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Microstructure Theory and the Foreign Exchange Market

A GROWING BODY OF theoretical literature, known as the study of securities market microstructure, deals with the behavior of participants in securities markets and with the effects of information and institutional rules on the economic performance of those markets. These institutional factors may arise from technology, tradition or regulation. Microstructure and its impact are important, because of the vast amounts of wealth which pass through securities markets — including the foreign exchange market — every day.

Microstructure is of interest to students of the foreign exchange market: microstructural analyses of other markets have yielded insight into traders' behavior and the effect of various institutional arrangements. Conversely, the foreign

exchange market is also of special interest to students of microstructure, because it combines two very different arrangements for matching buyers and sellers — bank dealers trade with one another both directly and through foreign exchange brokers.¹

Standard models of exchange-rate determination concentrate on relatively long-run aspects, such as purchasing power parity. While microstructure theory cannot address these issues directly, it can illuminate a more narrowly focused array of institutional concerns, such as price information, the matching of buyers and sellers, and optimal dealer pricing policies. Despite the substantial literature on microstructure, little attention has been paid to the particular microstructure of the foreign exchange market.²

¹Similar arrangements exist for other securities—for example, the federal funds market and the secondary market for Treasury securities—but these too have been relatively neglected in the literature.

²The shaded insert on the opposite page provides a context in which the microstructural approach can be compared with more traditional approaches to market efficiency.

Following some early articles by Demsetz (1968), Tinic (1972) and Tinic and West (1972), Garman (1976) performed the crucial task of defining market microstructure as an independent area of the literature, thus focusing the debate. Since then, market microstructure has burgeoned, led by Cohen, Maier, Schwartz and Whitcomb (1978a, 1978b, 1981, 1983), Amihud and Mendelson (1980, 1986, 1988), Stoll (1978, 1985, 1989) and Ho and Stoll (1980, 1981). See also Beja and Hakansson (1977), Cohen, Hawawini, Maier, Schwartz and Whitcomb (1980), Cohen, Maier, Ness, Okuda, Schwartz and Whitcomb (1977), Amihud, Ho, and Schwartz (1985), Schreiber and Schwartz (1986), Schwartz (1988) and Cohen and Schwartz (1989).

Cohen, Maier, Schwartz and Whitcomb (1979, 1986) and Stoll (1985) have surveyed the microstructure literature.

In addition to the early note by Allen (1977), very recently there have appeared some microstructural studies of the foreign exchange market: Bossaerts and Hillion (1991), Lyons (1991), Rai (1991) and Flood (1991). There is also an empirical literature measuring the determinants of the bid-ask spread in the foreign exchange market. See Black (1989), Wei (1991) and Glassman (1987) as well as the references therein. Because the focus of this article is on microstructure theory, such empirical studies receive little attention here.

Finally, although a consideration of the results of laboratory experiments would expand the scope of this paper to unwieldy dimensions, their role in establishing the sensitivity of market behavior to institutional factors must at least be acknowledged; see Plott (1982, 1991) for an introduction.

Price Efficiency in a Heterogeneous Marketplace

Implicit in most microstructural models is a presumption that participants in any given market are heterogeneous, that is, that they differ in certain key determinants of economic behavior: information, beliefs, preferences and wealth. Although this assumption consumes little attention in the microstructure literature — it is taken for granted — it is valuable to discuss it in the more familiar theoretical context of market efficiency.

The standard definition of price efficiency is: $f_m(p_t|I_{m,t-1}) = f^*(p_t|I_{t-1})$. In other words, the joint distribution over future prices, $f_m(p_t)$, as assessed by the monolithic market (or a representative agent in that market) and made conditional on the current information, $I_{m,t-1}$, available to the market is equal to the "true" joint distribution, $f^*(p_t)$, made conditional on all current information, I_{t-1} . Roughly speaking, the market sorts things out as accurately as possible.¹

This approach breaks down in a microstructural analysis. First, the simplifying assumption of homogeneous participants is abandoned. Although it is widely recognized "that investors do not show the homogeneity of beliefs which characterize our theories," the benefits of realism (i.e., the heterogeneity assumption) are often outweighed by other criteria (e.g., testability, tractability, etc.).² Emphasizing testability, Ross offers a standard rejoinder, namely that "since a single *ex post* distribution of returns is observed by all, over time one would not expect to observe systematic and persistent differences." This is a rational expectations argument, which depends crucially on the stationarity of the returns distribution and which ignores the effect of differences in opinions and beliefs, which go beyond differences in information.

