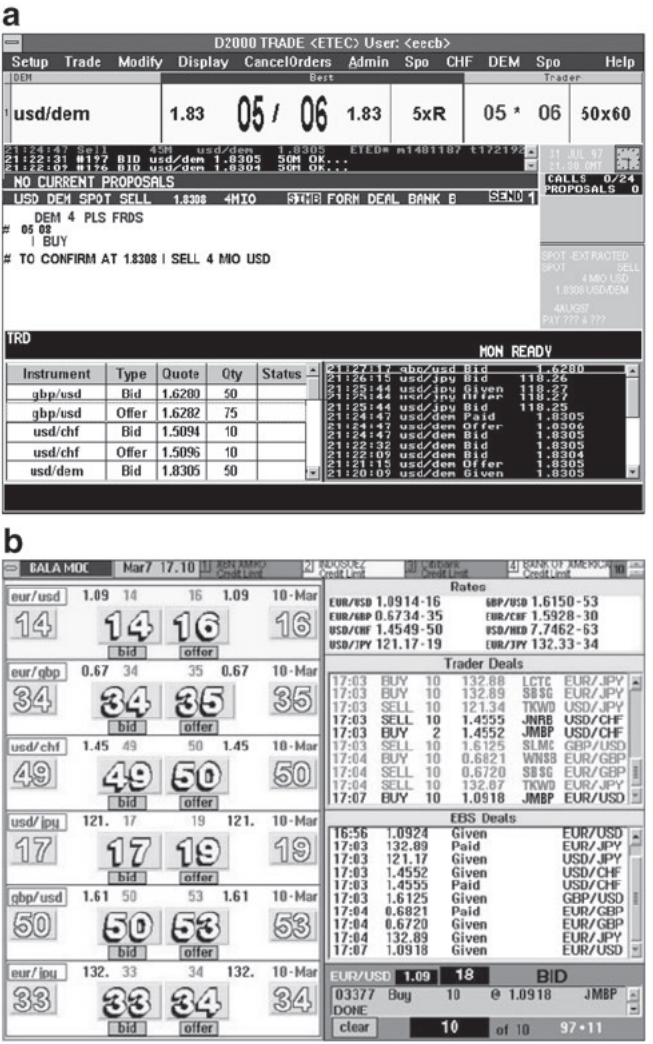

Figure 2 Electronic trading screens. (a) Reuters Dealing 2000. This screen shows the Reuters Dealing 2000 system. The part in the middle contains the D2000-1 system for direct bilateral trading, and the top section is the D2000-2 electronic broker. The dealer may choose the contents of the screen. The dealer may choose which exchange rates to display in the electronic broker and whether to display the best prices in the market (column marked best) and/or the best available to him (from credit-approved banks only). From the D2000-1 part we can see that the dealer has been contacted for a quote for USD 4 million against DEM. The dealer replies with the quote "05 08", which is understood to be bid 1.8305 and ask 1.8308. The contacting dealer responds with "I BUY," and the system automatically fills in the line "TO CONFIRM AT 1.8308. . . ." In the lower right corner of the screen, the dealer can see the price and direction of the last trades through the D2000-2 system. (b) EBS. The left half of the EBS screen shows the bid and offer (ask) prices. The dealer chooses which exchange rates to display (the base currency is written first). The prices shown are either the best prices in the market or the best available (from credit-approved banks only). The upper part of the right half of the screen shows the dealer's own trade. The lower part shows the price and direction of all trades through the system for selected exchange rates. "Given" means that it was traded at the bid price, and "paid" means it was traded at the ask price. The intuition is that the limit order dealer is "given" the base currency (buys).

The electronic brokers work in a manner similar to voice brokers; they actually offer speakers as well. When a limit order is entered, there is first a price priority to ensure that it is always the best prices that are traded on and then a time priority (price–time priority). Market orders are given priority according to time of entry, and the system matches the counterparties automatically.[6] As with voice brokers, the entry of orders is anonymous, but both parties see the counterparty's identity immediately after the trade.

Electronic brokers differ from voice brokers in three respects, and we will come back to each later on. First, electronic brokers offer a higher level of transparency. Second, the fee structure makes electronic brokers cheaper. Finally, electronic brokers match orders much more efficiently, at least for liquid standardized instruments. Table 4 compares spot volumes and shares of interbank spot volumes for direct trading, electronic brokers, and voice brokers. Initially, electronic brokers took market shares only from the voice brokers, but later direct trading also lost market share to electronic brokers. Today electronic brokers constitute the main trading channel in the interbank market. In Japan, electronic brokers had almost three times more $/€ spot trading than D2000-1 in April 2001 and twice as much ¥/$ spot trading.

A. Transparency

The introduction of electronic brokers has definitely led to higher transparency in the market. First, dealers can see the price and sign of all trades, not just the ones that the voice broker manages to announce. Hence, post-trade transparency is higher. Second, it is easier to follow the evolution of several exchange rates, so price transparency is higher. The dealer decides which exchange rates to display on the screen. Furthermore, even if the dealers cannot see the whole order book, they do have more pretrade information with electronic brokers than with voice brokers. In the top right-hand part of the D2000 screen, and at the side of the bid and offer (ask) on the EBS screen, the dealers can see the best bid and ask prices for trades larger than 10 million. Although this means higher transparency, the information is not particularly useful. As can be seen from the EBS screen, all figures here are equal to the best bid and ask prices. In periods with high liquidity, spreads can be more or less constant up to 10 million, as can be seen from the 16:00 o'clock graph in Fig. 3b.

