



Electronic Trading in Financial Markets

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Trading financial instruments has historically required face-to-face communication at physical locations. The Nasdaq over-the-counter market for stocks was one of the first markets where technology replaced physical interaction. Subsequently, most stock exchanges in the world, such as those in London, Tokyo, and Frankfurt, moved to electronic trading. The largest exchange in the world (by market capitalization), the New York Stock

Technological innovations such as electronic communications networks bypass human intermediaries, increasing competition and reducing transaction costs.

Exchange, still uses physical trading, but has introduced systems to let retail and institutional investors engage in electronic trading.

Innovations in computing and communications make possible global electronic order routing, broad dissemination of quote and trade information, and new types of trading systems. These innovations eliminate the need for direct person-to-person contact via trading floors or telephone networks. New technol-

ogy reduces the costs of building new trading systems, lowering the entry barriers for new competitors. Finally, improvements in communications technology enable faster order routing and market data transmission to a much larger group of participants. The growth in electronic trade execution systems on an international basis has been explosive, and new stock markets are almost exclusively electronic. A publication by M. Fan et al. provides a broad overview of how technology is

impacting financial markets (M. Fan et al., "Electronic Commerce and the Revolution in Financial Markets," South-Western College Pub., 2001). A book by L. Harris offers details on issues relating to financial markets' operations. (L. Harris, "Trading and Exchanges: Market Microstructure for Practitioners," Oxford University Press, 2002). The "Definition of Terms" sidebar explains several terms that this article discusses.

OVERVIEW OF ELECTRONIC MARKET STRUCTURES

A trading system's market structure includes the set of rules governing its trade execution mechanism and the amount of price and quote data it releases. Many diverse market structures exist. Three generic market structure types are

- a continuous limit order book,
- a single-price auction, and
- a trading system with passive pricing.

In an electronic limit order book, traders continuously post bids and offers on the system for other participants to view. A limit order is an order to buy a specified quantity of a security at or below a specified price, or sell above a specified price. The order book displays orders and typically ranks them by price and then by time. Figure 1 shows an example of the limit order book for Island, which is one of the largest electronic trading systems. Limit orders to buy are on the

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left side, and orders to sell are on the right, with each order's price and quantity displayed. The order book lists buy orders by descending price and sell orders by ascending price, with orders at each price highlighted in a different color. The highest-price bid is \$24.05, and the lowest-price offer is \$24.06, meaning the spread between the best buy and sell prices is 1 cent. For each security, the top 15 orders on each side of the book are continuously available on Island's Web site (<http://www.island.com>).

A limit order book does not typically display the user's identity, the order's entry time, or the period for which the order is good. A participant either initiates a trade with an order already on the order book or places a new limit order in the book. If a bid or offer is in the book and a participant enters an order on the other side of the market at the same price or better, the limit order book automatically and immediately matches the orders, and a trade occurs. The book can match incoming orders against more than one existing order.

In a single-price auction system, participants may submit bids and offers over a period of time, but the system executes all trades together at one price, at a single point of time. The system normally calculates the transaction price to maximize the total volume traded, given the bids and offers residing in the system. Bids and offers with prices at least as good as the system-calculated price are processed into trades, subject to a set of priority rules. This structure has variations, depending on order type and order information display.

Some electronic trading systems determine trade prices by explicitly referring to other markets' pricing and sales activity. We refer to such trading systems, which have no independent price discovery mechanism and whose prices are taken directly from a primary market, as *passive* or *derivative* pricing systems. Some systems allow for the possibility of price improvement by assessing market conditions in the underlying market and then pricing their trades at a price better than the best quote on the underlying market available at the time of the order entry. Prices may vary through the trading session—if the system operates at the same time as its associated primary market—or may be fixed at a single level, such as the closing price for an after-hours trading session. A system may base trade execution on different secondary priorities than those present in the primary market. The brokerage and trading services company ITG operates the largest passive pricing system—called POSIT—which traded 7.7 billion shares in 2002 and

Definition of Terms

A financial market is a communications system facilitating transmission of pre- and post-trade information, order routing, matching, execution, trade clearing, settlement, and custody.