In general then, at the level of detail involved in microstructural studies, the homogeneity assumption is not an excusable flaw; in a homogeneous market why — let alone how — would anyone trade?

More fundamentally, the notion of a "true" price must be questioned. In the context of the literature on price efficiency, the introduction of a "true" distribution as a theoretical conceit leads to joint testing problems, as the "true" distribution is *ipso facto* unobservable. More fundamentally, positing a "true" distribution confuses the chain of causality; it presumes that future prices are drawn from some exogenous probability distribution and that investor behavior is concerned with accurately estimating that distribution.

In fact, investor behavior in the marketplace determines the distribution of future prices, not the other way around. This fact in no way depends on the ultimate basis or motivation for investor behavior. In an explicit model of price discovery, the assertion of an *ex ante* exogenous equilibrium price is meaningless. As Schreiber and Schwartz put it, "the fact that security analysts assess the value of a stock for their own portfolios does not imply that they undertake a treasure hunt to find some golden number which one might call an intrinsic value."³ In sum, the standard theory of efficient markets is ill-suited to the modeling of price discovery. In comparing observed prices to an imputed "true" distribution, studies of market efficiency ignore more immediate concerns — for example, how well the institutional structure transmits information, whether arbitrage opportunities occur, and how well the market allocates assets among investors. These concerns are the focus of microstructural analysis.

¹See Fama (1976), chapter 5, for the definitive presentation.

²See Ross (1978), pp. 889-90. See Varian (1989) for a more thorough review of the theoretical issues involved in the heterogeneity assumption.

³See Schreiber and Schwartz (1985), p. 22.

This paper examines the extant literature on market microstructure to determine how it might be applied to the foreign exchange market.

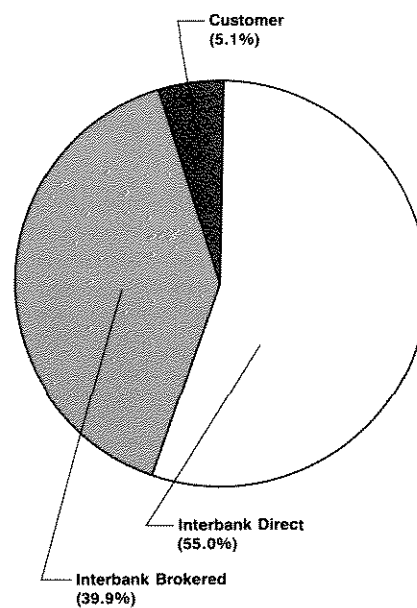
The paper begins with a brief description of the foreign exchange market. Aspects of the literature concerned with institutional details are addressed second, noting how such details can affect the performance of the market. Next, the literature dealing with behavioral details, especially the communication and interpretation of price information, is considered. Finally, the interaction of institutional and behavioral factors, notably the bid-ask spread, is discussed.

INSTITUTIONAL BASICS OF THE FOREIGN EXCHANGE MARKET

The foreign exchange market is the international market in which buyers and sellers of currencies "meet."³ It is largely decentralized: the participants (classified as market-makers, brokers and customers) are physically separated from one another; they communicate via telephone, telex and computer network. Trading volume is large, estimated at \$128.9 billion for the U.S. market in April 1989. Most of this trading was between bank market-makers.⁴

The market is dominated by the market-makers at commercial and investment banks, who trade currencies with each other both directly and through foreign exchange brokers (see figure 1).⁵ Market-makers, as the name suggests, "make a market" in one or more currencies by providing bid and ask prices upon demand. A broker arranges trades by keeping a "book" of market-maker's limit orders — that is, orders to buy (alternatively, to sell) a specified quantity of foreign currency at a specified price — from which he quotes the best bid and ask orders upon request. The best bid and ask quotes on a broker's book are together called the broker's "inside spread." The other participants in the market are the customers of the market-making banks, who generally use the market to complete transactions in international trade, and central banks, who may enter the market to move ex-

Figure 1
Spot Market Volume by
Transactor (4/89)



change rates or simply to complete their own international transactions. Market-makers may trade for their own account — that is, they may maintain a long or short position in a foreign currency — and require significant capitalization for that purpose. Brokers do not contact customers and do not deal on their own account; instead, they profit by charging a fee for the service of bringing market-makers together.

