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Principles of Trading Market Structure

HANS R. STOLL
Walker Professor of Finance, Director of the Financial Markets Research Center, Vanderbilt University, Nashville, TN 37203 U.S.A.

Although securities markets differ substantially in their trading procedures, all have the same objective of providing efficient and low-cost transactions services. Are the different trading procedures mutually compatible as the world financial markets evolve and become more integrated, or will different markets converge to the same structure? What are the benefits of continuous markets in contrast to call markets, of auction markets in contrast to dealer markets? What should be the rules of trading within a market? What should traders be required to disclose? What can be automated, and what form will automated markets take? What are the limits to automation? Why have markets been so slow to automate? What are the best procedures for resuming trading after a trading halt? To what extent should different markets be allowed to compete? Will competition result in excessive fragmentation of markets? How should related markets in the same country or in different countries be linked? Is the need for government regulation increasing or decreasing? This article provides a framework for analyzing these and other issues facing world trading markets, and seeks to provide guidance on market design and on public policy toward trading markets.[1]

This article is organized as follows. After a brief discussion of alternative forms of trading markets in section 1, key factors affecting the structure of a market are presented in section 2. The conclusion is quickly reached that active markets are continuous, and the focus in section 2 is on the design of continuous markets and the degree of automation that such markets can achieve. In section 3, principles for organizing the start of trading in the morning or after a trading halt are discussed. The resumption of trading after a halt poses special problems in determining a price that incorporates relevant information in the security and in related securities. In section 4, the industrial organization of competing markets is analyzed. In the United States and across the world, stock markets compete and futures and options markets offer products that compete with equity positions. The key problem is how to assure the benefits of competition among these markets without fragmenting markets. The implications for market design and public policy are summarized in section 5.

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1. Forms of trading markets[2]

1.1. Call markets

In a call market, orders for a security are batched over time and executed at a particular point in time. Call markets are quite common when the volume of trading is too small to justify continuous trading, but they are rare in active markets. The New York Stock Exchange (NYSE) initially operated as a call market, but continuous trading was introduced before 1900. The Paris Bourse switched from a once-a-day call market to a continuous market in 1986.

Call markets operate according to auction market principles. In an auction market, public orders (represented by brokers) trade with other public orders. An auction market can clear at a single price or at multiple (albeit, related) prices. In pit trading, as on futures markets, many bilateral negotiations occur simultaneously, and slightly different prices may be agreed on at the same time. In a single-price auction a single price is established that maximizes the volume of trade between buyers and sellers. Many continuous markets open trading with a single-price call auction.

1.2. Continuous markets

Continuous markets may be classified into continuous dealer and continuous auction markets. In a continuous dealer market, all public transactions are made against dealers' bid or ask prices. In a continuous auction market, all transactions of public traders are against the limit or limit sell orders of other public traders.

The most active markets in the world—debt markets, such as the U.S. government bond market, and foreign currency markets—are dealer markets. At the same time some of the most inactive markets, such over-the-counter markets in the stocks of small companies, are dealer markets. The dealer market is evidently a very flexible structure.

Continuous auction markets in which public orders trade only with other public orders are rare because the arrival of public orders is insufficiently frequent. Active futures markets most closely resemble a continuous auction market, but even active futures markets rely on the presence of scalpers who act in the capacity of dealers. Most continuous markets require the presence of dealers to provide liquidity. On the NYSE, the specialist provides liquidity on the floor, and upstairs firms provide liquidity for large block trades.[3] Automated continuous auction markets, such as Toronto's CATS (Computer Assisted Training System) or the Paris Bourse's CAC (cotation asisté en continu), are unlikely to be liquid unless professional traders post bid and ask quotes in the system. In order to provide continuous trading, auction markets must become more like dealer markets.

At the same time, dealer markets can be expected to become more like auction markets. In a dealer market, public limit orders could be exposed to public market orders, as is the case in an auction market, either by establishing a limit order book or by encouraging one of the dealers in the system to represent customer limit orders to the rest of the market.[4] In the NASDAQ market, an automated limit order file is being developed for its

Small Order Execution System (SOES). The impetus of technological change and increasing volume is causing different trading structures to become alike.

2. Forces affecting the structure of markets

Understanding the past and the likely future changes in trading arrangements necessitates an examination of the factors that influence trading structure. These factors include the nature and magnitude of the demand for trading, the cost of processing transactions, the role of automation in improving trading efficiency, and the cost of bearing risk. They also include the subtler issues of dealing with unexpected information that adversely affects certain outstanding orders, of dealing with investors who have privileged information, and of balancing the benefits of competition against the desire of some markets or dealers to build reputations. Finally, the increased institutionalization and globalization of markets are putting great economic pressure on current trading arrangements that date back to the 1800s.

2.1. Demand for trading

Other things equal, investors prefer to trade immediately. As a result, most major markets are continuous markets rather than call markets. Market structure influences the way in which the demand for immediacy is met. In a dealer market, immediacy is supplied, and continuity maintained, by dealers who quote bids and offers. In a continuous auction market with a book of limit orders, immediacy is supplied, and continuity maintained, by public investors who maintain orders in the limit order book. Most continuous auction markets also require the presence of dealers to supply immediacy (the specialists on the NYSE).

The level and nature for the trading services of a market depend on the trading motives of individual traders. Demand for trading is also enhanced by the network externalities of trading, which cause traders to go where other traders are.

2.1.1. Motives for trading *Liquidity trading.* Liquidity trading arises from the need to smooth consumption over time. If income is above normal, investors buy securities; if income is below normal, investors sell securities. Liquidity trading also arises for risk adjustment. For example, investors may change risk by switching between stocks and bonds.

A liquidity trader in need of cash wants to sell quickly to avoid the need to borrow money. All other things equal, the trader would place a market order. However, if the bid price is low relative to the ask price, the liquidity trader may place a sell limit order at the ask price and wait for a public market buy order to be executed against the limit ask price. In other words, the trader becomes a supplier of immediacy. The tradeoff between demanding and supplying immediacy is modeled in Ho and Stoll (1983, p. 1063). Basically the trader compares the market impact cost of trading immediately at a known price against the risk of trading at an unknown price with higher expected value.

Informational trading. Some traders trade because they have information that implies a price change. Information traders are presumed to be more anxious than liquidity traders and more likely to use market orders than limit orders. They are presumed to demand more immediacy, yet they cannot be too anxious for fear of giving themselves away.

An efficient market is said to reflect new information, yet a market with too much informational trading cannot succeed. If some traders have valuable information and cannot be identified, other traders are reluctant to trade. Dealers also raise bid-ask spreads to protect themselves against adverse information, and liquidity is reduced further. If there is too much private information, markets break down as no one desires to trade for fear of encountering someone with superior information.[5]

Government disclosure requirements can help assure traders that no one has significant special information, but disclosure requirements are unlikely to be complete. Market structure can also help to identify information traders. For example, it is sometimes argued that the specialist system is better able to identify information traders than a competing dealer system.[6]

Identification of information traders has social costs. The incentive to conduct research will be eliminated if government regulation and the market structure make it impossible for informed traders to benefit from their information.[7] Dealing with information trading thus poses a very difficult tradeoff between the viability of the market mechanisms and the adequacy of information gathering.

Noise trading. Noise traders are sometimes defined to be traders who believe they have information but, in fact, do not. Analytically, noise traders of this type frequently play the same role as liquidity traders: namely, to lose money to informed traders. This definition of noise trading is not consistent with rationality and requires the invocation of Barnum's Law to replenish the supply of noise traders in the system.[8]

An alternative definition in Black (1991) defines a noise trader as someone who pretends to be an information trader or a liquidity trader. In Black's model, noise traders are rational and do not lose money. They do not have fundamental information, but they have trading information. One piece of trading information is that they know that they are not informed, something that other traders do not know. They mimic information traders when they want to influence price, and they mimic liquidity traders when they want to limit the price effect of their trading. Black (1991) argues that noise traders add to liquidity. They break even; informed traders make money; and liquidity traders lose money.

2.1.2. Network externalities A market, like any communications network, is subject to network externalities. The demand for immediacy is more readily satisfied when more traders are in the market because the probability of executing an order increases with the number of traders. Demand creates its own supply since any demander of liquidity can become a supplier of liquidity by placing limit orders. In the presence of many traders, the need for intermediaries declines because the probability of finding another investor trading in the opposite direction increases. Just as a telephone system is more valuable as more people use it, so a market is more valuable as more people trade on it. As a result, a market is a natural monopoly that benefits from being the first-mover. This creates

exchange monopolies that pose some regulatory difficulties, particularly if the first market is not the most efficient.[9]

2.2. Order processing costs

Market structure is determined in part by the costs of processing orders. Order processing is accomplished by a communications system that brings buyers and sellers together and by a clearing system that brings about the transfer of ownership. Order processing costs benefit from economies of scale and network externalities on the supply side.

2.2.1. Communication A trading market is first and foremost a communication system, and the execution of the transaction is just the last step of the communications process. The communication system has three components: an information system, an order routing system, and an order execution system. Different markets perform these functions in different ways. Without the modern technology of the telephone or computer, these functions could only be carried out by face-to-face contact, but today a variety of communications mechanisms are available.

