

Chapter 2

Introduction to Market Microstructure

Chandrasekhar Krishnamurti

2.1 Chapter Introduction and Objectives

A stock exchange or bourse is a corporation or a mutual organization that provides trading facilities for traders to trade stocks and other securities. The top 12 exchanges have a combined market capitalization running to trillions of dollars. Obviously, investors, corporations, and academics are interested in the design and the functioning of stock markets. In this chapter, we provide an overview of type and design of markets, and price formation and price discovery.

This chapter has the following objectives:

- Define market microstructure
- Discuss market structure and design issues
- Highlight how some of the top exchanges like the New York Stock Exchange (NYSE), NASDAQ, Tokyo Stock Exchange, and London Stock Exchange operate

2.2 What is Market Microstructure?

A common definition of market microstructure is “It is the study of the trading mechanisms used for financial securities.” Professor Maureen O’Hara of Cornell University, an authority on market microstructure, describes market microstructure as “the study of the process and outcomes of exchanging assets under a specific set of rules.”

C. Krishnamurti
AUT University College of Business, WF Building, Wellesley Campus, 42 Wakefield Street,
Auckland 1010, New Zealand
e-mail: Chandrasekhar.krishnamurti@aut.ac.nz

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National Bureau of Economic Research (NBER) defines market microstructure as a field of study that is devoted to theoretical, empirical, and experimental research on the economics of security markets. It includes the role of information in the price discovery process, the definition, measurement and control of liquidity, and transaction costs and their implication for efficiency, welfare, and regulation of alternate trading mechanisms and market structures.

It appears at a superficial level that market microstructure is about designing a superior stock exchange. But market microstructure is much more than that. Market microstructure has broader interest among financial economists, since it has implications for asset pricing, international finance, and corporate finance. A basic premise of market microstructure theory is that asset prices need not reflect full information expectations value due to a variety of frictions. Thus, market microstructure is related to the field of investments, which is concerned with the equilibrium value of financial assets. Market microstructure is also linked to traditional corporate finance, since difference between price and value has the potential to affect financing and capital structure decisions taken by managers. The relationship between market microstructure and other areas of finance is relatively new and is continuing to evolve.

In this chapter, we will take an information economics perspective of market microstructure and summarize current research in the following key areas:

- Market structure and design issues
- Price formation and price discovery
- Information and disclosure
- Market microstructure interface with other areas of finance

2.2.1 Market Structure and Design Issues

In this section, we describe the salient features of the different trading systems that operate in the world today. This would facilitate a critical discussion on market structure and design issues that are critical to an understanding of the price formation process in financial markets. We begin by explaining the various prices, orders, and trading priority rules that are commonly used in market microstructure parlance.

Prices: An ask quotation is an offer to sell at a specific price, the *ask price*. It is also sometimes called the ask price. A bid quotation is an offer to buy at a specific price, the *bid price*. The price at which a transaction occurs is denoted as the *transaction price*. Transaction prices usually occur at previously announced bid or ask quotations but could also occur at a price that is in between the bid and the ask price.

Orders: A public trader gives an order to a broker who acting as the trader's agent directs the order to a market where the trade may be arranged. The trader must specify the exact number of shares to be bought or sold. In addition, the trading instruction should also include the price at which the trade is to be made. Based on how the trader specifies the price of trade, orders may be classified into either *market orders* or *limit orders*.

A *market order* to buy or sell is to be executed at the best price established on the market at a given point in time. For a market order seller (buyer), the best price is the highest (lowest) bid (ask) posted by a potential buyer (seller). A limit buy (sell) order specifies the maximum (minimum) price at which the trader will buy (sell). Price limits for buyers (sellers) are normally placed at prices below (above) the current price at which shares can be bought (sold). Limit orders that do not execute when they are placed remain active on the book until they execute, are withdrawn, or expire. Day orders are automatically cancelled at the end of the trading day. Good till cancelled (GTC) orders remain in the book until they are cancelled.

Market order traders face uncertainty regarding the exact price at which they will transact, but unlike limit order traders they are assured of transacting.

Trading Priority Rules: The Price Priority Rule: With *price priority*, buyers posting higher bids have priority over buyers posting lower bids and sellers posting lower asks have priority over sellers posting higher asks. In addition to price priority, a secondary trading priority rule is often established to specify the sequence to be followed for orders submitted at the same price. With *time priority*, the first order placed is the first to execute. Sometimes a size priority rule is used wherein the largest order is the first to execute. A third alternative is pro rata execution of all orders tied at the same price. Sometimes a class of orders such as public traders is given priority over market professionals.