The mechanics of trading differ substantially between brokered transactions and direct deals. In the direct market, banks contact each other. The bank receiving a call acts as a market-maker for the currency in question, providing a two-way quote (bid and ask) for the bank placing the call. A direct deal might go as follows:

Mongobank: "Mongobank with a dollar-mark please?"

(Mongobank requests a spot market quote for U.S. dollars (USD) against German marks (DEM).)

³For more thorough descriptions of the workings of the foreign exchange market, see Burnham (1991), Chrystal (1984), Kubarych (1983) and Riehl and Rodriguez (1983).

⁴See Federal Reserve Bank of New York (1989a) and Bank for International Settlements (BIS) (1990). Extending this figure over 251 trading days per year, this implies a trading volume of roughly \$32 trillion for all of 1989. Volume

has roughly doubled every three years for the past decade.

⁵Federal Reserve Bank of New York (1989a) lists 162 market-making institutions (148 are commercial banks) and 14 brokers; an earlier study, Federal Reserve Bank of New York (1980), lists 90 market-making banks and 11 brokers.

Loans 'n Things: "20-30"

(Loans n' Things will buy dollars at 2.1020 DEM/USD and sell dollars at 2.1030 DEM/USD—the 2.10 part of the quote is understood.)

Mongobank: "Two mine."

(Mongobank buys \$2,000,000 for DEM 4,206,000 at 2.1030 DEM/USD, for payment two business days later. The quantity traded is usually one of a handful of "customary amounts.")

Loans 'n Things: "My marks to Loans 'n Things Frankfurt."

(Loans n' Things requests that payment of marks be made to their account at their Frankfurt branch. Payment will likely be made via SWIFT.)⁶

Mongobank: "My dollars to Mongobank New York."

(Mongobank requests that payment of dollars be made to them in New York. Payment will most likely be made via CHIPS.)⁷

Spot transactions are made for "value date" (payment date) two business days later to allow settlement arrangements to be made with correspondents or branches in other time zones. This period is extended when a holiday intervenes in one of the countries involved. Payment occurs in a currency's home country.

The other method of interbank trading is brokered transactions. Brokers collect limit orders from bank market-makers. A limit order is an offer to buy (alternatively to sell) a specified quantity at a specified price. Limit orders remain with the broker until withdrawn by the market-maker.

The advantages of brokered trading include the rapid dissemination of orders to other market-makers, anonymity in quoting, and the freedom not to quote to other market-makers on a reciprocal basis, which can be required in the direct market. Anonymity allows the quoting bank to conceal its identity and thus its intentions; it also requires that the broker know who is an acceptable counterparty for whom. Limit

orders are also provided in part as a courtesy to the brokers as part of an ongoing business relationship that makes the market more liquid. Because his limit order is often a market-maker's first indication of general price shift, Brooks likens the posting of an order with a broker "to sticking out the chin so as to be acquainted with the moment that the fight starts."⁸ Schwartz points out that posting a limit order extends a free option to other traders.⁹

A market-maker who calls a broker for a quote gets the broker's inside spread, along with the quantities of the limit orders. A typical call to a broker might proceed as follows:

Mongobank: "What is sterling, please?"

(Mongobank requests the spot quote for U.S. dollars against British pounds (GBP).)

Fonmeister: "I deal 40-42, one by two."

(Fonmeister Brokerage has quotes to buy £1,000,000 at 1.7440 USD/GBP, and to sell £2,000,000 at 1.7442 USD/GBP)

Mongobank: "I sell one at 40, to whom?"

(Mongobank hits the bid for the quantity stated. Mongobank could have requested a different amount, which would have required additional confirmation from the bidding bank.)

Fonmeister: [A pause while the deal is reported to and confirmed by Loans 'n Things] "Loans 'n Things London."

(Fonmeister confirms the deal and reports the counterparty to Mongobank. Payment arrangements will be made and confirmed separately by the respective back offices. The broker's back office will also confirm the trade with the banks.)