The *information system* in a market provides data on past transaction prices and transaction volumes, informing traders where the market has been. Second, it provides information on possible future transaction prices by providing bid and ask quotes and, in some markets, quantities available at these quotes. Markets differ in the amount of such information provided and the breadth and speed of its distribution. Futures markets, for example, do not provide transaction volume data in real time as do most equity markets. The pit trading system of futures markets provides considerable information to those in the pit, but the breadth of distributions is limited. Many markets provide only limited information on the quantities that may be traded at the quotes, and the "firmness" of the quotes is uncertain.

With the rapid development of technology, the narrowly defined information system is being broadened to provide data for investment decision making that can be integrated in the trading decision. Thus information vendors such as Reuters are integrating forwards to provide pricing models or arbitrage models useful in investment decision making and backward to facilitate transactions processing.

The second element of a market is the *order routing system*. The desire to trade and the terms of the trade must be communicated to other market participants. Orders must be placed, collected, routed, and delivered to the point of execution. Procedures must be established for market orders, limit orders, and other contingency orders. Small retail orders may require different processes than wholesale and institutional orders. Markets differ in their procedures and the degree of technological sophistication in routing orders. Generally speaking, upstairs communications systems of brokerage firms seem to be more sophisticated than trading systems of market centers. In futures markets, orders arrive electronically but the trade delivery system in most futures markets is manual. Similarly, stock markets are less automated after an order reaches the floor than before.

The third element of the market is the *execution system*. Once an order reaches a market center, it must be queued and matched against other orders and executed. Most execution systems follow rules of price priority and time priority within the particular market center,

but such rules cannot always be applied across market centers. Even in a particular market center, absolute priority may not obtain. For example, in an active futures market pit, transactions in different parts of the pit may not follow the time sequence in which they were entered by customers and may even violate price priority. Price priority may be violated when orders do not match in size. A large order may be executed at a price that is inferior to a standing small order in the system.

Some markets require public priority over dealer priority. For example, public orders on the NYSE have priority over specialist orders at the same price, reflecting the fact that the specialist acts for the book of limit orders and has no competition on the floor. But not all market arrangements allow such priority. Futures markets require brokers to give public orders priority over their own orders, but the public order of one broker does not have priority over the order of another professional trader in the pit. Public priority makes sense when the dealer has certain advantages (as does the specialist), but when dealers and customer have equal access to other traders, as in an automated system, the rationale for public priority may not be supportable. Execution priority may also be based on order size. For example, small orders on the NYSE are sometimes given preference over large orders. On the other hand, some markets give a standing large order preference if it can match another large order entering the system.

Technology for automating the execution process has been operational since the late 1960s, yet few markets even today execute a large fraction of transactions automatically.[10] One of the puzzles in the organization of securities markets today is the failure to automate more of the process.

2.2.2. Clearing In addition to the communications system, a market also provides the postexecution services of trade comparison and settlement. Most markets are linked to a clearing corporation that compares trades and directs final payment and delivery. Trade comparison determines whether buyer and seller agree on the terms of a transaction. In U.S. equity markets, four business days are allowed for this process. Final settlement is made on the fifth business day. In an electronic market this process could be reduced to one or two days. Presently, futures markets clear transactions in one day. On the other hand, some European markets settle at the month-end or in rolling two-week periods. There appears to be a little disagreement that the clearing and settlement process can, and ought to, be more fully automated in all markets; but considerable difficulty arises in coordinating different institutions that currently provide the service.[11]

2.2.3. Economies of scale and externalities in order processing Adam Smith noted in 1776 that the division of labor and specialization of function are limited by the extent of the market. The larger the market, the greater the opportunity to exploit economies of scale. The extent of the financial markets has grown as communications technology has reduced the effective distance between physically separate locations. As a result, the processing of securities transactions has become more concentrated in specialized firms that handle order routing, execution, and clearing for themselves and for other firms.[12] Although the number of firms that process and clear trades is declining, the total number of brokerage firms is increasing; and competition among firms remains intense.

The network externalities present in the communications system (information, order routing, and execution) are also present in the clearing. It is less costly to clear a transaction if the contraparty clears on the same system. The economies arise from the fact that all trades in a security are cleared in the same system. Competition across clearing organizations can exist to the extent that different groups of securities are cleared on different systems. In the United States, clearing of most equity securities is done through the National Stock Clearing Corporation (NSCC).[13]

2.3. Technology and automated trading

While automation has dramatically reduced the cost of trading in the last 20 years, considerable potential still exists for improving efficiency of markets through additional automation. Prototypes of fully automated markets were developed in the early 1970s, but their acceptance has been slow. Today, fully automated systems for stocks include CATS on the Toronto Stock Exchange, the French version, CAC, and the Japanese version, CORES (Computer-Assisted Order Routing and Execution System).[14] A variety of small order execution systems have been developed in the United States.[15] On the futures markets, a fully automated trading system, Globex, structured very much like automated stock trading systems, is now being introduced. The new Swiss futures and options exchange, SOFFEX, and the even newer German options and Futures market, Deutsche Termin Borse (DTB), have also adopted automated procedures. But the bulk of securities and futures trading is not done on fully automated systems.

Automated systems have a few key features:

1. *Information system.* Automated systems provide ready access to last sale data and to price quotations. Transaction price and volume reporting are instantaneous. Automated systems can easily display bids and offers and order sizes. Some systems disclose identities of brokers handling the orders.
2. *Electronic routing.* Orders are electronically routed from brokerage offices to market centers. Brokers, in turn, can connect to their customers electronically.
3. *A limit order file.* Incoming orders are either executed against a standing bid or offer or are placed on the limit order file. Systems usually call for price and time priority. Rules specify treatment of size mismatches and handling of special orders. In principle, dealers and customers can enter orders, although systems may differ on the rules with respect to customers and dealers.
4. *Automatic execution.* Orders are automatically executed against the orders on the book. On the NYSE, limit orders are now stored electronically, but execution is not electronic. The specialist must intervene to complete the trade.
5. *Clearing.* Confirmation is immediate and trades are prematched before going to the clearing organization for the final settlement. Automation can greatly increase efficiency of the clearing process.

Greater automation than is now observed in most markets is technologically feasible. The amount and quality of information supplied to investors in making trading decisions can be enhanced. Electronic routing of orders from customers to brokers to the market

center can be improved. Many markets do not have a limit order file, let alone automatic execution. Dealer systems, like NASDAQ and London, do not have a centralized limit order file except for small orders. Where a computerized limit order file has been implemented and execution against that file is possible, as in the CATS system, use of the system is modest. In Toronto, only 20 percent of the volume is done over CATS because of opposition from existing members. Only in Paris has automated trading been adopted for all equities. Even clearing, over which there is little controversy, is not fully automated in any market. Automated systems are likely to perform well in processing small orders, but they do not appear to be as well suited for handling large orders that require risk bearing and negotiation.

One of the most frequently raised questions is why so little automation has taken place. The issue is murky. Those who believe more automation is possible argue that automation allows markets to do more efficiently what they already do. Delays in automation are due simply to the resistance of vested interests. Others argue that automation qualitatively changes trading arrangements and cannot be introduced by fiat. Some of the subtler factors affecting market structure that are less easily accommodated in an automated system are now considered. These include risk bearing, free trading options, informational trading, reputation building, and anonymity.

2.4. Risk bearing

Market structure influences and is influenced by arrangements for risk bearing. In the context of trading markets, two risks may be distinguished: inventory risk and transactions risk.

2.4.1 Inventory risk Every market is faced with temporary order imbalances, and markets are structured in part to minimize the cost of absorbing these imbalances. The supplier of immediacy takes on inventory risk by buying or selling unwanted securities. The risk arises because the price of the security may change adversely before the position can be unwound or hedged. In pure dealer markets, only dealers supply immediacy. In pure auction markets, only other investors supply immediacy. As noted earlier, most markets are a combination of dealers and public participants. Yet substantial differences exist in the provision of immediacy, and considerable controversy remains as to the optimal market arrangement. Some markets, such as the NYSE, rely on the designated dealer to bear the risk of meeting imbalances. Others, such as NASDAQ, rely on competing market makers. Futures markets encourage large numbers of scalpers that play the role of market makers. At the other extreme are auction markets, such as Paris's CAC, with minimal dealer intervention.[16]

A market provides optimal immediacy to investors if it attracts substantial risk-bearing capital and provides the flexibility to channel that capital to those securities in which imbalances are greatest. Risk bearing cannot be compelled (by capital requirements or regulatory requirements), but it responds to profit opportunities. Desirable market arrangements are those that provide sufficient flexibility so that risk-bearing capital may be readily channelled to securities that need it:

1. *Multiple dealers.* Many dealers are likely to provide more liquidity than a single dealer. While the NYSE argues for the single specialist, it relies on multiple dealers for block transactions. Upstairs trading firms provide liquidity for large institutional orders.
2. *Many securities per dealer.* Restricting the number of securities per dealer restricts the ability of the dealer to channel capital to the neediest segment of the market. A dealer with many securities also has flexibility to hedge risks by taking offsetting positions in different securities. Major NASDAQ market makers make markets in hundreds of stocks. NYSE specialist units continue to specialize, but they are consolidating and increasing in size.
3. *Free entry and competition.* Competition among dealers keeps prices of dealer services low and encourages innovation.
4. *Public limit orders.* Public limit orders enhance liquidity for other investors.