2.2.1.1 Taxonomy of Trading Systems

Trading systems can be classified on the basis of participants. Using this classification, we have (a) Dealer Markets and (b) Agency Markets. A broker is a trader's agent. A broker does not herself participate in the market but merely matches the order with a counterparty on the other side of the transaction. A dealer on the contrary participates in a trade as a principal.

Dealer Markets

As a principal, a dealer satisfies a public order by buying for her own inventory or by selling from her inventory. In a dealer market, public traders do not trade directly with each other but with a dealer who serves as intermediary. The over-the-counter (OTC) market in the United States is an example of a dealer market.

Agency Markets

In an agency market, public orders are directed to a broker's broker who matches them with other public orders. Market professionals do not participate in trading in an agency market. The Tokyo Stock Exchange (TSE) is an example of a pure agency market. The TSE is established by the limit order book. Floor officials called *Saitoris*

oversee the books and are not allowed to participate in trades as a principal. They only maintain the limit order book and monitor trading activity.

Trading systems can also be classified on the basis of when the participants are allowed to trade. On the basis of this categorization, we have (a) Continuous Markets and (b) Call Markets.

Continuous Markets: A continuous market allows trades to be made at any time during the trading day. In the United States, both the New York Stock Exchange (NYSE) and National Association of Securities Dealers Automated Quotation System (NASDAQ) are continuous trading systems. Both dealer and agency markets can be continuous. In a dealer market, the dealer making the market in a given stock is obligated to maintain a continuous two-sided market for the stock. In an agency market, a continuous two-sided market is maintained by public limit orders that have been entered on the limit order book and/or by floor traders in the crowd.

In a continuous market, traders can observe bid and ask quotations, transaction prices, trading volume during the trading day. This enables them to assess the market conditions before placing their orders. Furthermore, the posting of quotes in a continuous market gives traders the option of placing market orders and ensuring execution of their trades. If a continuous market is orderly, traders have an indication of the prices at which their orders will most likely execute. However, market order trades do not have complete certainty due to limited availability of information and lack of dissemination of information in a timely manner.

Call Markets: In a call market, orders are batched for simultaneous execution at points in time when the market is “called.” Call markets are typically called once or twice during the trading day. Call markets are primarily agency markets and not dealer markets. All order that have accumulated over a period of time are batched and executed simultaneously at the same price. Public orders interact directly with other public orders in the batching process and therefore do not need a dealer to participate as an intermediary. Trading in a call market can be done either by written auction or by verbal auction. On the Paris Bourse, verbal auction is used for the most actively traded issues while a written auction is used for smaller issues. Verbal auctions tend to be more expensive but are more desirable for floor traders who are able to adjust their orders in response to dynamic market conditions.

Traders can submit both limit and market orders in call markets. Market orders transact at whatever prices are established at the calls. In comparison to continuous market’s market order, traders do not have an indication of prices at which their trades are likely to be transacted. In fact, they are not even assured of a transaction. Since call markets normally include a provision that limits the maximum allowable difference from the previously established call price.

An auctioneer (an exchange official) is at the centre of the call. All orders for an issue are directed to the auctioneer when the stock is called. The auctioneer arrives at a clearing price that most closely matches the aggregate number of shares offered for sale with those sought for purchase. Then, all market orders to buy and sell, all limit orders to buy at the clearing price or higher, and all limit orders to sell at the clearing price or lower are executed. In a call market, all the buyers and sellers pay or receive the same price – the clearing price.

The price priority rule is strictly adhered to in call market trading. A secondary priority is also required to deal with issues such as discrete order size and minimum allowable price changes. The opening process at stock exchanges like NYSE and Amex follow a call market system at the opening of the market each day. Exhibits 2.1–2.3 provide the “league tables” of stock exchanges.

Exhibit 2.1 World’s largest stock exchanges based on domestic equity market capitalization

Exchange	USD bn end 2007	USD bn end 2006	% change in USD	% change in local currency
NYSE group	15,651	15,421	1.50	1.50
Tokyo stock exchange	4,331	4,614	−6.10	−12
Euronext	4,223	3,713	13.70	2.60
Nasdaq stock market	4,014	3,865	3.80	3.80
London stock exchange	3,852	3,794	1.50	−0.20
Shanghai stock exchange	3,694	918	302.70	276.80
Hong Kong exchanges	2,654	1,715	54.80	55.20
TSX group	2,187	1,701	28.60	9
Deutsche Borse	2,105	1,638	28.60	15.90
Bombay stock exchange	1,819	819	122.10	97.80
BME Spanish exchange	1,799	1,323	361.10	22.70
National stock exchange of India	1,660	774	114.50	91

