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INTERNATIONAL OPPORTUNITIES FOR THE USE OF INFORMATION SYSTEMS IN SECURITIES TRADING CREATED BY DEREGULATION OF THE LONDON STOCK EXCHANGE

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ABSTRACT

Big Bang, the deregulation of the London Stock Exchange in October of 1986, was accompanied by changing industry structure, altered regulatory environment, and new trading practices. In particular, trading was automated, and the floor of the Exchange rapidly was abandoned.

Such massive discontinuities have produced opportunities in other industries. Although they may prove temporary, opportunities are arising to seek competitive advantage in London. Given the information-intensive nature of securities trading, and the great differences in resources and experience with technology enjoyed by different firms, many of these advantages will entail use of information technology.

1. INTRODUCTION AND SUMMARY OF FINDINGS

A stock exchange is intended to provide an *efficient mechanism for price discovery* and a *concentration of liquidity*. That is, buyers and sellers should be brought together, in sufficient numbers that prices for stocks can be determined, and in sufficient numbers that those who want to buy or sell are assured of finding counter-parties for their trades.

For decades, the means of providing price discovery and liquidity was face-to-face dealing on the floor of an exchange. This is clearly no longer true: New York has its own upstairs market, the block trading desks of major brokerage houses; Tokyo has CORES, a market that is fully automated except for the 250 most active issues; and NASDAQ, an exchange in all but name, has never had a trading floor. In all of these, information systems, to varying degrees, substitute for face-to-face dealing and provide efficient mechanisms for performing the basic functions of an exchange.

London's Big Bang, the deregulation of the London Stock Exchange on October 27, 1986, remains the most sweeping deregulatory event ever undergone by a stock exchange or a financial market (*American Banker* 1986; *Institutional Investor* 1986). Almost overnight, the following changes occurred:

- Face-to-face trading on the floor of the exchange was supplemented by electronic dealing by an increased number of competing market makers.¹ The trading floor--along with its centuries old trading tradition--was then abandoned almost immediately

- Fixed commissions were eliminated, allowing institutional customers to negotiate for better rates and increasing competition
- Old restrictions on the roles of trading houses were dropped; these restrictions had required that a firm serve either as a *broker*, trading for customers' accounts, or as a *jobber*, servicing brokers, trading for the jobber's house account, and profiting from spreads and changes in the value of stocks held in the firm's position. Firms were now permitted *dual capacity* trading, in which they were allowed to perform both brokerage (agent) and market maker (principal) functions
- Membership in the Stock Exchange was opened up to an increasing number of firms, including several foreign financial institutions
- Mergers, consolidations, and acquisitions by United Kingdoms and foreign financial institutions dramatically altered the competitive situation faced by British brokerage houses

Concurrent deregulation, to varying degrees, has occurred in the world's major financial centers in New York, London, and Tokyo. However, the deregulation of the City of London is the most extensive, the resulting changes are the most drastic, and the opportunities created are most interesting for both traders and academic researchers.

As has been evident from experience with airline and telecommunications deregulation in the United States, sweeping deregulation is often accompanied by changing market structures, changing dominance in the market-

place, and the creation of new opportunities. Not all firms are equally adept at spotting these opportunities, nor are all firms equally well positioned to exploit them. Moreover, the players that perform best in the newly deregulated environment are not always the same as those that excelled previously.

What is the emerging structure of the equities market in London since deregulation? What are the opportunities? What are the unsolved problems? What is the role of information systems in responding to opportunities and resolving difficulties? In particular, what are the competitive implications of information systems? Which players are best positioned to operate in the new financial environment?

Perhaps the most visible change, which most characterizes the events of the City, is the new, more ready access to information by more people, off the Exchange as well as among its members. Once almost a club that was managed for the benefit of its members, the Stock Exchange is now open to all, including banks, foreign institutions, and the individual investor buying five shares of British Telecom.

In examining the strategic uses of information technology, we focused on the following issues:

- Linking markets globally to date has involved the efforts of individual firms to access key markets; for example, the United States firms had to establish their links to London in order to have access to the world's largest foreign exchange market and the Eurobond market. Years of coordinating trading between geographic markets has given the Americans the prototype for linking to any financial market in the world. Likewise, the recent dominance of Japanese firms in the U.S. Treasury market has forged their Tokyo-New York link.

Moreover, in international equities trading, these links are characterized more by exchange of information and instructions than by actual transactions on foreign exchanges.