Dealer markets such as NASDAQ and London have multiple dealers, each of whom can make markets in many stocks, but public limit orders are not exposed to the rest of the market. Exchange markets are restricted by the mechanics of exchange floors, which limits competition among dealers. Future markets attract competing scalpers in the pit, but the ability of the scalper to shift from one pit to another is dependent on the physical arrangement of pits. The NYSE specialist is limited to certain stocks, and the flexibility to trade other stocks or to hedge in other investments is constrained by the physical arrangements on the floor.

Automation can be helpful in facilitating the transfer of capital to those instruments most in need of it. Technological change has been much greater in upstairs firms than on trading floors. Upstairs firms earn a greater proportion of their revenues from trading profits today than 20 years ago, reflecting the growing comparative advantage of those firms in making optimal use of their risk capital. Exchange floors have lost ground to upstairs markets in providing risk-bearing capital, and exchange markets are finding ways to give dealers a bigger role. Automation can also improve the functioning of limit order systems and thereby enlist public orders to provide liquidity to other public orders. Limit order systems are being introduced in dealer markets such as NASDAQ and London. As auction markets make more use of dealers and as dealer markets introduce limit order systems, markets will become more alike.

2.4.2. Payments Risk A second important risk is the payments risk between the transaction time and the time of final settlement. Madhavan, Mendelson, and Peake (1989) identify the component risks: error risk, market risk, contraparty risk, and financial crisis risk. Error risk is the risk that the terms of the trade were incorrectly recorded. Market risk is the risk that the price changes adversely between the transaction time and the final settlement. Adverse price changes create an incentive to renege on a trade or to default. Contraparty risk is the risk that the party on the other side of the transaction cannot meet its commitment because of bankruptcy or similar eventuality. Financial crisis risk arises if a disruption in the financial system (a foreign exchange crisis or stock market crash) makes it difficult to complete transactions.

Different markets limit payments risk by procedures that range from reliance on the personal integrity of members to formal legal arrangements and guarantee funds. Large,

organized, modern trading markets "facilitate trade among strangers."[17] Not only are public investors strangers to each other but brokers may be "unknown" to other brokers. In such markets, it is no longer possible to rely on the personal integrity of members to assure market integrity. More formal arrangements for guaranteeing transactions are required as markets become more anonymous. Such arrangements include margin deposits and guarantees in various parts of the system.

From the perspective of the appropriate structuring of markets, it is obvious that the shorter the clearing time, the less the chance of nonpayment. Automation of clearing and reduction of clearing time can therefore reduce transaction risk. Of course, credit risk still remains after a transaction has been completed, but that risk is not directly related to the structure of trading markets.

2.5. Free trading options

Any market requires someone to place the equivalent of a limit order. In dealer markets, dealers place two limit orders—an order at the bid and at the ask. In an auction market, public traders place limit orders in a book of limit orders. A limit order furnishes the rest of the market with a free trading option that is "in-the-money" if unfavorable information arrives while the limit order is outstanding. For example, suppose an investor places a limit order to buy at 24 when the market price is 25. If new information suddenly arrives that justifies a price of 23, the rest of the market has an option worth one dollar.

Market structure influences who receives the option. An auction market gives the option to investors who can "pick off" dealers. Public investors that place limit orders are most subject to the free trading option problem since they find it most difficult to adjust limit prices quickly. Rock (1988) notes that limit orders need not be directly "picked off" by a dealer to disadvantage traders that place limit orders. The specialist can choose to better the quote on the book of limit orders when market conditions allow it but can fail to better the quote and allow the limit order to be "picked off" when market conditions indicate that bettering the limit order price would be undesirable. The effect is that the limit order fails to execute in those instances when execution might be favorable because the better price of a floor trader or dealer pre-empts the limit order.

The problem of free options also affects dealers and is illustrated with two examples. One comes from the use of the Intermarket Trading System (ITS) that connects the trading floors of U.S. exchanges. Dealers in the Cincinnati Stock Exchange post quotes in NYSE stocks that may be automatically executed. A floor trader on the NYSE observes an event, such as a large block that lower prices on the NYSE. He sends a sell order to Cincinnati before the dealer in Cincinnati can change her price. The dealer in Cincinnati is "picked off."

A second example comes from the NASDAQ market. The SOES system on NASDAQ obligates NASDAQ dealers to execute five orders up to 1,000 shares at posted bid and ask price. An upstairs brokerage firm supplies its public customers with computer terminals that enable customers to execute transactions over SOES. Customers monitor competing dealers in a stock and can execute against any dealer whose quotes are not adjusted to

reflect the latest information (including the quotes of the other dealers in the stock). Put differently, customers monitor dealers to look for free options that are in-the-money.

The value of the option depends on its maturity and on the stochastic process for security prices, both of which are influenced by market structure. Typically, the maturity of an option is less for a market professional at the market center than for a public customer. For example, the specialist on the NYSE can monitor his quotes continuously and make changes quickly if new information warrants a change in the quote. A public customer cannot change a limit price as rapidly. If markets become congested (as during periods of market turmoil such as October 19, 1987), the value of the option increases since it is outstanding for longer period. If time priority is not maintained, the maturity of the free trading option implicit in a limit order is uncertain.

The value of trading options also depends on the short run volatility of prices. If prices move discontinuously by large amounts (as on October 19, 1987), trading options can have large value even if outstanding for short periods of time.

Public customers are more likely to place limit orders if they know that the order will be executed quickly and in order of time priority. Another features that traders like is cancelability. The value of the option is small if orders can be easily and quickly canceled. Since limit orders add to the liquidity of a market, it is desirable to reduce the value of the option given away by placing a limit order.

The severity of the free option problem can be overstated. After all, investors have been placing limit orders on the specialist's book for years. Stoll (1985) estimates that in 1979, 48 percent of NYSE volume involves a limit order on one side of the trade. Such limit orders are most probably for small orders. In recent years, as the volume of large institutional orders has increased, the fraction of volume accounted for by limit orders has undoubtedly decreased. The free option is a problem primarily in the case of large transactions, where there is more to lose. Institutions are, therefore, less likely to place limit orders. Institutions can also afford to hire someone to "work" the order.

Automation has opposing effects. It can reduce the free trading option by speeding execution. If orders can be entered quickly and withdrawn if not executed, the maturity of the option is reduced and its value lessened. Automation can also reduce the value of the option by making possible complex contingent orders. A recent suggestion would allow investors to make limit prices contingent on the market index. In that way, market volatility does not create option value.[18] A variety of other contingent limit orders can be imagined that would reduce the option value of the limit order. Since limit orders enhance the liquidity of markets, changes to reduce the value of the free trading option are to be encouraged.

Automation could have an adverse effect by changing the relative positions of dealers and customers. The speed advantage of the dealer over the customer is reduced in an automated market, and it is possible that the dealer is unable to change quotes fast enough to avoid being "picked off." One way for a dealer to limit the cost of an option is to limit the amount traded at the posted price. Other modifications are to limit interdealer trading or to limit access of other "market professionals" to an automated system.[19] If it is too costly for dealers to guard against that risk, the quality and quantity of risk bearing may be reduced.

2.6. *Effect of informational trading*

The presence of traders with private information complicates greatly the design of trading systems. Those with information do not want to give the information away and those without information do not want to lose to informed traders. Placing an order gives away information. It tells the rest of the market that a trader has decided to buy or to sell. If the order is large, the market may infer that significant information motivated the order; and prices may move to the disadvantage of the trader placing the order. Informed traders prefer market structures that enable them to capture at least some of their information. Uninformed traders prefer market structures that provide protection against adverse information.

The informational trading problem is different from the problem of the free trading option. A free trading option exists because new public information arrives in the time period during which the limit order is outstanding. The informational trading problem arises even if limit orders have an infinitesimally small maturity (and thus no option value). An informed trader with private information can trade at the limit price immediately after the limit order is entered. Informed traders standing in "the crowd" or in the pit can take advantage of incoming market orders that seek a contraparty. Subtle negotiation between potential traders may be necessary so that the placement of the order does not cause too much information to be revealed and so that private information possessed by the contraparty is elicited. With respect to the outcome of such negotiations, it is probably accurate to quote the Wall Street adage, "He who trades last wins." Market structure determines who trades last.

Automation can limit negotiation. Automation is resisted because trade indications in an automated system are irrevocable, if only for an instant. Automated systems make it difficult to convey characteristics of the trade that could serve to protect traders against adverse information. In face-to-face negotiation, price and quantity indications are not irrevocably given, and assurances about the nature of the trade are more readily exchanged. Each party to a potential transaction retains a right to back out of the trade, particularly if unusual conditions occur. Automated systems can work for small transactions in which potential losses to informed traders are small, but they have not worked well for large transactions where fears of adverse information are substantial.

Market structure affects incentives for research. If research becomes unprofitable, it will not be carried out. Certain trading arrangements may allow informed traders to benefit from their information. Gammill (1989) argues that "cooperative trading" arrangements, such as the specialist system, encourage research because market makers can afford to lose to informed traders.[20] Others argue that the specialist provides more protection against informed traders than a competing dealer market because the specialist is able to observe all the trading.