Source: World Federation of Exchanges. <http://www.world-exchanges.org>

Exhibit 2.2 Evolution of domestic market capitalization – a regional perspective



Source: World Federation of Exchanges. <http://www.world-exchanges.org>

Exhibit 2.3 Largest exchanges by total value of share trading

Exchange	USD bn end 2007	USD bn end 2006	% change in USD	% change in local currency
NYSE Group	29,910	21,789	37.3	37.3
Nasdaq Stock Market	15,320	11,807	29.7	29.7
London Stock Exchange	10,333	7,571	36.5	26.1
Tokyo Stock Exchange	6,476	5,823	11.2	12.2
Euronext	5,640	3,853	46.4	34.5
Deutsche Borse	4,325	2,737	58	45.2
Shanghai Stock Exchange	4,070	736	452.7	426.6
BME Spanish exchange	2,970	1,934	53.6	41.1
Borsa Italiana	2,312	1,591	45.3	33.6
Hong Kong Exchanges	2,137	832	156.7	157.8
Shenzhen Stock Exchange	2,103	423	397.6	374.1
Korea Exchange	2,006	1,342	49.5	46

Source: World Federation of Exchanges. <http://www.world-exchanges.org>

The New York Stock Exchange

The New York Stock Exchange (NYSE) is the world's largest and most liquid cash equities market in the world. NYSE provides a reliable, orderly, liquid, and efficient market place for investors to buy and sell listed common stocks and other securities. As of 30 April 2008, NYSE's domestic market capitalization exceeded US \$ 14 trillion. More than 2,300 companies are listed on NYSE, including over 400 foreign companies. On an average trading day, about 2.5 billion shares are traded valued at over \$ 121 billion.

NYSE blends various aspects of electronic trading and traditional open outcry, auction market trading. To trade on the trading floor of NYSE, an exchange-issued trading license is required. Only qualified and approved NYSE broker-dealer entities may acquire and hold licenses. The holders of these licenses are either floor brokers or specialists.

Floor brokers represent public orders to buy or sell shares and wish to get the best price for their customers. There are two types of floor brokers on the trading floor: house brokers and independent brokers. House brokers are engaged by brokerage firms that hold accounts for public investors. These market professionals buy and sell securities as an agent for their customers. The majority of independent brokers are "direct access" brokers who deal with institutional investors at low commission rates.

Each stock listed on the NYSE is allocated to a *specialist*, a market professional who acts as a contact point between brokers with buy orders and those with sell orders. Specialists act as auctioneers in the specific stocks they are allocated to trade at a designated location, called a trading post. All buying and selling of a given stock occurs at that location. The specialists are aided by highly sophisticated technology to facilitate their duty to provide a continuous liquid market. NYSE has the capacity

to trade up to 10 billion shares per day. The orders are electronically directed to the trading posts, booths, and hand-held computers on the trading floor in one of the following four ways:

- SuperDOT
- BBSS
- NYSE e-Broker
- NYSE Direct +

SuperDOT (Designated Order Turnaround System): It is an electronic order routing system to direct buy and sell orders to the specialist's workstation at the trading post. SuperDOT handles most of the smaller orders and accounts for more than 95% of all orders.

BBSS (Broker Booth Support System): It is a highly sophisticated computer system that is used to receive orders on the trading floor. The system is linked to the specialist's post and the broker's handheld computer.

NYSE e-Broker: It is a wireless hand-held tool that enables floor brokers to submit and manage quotes and orders. It is also used to track executions and transmit information between the brokers and the customers.

NYSE Direct+: It is a high speed electronic communication system between NYSE member firms and the exchange. It enables immediate execution of customer orders.