A trading system's programming instantiates specific rules regarding allowable messages that participants can send and receive and the type of information displayed. The system transmits pre- and post-trade data about quotes and trades



to market participants.

Order routing is the act of sending orders from their originators, primarily investors and broker-dealers, to the execution system.

Order matching and execution is a transaction algorithm that translates orders into trades, which consist of transaction prices and quantities.

Clearing and settlement is the process of exchanging the seller's shares for the buyer's cash.

Figure 1. Island's limit order book.

refresh island home disclaimer help			
GET STOCK			
MSFT	go		
SYMBOL SEARCH			
LAST MATCH		TODAY'S ACTIVITY	
Price	24.0510	Orders	37,864
Time	13:15:23.745	Volume	6,972,147
BUY ORDERS		SELL ORDERS	
SHARES	PRICE	SHARES	PRICE
1,000	24.0500	5,000	24.0600
100	24.0500	2,000	24.0700
2,100	24.0320	4,000	24.0700
2,650	24.0240	500	24.0770
2,500	24.0240	300	24.0780
1,000	24.0220	700	24.0790
4,500	24.0210	1,000	24.0800
2,000	24.0200	2,600	24.0900
2,500	24.0200	3,000	24.0900
300	24.0100	2,000	24.0900
1,000	24.1000	1,000	24.0900
200	24.1000	750	24.0900
200	24.1000	1,200	24.0990
45	24.1000	5,400	24.0990
6,000	24.1000	100	24.1000
(498 more)		(587 more)	

ELECTRONIC TRADING

has been growing at an annual rate of about 50 percent. POSIT prices its trades at the midpoint of the bid/offer spread (the difference between the lowest asking price by a seller and the highest bid from a buyer) in the stock's primary market at the moment the match is run. Eight times daily—at 9:40 a.m., 10 a.m., and 10:30 a.m., and on the hour from 11 a.m. to 3 p.m.—POSIT compares and matches all buy and sell orders confidentially. If an imbalance exists between buy and sell orders, the system randomly selects orders on the excess side to match the number of orders on the smaller side. Orders that the system does not select do not execute.

THE GROWTH OF ELECTRONIC COMMUNICATIONS NETWORKS

The Securities and Exchange Commission (SEC) defines the biggest electronic trading systems, electronic communications networks (ECNs), as “electronic trading systems that automatically match buy and sell orders at specified prices” (<http://www.sec.gov/answers/ecn.htm>). The SEC describes ECNs as integral to the modern securities markets, and in August 2002 ECNs accounted for approximately 40 percent of volume in Nasdaq securities. The most common ECN structure is similar to the electronic limit order book dis-

cussed earlier. Several ECNs are currently registered in the NASDAQ system: Attain, Archipelago, Brass Utility, Bloomberg Tradebook, Instinet, Island, NexTrade, and Track.

ECNs' automated communication and matching systems have led to lower trading costs. By matching buyers and sellers directly, ECNs bypass human intermediaries such as dealers, reducing their profits. Dealers on the New York Stock Exchange and the Nasdaq have average operating margins of approximately 50 percent and 25 percent, respectively. ECNs offer other traders the opportunity to undercut these margins, increasing competition and reducing transaction costs.

ECNs also offer faster trade execution. Their leading-edge technology allows significantly faster order execution than established market centers' trading systems. For example, the average execution time for an ECN is two to three seconds, compared with more than 20 seconds for an order through an exchange. Furthermore, ECNs typically provide investors with more complete price information than traditional market centers by allowing them to see the ECN's limit order books. This information allows investors to better assess market conditions and optimize their trading strategy.