[6]Electronic brokers therefore are also called automatic matching or electronic matching systems.

Table 4

Interbank Spot Volume and Volume on Different Interbank Trading Systems[a]

		United Kingdom		United States		Japan	
		Volume	Share (%)	Volume	Share (%)	Volume	Share (%)
2001	Interbank spot	107	31	56	39	28	23
	Voice broker, spot					1	5
	Electronic broker, spot	72	67	44	79	13	48
	Direct (telephone/ D2000-1)					13	47
1998	Interbank spot	180	34	72	42	47	43
	Voice broker, spot	9	5	15	21	5	10
	Electronic broker, spot	70	39	46	64	17	37
	Direct (telephone/ D2000-1)	101	56	11	15	25	54
1995	Interbank spot	146	42	82	59	43	36
	Voice broker, spot	51	35	35	43	11	25
	Electronic broker, spot	23	16	14	17	5	12
	Direct (telephone/ D2000-1)	71	49	33	40	27	63
1992	Interbank spot	115	50	95	77	48	52
	Voice broker, spot	53	46	32	34		
	D2000-1	55	48	39	41	39	81
1989	Interbank total	161	88	116	93	78	70
	Total broker	71	44	57	49	41	52

[a]Source: BIS (1990, 1993, 1996, 1999, 2002). All volumes are corrected for local double-counting. The interbank spot share is the share of the interbank volume as defined earlier. The share of each system is the share of the interbank spot volume. The direct share for 1995, 1998, and 2001 (Japan only) is the interbank spot volume less the broker volumes. The electronic broker number for the United Kingdom in 2001 is only approximate, based on interviews by BoE with dealers and brokers. Empty cells are due to missing data, but there is reason to believe that spot volumes of voice brokers in 2001 were small. Electronic brokers were introduced after the 1992 survey.