While important, the problem of informed trading can be exaggerated. Surprisingly, the ability of large traders to exploit their information is limited. Studies of block trading indicate that prices recover after block sales.[21] This implies that the seller receives the least favorable price. Thus, the current procedure for negotiating block trades has, on average, been of little benefit to sellers of large blocks and has adequately protected buyers of blocks. As a result, one may question the reluctance of large investors to disclose

blocks publicly or to use automated trading procedures. The evidence is less clear on the buy side because prices of stocks do not fall after a large block purchase.

The quality of a market depends on the balance of power between the informed and the uninformed, something that is affected by automation. If informed investors become too strong, uninformed investors are reluctant to trade, and market liquidity is reduced. If the informed become too weak and cannot profit from their research, the incentive for research is reduced, and market prices are less accurate reflections of underlying economic value.

2.7. Reputation, responsibility, anonymity, and atomistic competition

In a market with many atomistic, anonymous, and equally informed competitors, traders are indifferent about the other side of the trade. But if traders are differentially informed, those with information desire anonymity and those without information desire protection. Markets differ in their transparency. U.S. markets disclose bids and offers, transaction prices, and volumes. Timely disclosure of such trade information helps investors infer private information of traders and thereby helps protect uninformed investors.[22] But confidentiality may also protect the uninformed. If no one knows the presence of a limit order placed by an uninformed investor, no one can pick off the order. Complete confidentiality is, however, difficult to attain, as certain brokers or dealers are likely to know of the presence of the limit order. Consequently, increased transparency is likely to offer greater protection to the uninformed than attempts at confidentiality.

In many markets, intermediaries provide some protection against adverse information. Intermediaries build reputations and assume responsibility for the quality of a market.[23] That includes the fairness of the price and the general speed and quality of execution. The tremendous growth in block trading indicates that the interests of buyers and sellers are reasonably well protected by block trading intermediaries. Some argue in favor of the designated specialist system on the grounds that the specialist takes responsibility for the quality of the market in a stock. Markets like the CBOE have assigned designated primary market makers (DPMs) to make markets in newly listed options. The intent is to give the DPMs responsibility and a certain advantage.[24] The NASD has recently imposed obligations on its market makers. Assigning responsibility in this manner is usually part of the strategy to enhance the reputation of a market.

Automation, it is argued, increases anonymity and inhibits the creation of reputations and the taking of responsibility. It increases anonymity because no one sees the face of the trader or the person for whom he is working. That may make it more difficult to protect other traders against adverse information. Reputation building is more difficult because in automated systems it is difficult to capture all the benefits of creating a good market. Other intermediaries may trade at prices established by the trader creating the quality market. Responsibility is not taken because it is difficult to be compensated for it as the automated system allows others to skim the easy trades.

Counterarguments can be fashioned to each of these concerns about automation. Automated markets can limit anonymity. For example, the CATS system publicly discloses the broker on each trade. Reputations can be built in an automated market by providing superior liquidity. Quality dealers can be rewarded by automated preferencing

arrangements that allow customers to channel all orders to a preferred dealer so long as she trades at the best price. Similarly, responsibility can be assigned in an automated system and rewards established. The DPM on the CBOE is automated while other market makers are not.

The validity of these arguments and counterarguments is not obvious a priori, and government regulators or systems scientists are not likely to provide a blueprint for the ideal automated market. Markets are likely only slowly to grope their way to the appropriate modifications in trading arrangements that provide efficient order processing, supply risk-bearing services, and deal with the subtler problems of free options, information trading, and reputation building. The limits of automation have not yet been tested, and more automation is needed. But a regulatory mandate to computerize markets is too abrupt a means of achieving greater automation.

2.8. Institutionalization

Institutionalization has changed the structure of markets. A larger fraction than ever of U.S. equity trading is in fact carried out in the trading rooms of upstairs brokerage firms. More than 50 percent of the volume of trading on the NYSE is block transactions, most of which are negotiated and assembled in the upstairs dealer network. Institutionalization has pushed markets toward the dealer form of organization.

In futures markets the same trend is to be expected, although it is less developed. Upstairs institutional traders are demanding better facilities for executing large transactions that are currently broken up into many small transactions on the floor. Futures markets floors are still populated by many small "locals" trading for their own accounts, but the locals are likely to find it increasingly uneconomical to trade only for their own accounts on the floor, particularly as large institutions put pressure on markets to provide greater liquidity in size. As in the stock market, one can expect an increasing number of transactions to be arranged upstairs.

While institutional investors are open to trading mechanisms that reduce trading cost, they tend to oppose automated executions of large trades. The problems of risk bearing, free options, and informational trading are not severe in small transactions, but the problems become much more difficult in large transactions. As a result, automation of large transactions is less desirable and less likely.

2.9. Historical accident and vested interests

Current trading arrangements are determined in part by the accidents of history, and history may not select an optimal system. Once in place, a market is difficult to change because vested interests have become well entrenched. Establishing competing markets is also difficult because the network externalities of existing markets ward off competitors. Modernizing trading markets thus becomes a political problem as well as an economic and technological one. Since exchanges are membership organizations, they face a political problem in modernizing so that all major constituencies are better off—a task that can

be difficult. Governmental intervention to modernize markets has the danger that a straitjacket is imposed on markets that would make future modernization even more difficult.

2.10. Summary

In this section, a laundry-list of nine factors that influence the design of markets is presented. First, the level and the nature of the demand for immediacy influence market design. Investors tend to prefer continuous markets rather than call markets. Trading markets enjoy network externalities because investors want to trade where other investors trade. Arrangements for protecting liquidity traders from informed traders (such as insider trading rules and disclosure requirements) influence the success of a market.

Second, a market design must specify the how trades are to be processed—from the initial stage of gathering information about current prices to the routing and executing orders through the final phase of clearing trades. Network externalities also present on the supply side because clearing costs are reduced if all traders clear in the same system.

Third, a market's design is influenced by how much of the trading process is automated. Automation increases the speed and reduces the cost of the purely mechanical part of processing orders, but the slow pace of automation implies that automation creates difficulties for a significant number of market participants. All automated trading systems rely on the same key features, the most important of which is a limit order file. Such systems seem to work well for processing small orders but are less suited to large orders that entail greater risk.

Fourth, market structure is affected by arrangements for bearing risk, and different markets employ different arrangements for bearing inventory risk and the risk associated with clearing trades. Even in floor-based exchange markets, large trades tend to be traded in an upstairs dealer network.

Fifth, free trading options are implicitly granted when traders place limit orders, and the success of a market depends in part on minimizing the value of these options.

Sixth, in addition to the free trading option, markets must deal with the problem of informational trading. Uninformed traders, who help provide liquidity to a market, are reluctant to enter if the probability is high of losing to an informed trader.

Seventh, the quality of a market may be enhanced by dealers or other intermediaries who assume responsibility for the quality of a market, but the assumption of responsibility may be difficult in a large fully automated, anonymous market. Automation affects the value of free trading options and who receives them. It affects the balance of power between the informed and the uninformed, and between the public customer and the market professional.

Eighth, the institutionalization of markets has created a demand for larger market-making capacity, which has been supplied by upstairs trading rooms. Institutionalization is causing trading to move from exchange floors to computer screens in upstairs offices.

Finally, market structure is influenced by vested interests within existing markets that tend to slow the introduction of new trading methods. Administrators of markets and regulators have a tough time in distinguishing the legitimate concerns about technological change from those reflecting vested interests.

If a market could be viewed simply as a facility for producing transaction services, the appropriate recommendations for market design would be to automate. But the subtle issues of free trading options, informational trading, and risk bearing complicate the design of markets and help explain the sometimes puzzling delay in the adoption of new technologies.

3. Opening a continuous market

The start of trading in the morning or after a trading halt (as after a circuit breaker has taken effect) poses some special problems. Orders have accumulated and must be executed at a fair price, and new orders are being placed at the market opening.

Dealer markets, such as NASDAQ or London, simply start trading at the quotes posted when trading begins. Before trading begins, dealers post quotes and update quotes on the basis of new information and their order flow, thereby conveying useful information to the public. Formal arrangements for consolidating order flow across dealers in the same security generally do not exist. If a dealer expects a large order imbalance at the opening, the dealer must prearrange to share it with other dealers or lay off the position on to other dealers after trading has begun.