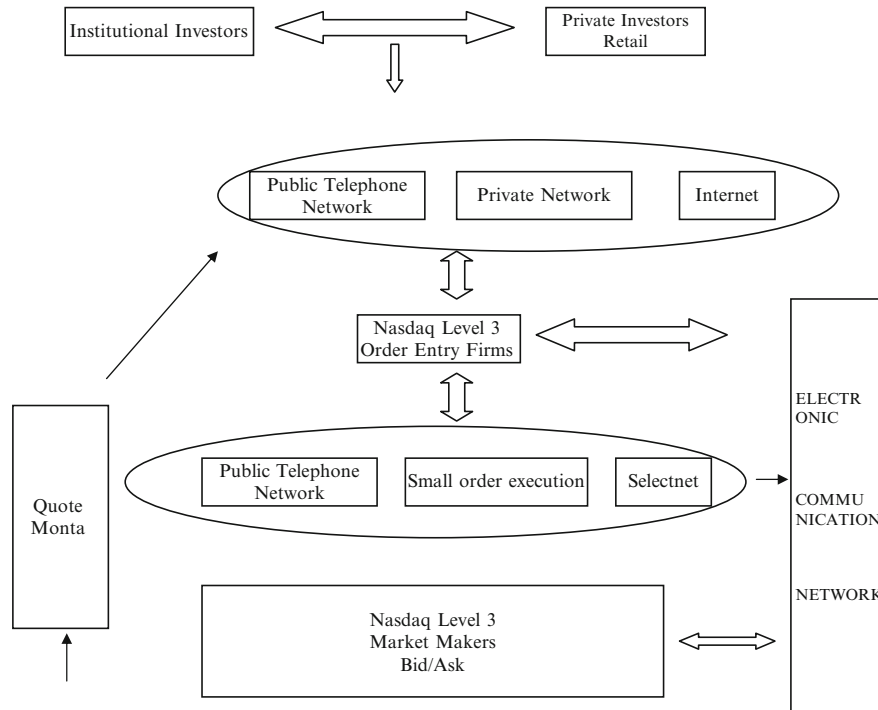
National Association of Securities Dealers Automated Quotation System

NASDAQ is the acronym of the National Association of Securities Dealers Automated Quotation System and has been designed as a dealer market. NASDAQ was created with the intention of enhancing the efficiency of the OTC markets for stocks. In essence, NASDAQ is a telecommunication network linking thousands of geographically dispersed market participants. A pictorial overview of the NASDAQ system is provided in Exhibit 2.4.

NASDAQ has been designed as a dealer market. By providing quotes and therefore liquidity, market makers are the principal players in the NASDAQ market structure. They are independent dealers who actively compete for investor orders by displaying quotes representing their buy and sell interest in addition to customer limit orders. Every market maker has equal access to NASDAQ's trading system, which broadcasts their quotations simultaneously to all market participants. By standing ready to buy and sell shares of a company's stock, market makers provide immediate liquidity to NASDAQ-listed companies. Currently, there are more than 500 market making firms that provide liquidity support for NASDAQ-listed stocks.

NASDAQ market makers are charged with three major tasks. First, they are required to disclose their buy and sell intentions by displaying two-sided quotes in all stocks in which they choose to make a market. Second, they have to comply with the Securities and Exchange Commission's Order Handling Rules (SEC) with respect to displaying quotes and orders. Third, they are obliged to honour their quotes and to report trading in a timely manner. Failure to abide by the rules can lead to disciplinary action.

Exhibit 2.4 The National Association of Securities Dealers Automated Quotation System (NASDAQ)



There are four types of market making firms: (1) Retail market making firms own a retail brokerage network that serve individual investors. The order flow from this segment facilitates liquidity provision for the company's stock; (2) Institutional market making firms specialize in executing large block orders for pension funds, mutual funds, insurance companies, and asset management companies, among others; (3) Regional market making firms focus on both companies and retail investors of a particular region. The regional market maker gives companies and retail investors the benefit of expert in-depth knowledge of stocks of a particular area of the country, providing more extensive coverage than might be available elsewhere; (4) Wholesale market making firms provide liquidity services for institutional clients as well as for other broker-dealers who are not registered market makers in a stock. They provide liquidity for a company's stock by being an important source of trade facilitation for retail, institutional, and regional firms.

NASDAQ contains an automatic execution system for orders of up to 1,000 shares called the Small Order Execution System (SOES). SOES guarantees immediate automatic execution at the best possible bid or offer price available in NASDAQ for all eligible orders even under turbulent market conditions. When an investor places a sell order, SOES would direct the order to the market maker currently offering the best bid price and ensure execution automatically at the best displayed

price. NASDAQ trading information is currently simultaneously broadcasted to more than 500,000 computer terminals worldwide. This allows all NASDAQ participants' equal access to market information. All market makers in the NASDAQ National Market have to mandatorily participate in the SOES.

Another way to place orders on NASDAQ is by using the SelectNet, which works as an email system to enable market makers to negotiate prices among themselves. Through SelectNet, a market maker can either send a stock order to another market maker making a market in that particular stock or broadcast the order to all market makers through NASDAQ's electronic marketplace. A screen-based negotiation feature facilitates market makers to accept, reject, or make counter offers. After the parties have agreed on the terms of a trade, SelectNet locks-in the trade details for clearance and settlement and simultaneously reports the trade. SelectNet is not a matching service. It is merely a tool for routing information.