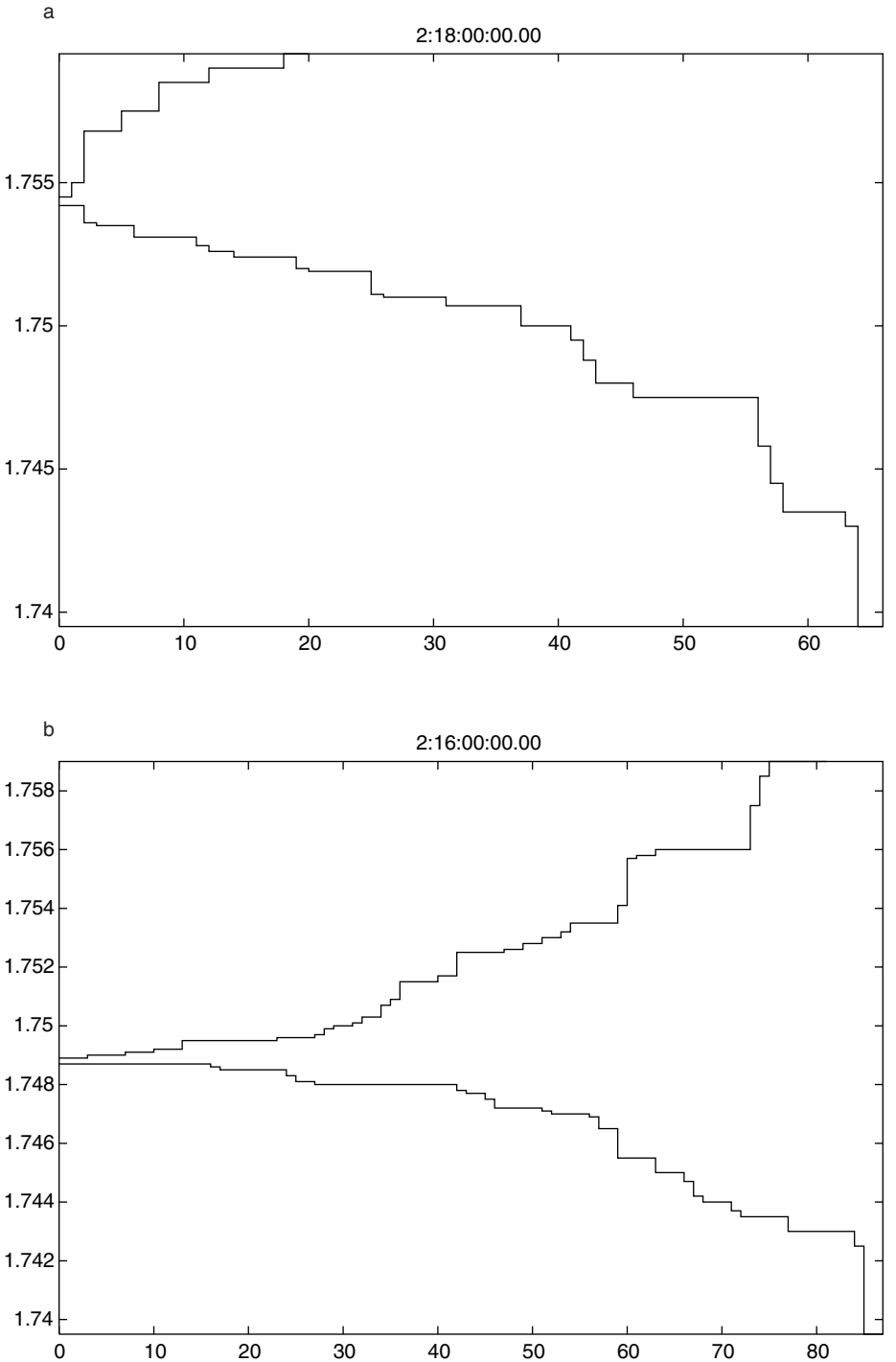

Figure 3 The order book at D2000-2. Source: Danielsson and Payne (2002). The graphs show the "depth" at one point in time at the electronic broker Reuters D2000-2.

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Figure 3a shows the whole order book on D2000-2 at 18:00 one day in October 1997. The market is much deeper at the bid (lower curve) than at the ask (upper curve).[7] If a dealer wants to buy 10 million with a market order he, will "walk up the book" ("lift the ask") so that the first part of his 10 million will be filled at the lowest ask and then subsequently at higher prices.[8] The dealer cannot see these curves, but on the electronic broker screens he would see that the ask prices for sizes larger than 10 million are (much) higher than the best ask. So when entering his market order for 10 million, he knows approximately what his average price will be. This information would not be available with voice brokers.

The economic impact of higher transparency may be a more informationally efficient market, i.e., exchange rates that reflect available information better. Richard Payne (2003) and William Killeen *et al.* (2001) have studied the information content of order flow through D2000-2 and EBS, respectively. Both studies find a permanent effect on exchange rates due to order flow. This implies that order flow aggregates relevant information because, if the effect was temporary, it would mean that the information lost value, which can hardly be a property of truly relevant information.

Because electronic brokers do not see geographical borders like voice brokers, they might be more effective in aggregating dispersed information. All participating banks are on an equal footing, and from Table 5 we see that the cross-border share of interbank spot trading has increased. This positive aggregation effect could be counteracted by fragmentation of the trading process because there are two electronic brokers. Fragmentation is unfortunate because there is a positive externality if all flow is concentrated in one system; both liquidity and information aggregation improve. However, before the introduction of electronic brokers, the market for indirect trading was probably more fragmented, as the voice brokers were both more regional in their coverage and more numerous. Furthermore, the market has settled the fragmentation problem already: EBS is dominant in $, €, and ¥ trading, whereas D2000-2 dominates in £ and smaller currencies.

Reuters and EBS report having installed 7000 and 2500 keystations, respectively. In terms of volume, EBS is probably the larger given its dominant position in the largest markets. Reuters probably has more keystations installed because almost all banks want the D2000-1 part that comes with the Dealing 2000 system.

[7]This kind of picture is not unusual at this time of day after the European markets have ceased their most active trading ("closed"). The similar picture from 16:00 in Fig. 3b when both Europe and New York are active shows almost similar depth at both the bid and the ask.

[8]If the dealer is selling, his market order will be "hitting the bid," i.e., first selling at the highest bid and subsequently at lower prices.

Table 5
Interbank Share and Cross-Border Share of Total Spot Volumes (%)[a]

	Interbank share				Cross-border interbank spot			
	1992	1995	1998	2001	1992	1995	1998	2001
United Kingdom	77	75	83	68	68	67	66	75
United States	73	57	49	56	58	61	60	73
Japan	76	74	80	83	68	70	69	73
Singapore		79	73	80	79	74	83	87
Germany		84	82	79	87	87	83	87
Switzerland		85	80	70	76	81	84	78
Hong Kong		86	85	85	75	81	80	85
France	80	78	81	74	77	79	79	82
Canada	74	61	71	64	82	72	79	87
Netherlands	85	76	64	64	80	87	86	92
Sweden	68	74	60	47	85	87	97	94
Denmark	80	87	79	75	77	92	92	93
Norway	78	62	83	86	75	83	94	96
Finland		78	71	55		89	98	97
Austria	81	55	75	76	85	92	94	98
Belgium	72	74	44	58	85	85	79	89
Greece		64	55	39	58	73	76	96
Ireland	88	84	83	77	94	91	90	96
Italy	73	70	70	75	79	85	84	92
Spain	93	91	86	43	78	80	86	93

[a]Source: BIS (1990, 1993, 1996, 1999, 2002). Interbank share of total volume and cross-border share of interbank spot volume. For almost all countries, the cross-border share of interbank spot volume has increased. For a majority of the countries, the interbank share has decreased.