- Numerous forces have led to increased desire among investors for diversification of their portfolios. Principal among these have been increased access to information, leading to greater understanding of foreign markets and a greater awareness of opportunities, desire to limit exposure or risk in individual countries, and the desire to obtain the best risk-adjusted rate of return available anywhere. Additionally, the vast current accounts surplus of Japan has led to an excess of investible funds, or liquidity: Japanese institutions simply have more money than can readily be absorbed by the Tokyo Stock Exchange, increasing the attractiveness of foreign investments. The Tokyo market, with an excess of

liquidity, is described as "somewhat like trying to fit the contents of a quart bottle into a pint" (Vartan 1988). Deregulation has made it easier for private as well as institutional investors to diversify their portfolios. Increased diversification has in turn spurred interest in composites and derivatives of these securities. The result has been increased complexity of securities, size of their markets and volatility of their prices.

It takes real, reliable, rapid access to information to participate actively in any market. This in turn requires technology.

- London firms vary widely in their acceptance of and attitude toward technology, with interesting implications. Since investment in technology requires substantial capital commitments, the need for capital was a major factor in the wave of mergers preceding Big Bang. Interestingly, although the opportunity to invest in information technology was ignored by some firms, the consensus now seems to be that the attention paid to technology will be a factor determining the successful firms. Those who cannot bring themselves to commit the necessary capital to technology may not have the confidence in themselves needed to make such a bet on their long term viability (Mitford-Slade 1987).

However, technology for its own sake will not be the key. Since innovation and speed are two of the factors critical to success in the securities business, the people who know the market must be able to communicate effectively with those who understand technology and back office processing needs. Communication channels are facilitated by senior management that realizes the importance of technology as a tool for monitoring, and thus controlling, the new and increasing risks of the business.

2. INFORMAL NATURE OF MARKET LINKAGES

2.1 Exchange of Price Information

For a market to exist, its participants must have *liquidity*, or funds to invest, and the ability to transact based on occurring events. This means they must have sufficiently rapid access to all the information necessary to make a decision. Therefore, participants, whether brokers, market makers, or investment managers, are coming to desire links to real-time sources for price quotes, financials, news, exchange rates, and other information that is significant to each deal.

Most sources of pricing information for equities display *indicative* prices, which are merely suggestive of prices at which securities may be bought or sold; thus, these systems require contact with the market maker to establish a *firm* price upon which a transaction can be executed. Except for Reuters' foreign exchange dealing system (which

carries 30 percent of the world's FX transactions), negotiating prices requires human contact. Reuters' system provides a prototype of the world of "automated trading" in which a dealer hits a button to connect within two seconds with the market maker displaying the best indicative price. The market maker in turn knows automatically which dealer is requesting a firm price and can use this to determine what price to give him. Negotiations can thus be conducted and concluded completely electronically. This electronic conversation allows a trade to be automatically confirmed, recorded and printed, reducing opportunity for error, as well as to gather information from the tone of a human voice.

Instinet, also a Reuters company, is an example of electronic price quotation and trade execution for equities markets. Access to this system by institutional clients that are not exchange members allows them to advertise their orders electronically to other non-members and in essence to execute trades outside the official market. (Currently, rules at many stock exchanges limit the ability of member firms to trade equities off the floor of an exchange.) Instinet provides the medium that functions in one sense as the broker; in another sense, Instinet serves as a prototype for the automated electronic market of the future. Obviously, the existence of such a system has implications for the future of many of the intermediaries in the securities business. Just as the introduction of automated execution systems for small orders on the New York Stock Exchange (DOT--Designated Order Turn-around) and NASDAQ (SOES--Small Order Execution System) reduced the need for additional brokers to handle small trades, Instinet may reduce order flow for some brokers.

2.2 Dual Pricing Sources and Arbitrage

The linking of markets, and the linking of securities to form derivative instruments that followed, generate an additional need to integrate the systems feeding information to market participants. This permits them to do quickly the complex computations required, especially for arbitrage decisions. Opportunities for arbitrage arise when the same security is traded in two or more separate markets, such as Big Board issues traded in London, or when the same security or commodity can be traded in two or more different ways, like equities and futures contracts or options on those equities. Price changes generally destroy these opportunities shortly after they are discovered; therefore, speed of discovery and speed of execution are critical. Sometimes opportunities are created by obtaining access to a separate market that competitors do not have or to a better source of one of the "ingredients" required to create a duplicate of a security, for example, a real-time feed of foreign currency rates when valuing a security priced in two different currencies. Assuming the ability to open a position in one market and close it in another (i.e., the *fungibility* of in-

struments), global trading and the arbitrage activities that make markets efficient are dependent on technology to handle the increasing size, complexity and risks.