Tokyo Stock Exchange

Trading on the Tokyo Stock Exchange (TSE) is organized very differently from that prevalent in the NYSE and NASDAQ. There is no designated liquidity provider in TSE. Liquidity on TSE is provided by the combination of a limit order and a mechanism for slowing down the trade process during periods of order imbalances. Liquidity is organized by the *Saitori* on the TSE who is the counterpart to the specialist on the NYSE. It is the responsibility of the *Saitori* to maintain the public limit order book and to govern the trade process. The *Saitoris* do not trade for their own account. They match market and limit orders, issue warning quotes when trade execution results in price changes that exceed exchange-prescribed maximum variation limits. Trading is halted when order execution would result in price changes that exceed exchange mandated daily price limits. Daily price limits and maximum price variation limits depend on the price level of the stock and are shown in Exhibits 2.5 and 2.6.

The daily price limits for most stocks are quite large in percentage terms and are therefore rarely hit. On the contrary, the maximum price variation limits that are allowed between the trades are much smaller for most price ranges and thus this barrier is hit much more frequently.

The procedure used by *Saitoris* to slow down trade and attract liquidity is depicted in the diagram in Exhibit 2.7. It describes possible events that occur following the arrival of a market order.

Sequence 1 indicates that a market order is completely filled at the prevailing quote and a regular trade occurs. Sequence 2 denotes that a market order walks up or down a limit order book, that is, parts of the trade are executed at different prices. The *Saitori* issues *chui kehai* (warning quotes) as each new price is hit but no trading halt occurs. Sequence 3 shows the sequence of events following when the price change on entire order execution exceeds maximum allowable price variation. In this case, the *Saitori* only allows partial execution of a market order. The *Saitori* then issues a *chui kehai* at the maximum price variation and halts the trade. In sequence 4, we have a situation where the *Saitori* prevents a market order from

Exhibit 2.5 Maximum price variation limits between trades on the Tokyo Stock Exchange (TSE)

Last special quote	Price level (¥)	Price variation (¥)
Less than	500	±5
Less than	1,000	10
Less than	1,500	20
Less than	2,000	30
Less than	3,000	40
Less than	5,000	50
Less than	10,000	100
Less than	20,000	200
Less than	30,000	300
Less than	50,000	400
Less than	70,000	500
Less than	100,000	1,000
Less than	150,000	2,000
Less than	200,000	3,000
Less than	2 million	30,000
Less than	3 million	40,000
Less than	5 million	50,000
Less than	10 million	100,000
Less than	15 million	200,000
Less than	20 million	300,000
Less than	30 million	400,000
Less than	50 million	500,000
50 million or more		1 million

Source: TSE Fact Book 2003

fully executing, since the required price change would exceed the maximum price variation, and during the halt another market order on the same side arrives from a different brokerage house. The arrival of the second order on the same side of the market from another exchange member is taken as an indication of a possible change in equilibrium price. Now the *Saitori* issues a *tokubetsu kehai* (special quote), continues the trading halt, and gradually revises the special quote typically every 5 min in the absence of additional orders. The *Saitori* in effect publicizes this change in equilibrium price to the market through this measured revision of the special quote. When the special quote reaches the current best quote, the pending order will be fully executed under the assumption that the resulting price change would not exceed the daily price limit.

London Stock Exchange

London Stock Exchange (LSE) is one of the oldest exchanges in the world. It is more than 300 years old. They initially started operations circa 1698 in Jonathan's Coffee House in Change Alley in London. The origins of capital market in London dates

Exhibit 2.6 Tokyo Stock Exchange (TSE) daily price limits daily price limit is based on previous day's closing price or special quote