The increased transparency probably represents the greatest progress for the foreign exchange market. At first glance, it might seem optimal to have a perfectly transparent market. But then informed dealers do not have incentives to participate, and hence less information will be aggregated. Furthermore, higher transparency makes it more risky to take on large trades from customers because it is more difficult to offset the trade before the rest of the market is aware of it. As suggested in Section III, inventory control after the customer trades is very important in the foreign exchange market. However, the transparency of the interbank foreign exchange market prior to electronic brokers was so low that in this case the improvement in transparency is probably welfare improving. And there are no signs that dealers do not want to trade using the electronic brokers, despite the higher transparency. As Table 4 shows, the volume and share of trading have been increasing since their introduction.

B. Liquidity

There seems to be some disagreement as to whether the electronic brokers have improved the liquidity of the market. In a quote-driven market, liquidity is provided on demand, i.e., when the market maker is contacted (direct trading, like D2000-1). The market maker might be reluctant to trade, perhaps because of high volatility, and therefore demands a wide spread, but if he follows the norms of the market, immediacy will be supplied. In an order-driven market, immediacy will not be supplied unless the liquidity provider, the limit order submitter, finds it beneficial. Voice brokers used to call market makers to get them to enter limit orders in such situations, but electronic brokers can hardly make such calls.

In a survey by the Federal Reserve Bank of New York in 1998, market participants expressed concerns that the electronic brokers were replacing not only voice brokers but also market makers (direct trading). They also believed that electronic brokers would lead to less two-way (both bid and ask) quoting in periods of distress and, hence, lower liquidity. Entering of a limit order on an electronic broker is an free option given to the market, and this option increases in value with volatility. Judging from Table 4 electronic brokers have also taken market share from direct trading, so the concern of less market making may be justified.

It would be wrong, however, to conclude that liquidity is lower due to the adoption of electronic brokers. Alain Chaboud and Steven Weinberg (2002) have found that there are no changes in volatility in the period from 1987 to 2001. And the fear of a shortage of limit orders on both the buy and sell sides of the market applies more to markets with lower liquidity initially. The currencies traded through electronic brokers were those that were most liquid before the introduction of electronic brokers.

Electronic brokers may actually prove more liquid than direct market making trading in periods of distress. This is because with the electronic brokers more dealers are exposed to informed traders. Thus, the dealers share the disadvantage of trading with better informed dealers, whereas in direct trading the market maker must carry the disadvantage alone.

Furthermore, the comparison is not completely fair. Both the voice brokers and direct trading have a stronger regional focus, whereas electronic brokers are not aware of borders or established relationships. Electronic matching is much more efficient, and without the regional focus electronic brokers can attract liquidity more easily than voice brokers and direct trading. Consequently, the potential for liquidity is much greater with electronic brokers.

Gabriele Galati links the fall in volume from 1998 to 2001, seen from Table 3, partly to the introduction of electronic brokers.[9] With the increased price transparency offered by electronic brokers, there is less need for dealers to trade to know where the market price is trading at the moment. Of course, the regional voice brokers could have filled that role (they do announce prices), but the global electronic brokers do it so much better. And more efficient matching means that there is less need for the hot potato trading mentioned earlier as a means of sharing risk. Electronic brokers are particularly apt for the kind of risk sharing we see in the interbank market. Table 5 also shows that the interbank share of trading has decreased in most of the countries, consistent with less hot potato trading. The fall in volume has come without any increase in volatility, implying that electronic brokers maintain a level of liquidity at a lower level of volume than the previous market structure.

C. Transaction Costs

Dealers choose to trade through the electronic brokers instead of voice brokers despite the increased transparency, because of more efficient matching, higher execution speed, and lower transaction costs. Commissions are lower for electronic brokers than for voice brokers. On the electronic brokers only the aggressor (market order) pays commission, and in the case of Reuters D2000-2 the commission is $25 independent of order size. The presence of a competitor probably keeps commissions low as well. After all, EBS was started as a challenge to Reuters' dominant position. Commissions for voice brokers are often paid by both parties and increase with size. However, voice brokers often charge individual commissions, so some dealers may find that for small orders voice brokers are cheaper. Lower commissions together with more efficient order processing reduce the order processing cost element of the spread.

Because dealers share the disadvantage of trading with better informed counterparties with other dealers when trading on brokers, the information component may also have decreased. The more liquid the broker, the stronger this sharing. More efficient matching makes inventory control easier, which decreases the inventory element of spreads. Furthermore, the flexibility and liquidity of electronic brokers make inventory control cheaper in a subtle way. Back in 1992, the Lyons dealer mentioned earlier could control inventory by placing a market order (direct or indirect) and

[9]The other reasons Galati invokes are consolidation within the banking and corporate sector and increased risk perception after the Asian crises in 1998.

paying half the spread, by shading quotes, or by placing a limit order with a (less liquid) voice broker. The dealers studied by Bjønnes and Rime in 1998 used a different strategy: they placed limit orders *at* the best bid when they wanted to increase inventory (buy) and thereby avoided the cost of "shading" to induce trade in their preferred direction. In calm periods, brokers' liquidity was so good that they did not have to improve upon the best prices in order to control inventory.