The significance of the human element in this high speed trading environment is not yet known and will be difficult to resolve for some time. This element is exemplified by the specialist system on the floor of the New York Stock Exchange. Some argue that this system is the most efficient and liquid form of a market, that its tradition of human interaction is more forgiving of errors and more understanding of the bigger picture in the market, and that it cannot be easily displaced.² Others argue that the City's bold move to abandon its exchange floor and rely on an upstairs electronic market is the way of the future, and that as the speed and liquidity of London exert pressure on New York, the New York Stock Exchange specialist system will be forced to adapt (Mitford-Slade 1987). It remains to be seen just how much direct human interaction can be removed by blinking screens and satellite networks, before there is some detrimental effect on the markets.

With information technology emerging as a key factor in today's markets, geographic location of a trader may soon prove to be almost irrelevant. The relevance of geography, it has been argued, is principally that proximity to the market facilitates reading its nuances; this ranges from "sensing the fear" in Singapore, to watching a senior Nomura trader running in Tokyo, to conversations overhead in a pub in London.

2.3 Need for Regulation in Linked Markets

Governments are beginning to negotiate to establish some bilateral guidelines between markets. Cases of cross-border abuses have not yet appeared, but there is some discussion of a trend toward re-regulation of the markets. As the regulatory agencies themselves obtain real-time access to the markets and develop their own systems for surveillance, there is a concern that the imposition of tighter controls will add costs to those in the business. Regulating the issuance of securities and the disclosure of corporate financials is generally accepted as essential to the markets' credibility, but some question the degree to which the actual business activities of participants should be regulated.

One of the major debates is whom the regulators should seek to protect through their rules. There is a great difference between rules protecting small investors and those protecting institutions. Western governmental bodies have frequently favored the former, and thus may place unnecessary constraints on those serving entirely the latter. However, the increasing interest in promoting the retail distribution of securities, particularly in the United Kingdoms and France, will probably reinforce this preference on the part of politicians.³

3. PRIVATE LINKING OF MARKETS: INTRA-FIRM INTERNATIONAL TRADING

3.1 The Firm's Global Position

Not all firms choose to maintain a global position in corporate securities trading. Some of the major United Kingdom investment banks are content to stay home and specialize in United Kingdom securities. Those firms that have established international links over the past decade or two have done so out of necessity. The importance of foreign exchange to any international financial institution drives it to seek access the major FX market, London, and to justify the technological investment necessary to build a global network. While information links may be necessary to establish linked global 24-hour trading, putting links in place does not assure that such trading succeeds. United States firms, having grown accustomed to geographically-extended trading operations, have also developed the infrastructure and mentality required. This includes learning to coordinate trading strategies over long distance telephone, monitoring and controlling positions for most of the day's 24 hours, and hiring traders for the graveyard shift (*Business Week* 1987). Even this will not assure successful international trading. Investor demand will be critical in driving internationalization of the securities markets, and predicting this demand has proved to be quite difficult.

There are arbitrage implications of a firm's trading strategy that go beyond technology and infrastructure. Who controls the firm's position? What if seizing an arbitrage opportunity (placing a deal) places the firm or the trader briefly over limits established by the home office? The time to call New York to obtain permission will almost certainly result in the loss of the opportunity. Current practices vary widely among firms.

3.2 Product Innovation: Securitization and Derivatives

Confirmation was received of the short-lived profitability of many of the new derivative securities, created as a composite of other assets or securities. A close working relationship and common language between those in the market dreaming up the products and those building the systems was also confirmed as critical to a firm's success in profiting from these products for as long as possible (and longer than the competition) (Clemons and Adams 1988b). Perhaps significantly, the two firms in London most actively embracing this view had London operations headed, at different times, by the same individual.

Because of complexity of these new derivative instruments, their risks are more difficult to assess and thus to manage. Here, the technology that created them must be used to calculate and monitor these risks. Besides the initial packaging and pricing, there are risks associated

with making a market in these derivative instruments. Merrill Lynch's experience in 1987 with stripped mortgage-backed securities, in which several hundred million dollars were lost in two weeks, is but a single example of the need for systems to model risk and monitor exposure.