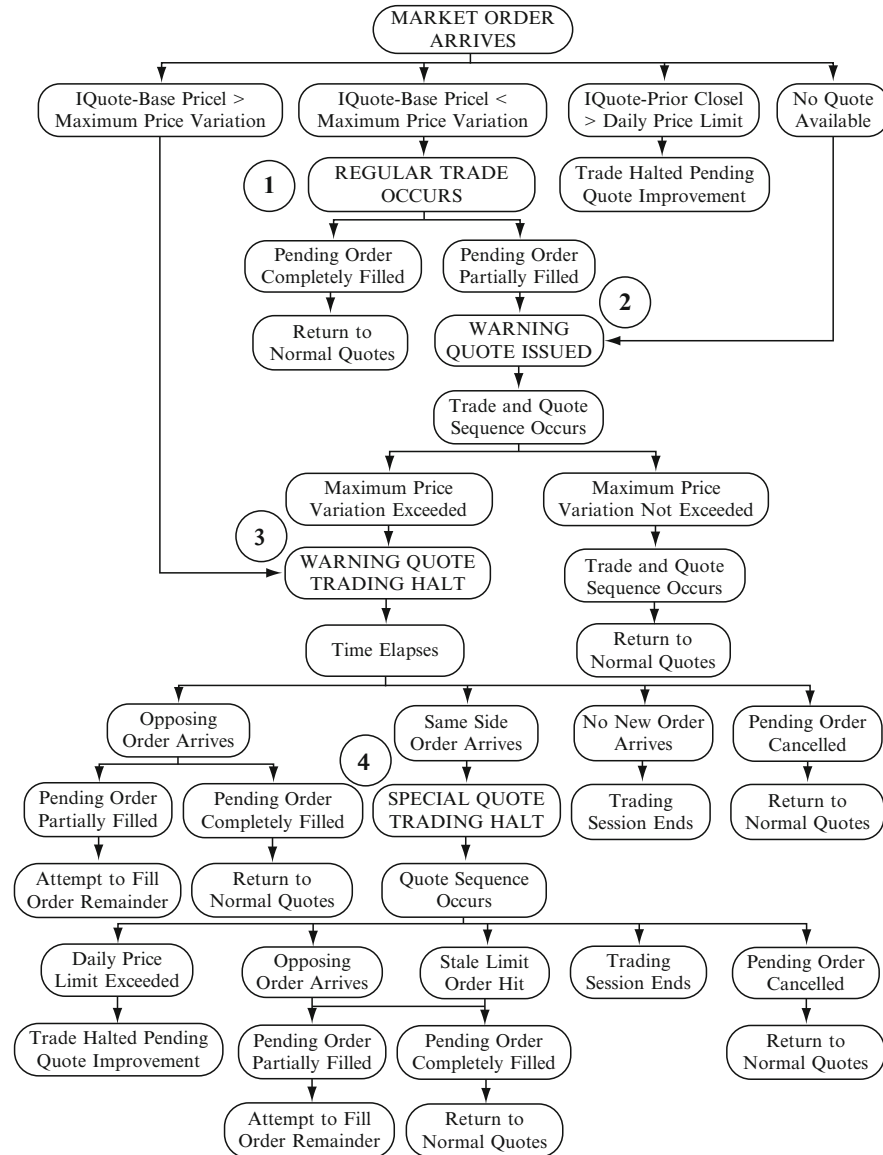
	Previous Day's Closing Price/Special Quote (yen)	Daily Price Limits (yen)
Less than	100	±30
Less than	200	50
Less than	500	80
Less than	1,000	100
Less than	1,500	200
Less than	2,000	300
Less than	3,000	400
Less than	5,000	500
Less than	10,000	1,000
Less than	20,000	2,000
Less than	30,000	3,000
Less than	50,000	4,000
Less than	70,000	5,000
Less than	100,000	10,000
Less than	150,000	20,000
Less than	200,000	30,000
Less than	300,000	40,000
Less than	500,000	50,000
Less than	1 million	100,000
Less than	1.5 million	200,000
Less than	2 million	300,000
Less than	3 million	400,000
Less than	5 million	500,000
Less than	10 million	1 million
Less than	15 million	2 million
Less than	20 million	3 million
Less than	30 million	4 million
Less than	50 million	5 million
50 million or more		10 million

Source: TSE Fact Book 2003

back to 1593 when the first joint stock company called “Muscovy” was formed by 240 investors who subscribed to one share each worth £ 25 for the specific purpose of provisioning the search to discover a north-east passage to the mysterious far-east.

Capital markets in London have come a long way, since then facilitating the financing of the industrial and the current service economies of the globe. LSE went through a major deregulation of the market known popularly as the “big bang.” The major changes characterizing the big bang are listed below:

- Ownership of membership firms by an outside corporation is allowed
- All firms become brokers/dealers able to operate in a dual capacity
- Individual members cease to have voting rights

Exhibit 2.7 Possible sequence of events following the arrival of market order

Source: Lehmann and Modest (1994)

- Age-old trading floor was replaced by electronic screens and negotiations over the phone
- Fixed commissions were abolished
- The Exchange becomes a public limited company

There are three major market segments on the LSE:

- The main market
- Alternative investment market (AIM)
- Market for international securities

A domestic stock may trade in one of the three different trading systems: the SETS, the SEAQ, or the SEATS Plus. SETS stands for stock exchange electronic trading system and is the LSE's blue chip market. SETS is fully electronic, order driven, and an anonymous market with no market makers. The SEAQ is a quote-driven market and stands for stock exchange automated quotation system. SEAQ is LSE's market for medium-size stocks and the most liquid AIM stocks. The market is based on two-sided continuous market maker quotes.

Finally, the SEATS Plus (Stock Exchange Alternate Trading Services) is an electronic market. It combines an order-driven market with a quote-driven market and offers the benefits of an order-driven system with guaranteed liquidity provided by market makers. This service is utilized by small, less, liquid stocks and all AIM securities.