Finally, because the dealer can decide on the time of submission of limit orders, there is more scope for active timing that is not available with incoming direct trades. A dealer who wants to buy immediately, e.g., in order to utilize information, can either submit a market order at the best ask or enter a limit order that improves the best bid. Of course this kind of "shading" is a signal to the rest of the market, but so is a market order. The advantages are that the dealer does not pay commissions on the limit order and that she may trade at a better price than with a market order. This strategy makes the spread tighter, especially because it is seldom the same dealer that submits both best bid and best ask.

The decrease in spreads should not be exaggerated. Spreads were also small in 1992 according to the study by Lyons (three pips), whereas evidence from electronic brokers shows spreads around two pips. Charles Goodhart *et al.* find that the average spread in both dmark/$ and $/€ was between 2.5 and 3 pips using data from 1997 and 1999, respectively. In the meantime volume also increased, so that the direct impact of electronic brokers as such is difficult to evaluate. For customers and small banks the gains are significant, however. Small banks did not have access to tight spreads earlier, and higher price transparency has enabled customers to have a more precise view of spreads in the interbank market, which has led to smaller spreads for customers.

To this should be added the suggestion that the effective spread in $/€ may be higher than that for dmark/$ because the electronic brokers are rigidly set at four decimals. Because a typical dmark/$ exchange rate was 1.8 and the typical $/€ rate is somewhat below parity, each pip is more valuable. The electronic brokers so far have set the quote at 4 decimals, but perhaps 5 decimals should have been used.

D. The Future of Direct Trading and Voice Brokers

So far electronic brokers have taken market share from both voice brokers and direct trading. This does not mean that voice brokers and direct trading will disappear from the market. Electronic brokers are most suitable for very liquid markets, and the foreign exchange market is much more

than $/€. Many smaller currencies are not traded on electronic brokers because their markets are not liquid enough. And in periods of distress, some direct trading may be wanted because then there are always trading possibilities, whereas the liquidity of electronic brokers may diminish during such periods. The release by EBS of a direct trading product called EBSTrader constitutes further evidence. Furthermore, it is no means sure that a purely electronic broker market would be optimal. The results are mixed (see Larry Harris, 2002).

Voice brokers too have a role in the market. In less liquid currencies they can use their knowledge of positions to track down counterparties. Voice brokers are also moving into less liquid derivatives. Instead, what we can expect to see is more derivative trading through electronic brokers. Forwards were introduced on the D2000-2 in 1997, and attempts are being made to set up electronic brokers, independently of Reuters and EBS, for options trading.

E. Policy Implications

What are the consequences for the authorities? Increased transparency is also beneficial for the authorities. Several central banks have electronic brokers installed and use them for market monitoring, among other things.[10] Electronic brokers may prove useful for secret interventions, given pretrade anonymity and matching without human interventions and possible information leakages as with voice brokers.

If we come to a situation where the majority of interbank trading is directed through the two electronic brokers, the systems may also prove useful in attempts to regulate the foreign exchange market. By regulating brokers and requiring banks to use only regulated electronic brokers, the way could be opened for implementing trading halts, for example. Another possibility is to collect a transaction tax ("Tobin tax") through the electronic brokers.

Will we see electronic brokers with open limit order books, i.e., so that dealers can see the curves in Figure 3? Many equity markets have introduced this. Some equity markets have done it to counter competing trading venues and thereby attract liquidity. For the sake of argument, we leave the question of competing trading venues like Internet sites for customers for the next section.

[10]A questionnaire survey of central bank use of electronic brokers has been conducted for this chapter. Many central banks required confidentiality for their replies, which prevents us from being specific.

In the foreign exchange market, an open limit order would be a giant leap with respect to transparency. So far transparency has evolved endogenously and at a rather low level. Reuters and EBS will probably not open the book unless the users, the banks, want it. Interbank trading is very much about inventory control because the customer orders are so much larger than the ordinary interbank transaction. Opening the book as in equity markets would make it much more difficult to control inventory because it would be harder to hide one's trading intentions.

Even if an open book could improve efficiency, it is by no means certain that regulators should try to implement it. The increased inventory costs could feed back to customer spreads because it becomes more risky to take on large positions.

V. INTERNET TRADING

Internet trading represents a possible structural change in the bank–customer relationship. Through the 1999s, customers' trading was an important source of both income and information for banks. Internet trading has made the customer segment much more competitive and may increase the transparency of customers' trading, thereby changing the information role of customers. In this section we discuss the evolution of customer trading, the consequences of Internet trading, and what may lie ahead.

In the early 1990s, customers' access to information on interbank market activity was low, and they were relatively loyal to their banks. Customers requested quotes from banks over the telephone. A Reuters service called FXFX provided customers with information on interbank prices, but spreads on FXFX were much wider than in the interbank market. The midpoint was quite accurate, though. Banks used this screen as an advertising channel to customers. In this period, customer trading was very profitable for banks.

During the 1990s, price transparency for customers increased, partly as a result of electronic brokers that made interbank transaction prices easier to collect and publish on-line. This, together with a increasing concern on the part of customers about noncompetitive terms and being locked in with their banks, led customers to start shopping around at several banks for quotes. The customer segment became more competitive.