Value dates and payment arrangements are the same as in the direct dealing case. In addition to the payment to the counterparty bank, the banks involved share the brokerage fee. These fees are negotiable in the United States. They are also quite low: roughly \$20 per million dollars transacted.¹⁰

⁶The Society for Worldwide Interbank Financial Telecommunication (SWIFT) is an electronic message network. In this case, it conveys a standardized payment order to a German branch or correspondent bank, which, in turn, effects the payment as a local interbank transfer in Frankfurt.

⁷The Clearing House for Interbank Payments System (CHIPS) is a private interbank payments system in New York City.

⁸See Brooks (1985), p. 25.

⁹See Schwartz (1988), p. 239.

¹⁰See Burnham (1991), p. 141, note 16, and Kubarych (1983), p. 14.

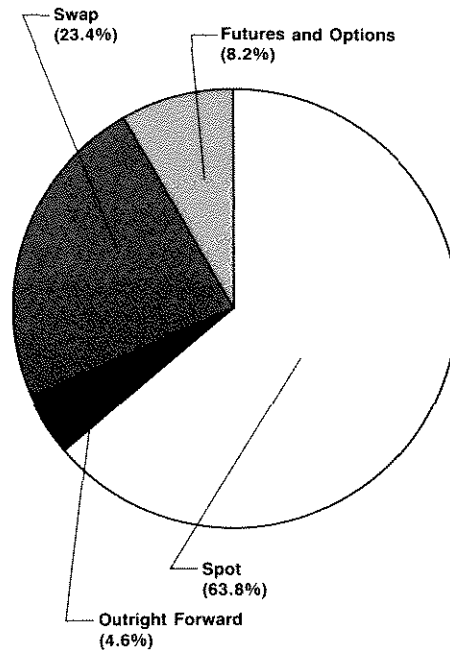
The final category of participants in the foreign exchange market is the corporate customers of the market-making banks. Customers deal only with the market-makers. They never go through brokers, who cannot adequately monitor their creditworthiness. Typically, a customer transacts with a bank with which it already has a well-established relationship, so that corporate creditworthiness is not a concern for the bank's foreign exchange desk, and trustworthiness is not an issue for the customer. The mechanics of customer trading are similar to those of direct dealing between market-makers. A customer requests a quote, and the bank makes a two-way market; the customer then decides to buy, sell or pass. The chief difference between this and an interbank relationship is that the customer is not expected ever to reciprocate by making a market.

Participants in the foreign exchange market also deal for future value dates. Such dealing composes the forward markets. Active forward markets exist for a few heavily traded currencies and for several time intervals corresponding to actively dealt maturities in the money market. Markets can also be requested and made for other maturities, however. Since the foreign exchange market is unregulated, standard contract specifications are matters of tradition and convenience, and they can be modified by the transacting agents.

Forward transactions generally occur in two different ways: outright and swap. An outright forward transaction is what the name implies, a contract for an exchange of currencies at some future value date. "Outrights" generally occur only between market-making banks and their commercial clients. The interbank market for outright is very small, because outright trading implies an exchange rate risk until maturity of the contract. When outright are concluded for a commercial client, they are usually hedged immediately by swapping the forward position to spot. This removes the exchange rate risk and leaves only interest rate risk.

A swap is simply a combination of two simultaneous trades: an outright forward contract and an opposing spot deal. For example, a bank might "swap in" six-month yen by simultaneously buying spot yen and selling six-month forward

Figure 2
Market-Maker Volume by Type (4/89)



yen. Such a swap might be used to hedge an outright purchase of six-month yen from a bank customer.¹¹ In effect, the swapping bank is borrowing yen for the six months of the outright deal. The foreign exchange market-maker swaps in yen — rather than simply borrow yen on a time deposit — because banks maintain separate foreign exchange and money market accounts for administrative reasons. Swapping is generally the preferred means of forward dealing (see figures 2 and 3).

In practice, the vast majority of foreign exchange transactions involve the U.S. dollar and some other currency. The magnitude of U.S. foreign trade and investment flows implies that, for almost any other currency, the bilateral dollar exchange markets will have the largest volume. Consequently, the dollar markets are the most liquid. The possibility of triangular arbitrage enforces the law of one price for the cross rates. The upshot is that liquidity considerations outweigh transaction costs. A German wanting

¹¹Hedging an outright purchase of currency with an opposing swap deal still leaves an open spot purchase of the currency. This can be easily covered in the spot market.

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