Auction markets, such as the NYSE or Tokyo, open with a form of call auction market procedure, the details of which are not always clear. Observers criticize opening call auctions, but they do not suggest their abolition. Instead, critics suggest improvements in auction markets and their integration into the continuous market.[25] The discussion has even led, in the United States, to an attempt to start an independent opening auction market in common stocks for institutional investors.[26] A number of factors influence how call auction markets function:

1. Should the auction be a single-price auction in which all orders receive the same price or should multiple prices be allowed? Auction markets usually open with a single price. Dealer markets can open with different prices because trades at the ask and at the bid are possible and because dealer quotes may differ. Similarly, futures markets open with multiple, albeit closely related prices.
2. If a single-price auction is selected, how much should be disclosed about order imbalances and about likely opening prices? On the NYSE, disclosure requirements are not clear except on index expiration days and when large price changes are imminent. In such cases, preopening price indications are disseminated. On the Tokyo Stock Exchange, no disclosure is required. In Italy, a full Walrasian market with recontracting is apparently implemented.[27] In France, the CAC system displays all purchase and sale quantities and prices. No major market allows investors to submit demand schedules that specify alternative order amounts at each possible market clearing price.
3. What degree of recontracting and canceling of orders is possible? Investors may change their minds about trading as the likely clearing price changes in the preopening period; and, as a result, they may want to withdraw orders or place additional orders.[28] But if investors are allowed to withdraw orders, manipulation of the call auction

market may be encouraged. One solution is to allow cancellations only up to a certain point, say, 15 minutes before the final price is set, and thereafter allow changes in price that serve to better prices—increases in buying prices or decreases in selling prices. Another solution is to impose fees for canceled orders.[29]

4. To what extent should dealers participate in the opening? In futures, scalpers are directly involved in opening transactions. On the NYSE, the specialist absorbs imbalances. In Japan, dealers cannot intervene in the opening. The participation of dealers adds to liquidity. However, if the dealer has privileged information about orders, obvious conflicts of interest arise since the dealer may be able to trade at an opening price known to deviate from equilibrium. No such conflict exists if information on order flow is publicly displayed, as in the CAC market or in other computerized auction markets.
5. How should price parity across different securities be maintained at the opening? Analysis of the functioning of an opening auction is often restricted to a single security. But securities are priced relative to each other, and information on the likely opening prices of other securities is necessary properly to open any single security.[30] One can imagine a well-functioning single-price auction for a single security; but without pre-opening price indications to guide traders in other securities, the overall quality of openings in all securities would be flawed.

A discussion of the issues raised in opening a securities market makes clear the benefits of a market in which the evolution of prices is continuously observable. In a continuous market, traders and information usually arrive in small increments. A trading delay hides new information and the desires of investors to trade. After a delay, it becomes difficult to convey information accurately and to accommodate appropriately the trading needs of investors. Empirical evidence in Amihud and Mendelson (1987) and in Stoll and Whaley (1990) shows that return volatility is greater around openings on the NYSE than at other times. One of the benefits of 24-hour trading is that the flow of information and the trading desires of investors are continuously reflected in prices.[31] If markets are closed, the procedure for reopening must be more transparent than is current practice in most markets.[32]

4. Industrial organization of securities markets

To this point the focus of discussion has been on the design of trading at a particular trading center. However, securities are traded in different competing markets. Stocks listed on the NYSE may be traded on regional exchanges, on NASDAQ, in foreign markets, and on proprietary trading systems. Large blocks are traded in upstairs dealer markets (although transactions are brought to the exchange for execution). Under recently passed Securities and Exchange Commission (SEC) regulations, options on common stocks and on indexes may be traded at any one of five option exchanges. Stock index futures and futures options, which can substitute for positions in stocks, are traded on several futures exchanges. To some, the dispersal of equity trading and the new forms in

which equity positions can be established are a sign of dangerous fragmentation, while to others these developments are a healthy sign of increased competition.

Fragmentation may be defined as the inability of an order in one market to trade with an order in another market. Debate over the organization and appropriate regulation of equity markets pits those opposed to fragmentation against those in favor of competition. Those who would consolidate markets worry that fragmentation of trading lowers liquidity and adversely affects price and time priority of orders. Those who favor competing markets value the beneficial effects of competition in lowering costs and spurring innovation.

Regulatory policy toward financial markets depends critically on the attitude of regulators toward the fragmentation of markets. If regulators believe that the evils of fragmentation outweigh the beneficial effects of competition, they are likely to take a more active role in shaping securities markets—to limit the number of markets and to require linkages of existing markets. On the other hand, if they believe the benefits of competition are paramount, they are likely to give freer reign to the underlying economic forces that are producing increasingly dispersed markets.

4.1. Sources and effects of fragmentation

It has long been argued that an exchange is a natural monopoly. Consequently the first exchange has, in the past, become the dominant market. Satellite markets can be established, and fragmentation can occur, only if the natural advantages of the primary market can be overcome. To do this, investors must first be convinced that prices in satellite markets are no worse than those in the primary market. If this is not possible, investors have no reason to trade in the satellite market. A promise of equal price is meaningful only if quotes and transaction prices can be monitored to assure that prices on the primary and satellite markets are aligned, something that was difficult in the past. Today, high-speed communications facilities make such monitoring easy, with the result that fragmentation is increasingly likely. Paradoxically, while fragmentation is more likely, its effects are less adverse because investors can more easily guarantee the equality of prices in different markets.

Second, fragmentation also requires that the costs of establishing a satellite market and executing transactions on it are less than the costs of trading on the primary market. If a primary market is the low-cost producer of transaction services (because it enjoys economies of scale in processing transactions, for example) a satellite market will find it impossible to compete. Competing satellite markets tend to arise if the primary market attempts to exploit a natural monopoly by raising prices above costs. During the fixed commission era before 1975, third market firms flourished for this reason, and most such firms disappeared after negotiated rates were introduced. To the extent that the primary market bears regulatory costs avoided by the satellite market, a cost advantage exists for satellite markets. Critics argue that competing systems free ride on existing exchanges that bear heavy costs in establishing fair market prices.[33] But free-riding is possible only if costs are low enough on competing systems to overcome the natural advantages of the primary market.

Fragmentation of markets is said to have several adverse effects. Fragmented markets maintain price priority, but they do not maintain secondary priorities such as time priority.

The absence of secondary time priority may reduce the incentive to place limit orders and thereby reduce the liquidity of all markets. The incentive to place a limit order is affected by the likelihood that the order is executed if the limit price is reached.[34] If the order does not have time priority, a later order at the same price may be executed first. This possibility reduces the incentive to place limit orders, which in turn reduces the market's liquidity. Harris (1990) argues for time priority rules but notes that time priority is valuable only if the tick size is sufficiently large. If a later order can easily better the price of a standing limit order, time priority has little value. Harris shows that the larger the tick size, the greater the benefit of time priority.

Fragmentation is said to reduce the volume of trading in the primary market and therefore to reduce liquidity in that market. However, aggregate volume is not reduced. As long as public investors can send trades to any market, and as long as dealers in one market can lay off positions in another market, aggregate liquidity is not adversely affected. If transaction sizes in the primary market remain unchanged under fragmentation, the existence of several simultaneously operating markets can increase liquidity, albeit at the cost of increased spreads. Suppose a large trader can sell a block of 50,000 shares by selling 5,000 shares simultaneously to each of 10 dealers in the several markets as opposed to selling 5,000 shares per trade in a sequence of 10 trades. Each dealer will find it more difficult to lay off the acquired inventory in the presence of dealers in other markets who are also trying to lay off inventory. As a result, dealers in all markets will have to raise their spreads. The higher spreads are justified in the sense that aggregate depth is large—50,000 shares, not 5,000.[35] In a centralized market, 10 trades of 5,000 shares would be traded at sequentially lower bid prices. The average transaction price might be the same as in a fragmented market, although the spread would always be lower.[36]

Fragmentation may induce strategic behavior by dealers in the primary market center. Suppose the satellite market guarantees the quoted price in the primary market. The dealer in the primary market could retaliate by widening the quote and letting it be known that she is willing to negotiate trades inside the quote for customers who come to the primary market.[37] In effect, this strategy reduces the informativeness of quotes disseminated by the primary market and thereby increases the risk to customers who trade on the satellite market.

4.2. Sources and effects of competition

The nature and sources of competition are in the process of changing dramatically. Competition arises not only from other exchanges with similar structures but also from proprietary trading systems, derivative markets, and markets in foreign countries.

In the United States, the NYSE, regional exchanges, and OTC dealers compete with each other. Regional exchanges have had the right to trade stocks listed on the NYSE pursuant to "unlisted trading privileges" granted by the SEC. Similar regional trading of NASDAQ stocks has recently been approved. Competition from the regionals has existed at a modest level for many years and has produced no opposition from the NYSE since 1941 when the SEC multiple trading case prohibited the NYSE from restricting its members' activity on the regionals. Today, NYSE members are the principal users of the regional markets. In recent years regional exchanges have provided a mechanism for firms

with automated execution and clearing abilities to offer trading services at prices that match those on the NYSE. The ITS system, which links NYSE, regional, and NASDAQ markets, facilitates this competition by allowing dealers in one market to lay off positions in other markets.

A second source of competition is the "third market" in NYSE-listed securities, which is made by OTC dealers that are not exchange members. Prior to competitive rates, the third market competed by charging lower commissions. With the advent of competitive rates, the advantage of many third market firms in cutting commissions was lost, and most third market firms failed. In recent years competition from third market firms has taken a new form. Some firms, such as Jeffries and Co., offer trading services to institutional investors. Other firms, such as Bernard Madoff and Co., provide automatic execution at the inside quote to brokers handling individual investor orders. Controversy has arisen over Madoff's practice of paying for order flow by rebating a cent to two cents to the broker. Similar rebates, albeit not in cash, are made by firms operating in regional markets.