A. The Emergence of Nonbank Customer Trading

In the mid-1990s several Electronic Communication Networks (ECNs) were set up in the United States as alternative trading venues for equity

trading. In these markets, customers were also concerned about noncompetitive pricing by their brokers trading on the NYSE and NASDAQ, and they could often get better terms with the ECNs. In the same spirit, CMC started Deal4Free, the first nonbank Internet site for customer trading, in May 1996. Later, several nonbank Internet sites were established for customer-to-customer trading, such as IFX Markets (1999), MatchbookFX (September 1999, closed down in 2000), HotSpotFX (February 2001), OANDA (March 2001), and ChoiceFX. Most of these systems are organized as crossing networks, but they try to resemble electronic brokers. Crossing networks are trading systems that obtain their prices from another trading venue; hence, there is no price discovery. However, some, like CMC's Deal4Free, are more like traditional direct trading with their own price discovery, whereas some, like ChoiceFX, depend on limit orders from customers (like an electronic broker).

Most of the independent sites start up as crossing networks because they cannot expect to get sufficient limit orders to create a viable market. Some of them, like Deal4Free and IFX, operated as market makers prior to the Internet and provide some liquidity on their own. The sites mimic electronic brokers, but most often the site is counterparty to all trades. This suits customers because they do not want to take the counterparty risk themselves, but on the other hand they could be concerned that the site may not take sufficient account of their needs as the site also trades on its own. The sites can be counterparty to all transactions because customers must place a margin account with the sites and because they control the matching. Some of the sites probably hope to some day have sufficient liquidity, i.e., limit orders, to have a true exchange, but many are happy being crossing networks. It is important to note that crossing networks are dependent on the interbank market (primary market) and therefore cannot replace it. They can attract a lot of customers from the banks, however, and thereby influence the interbank market.

Transparency differs from site to site. ChoiceFX is very similar to the interbank electronic brokers, whereas HotSpotFX, ChoiceFX, and MatchbookFX (before cease of business) show the whole order book. Knowledge of the whole book is useful even in a crossing network for two reasons: first, it may give a signal on marketwide customer flow, and second, it may be useful for timing of trading.

Whether nonbank sites will be a major force depends on whether they give competitive terms. In many cases they do not. The interbank spread for volumes of €1–5 million is two pips, and the customer spread could be three to five pips for good customers. Some of the nonbank sites advertise these kinds of spreads, but then for one-tenth of the volume. The focus for many nonbank sites is the small customers, and they might be competitive

in this subsegment, but they will not be a major force. That does not mean that their presence does not influence the competition for customers; it does.

B. Internet Trading with Banks

Banks' initial response to the nonbank Internet trading sites for customers was to establish their own customer sites. In these sites, pricing is still given on request, but the administration of orders is easier for both customers and banks. The first network-based trading opportunity offered to customers by a bank was a closed network called FX Connect, introduced by State Street in August 1996. The introduction of the bank-independent Currenex, which started trading in April 2000, was a turning point. This was the first multibank site, meaning that several banks were invited to provide prices. Immediately afterward, FX Connect opened up its system to other dealers as liquidity providers. FXall followed with their first trading in May 2001, established initially with seven major banks as owners in June 2000. The last addition was Atriax, started in December 2000 and backed by Reuters and three of the biggest banks. The big four sites quickly became FXConnect, Currenex, FXall, and Atriax, but Atriax was later closed down in early April 2002. More details on the four multibank sites are provided in Table 6.

According to a survey made by TowerGroup in March 2002, volumes traded through banks' Internet portals are still limited. FX Connect by State Street is the largest with $6 billion as a daily average for March 2002. FXall was second with $1.5 billion and Currenex was third with $1.1 billion, whereas Atriax had $0.3 billion (just before they closed down). The volume of banks' proprietary customer sites was estimated to be $5.5 billion aggregated. This should be compared with the total volumes of other financial institutions ($329 billion) and nonfinancial customers ($156 billion) from the most recent survey by BIS. The total Internet *bank* volume of $14.4 billion is small, so far, compared to the traditional volume. The aggregate volume of the nonbank independent portals is probably lower. Euromoney reports strong growth for these sites since and reports $10 billion and $4 billion on normal days in November 2002 for FX Connect and FXall, respectively.

The lack of convincing success (several portals have closed down already) is probably related to the facts that (i) many customers are worried about security with Internet-based trading (FX Connect started as a closed network) and (ii) the portals are struggling with high costs, as true straight through processing (STP) is expensive to install. STP means that the trades

Table 6
Overview of Multibank Internet Trading[a]

	Atriax	Currenex	FXall	FX Connect
Shareholders	Three banks, Reuters, employees	VC firms, one corporate, one bank, employees	Fourteen banks	State Street
First public trading	June 28, 2001	April 27, 2000	May 10, 2001	April 2000 (1996)
Transaction fee	Paid by price makers	Both counterparties	Paid by price makers	Paid by price makers
Numbers of banks competing	Unlimited	Unlimited	Unlimited	Up to 5
Pricing	Request for quote	Request + streaming prices (auto–manual feed)	Request + streaming prices	Request for quote
Real-time streaming firm prices		Yes	Yes	No
Number of currencies	43	160	Unlimited	Unlimited
Number liquidity providers	About 70	45	53	34
Number of customers	300 (approximately)	200 (approximately)	Undisclosed	425
Customer type	Corporates 50%, investors 50% (est.)	Corporates 75%, investors 25%	Corporates 40%, investors 60%	100% investors

[a]Source: Euromoney, FXWeek, and companies' web pages. Atriax ceased business in April 2002. Number of liquidity providers mean banks providing prices.

enter directly into the customers' systems without any manual work. In a survey by Euromoney after the demise of Atriax, a majority believed that there would be only two multibank portals within a short time. Which of the three remaining big ones will disappear is difficult to say from banks' practices. Today most banks participate in two or three of the multibank portals in addition to running their own (single-bank) portal.