The major objectives of a stock exchange are to provide liquidity and price discovery. We elaborate on liquidity below and discuss price formation in the next subsection.

Liquidity is not unlike beauty, in that it is easier to recognize but far more difficult to define or measure. To compound the difficulty, there are several dimensions of liquidity. An asset is considered to be liquid if it can be converted to cash with ease. Ease of conversion can be measured either by the time taken to trade an asset for cash or by the cost of trading an asset for cash immediately. In market microstructure literature, more attention is paid to the cost of immediacy as opposed to the time required to trade. Immediacy costs can be further broken down into explicit and implicit costs. Brokerage commissions and taxes constitute explicit costs of immediacy. Implicit costs are hidden costs. They are also execution costs and include the following:

- Rounding of prices
- Bid-ask spreads
- Market Impact Effects
- Imperfections in the Price Determination Process

We discuss these factors below.

Rounding of Prices: Bid-Ask Spread – Bid-ask spread exists due to the existence of an order imbalance in real-time. Buy and sell orders do not arrive simultaneously to clear at the existing equilibrium price. An explicit or implicit market maker provides a two-way quote – a buying price and a selling price with associated quantities for immediate execution. The bid-ask spread is then the compensation for providing immediacy. Market impact costs are due to large orders moving the transaction prices albeit temporarily. Real-world securities markets are characterized by several imperfections.

A liquid market is characterized by breadth, depth, and resiliency. Breadth refers to the existence of orders in substantial volume. Depth is the existence of orders on both sides of the market near the current equilibrium price. Resiliency is the responsiveness of new orders to price changes caused by temporary order imbalances. A market is not resilient when the order flow does not quickly adjust to errors in price discovery.

2.2.2 Price Formation and Price Discovery

Markets have two principal functions according to O'Hara (2003). They are provision of liquidity and the facilitation of price discovery. Clearly asset prices evolve in markets. This evolution is influenced by the nature of players in the market and the trading system in vogue. Traditional market microstructure literature has categorized traders based on their information system – informed traders and uninformed traders. Informed traders have an informational edge regarding the stocks that other traders do not possess. They exploit this informational advantage while trading with others. The uninformed investors trade for noninformational reasons. In some cases, they are termed as “noise traders,” since their trade is based on their beliefs and sentiments that are not grounded on fundamental information. Information is revealed to the market through the trading activities of informed traders.

To profit fully from their informational superiority, informed investors have incentives to slow down the rate at which their trading influences prices. Sometimes, they engage in stealth trading as shown by Chakravarty (2001), using audit trail data for a sample of NYSE firms that medium-size trades are associated with a disproportionately large cumulative stock price change relative to their proportion of all trades and volume. This result is consistent with the predictions of stealth-trading hypothesis attributed to Barclay and Warner (1993). In that paper, they posit that informed investors use medium-size trades rather than large traders to prevent information from being too quickly impounded into stock prices. Chakravarty (2001) finds that medium-size trades are trades initiated by institutions that account for this disproportionately large cumulative price impact. His findings are in conformity with street lore that institutions are informed traders.

2.2.3 Information and Disclosure

There are many informational issues surrounding market microstructure. These include information dissemination and disclosure. Madhavan (2000) defines market transparency as the ability of market participants to observe information about the trading process. Information in this context refers to knowledge about prices, quotes, volumes, sources of order flow, and the identities of market participants.

Issues of transparency have been vital to some recent policy debates. For instance, the issue of delayed reporting of large trades has been highly controversial

and continues to be an issue as stock exchanges with different reporting rules form trading linkages. A directly related issue concerns the consequences of differences in trade disclosure across markets. These differences may induce order flow migration, and therefore affect liquidity and the cost of trading.

Transparency constitutes a major factor in debates over floor versus electronic systems. Floor systems such as the NYSE typically do not display customer limit orders unless they represent the best quote. In contrast, electronic limit order book systems such as the Toronto Stock Exchange Computer Assisted Trading System (CATS) and the Paris Bourse *Cotation Assistée en Continu* (CAC) system publicize not only the current quotes but also information on limit orders away from the best quotes. In general, the trend around the world has been towards greater transparency.