A third source of competition are proprietary trading systems, for-profit systems that typically serve a particular niche. Proprietary systems are similar to regionals or third market firms in their competitive effect, but they often fall into a regulatory limbo in that they are not appropriately classified as an exchange or a broker dealer, the normal classifications for regulatory purposes. The SEC has allowed 20 proprietary systems to operate under no-action letters exempting them from registration as an exchange. These include Instinet, POSIT, Delta Government Options, Wunsch Auction Systems, and automated execution systems of brokerage firms.[38] Instinet is a computer network that permits subscribing institutions or broker-dealers to execute automatically against indications of interest placed in the system by other subscribers. POSIT and Instinet Crossing facilitate portfolio trading by institutional investors. Delta Options is a market for options on government securities. The Wunsch Auction System is a fully automated single-price auction in listed stocks open to subscribing institutional investors. Certain NASD firms provide automatic execution for their customers' small orders at the inside quote on NASDAQ.

A fourth source of competition are derivative markets in which positions in the underlying security can be synthesized. Equity options and index options are traded on five option exchanges, and index futures are traded on four futures exchanges. New OTC equity derivative markets offer tailored equity positions, such as options on tailored indexes, including foreign indexes, or other tailored equity positions. Since the prices of options and their underlying stocks must be closely linked, one might argue that stocks and their options should be traded on one market to avoid fragmentation. If traded in different markets, prices of stocks and their options may be out of line just as prices of trades in a single stock may be out of line. Yet to require integration of option and stock markets seems to be extreme and would probably have impeded the development of option markets.[39] Active users of option and stock markets find ways to link the two markets.

A fifth source of competition in the provision of trading services arises internationally. The same or closely related instruments can be traded in different markets around the

world. London trades U.S. stocks, and U.S. markets are attempting to trade foreign stocks.[40] Increased international competition will be difficult to contain, and it would be farfetched to attempt to limit international fragmentation by regulation. Markets are linked internationally, but the links have been forged by the users of markets, not by regulation. With respect to the bulk of cross-border trading, fragmentation is likely to be more severe across time than across space. Since investors in a given time zone trade during business hours, markets for nonlocal securities will be provided to serve investors in that time zone.[41] That implies, for example, that European markets will provide trading services for stocks of U.S. and Japanese companies during Europe's business hours, that Japanese markets will provide trading services in stocks of U.S. and European companies during Japan's business hours, and that U.S. markets will provide trading services for stocks of European and Japanese companies during U.S. business hours. Because of network externalities, a dominant market is likely to arise in each time zone for stocks of the major companies domiciled in countries outside that time zone. The foreign markets in a stock would not be active while the home market for the stock is open. Market links would be necessary only to provide the link from one time zone to the next.

The continued presence of regional markets, the development of new third market trading systems and of proprietary trading systems, and the growth of equity derivatives and global trading are clear indications that competition and innovation in trading systems are taking place.[42] Competition improves efficiency and enhances innovation. Trading costs have declined dramatically at the same that innovative trading technologies have been introduced.

The nature of competition has changed. First, the unit of competition is changing. In prior years, broker and dealers competed within a single trading market. Today, with the weakening of the dominant exchange's natural monopoly, trading markets compete. The NYSE competes with foreign markets and other markets in the United States. Yet the NYSE has not, until recently, viewed itself as a profit-oriented business operating in a competitive environment. Instead it has viewed itself and been viewed by others as a self-regulatory membership organization responsible for overseeing its market. While this role continues to be important, the NYSE and other exchanges are being forced to think more like business organizations.

Second, innovations in trading services are now more closely related to innovations in financial products. Futures and options can be used to simulate stock positions. Appropriate trading strategies in bonds and stocks can simulate options. OTC markets offer financial products such as synthetic equity, portfolio insurance, long dated options, and other products that are created by trading strategies. Trading technology and product innovation are closely related, and this implies that exchanges, long accustomed to trading existing products, must think of innovating in financial products as well as in trading technology.[43]

Innovations in new products and trading technology are stimulated by competition. If one believes that exchanges as well as brokers and dealers can innovate, the future structure of markets must allow for competition among exchanges and other trading systems as well as among brokers and dealers.

4.3. Regulatory policy

In the financial markets, regulatory intervention has been justified on three grounds: (1) to limit systemic risk by insuring the financial integrity of brokers and dealers; (2) to set standards of conduct and to guarantee transparency of markets, forms of intervention that can be justified as a way to reduce agency costs of investors. Transparency of markets, standard rules of trading, and standards for settlement reduce the costs to investors of monitoring brokers and dealers; (3) to oversee and limit the market power of exchange monopolies as a substitute for antitrust regulation. It is not possible to resolve in general terms the degree of appropriate regulatory intervention. Instead some specific issues affecting the nature and degree of regulatory intervention are examined.

4.3.1. The appropriate unit of competition and the appropriate structure of regulation The SEC regulates financial markets by regulating broker-dealers and exchanges. An exchange is a membership organization that has regulatory responsibilities vis-a-vis its members. Broker-dealers are regulated indirectly by their exchange or other self-regulatory organization (SRO). New trading systems may not fall easily into existing regulatory cubicles of "exchange" or "broker dealer." A trading system need be neither an exchange—because it need not have members—nor a broker dealer—because it need not have customer contact. A trading system can consist primarily of a computer program for the routing, matching, queuing, and execution of orders. As a result, the SEC has granted no-action letters exempting 20 proprietary trading systems from regulation as an exchange.[44]

In light of the growing number and variety of trading systems, it is appropriate to reconsider the implementation of the U.S. SRO system. Regulation through an SRO may be appropriate in a central market; but when different market centers compete, regulation through a particular market, such as the NYSE, can pose some difficulties. On the one hand, an SRO receives implicit certification from the SEC, and this may provide a competitive advantage vis-a-vis other trading markets that do not have SRO responsibilities. On the other hand, an SRO incurs costs of implementing regulatory policy that are avoided by competing trading markets without oversight responsibility. One approach is to separate more clearly the regulatory unit from the business entity responsible for offering trading services.

4.3.2. Policy toward market linkages Regulators have several options for dealing with market fragmentation. First, they can ban fragmentation and require all trades in a security to take place in a given market center. This approach has been adopted in France where a security may be listed on only one of the seven French exchanges.

Second, regulators may allow different markets but require links among them for routing orders. In the United States, the Intermarket Trading System (ITS) links trading floors of all markets trading NYSE-listed securities.[45] The SEC has been criticized for not actively facilitating a totally integrated national market system that goes beyond ITS.[46] The SEC position appears to be a compromise of requiring some integration while also

allowing markets to evolve without imposition of grand design by regulators. In the options area, the SEC appears to have taken a stronger stance in requiring links of the five different option exchanges. Options are cleared by a single entity and the SEC recently required that the five option exchanges develop a trading link.[47]

Third, regulators may allow trading to take place in different unlinked markets but require trades to be reported centrally. In the United States, transactions in NYSE-listed stocks may be carried out on any one of several market centers, but transactions are reported over a single consolidated transactions reporting system, and all quotes are reported over a single consolidated quote system.[48] In London, trading off the SEAQ system is permitted but reporting to the central market is required from all exchange members. Under the view of exchanges as business organizations, a hands-off policy might go further, allowing exchanges, for example, to restrict real time dissemination of prices and allowing exchanges to choose whether they want to link with other exchanges.[49]

Fourth, regulators may allow competing markets that are not linked and are not required to report centrally. This approach places the burden of linking markets on customers (and their brokers) who must determine which market offers the best price and who must route the order to that market. Regulators could still require public disclosure of all quotes and transaction prices, albeit not necessarily in a centralized system. In the United States, competing futures markets trade related commodities, but their trading floors are not linked and prices are not required to be disseminated in a centralized system. However, private information vendors disseminate information in a consolidated form.

Economies of scale in executing and processing trades, along with the network externalities of a market, might justify a single national market system in which brokers and dealers would compete but in which the need for separate market centers or exchanges would disappear. However, if such a single market is economically justified, it need not be imposed by regulations to link components.

4.3.3. Priority rules in fragmented markets If fragmented markets in the same instrument exist, investors cannot always be guaranteed price priority, and will find secondary priorities such as time and size difficult to maintain. For example, ITS does not maintain public priority since it is used only by dealers. Customer orders to the NYSE get the best NYSE price, but are not guaranteed the best price in any market. Instead of specifying how exchanges must be organized to achieve fair pricing without violation of priorities, regulators could state requirements for brokers. Brokers would then be responsible for achieving good prices. Naturally, the cost of doing so depends on the severity of the regulatory requirements. Three possible requirements in increasing order of severity are the following:

1. *Best execution requirement.* Under this requirement a broker is responsible for achieving "best execution." The term best execution is subject to interpretation, but one meaning is that the broker check all markets for a security and send the order to the best market.[50]

2. *Trade-through prohibition.* A large order may go to the best market but activate other orders at prices inferior to those in a competing market. In other words, an order may "trade through" a better price available on another market. Trade-throughs are difficult to prohibit because it is difficult to check each market as a transaction is being executed.
3. *Order exposure requirement.* The market center with the best stated price may not be the best market center for the transaction size of a particular customer. One approach for solving this problem would be to require brokers to check every market in which a security is traded to determine which market would do the entire trade at the best price. But exposing an order to all markets gives away valuable information and is a time-consuming process.

Some of the proposals for guaranteeing equal prices in all markets are clearly burdensome. One way of avoiding that burden is to mandate a market in which all orders are channelled through a central computer that maintains priority rules. The obvious drawback to this solution is that it reduces competition. It may be preferable to live with small violations of priority to achieve the benefits of competition and the attendant improvements in efficiency. It is probably a fact of life that one can't have competition without fragmentation.