When making a market in any security, firms have had to undergo increasing scrutiny by the market. First a firm had to reveal an indication of its bid/ask prices for a security over a system accessible by other market makers, then over a system accessible by the clients themselves. (This is the current situation in the Eurobond market.) Elimination of dealers' ability to show different prices to different market participants was the next step, as competition forced everyone to keep prices in line with the market. The transition from indicative to firm price quotation over a system (as instituted in London) increased a firm's exposure to the market by obligating it to deal at the price shown on the screen.⁴ In London, some firms have managed this exposure by not answering the phone when someone calls to "hit" the market maker at the price displayed, thus avoiding the obligation to deal. The final step is to automate trading such that a machine automatically accepts and executes the trade.⁵

The final phase contains implications for how a firm updates its quotation display. For more complicated securities, for which time-consuming valuation computations are required, a delay in updating a display could be costly. Therefore, the extent to which trading is automated and human interaction eliminated affects a firm's exposure in the market and thus the degree of risk it assumes. One can expect that the firm with information technology best supporting such an environment is the one best controlling its risk exposure and more accurately projecting its returns.

4. TECHNOLOGY AS A SOURCE OF COMPETITIVE ADVANTAGE

4.1 Trading and Investment Management

Much of the discussion immediately preceding and following Big Bang focused on the trading room, where so much money visibly can be made and lost. Competitive advantage for traders can be delivered by systems that provide greater speed or accuracy⁶ or support innovation through system integration. These systems support the revenue generation related to arbitrage and market timing. Prior work in other areas of competitive information technology indicates that these systems are likely to be employed by all major trading houses, rendering such systems *strategic necessities* (Clemons and Kimbrough 1986).

At present, there is reason to believe that as more institutions attempt to exploit arbitrage opportunities, and develop necessary systems, these opportunities will last

for shorter and shorter periods of time. One senior trader we met with spoke about *specatrage*: as the arbitrage opportunities get shorter and shorter, delay in execution of an order could allow the market to move against the firm, closing the arbitrage window. Windows have gotten so short that some traders attempt to predict when a window will open and place their arbitrage orders *before* the opportunity arises. This, of course, is no longer risk-free arbitrage. It does illustrate how competitive pressure in efficient markets eliminates arbitrage opportunities; it also illustrates how a competitive advantage quickly can evolve into a strategic necessity.

Luck sometimes brings windfall profits when the market moves with you. On the down side, however, losses can be equally unpredictable; often they can be traced to an incorrect estimate of the risks undertaken. It is here that the management control function must look for ways to understand and communicate these risks and that information technology may have its greatest, though largely invisible, impact. At present, there are still significant differences between the real-time systems employed by Merrill Lynch or Goldman Sachs to monitor their firms' trading positions and the systems available to most British or Japanese trading houses. The most advanced American firms believe that their systems are presently sources of competitive advantage. This belief is shared by their Japanese competitors, many of which are investing in similar systems today. Thus, we expect that systems for risk management, control, and management alerting ultimately will also prove to be strategic necessities.

The traditional investment managers of the major United Kingdoms pension funds are facing stiffer competition from new independent fund managers. The pressure on showing higher short term returns is pushing the United Kingdoms towards the structure of United States fund management with the unbundling and specialization of services provided and the development of a competitive selection system for fund managers (*Financial Times* 1987). These changes may prompt the United Kingdoms managers to begin creating differentiating, value-added products to win pension management contracts. These products could include some of the terminal-based services, seen in the United States, that give clients direct, electronic access to their portfolios' current status.

4.2 Settlement

The fact that highly qualified settlement staff in London are worth almost as much as traders attests to both their scarcity and their importance (Mitford-Slade 1987). There continue to be indications that some firms are having greater difficulty than others in dealing with their back office backlog; indeed, it is reported that firms have been turning business away because of settlement problems (Wall Street Journal 1987a). Although the decrease in trading volume that followed the October 1987

crash has reduced the urgency, we anticipate opportunities for third party vendors of settlement services and for vendors of trading systems that provide automatic links to settlement.