So far the main consequence of Internet trading is limited to transaction costs for customers. As Table 6 shows, requesting quotes, as in market making, as opposed to trading through brokers is still the most common. Compared with earlier practice, multibank portals enable the customer to obtain quotes from more banks, more efficiently, and this increases the competition. With pricing on request, customer order flow will still be private information held by banks. With an electronic broker for customers, as with interbank brokers, customer trading would, to a lesser extent, be private information. More recently, at least two of the portals have started working with structures more similar to those of crossing networks, with prices feeding into the system automatically.

C. Possible Scenarios

Lyons (2002) suggests three possible scenarios with regard to the bank–customer relationship. In the first, Internet trading proves so successful that banks lose their entire customer trading. Hence, interbank trading will also vanish because customer trading is the primary reason for interbank trade in the first place. Because there is a positive externality with centralized trading, a network benefit, a centralized electronic broker that reaps all network benefits will probably emerge. Customers trade with each other, while the banks act as legal middlemen for the counterparties in the settlement of the trade. Lyons believes that a centralized electronic broker would be more efficient in providing liquidity than the current dealership structure, where dealers, acting as market makers, fill orders from their own inventory. The reason for this is that the risks associated with such trading are high, and the efficient matching performed by electronic brokers makes them very efficient for risk sharing. Furthermore, the banks have an advantage in settling the trades because they are better at credit management. This centralized electronic broker will offer much higher transparency than there is at present, but customer order flow will still be informative.

The second scenario is a continuation of the current state of affairs, with banks having all customer trading. In this scenario, banks give customers favorable terms so as to keep away the competition from nonbank sites.

Banks are willing to do this because they are able to profit from the information in their customer order flows.

In the final scenario, one of the interbank electronic brokers allows customers to trade alongside dealers. If a nonbank site acquired considerable liquidity, the owners of EBS, one of the interbank electronic brokers, could open their system to customers and offer much higher liquidity than their nonbank competitor. In this scenario, the banks again would be middlemen between customers. This third scenario implies higher transparency than there is in today's structure, but unless the electronic broker in which customers participate is an open one, customer order flow will remain private information because one cannot tell identities from the electronic brokers. Information about marketwide order flow will be much better, however.

Of these scenarios, the second, the continuation of the current bank–customer structure, is most likely. If the first were about to emerge, the third scenario would certainly put a stop to it. However, of the three scenarios, it is the second that the banks prefer. They would rather keep information about their customer flows private than share it. So banks quote tight spreads to customers, keep the nonbank sites at a low level, and gain by their informational advantage. We see that this is how FXall and FX Connect are set up: price competitively, so as to gain customer flow and keep the nonbank sites away, but within a dealership structure so as to keep the customer order flow private information.

Let us end this section by drawing attention to the CLS Bank mentioned in the Introduction. Currently, banks are better at handling counterparty risk than nonbank sites. Because only banks can participate in the CLS Bank, this system will give banks an even larger advantage in handling counterparty risk, making it even more difficult for nonbank sites to attract large flows.

VI. SUMMARY

In this chapter, we have discussed the possible consequences of electronic trading in foreign exchange markets. The first electronic trading system in the foreign exchange market was the Reuters D2000-1 system for direct trading. Its contribution was merely to replace trading over the telephone or telex and to make direct trading more efficient. The impact on the market structure as such was small.

In 1992 electronic brokers were introduced. They quickly took market shares from the traditional voice brokers, because of their lower costs. At the end of the 1990s, they also took market shares from direct trading. Their main advantage is the very efficient matching they offer, which is so impor-

tant for controlling risk in foreign exchange markets. Their introduction has made the market more transparent and, thus, hopefully also more efficient, but this is hard to test. When it comes to liquidity provision, the interbank market is still a hybrid market. However, it is more transparent, more centralized, more effective in matching, and with a shift of focus from market making to order books. When it comes to consequences for volatility and transaction costs, the effect of electronic brokers seems to be modest. Transaction costs have not changed much since 1992, and volatility has stayed more or less the same. In the coming years, we expect to see more derivative trading on electronic brokers.