By displaying only the price and size of an order, ECNs provide trader anonymity. Anonymity is potentially important for informed institutional investors, because less-informed traders may attempt to copy their strategy. In addition, if other market participants can obtain prior or contemporaneous knowledge of transactions, they may attempt to trade before the institutional investors can complete their trades, a practice known as front running. In financial markets, any sort of front running or information leakage is a serious concern.

ECNs offer brokers and their customers access to their limit order book. Typically, ECNs first attempt to match customer limit orders within the ECN. When ECNs find an internal match, the trade executes immediately. Some of the larger ECNs such as Instinet and Island match more than 70 percent of their order volume internally. When they do not find internal matches, ECNs offer subscribers several options. The subscriber can leave the limit order on the ECN's book, cancel the order, or route the order to another ECN or market.

ECNs compete with each other by targeting different clienteles and following various strategies. Some ECNs such as Island use only limit orders and are destination-only ECNs, meaning orders do not leave the ECNs until they are canceled, regardless of whether or not they could execute somewhere else. If a match is not found, the ECN posts the order on the Nasdaq as soon as it becomes the ECN's best quote, and waits for an incoming order to trade at its price. Other ECNs take market orders (orders to buy or sell a stock immediately at whatever is currently the best available price) and limit orders and, if an internal match is not available, route them to the Nasdaq in search of the optimal price. These outbound-routing ECNs actively seek out-



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Nasdaq's Communication Network

SuperMontage increases transparency across Nasdaq, provides new order entry tools to facilitate complex trading strategies, and improves Nasdaq's order execution. The SuperMontage display in Figure A lists each market participant by moniker with its best bid and ask price and then the number of hundreds of shares available at those prices; the columns on the left are sorted by bid price, and the columns on the right by ask price. SuperMontage includes the traditional information provided by Nasdaq of the best price by market participant, but also allows participants to post orders at three prices. Market participants can also post orders anonymously with these orders. They are aggregated together and listed under the "SIZE" moniker. SuperMontage also allows traders to directly factor ECNs into their order-routing decisions.

Although SuperMontage is a large step forward for Nasdaq and lets users trade directly with one another more quickly than before, it does not offer all of the functionality that ECNs do. SuperMontage does not allow orders to be conditional upon one another—for example, having one order cancel if another executes. SuperMontage does not allow direct negotiation between traders. Also, SuperMontage does not provide

Figure A. Nasdaq's SuperMontage.

post-trade anonymity for traders. The SIZE moniker allows pretrade anonymity; but, unlike trades on ECNs, the clearing and settlement process for SuperMontage trades reveals trader identities.

side liquidity. If the national best bid or offer, the best price available across all markets, is from another market, an outbound-routing ECN sends its orders there. Interestingly, outbound-routing ECNs are some of the best customers of destination-only ECNs.

ECNs differentiate themselves in other ways. Outbound-routing ECNs employ proprietary methods/algorithms to select the market center that is likely to provide the best combination of speed, quality, price, and certainty of execution for its customers. Other ECNs batch orders for short periods and conduct regular "call markets" to establish a stock price, as described earlier in the single-price auction system. ECNs also vary in the manner and type of information they provide investors, with some posting all or part of their limit-order books on Internet sites such as Island, while others provide limited access to price information. These various approaches to price discovery, execution, and information dissemination attract diverse clients with wide-ranging trading needs.

For their services, ECNs charge fees that subscribers pay directly and nonsubscribers pay indirectly. For subscribers, these fees include a fixed component, the cost of purchasing the ECN terminal and line feed, and a per-share fee for execution. ECN subscribers typically submit limit orders without charge, but pay an access fee of 0.1 cent to

2 cents per share for orders that execute against a standing ECN limit order. To encourage depth in the limit order book, some ECNs charge a fee if an incoming order immediately executes against the limit order book. In Island's case, the execution fee is 0.19 cent per executed share; a 0.11 cent rebate per executed share is paid if a limit order does not execute immediately and subsequently executes against an incoming order.