4.3.4. Restraint of trade Certain rules of market centers have anticompetitive effects. If market centers are to compete effectively, what is the appropriate degree of regulatory interference in exchange rules that may restrain trade? Regulators have eliminated fixed commissions, but they allow markets to limit entry and to set a variety of other rules. Many markets require their members to trade the listed securities on that market alone. In futures markets, this rule applies since exchanges, as creators of futures contracts, require trading only on their floors. CFTC rules have the effect of approving and supporting this exchange rule. On the NYSE, Rule 390 requires all transactions in which a firm acts as principal to be executed on the floor of the Exchange. Rule 390 is approved by the SEC. The effect of Rule 390 and similar rules is to make it difficult for competing markets to attract business from brokers that are members of existing exchanges. Other markets (Switzerland, Britain) do not restrict off-board trading but require all transactions to be reported centrally.

Another practice declared illegal in the United States is to limit the distribution of price information. Fragmentation is effectively curtailed if prices in the primary market are not available to satellite markets, but so is competition. In the absence of price quotes in the primary market a satellite market would not know what price to quote and could not effectively guarantee transactions at the same price as those on the primary market. However, the absence of prices reduces the ability of public investors to manage their portfolios and to monitor brokers. Regulators have typically required the dissemination of quotes and transaction prices.[51] The principle of market transparency has been a useful guide to regulatory policy.

The need to regulate the conduct of individual exchanges tends to decline as competition from other markets intensifies. One of the important benefits of the new forms of

competition and the "looser" industrial organization is that the market power of any exchange or trading system is reduced, which in turn reduces the need for regulatory oversight.

4.4. Summary

Increasing competition among a growing number of trading markets is inevitable. Exchanges within the United States and in foreign countries trade the same stocks. OTC markets compete with exchanges. Derivative markets in futures and options trade instruments that compete with stocks. Proprietary trading systems, serving particular clienteles, compete with established exchanges. Competing markets can be successful if they have lower costs than established markets and if they can show their prices are no worse than those in established markets. Competition fragments markets in the sense that orders in one market do not have the opportunity to trade with orders in another market, but modern communications technology keeps prices aligned and makes it possible to assure investors that they receive price priority even when they trade in a satellite market. Market fragmentation may cause secondary priorities, such as time priority, to be violated, but the beneficial effects of competition probably outweigh these second order effects of fragmentation.

Increased competition reduces the need to regulate conduct of brokers, dealers, and exchanges or to oversee the actions of exchanges. A competitive market tends to be self-regulating. On the other hand, the need to set standards (for example, as to transparency, clearing procedures, trading priority rules) increases because a large number of competitors increases potential confusion. Standard setting is justified on agency cost grounds much as traffic lights or accounting standards are justified. As the number of markets increases, the need for standards increases. Some would argue that the dangers of systemic risk due to financially weak brokers or markets also increases, although such a position is subject to debate.

Regulators face a number of difficult problems in dealing with the increasingly dispersed trading markets. They must decide what degree of regulation is appropriate for the new types of markets. In so doing they will have to reconsider the definition and appropriate regulation of exchanges as well as the current role of self-regulatory organizations. They must decide to what degree various trading markets must be linked. Should markets be linked directly (that is, by linking order routing systems) or is it sufficient to rely on investors to link markets indirectly by shopping among markets for the best price and best service? Given the large number of related markets, including derivatives and foreign markets, direct links among all markets are clearly not feasible. Furthermore, the cost of building linkages and the adverse incentive effects on exchanges that are linked argue against direct linkages. Instead, it is probably sufficient to rely on the information network of upstairs brokers and dealers to provide price and volume information that links markets indirectly. Regulators must establish priority rules in trading that are fair to investors and yet not unnecessarily costly to investors. In transparent markets, most investors can determine for themselves if they are getting proper executions. Regulators have also been overseers of exchange monopolies, but the need for such oversight is declining with increased competition.

Today, competitive forces within the United States and from foreign markets are overwhelming any attempt to establish a single integrated market system. A certain degree of fragmentation is inevitable, but high-speed communications link markets and limit the adverse effects of fragmentation.

5. Summary and implications for market design and public policy

Optimal strategy for exchanges and optimal public policy for regulators must take account of the fundamental forces determining the structure of trading markets. The first part of this article examines the factors that affect the design of a particular trading market, including how to start trading. Market design poses difficulties, not because it is complicated to design efficient trade-processing systems but because trading rules affect the relative position of traders and their ability to negotiate prices. The second part of this article considers the nature, extent, and desirability of competition among different trading markets. The key problem is how to assure the benefits of competition while avoiding adverse effects of the resulting fragmentation of markets. Regulatory policy plays an important role in setting the ground rules for competition.

5.1. Forces affecting the shape of a market

On the demand side, all traders, whether motivated by liquidity needs, by information, or by other forces, desire immediacy. As a result, markets are moving to the continuous form rather than the call form of trading, all other things equal. The question is not whether markets will be continuous or call but whether they will be continuous auction markets or continuous dealer markets.

From the supply-side perspective, the shape of markets is determined in important ways by the production technology for providing trading services—the information system, the order routing system, the execution system, and the trade comparison and settlement system. Electronic systems, by replacing cumbersome face-to-face and telephone communication, enhance the efficiency with which orders are processed. Modern communications technology extends the market beyond the confines of the trading floor and increases the opportunity for certain firms to exploit economies of scale in processing trades. As a result, a declining number of firms now specialize in "back office" services.

Existing markets enjoy a natural monopoly resulting from network externalities on the demand side and the economies of processing and clearing trades on a single system. But modern communications technology gives competing markets the ability to access investors and thereby threatens the dominance of established markets.

The quality of a market is affected by its provision of risk-bearing services to offset temporary imbalances in public orders. Pure auction markets rely on public limit orders to provide liquidity to incoming orders. Dealer markets rely on dealers to provide immediacy by continuously quoting two-sided markets. Small orders can be "processed" without the need for much risk bearing in either type of market. Large orders, which require

significant risk bearing and negotiation, tend to be traded in dealer markets. Institutionalization of trading is causing the bulk of trading volume to move to upstairs screen-based dealer markets.

Dealer and auction markets are becoming alike as each type of market adopts elements of the other. Dealers play increasingly important roles in auction markets in order to provide continuity, and dealer markets are finding ways to incorporate a book of limit orders that will narrow spreads and increase liquidity.

Automated markets are well defined and remarkably similar across markets for stocks, futures, options, and bonds. As automation proceeds, the trend to greater similarity of market structures will be reinforced.

Automation can improve risk-bearing services of a market by facilitating the channelling of capital to those securities most in need of capital. Automation can also reduce payments risk by shortening the time for clearing trades.

Free trading options are implicitly granted when investors place limit orders or dealers provide quotes to the rest of the market. A standing limit order is in danger of being picked off by traders with more current information. If the value of these options is large, investors and/or dealers will be reluctant to provide liquidity. Markets must also deal with the problem of informational trading. Uninformed investors, who provide liquidity, are reluctant to trade if the probability of losing to an informed investor is high.

Trading rules, the degree of market transparency, and market organization affect who is picked off and how the adverse information trading problem is handled. When dealers post bid and ask prices, dealers are picked off, particularly if customers have access to high speed automated order routing systems. In auction markets, where customers place limit orders, customers are picked off. Time and size priority rules affect the risk of being picked off. Dealer quotes or customer limit orders are more likely to be placed if time (as well as price) priority is guaranteed, for then the risk of a long outstanding order is reduced.

Transparency is relevant. If limit orders are not disclosed, they cannot be picked off. On the other hand, full confidentiality is almost never possible (the specialist sees the orders on the NYSE), with the result that in the name of confidentiality certain individuals receive privileged information. Most markets have increased transparency, not reduced it.

It may be possible to enhance the quality of a market and reduce the dangers of being picked off or losing to informed traders if a market designates intermediaries to assume responsibility for the market in particular securities. In order to maintain their reputation and garner repeat business, such intermediaries seek to maintain fairness that may not be as feasible in an anonymous market with many atomistic competitors.

The process of automating trading is far from complete. While automation increases the speed and reduces the cost of the purely mechanical part of order processing, it also produces subtle changes in trading procedures. Automation affects trading rules and market transparency. It affects what is disclosed and who is first to indicate a desire to trade. Automation affects the relative positions of informed and uninformed, of public investors and market professionals. Who is picked off changes when markets automate. The value of private information is reduced as information and trading move more rapidly. Some fear that automated markets will be too anonymous and will make it difficult for financial intermediaries to build reputations and assume responsibility for the quality of the market. Automation of trading has, as a result, taken much longer than was originally anticipated.

Automation also raises some not so legitimate concerns as vested interests are reluctant to adopt innovations that threaten existing procedures. As a result, the innovators in trading markets have not been the major existing markets but rather the "upstarts." The limits of automation, particularly on established markets, have not yet been tested. More is desirable and more is likely.

Even as markets are becoming more continuous, call auction procedures for opening markets need to be refined and made more transparent. The evidence indicates that markets are difficult to start after an extended halt because it is difficult to convey in the opening price of each of many securities the information implicitly conveyed by the opening prices of all other securities. Small iterations in continuous markets tend to keep prices of different securities aligned. The difficulty of starting trading suggests that we should be slow to shut down trading.