Internet trading is relatively recent in the area of foreign exchange. Independent Internet sites have challenged the banks' relationship with customers and made competition for customers stiffer, with lower transaction costs for customers as a result. Will these nonbank Internet sites be able to take over banks' dominant position as liquidity providers to customers? Most likely not. The banks believe that customer order flow is important private information and, hence, are willing to fight for it. Furthermore, they have the necessary means to win the war. At the moment the bank-based Internet sites have more liquidity and are pricing competitively so as to keep the nonbank sites out of the main market. If this does not succeed, they can let customers into the interbank market. We will most likely see a consolidation of Internet sites in the future as the site with highest liquidity reaps the network effects and becomes dominant. This site will have liquidity provided by several banks. This might lead to an increase in customer flow transparency, but should not alter the private information nature of customer trading.

It is important to note that the structure of the foreign exchange market has evolved endogenously with the banks in the driver seat. The structure and previous changes in structure have probably been beneficial for the banks. Do the private interests of banks go hand in hand with public interest? One could of course argue that the market should be regulated, that trading should be more transparent, etc., but it is not certain that this would lead to a welfare improving outcome. Transaction costs are low for customers too, and the market has implemented new systems that make trading more efficient in handling the peculiarities of foreign exchange. However, volumes are also extremely large in the foreign exchange market, making the amounts used on transaction costs considerable, and the efficiency of foreign exchange rates, or the lack thereof, is an open question. The introduction of electronic trading has made the market more centralized and, hence, more accessible to regulation. Regulation of foreign exchange markets is no longer a utopia and should be considered.

A. WEB SITES ON TRADING AND NETWORKS

As of Dec. 31st 2002:

1. Academic sites
   a. Nicholas Economides' site for network economics (www.stern.nyu.edu/networks/site.html).
   b. Ian Domiwitz' page for trade automation (www.smeal.psu.edu/faculty/ihd1/automation.html).
2. Interbank trading systems
   a. EBS (www.ebs.com).
   b. Reuters D3000 (about.reuters.com/products/dealing3000/index.asp).
   c. Reuters D3000 and D2000 (about.reuters.com/transactions/tran00m.htm).
3. Multibank Internet trading
   a. FXall (www.fxall.com). Supported by 55 banks. Voted best in Euromoney's 2002 FX poll, second in market share. Started trading in May 2001; tradable prices are fed automatically into the system from other systems.
   b. Currenex (www.currenex.com). Owned by nonbank investors. Trading started in April 2000.
   c. FX Connect (can be reached through www.globallink.com). Initially a closed system owned by State Street, now an Internet platform where 33 banks participate. Rated first in market share in Euromoney's 2002 FX poll. Opened up to other banks in March 2000.
   d. Centradia (www.centradia.com).
4. Single-bank Internet trading[11]
   a. Citigroup's CitiFX (www.citifx.citibank.com). Trading occurs at daily fixings on prices from EBS and Reuters.
   b. Goldman Sachs (fx.gs.com).
   c. Dresdner Kleinwort Wasserstein's Piranha FX (www.drkw.com/online/fx).
   d. Deutsche Bank's db markets (www.deutsche-bank.de/tradingproducts_e.htm with further links to db markets).
   e. Credit Suisse First Boston's PrimeFX (www.csfb.com/primetrade/index.shtml and www.csfb.com/fixed_income/pdf/PrimeFX.pdf).
   f. Canadian Imperial (www.fxdealing.cibc.com).

[11]These pages are usually for registered customers only. The list here contains only those that have some information for nonregistered customers.

5. Nonbank sites for Internet trading
   a. HotSpotFX, on-line trading (www.hotspotfx.com). A system that resembles an electronic broker, but for customers.
   b. IG Markets, on-line trading (www.igforex.com).
   c. OANDA (fxtrade.oanda.com). Test the trading platform with virtual money.
   d. FXDealerDirect (www.fxdd.com). Direct trading software for the retail market.
   e. DealStation (www.mgforex.com). Direct trading.
   f. GAIN Capital (www.gaincapital.com). Internet electronic broker.
   g. ChoiceFX (www.choicefx.com).
   h. CMC's Deal4Free Forex (www.deal4free.com/forex). Direct trading. Voted best independent nonbank platform in Euromoney's 2001 Internet Awards.
   i. GFT's DealBookFX (www.gftforex.com/products/dealbookfx).
   j. GCI (www.gcitrading.com).
   k. CMS (www.cms-forex.com).
   l. IFX Markets (www.ifxmarkets.com).
6. General information
   a. Yahoo (dir.yahoo.com/Business_and_Economy/Shopping_and_Services/Financial_Services/Investment_Services/Brokerages/Currencies/Internet_Trading).
   b. Business.com (www.business.com/directory/financial_services/investment_banking_and_brokerage/brokerage_firms/foreign_exchange_brokers).
   c. Euromoney magazine (www.euromoney.com). All but the four latest issues are free to the public, including their FX poll.
   d. FXStreet (www.fxstreet.com). A portal to on-line brokers.
   e. FXlinks (www.fxlinks.com). A portal to trading and analysis.
   f. FXWeek magazine (www.fxweek.com). Lots of useful links, surveys of banks, and bank revenues.
   g. The Money museum (www.moneymuseum.com). A web site of Olsen & Associates.
   h. The Foreign Exchange Committee of Federal Reserve Bank of New York (www.newyorkfed.org/fxc/fxc.html).
7. Continuous Linked Settlement (www.cls-services.com)
8. FXNet (www.fxnet.com)

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