Countries have much to do in resolving settlement problems within their domestic markets and are far from dealing with the more complex issues surrounding cross-border settlement. If an international settlement network were to develop, one opinion is that it would be independent of existing exchanges (Clemons and Adams 1988a). In the same vein, an individual not from Reuters suggested that if Instinet provided a settlement system, it would itself *be* a stock exchange. With Instinet, Reuters has defined its role as solely providing the communication link to the clearing corporation and not as being the clearing system itself.

5. COMPETITION AMONG NATIONAL MARKETS

5.1 Retaining National Trading Volume

Big Bang had two objectives:

- to comply with government requirements that the Exchange end practices that were viewed as restricting trade
- to enhance the competitive position of the London Stock Exchange in comparison to Continental exchanges, and even in comparison to the major exchanges in New York and Tokyo

If a market is inefficient or expensive, people will circumvent it and deal directly with their counter-parties, or they will find another, more efficient market. Rather than fight this, London exploited it, making their market more efficient than any in Europe and opening it to foreign brokerage firms and investors. In this market, members can trade from anywhere. The City's hope is to attract money and people to its market, thus effectively becoming both *the* European market and the place where United States stocks are traded when New York is closed. These efforts appear to have had some degree of success: while both the New York and Tokyo Stock Exchanges each trade less than 100 foreign equities, over 700 foreign issues are traded in London. And, although non-domestic issues account for less than 5 percent of New York's volume and less than 2 percent of Tokyo's, non-United Kingdoms turnover is fully two thirds as large as domestic volume.

In giving greater access to more people, the City intended to create a more informed market, which, in turn, should create more investor attention, liquidity, and volume. With more information at their fingertips investors should have more confidence in their securities valuation and should trade more astutely and more actively.

5.2 The Changing Role of the Exchange and the Changing Role of Information Technology

London's SEAQ took the process of using information technology to support the functions of an exchange further and faster than any other exchange to date. For example, on NASDAQ, prices are still only indicative, except for orders small enough to be executed through SOES, its small order execution system; on SEAQ, prices are firm for larger lots, often L x L or even XL x XL. (L x L represents a firm commitment to deal in lots of up to 100,000 shares at the quoted price, and XL x XL represents a firm commitment to deal in lots up to 1 million shares.) Competing market makers adjusting their prices to meet the market assures efficient price discovery and SEAQ screens disseminate this pricing information as efficiently as did the floor of an exchange. Moreover, since these screens are readily available off the market, more investors now have access to real-time price information and to market makers. This increases the potential number of players and thus increases liquidity.

In one sense, however, the SEAQ system is only an officially sanctioned information system for price quotation and dissemination, with feeds to settlement and surveillance. If this is the case, what is the difference between an exchange such as the International Stock Exchange and an information vendor such as Reuters? What prevents a systems vendor from displacing the Exchange's information system with a more complete and faster processing system with greater end-user computing power? Competing systems for London, or alternatives to the NYSE, could come from a variety of sources: Reuters, EDS, AT&T/Telerate, or even brokerage houses like Merrill Lynch or Nomura. While Barclays de Zoete Wedd's automated trading system at present accepts only small bargains, it clearly represents a first move in this direction (Barclays de Zoete Wedd 1988; Cane 1988); similarly, the system developed by five French banks to trade derivative instruments is proceeding, despite opposition from the Paris Bourse, indicating the threat that financial institutions may represent to traditional exchanges (Graham 1988).

6. CONCLUSIONS

We believe that further changes are in store for major financial markets. These changes are likely to be dramatic, and may be surprising to many academic researchers and veteran traders. The following forces will drive this change:

- Linking markets for different securities, both domestically and internationally, has created a wider array of choices for investors (Wall Street Journal 1986a, 1986b, 1987a, 1987b). More imaginative investors have seen opportunities in forming new securities from the combinations of the wider variety of under-

lying primary instruments to whose prices they have gained access.

The value of these creations is derived from higher, more diversified returns, but is countered by the new, and often unknown, risks embodied in these new instruments. Understanding the increasing number of factors that affect a new security's value and keeping track of them will require greater management attention and increased systems support.

- Deregulation was designed to increase the fairness and scope of competition in the markets, based on the belief that through pure competition the markets maintain their efficiency. Increasing numbers of competing market makers, plus the technology that forms their market, has made more of their information available to more people. This trend of opening the markets has exposed market makers to new risks. By imposing an obligation to trade at the price advertised, the Stock Exchange gives a market maker very little room to hide and forces a more active management of his positions.
- The removal of the human element will be difficult as long as the market can be moved by rumors and the tone of the human voice. Face-to-face trading, both in auction and specialist markets, appears firmly entrenched at present in North American equities and futures trading.
- The attitude of a firm's management toward the long term nature of investment in information technology continues to be a factor determining a firm's success in meeting the need for information technology to support constant innovation. The effectiveness of communication between technologists and rocket scientists will be a key in determining this success.