Competition from the ECNs forced Nasdaq to change the way it operates. Its solution is SuperMontage, which the "Nasdaq's Communication Network" sidebar describes. SuperMontage and the ongoing innovations by ECNs continually change the competitive environment and have led to a complex array of competing markets for US equity trading. Wall Street firms have at times taken ownership in many of these markets simultaneously. These relationships provide ECNs with capital, order flow, and legitimacy.

ELECTRONIC SYSTEMS IN MARKETS OTHER THAN EQUITIES

The foreign exchange (FX) and bond markets provide an interesting contrast to stock markets. These have traditionally been dealer markets that operate over the telephone. No physical location exists, and trading is done directly by pairs of dealers or with the help of brokers that

intermediate between them. In recent years, portions of the foreign exchange market rapidly moved to electronic trading. In contrast, the bond market has been slow to change and is still largely a telephone market.

The enormous volume of foreign exchange—\$1.5 trillion a day—has traditionally been a multiple-dealer market. In such a market, trade transparency is low and a large amount of trading volume and trades between dealers account for close to two-thirds of the activity. Historically, this activity was telephone based. Then Reuters and EBS developed two major electronic systems for providing quotes. Initially, trades were still conducted over the telephone. Not surprisingly, these systems later developed into full trading platforms, allowing trade execution. In 1995, 25 percent of trading was conducted electronically. By 1998, this had risen to 50 percent, and it is expected to continue rising. Although FX trading between dealers has largely become electronic, trading between large corporations and dealers remains telephone based. Several electronic platforms now disseminate quotes and allow trading, but their volume is not yet substantial. The interdealer market's move toward electronic trading, coupled with the corporate market's continued use of telephone-based trading provides an interesting dichotomy.

Traditionally, the structure of bond markets has been similar to that of foreign exchange markets, with secondary trading in government, municipal, and corporate bond markets occurring over the telephone with multiple dealers. US Treasury securities trading is around \$200 billion per day. In contrast to the FX market, the move toward electronic trading has been relatively slow. In 2000, about 40 percent of US Treasury securities were traded electronically and only 10 percent of corporate bonds were traded electronically. This is not due to a lack of electronic bond-trading platforms: There were 11 electronic trading systems in 1997, 40 in 1999, and more than 80 by 2000.

ARE ELECTRONIC MARKETS INEVITABLE?

Although ECNs have come to play a very important role in equity trading, the FX and bond markets suggest that electronic trading might not be preferable for all investors, types of securities, and market environments. The adoption of electronic information dissemination and execution can reduce the costs of order execution significantly compared to traditional physical exchanges. These reductions come through lower development and operating costs, as well as important liquidity advantages arising from the greater transparency of electronic trading systems

compared with systems relying on human intermediation.

However, for large transactions, many institutions avoid exchanges completely by using the "upstairs market" for institutions trading with one another. This trading of large blocks typically occurs without formally posting limit orders, which is the heart of most electronic trading systems. Instead, institutions do not reveal orders until a party willing to take the opposite side of the transaction is available for a large trade. It is possible that these types of

traders dominate trading in parts of the FX market and the bond market. Electronic systems have tried to develop approaches to automate these more difficult trades, but unless these can be perfected, the adoption of electronic trading systems by existing markets might result in additional trading moving off-exchange. Although technological trends favor the adoption of electronic trading systems and these systems have made great inroads in several markets, until they can replicate all the func-

Until electronic trading systems can replicate all the functions of a floor-based system and human intermediaries, a role remains for floor-based trading.

tions of a floor-based system and human intermediaries, such as dealers, market makers, and specialists, a role remains for floor-based trading.

As technology and ECNs continue to grow and transform securities trading, many issues warrant further exploration. When are electronic markets the most useful in volatile markets? What types of traders use ECNs—more informed institutions or retail investors? Are traders willing to pay more for the speed and anonymity that ECNs provide? How does ECN activity impact existing markets in terms of volatility, trading costs, and market depth? Will these systems enable the full development and adoption of 24-hour global electronic markets? ■

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