The practical significance of market transparency has given rise to a large theoretical and empirical literature. In particular, several researchers have studied the consequence of disclosing information about the *identity* of traders or their *motives* for trading. These issues arise in many different situations such as the following:

- Post-trade transparency and reporting;
- Pre-disclosure of intentions to trade such as sunshine trading or the revelation of order imbalances at the open or during a trading halt;
- Dual-capacity trading, where brokers can also act as dealers;
- Front-running, where brokers trade ahead of customer orders;
- Upstairs and off exchange trading;
- The role of hidden limit orders in automated trading systems;
- Counterparty trade disclosure; and
- The choice of floor-based or automated trading systems

2.2.4 Market Microstructure Interface with Other Areas of Finance

A popular measure of liquidity is the bid–ask spread which is the difference between the bid and the ask price quoted by a dealer who makes a market in a stock. The bid–ask spread may be viewed as the price required by the dealer for providing immediate execution of orders. Amihud and Mendelson (1986) examine the relationship between bid–ask spread and stock returns. If investors assess the value of a stock based on their returns net of trading costs, then they should demand a higher rate of return for high spread stocks so as to compensate them for higher trading costs. Thus, investment decisions should incorporate liquidity considerations in addition to risk. While an investor can reduce the risk by holding a diversified portfolio, the cost of illiquidity cannot be diversified away.

Besides required rate of return, liquidity also affects the holding period of a stock. The cost due to the bid–ask spread has to be borne by the investor only once over the holding period. A premium is paid when the stock is purchased and a price concession is made at sale. A longer holding period effectively reduces the amortized

transaction cost per unit of time. The larger the holding period of an investor, the lower the extra return required compensating for the bid–ask spread. Thus, stocks with high bid–ask spread will be held by investors with longer holding periods. Conversely, short-term investors should hold low-spread securities.

Amihud and Mendelson (1986) show empirically that security returns reflect the percentage bid–ask spreads. Observed gross returns tend to increase with spread. By their estimates, the monthly excess return of a stock with a 1.5% spread is 0.45% greater than that of a stock with a 0.5% spread. These results have several implications for investment management. First, low liquidity investments are required to produce higher returns for the holders. Real estate and stocks of small firms typically have lower liquidity and therefore produce higher returns. Second, portfolio manager are advised to pay attention to investment horizons of their clients. While a client with a longer holding period is able to withstand the burden of some illiquid assets in her portfolio, other investors with shorter horizons should be directed to hold low-spread securities.

Amihud and Mendelson's framework points out to the benefits of liquidity increasing investments. As a direct consequence of liquidity improvements via lower spreads, the value of a stock should increase. This effectively decreases the cost of capital of the firm. One such move could be to switch the listing of the stock to a more liquid trading environment. Amihud et al. (1997) document large changes in stock prices of companies moving to a more liquid trading system on the Tel Aviv stock exchange.

The going public decision is one such project. The cost benefit analysis of the project is given by

$$C_0 + \frac{c}{R_1} < \frac{E}{R_1} - \frac{E}{R}, \quad (2.1)$$

where C_0 is the initial cost of the public offering, c is the recurring cost associated with public ownership, E is the perpetual cash flow generated by the firm, R is its initial cost of capital and R_1 the cost of capital subsequent to the firm going public. This equation can be approximated as follows:

$$C_0 + \frac{c}{R_1} < \frac{E}{R} \cdot \frac{\Delta R}{R}, \quad (2.2)$$

where $(\Delta R/R)$ is the relative reduction in the required rate of return.

Amihud and Mendelson (1988) discuss a number of implications of this model. First, a given change in liquidity has a greater effect on the cost of capital when liquidity is already high than when it is low. Thus, it may be more beneficial for firms which are already highly liquid to invest further in increasing the liquidity. Second, a given investment in a liquidity increasing project might provide a greater reduction in the cost of capital and a greater gain for low liquid firms. Third, the benefits of increased liquidity are proportional to the initial value of the firm. Thus, we should expect larger firms to benefit more and therefore to invest more in liquidity enhancing projects as compared to small firms. Finally, for some stocks decreasing liquidity rather than increasing it will be beneficial to the firm when the left hand

side of (2) is greater than the right. This implies that the cost of increasing liquidity exceeds the potential benefits. Bharath and Dittmar (2007) provide empirical evidence by showing that low liquidity firms are more likely to go private subsequent to their going public, *ceteris paribus*.

2.3 Concluding Comments

In this chapter, we provided an overview of market microstructure – one of the branches of financial economics. We discussed the organization of major stock exchanges of the world and the process of price discovery. Market microstructure is of special interest to practitioners because of the rapid transformation of the market environment by technology, regulation and globalization. We discussed the practical applications with a focus on market structure, transparency and applications to other areas of finance. The next chapter deals with the regulation of financial markets and services.

2.4 End of the Chapter Exercises

1. What is market microstructure?
2. Describe the different types of trading systems.
3. Compare and contrast how the major stock exchanges are organized.

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