5.2. Competition and fragmentation

Competition in the provision of trading services has increased dramatically. The dispersal of equity trading and the new forms in which equity positions can be established has led to a debate between those who consider these trends to be a sign of dangerous fragmentation and those who consider them a healthy sign of increased competition.

Competition in the provision of trading services has taken many different forms. In the United States, regional exchanges and the NASDAQ market compete with the NYSE. Proprietary trading systems that route and execute orders are competing with central markets. New automated systems, such as the Wunsch auction or the CATS system in Toronto, are operational. Foreign markets trade U.S. equities, and U.S. markets are developing the capability to trade foreign stocks. Futures and options can be used to create equity positions in competition with the stock market.

Competition fragments markets, but fragmentation will not take place unless investors are assured of a price in a satellite market that is no worse than the price in the market center. With modern technology this assurance of price priority is easier to provide. As a result, fragmentation is more likely today than before, but it is less harmful. Fragmented markets fail to maintain time priority of orders in different markets. Satellite markets may also "free-ride" on the market center and avoid the oversight costs of assuring market integrity.

A problem for regulators is how to accommodate the inevitable forces of competition while limiting the adverse effects of fragmentation and imposing fair regulatory costs on all markets. This article outlines different priority rules and different procedures for linking markets that regulators may impose. It seems safe to say that a certain amount of market fragmentation appears to be a cost of competitive markets.

Increased competition reduces the need for regulation. Attempts to micro-manage the structure of trading markets all too often entrenches existing exchanges or causes rules to be established that limit the ability of markets to respond to changing circumstances.

Notes

1. For an excellent discussion of market structure issues from the perspective of the NYSE, see Shapiro (1989). For a description and analysis of developments in world equity markets, see Huang and Stoll (1991). An article that provides important insights on the organization of markets is Harris (1990).
2. For excellent discussions of alternative trading arrangements see Cohen, Maier, Schwartz, and Whitcomb (1986, ch. 2) and Schwartz (1988, ch . 2).
3. Stoll (1985) shows that in 1979 specialists participated as dealers on one side of trades in about 24 percent of NYSE share volume. The NYSE Fact Book reports that this participation was 19 percent in 1989.
4. Surprisingly, there is little evidence that dealers in dealer markets like NASDAQ or London represent public limit orders to the rest of the market.
5. A considerable academic literature has developed on the effect of private information trading on the bid-ask spread and the short run behavior of prices. Articles include Copeland and Galai (1983), Glosten and Milgrom (1985), Easley and O'Hara (1987), and Laux (1990).
6. See Glosten (1989), Gammill (1989), and Benveniste, Marcus, and Wilhelm (1991) on this point.
7. Grossman (1976) provides a theoretical analysis of this problem.
8. Murphy's Law (What can go wrong, will) ensures that noise traders encounter information traders, particularly on the large trades. Barnum's Law (A sucker is born every minute) ensures that noise traders, driven from the market by trading losses to the informed, are replenished.
9. See Katz and Shapiro (1986) and Farrell and Saloner (1988) for analyses of network externalities in other areas.
10. The NYSE DOT system processes three quarters of all transactions (Shapiro, 1989, p. 20), but most orders are not executed automatically. Intervention by the specialist is required.
11. For example, coordination between securities and futures markets is difficult because futures markets settle in one day. Coordination across countries faces a variety of difficulties including differences in banking laws, exchange rates, and so on. See U.S. Congress, Office of Technology Assessment (1990a) for a discussion of clearing.
12. See Minnerop and Stoll (1986).
13. There are some competing clearing organizations—the Midwest Clearing Corporation and the Philadelphia Stock Clearing Corporation, for example.
14. Huang and Stoll (1991) provide a brief description of these systems.
15. Domowitz (1989) provides a detailed analysis of the mechanics of three automated execution systems—RAES, SOES, and Globex.
16. See Grossman and Miller (1988) for a discussion of different markets' arrangements for providing risk bearing.
17. Telser and Higinbotham (1977, p. 998).
18. See NYSE Market Volatility and Investor Confidence Panel (1990) for this recommendation. Suggestions for a variety of contingent limit orders appear in Black (1971, Part II).
19. London has limited the requirement that dealers honor their quotes vis-a-vis other dealers. NASDAQ has classified traders who trade more than five times a day in the same stock as professional traders and has banned such trading.
20. See also Glosten (1989) on this point.
21. See Kraus and Stoll (1972) and Holthausen, Leftwich, and Mayers (1987).
22. The London market has limited transparency to protect market makers. Large trades, which presumably signal the presence of information, are not reported for 90 minutes to give the market maker time to unload his position on the unsuspecting public.
23. Chan and Weinstein (1991) analyze the specialist from this perspective. Beneveniste, Marcus, and Wilhelm (1991) provide a model of a specialist who helps protect uninformed from informed traders.
24. The DPM shares in the volume of trading so long as the quote of other market makers in the crowd is matched.
25. See Amihud and Mendelson (1990a); Amihud, Mendelson, and Murgia (1990b); and Stoll and Whaley (1990).

26. The Wunsch Auction executes transactions prior to the opening of the NYSE. Orders are submitted between 7 AM and 9 AM, and a single price that clears the market in each stock is established at 9 AM. Commissions are structured to encourage early submission of orders. Orders cannot be removed once entered, but they may be offset (thereby incurring another commission). The price of an existing order can be improved (higher buying price or lower selling price) at no penalty.
27. See Amihud, Mendelson, and Murgia (1990b).
28. This would be less likely if investors could submit demand curves.
29. As in the Wunsch auction.
30. Amihud, Mendelson, and Murgia (1990b) make this point.
31. Harvey and Huang (1991) show, for example, that the difference between nighttime and daytime volatility in the U.S. foreign currency futures market is less than that in the U.S. stock market. This reflects the fact that currencies, unlike common stocks, are traded somewhere in the world at all times.
32. Two recent theoretical papers contrasting call auction markets to other market mechanisms are Bronfman and Schwartz (1990) and Madhavan (1989).
33. Mulherin, Netter, and Overdahl (1991) argue that proprietary exchanges expropriate the property rights of existing exchanges. Substantial controversy has arisen over the practice of paying for order flow by certain dealers who match NYSE quotes. Such dealers are not members of the NYSE and do not incur the costs of membership.
34. See Amihud and Mendelson (1990a) on this point.
35. The higher spreads of NASDAQ and London stocks than of NYSE stocks partially reflect this.
36. Alternatively, the block could be negotiated off the floor and sold on the floor at a price that deviates from the standing bid. Under this procedure, existing buy limit orders usually receive the block price.
37. I am grateful to Marshall Blume for making this point to me.
38. See Becker, Adkins, Fuller, and Angstadt (1991). See also U.S. Securities and Exchange Commission (1989). Seven of the 20 systems have gone out of business.
39. On the other hand, prohibiting side by side trading of stocks and options on the same exchange as the SEC has done is also undesirable in competitive markets.
40. An example of increased international competition is the introduction of trading in foreign (and perhaps U.S. stocks) on the NASDAQ system from 3 AM to 9 AM during London's trading hours. Trading would be open to NASDAQ members whether based in the U.S. or Europe, but NYSE off-board trading restrictions would apparently still restrict U.S. firms' use of this facility.
41. See Stoll (1990) for an analysis of the shape of world equity markets.
42. One recent measure of the effect of competition is the NYSE's June 1991 adoption of an after-hours trading session in response to competitive pressures from POSIT, Instinet, and trading in London by NYSE-member firms.
43. With respect to new products, futures markets have been substantially more innovative than stock exchanges, as evidenced by the outpouring of new product introductions in the 1980s. In part, this greater innovation reflects the fact that futures contracts are traded and cleared exclusively on the originating exchange, which makes it possible for the revenues generated by new products to be captured by the members of the originating exchange.
44. Becker, Adkins, Fuller and Angstadt (1991) describe the criteria for registration as an exchange and as a broker dealer and discuss the basis for exemptions under current law.
45. It is important to note that ITS links dealers in different markets. It does not link customers. Customers are guaranteed best execution on the market to which they send their order, but ITS does not guarantee a customer the best price on any market in which the stock is traded.
46. For an analysis of a national market system, see Peake (1978). For a recent criticism of SEC policy, see the report by the U.S. General Accounting Office (1990). See also U.S. Office of Technology Assessment (1990b) for a critical assessment of current U.S. securities markets' structure.
47. Amihud and Mendelson (1989) evaluate alternative systems for linking markets.
48. In addition to the NYSE, NYSE listed stocks may be traded on the regional exchanges—Midwest, Pacific Coast, Philadelphia, Boston, Cincinnati—and on NASDAQ and Instinet.
49. Mulherin, Netter, and Overdahl (1991) argue that exchanges are businesses that should be given property rights over prices they create. They also discuss the desirability of requiring exchanges to link with other

exchanges and the effect on organized exchanges of allowing competing markets that are not subject to the same regulation and free ride on the basis of prices established in existing markets.

49. Interpretation is difficult because different markets may charge different commissions and may impose different access costs.
50. See Mulherin, Netter, and Overdahl (1991) on this issue.

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