There appear to be major differences among the strategies selected by London financial institutions. Some appear to be correlated with the home country of the firm:

- United States firms have greater experience with use of technology for trading, settlement, derivative instruments, and decision support
- Japanese firms have almost unlimited resources, and are likely to be a major force in any market they choose to enter, from London equities to United States treasuries and commodities.

Competitive advantage using information technology will continue to be difficult, uncommon, and temporary. Successful strategies to use information technology must be founded on a firm's understanding of its key strengths and limitations, selection of clients it can profitably serve, and the markets in which it must operate in order to

serve them. Defining the scope of its activities is required before making the technological investments necessary to support the business and properly analyze the risks. Moreover, these decisions, made individually by the various firms involved in the securities business, will determine to a large extent how markets are linked.

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9. ENDNOTES

1. Although rules and market structures differ among markets, trades on an exchange are between *member firms*. In any given trade, a member firm can be acting as a *principal*, trading for its own account, or as an *agent*, trading for the account of a client. *Market makers* are principal traders, buying or selling securities for their own inventories (*positions*), and facilitating trading among brokers or investors. Unlike investors, who hold stocks for varying periods of time for appreciation or dividends, market makers hold stocks for very short periods and make their profits on *spreads* (the difference between buying and selling prices) and on short term price fluctuations.
2. This view was supported by Mr. Jack Davis, Director of International Market Planning for Quotron in London, and by Mr. Robert Reid, formerly Senior Vice President of the NYSE and currently Chairman of Instinet, both in private conversations. However, this has been a topic of much discussion since the market crash on October 19 and 20. The size of the drop on the New York and the American Stock Exchanges was less, on a percentage basis, than the drop on the NASDAQ over-the-counter market. It is unclear how much of this difference is due to the dif-

- ferences between specialists on the exchanges and competing market makers on NASDAQ.
3. It is instructive to examine the different responses to the market crashes on Black Monday and Bloody Tuesday, October 19 and 20. The British market, despite the Thatcher government's successful privatization efforts, is largely an institutional market. In Britain official response to the fall of the market is that it efficiently reflected changing investor desires and expectations, and interference with market efficiency is not justified. There was also a desire to *increase* the opportunities for use of derivative instruments like futures and options (*Quality of Markets* 1987). The United States market has a more significant retail presence, and the retail side is often terrified of price volatility. Therefore, United States regulators have considered numerous mechanisms to slow any future rapid drops in the markets, suggesting limitations on daily price movements in individual equities, limitations on forms of program trading, particularly index arbitrage involving futures contracts and equities, if the market has moved more than a fixed amount in a single session, and increased margin requirements for derivative instruments to decrease their role.
 4. London introduced SEAO, the Stock Exchange Automatic Quotation system, at the start of Big Bang. Market makers post firm prices through SEAO, as well as the maximum size bargains they are willing to deal at those prices. Although posted prices can be changed, firms must trade at their posted prices.
 5. SAEF, the SEAO Automatic Execution Facility, currently under development in London, will be an example of an automatic execution facility. Market makers will quote firm prices and lot sizes in SEAO and automatic execution will be achieved through SAEF, with immediate and automatic feeds to settlement and to surveillance.

Barclays de Zoete Wedd (BZW), a major market maker in London, has just introduced its own automated trading system for small orders, TRADE, in advance of SAEF. While trades will be executed at the best prevailing price, BZW market makers will have first opportunity to accept bargains through TRADES. It is not yet clear whether TRADE will preempt SAEF, nor whether it will increase BZW's share of the London equities market (Cane 1988).
 6. The advantage offered by speed becomes quite clear after observing traders. One afternoon in the bond futures trading room in the basement of the Tokyo Stock Exchange, we saw a 20 basis point change in the exchange rate--the difference between 149.05 and 149.25 yen to the dollar--result in *every* trader raising his hand to dump bonds at market, in other words, at *any* price. What would half a second advance notice of the rate change have been worth to an investor? The advantage offered by even half a second has been sufficient for some institutions to change their data feeds from satellite links to fiber.