Electronic Trading Networks and Electronic Commerce

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Abstract

The increased competition witnessed in the market for executing orders for financial assets is the result of efforts to develop new solutions to the evolving needs of the investment community. The structure of market mechanisms reflects the use of contemporary technologies. Recent innovations in trading technologies involve the use of electronic networks to create value-added services and thus attract order flows away from existing trading institutions. Electronic commerce technologies can be exploited to implement highly disintermediated structures where individuals can directly trade combinations of assets with each other and settle trades on a real-time basis.

Introduction

This past decade has seen a significant increase in competition, both in the U.S. and elsewhere, for the business of matching buyers and sellers of financial securities. Organized exchanges in financial centers like London, Paris, Frankfurt, Stockholm, Geneva, and Toronto, as well as new financial intermediaries like Arizona Stock Exchange (AZX), Reuters, Bloomberg, Tradepoint, Investment Technology Group (ITG) and OptiMark Technologies, have implemented trading mechanisms with varying levels of automation. New trading centers are increasingly being structured as order-driven systems operating over electronic networks.

A critical feature of the ongoing innovation in order execution systems is that they reflect attempts to exploit evolving technologies to design systems that reflect the needs of the investment community. The U.S. Securities and Exchange Commission (SEC) is in the process of considering and application by the Nasdaq market to implement an electronic trading system designed by OptiMark Technologies. This system is based on an order matching algorithm that takes into consideration the preferences (or satisfaction levels) of investors for trades at various prices and quantities. The reasoning is that an investor's trading decision is multidimensional.

Instead of specifying a simple limit or market order as required using existing mechanisms, the investor can present a price-quantity schedule to the OptiMark system: 1.0 (or full) satisfaction if a buy order for 200,000 units of a stock is executed at a price less than or equal to $100; 0.8 satisfaction if order executed at $110; and so on. This application is designed to

systematically capture the fuzzy nature of a trader's preference for specific quantities of any item at different prices (and vice versa). The system then employs an algorithm running on a supercomputer to cross orders taking into consideration limit prices, quantities and satisfaction levels.

At a broader level, the OptiMark system is indicative of how technological developments can be used as vehicles to turn theory into practice. For instance, we learn from Markowitz's [4] portfolio selection theory that the average investor prefers to hold diversified portfolios of assets. This preference implies that investors are interested in acquiring specific combinations of assets. A rational investor would be willing to pay a premium to trade a preferred basket of financial securities.

Based on developments in the marketplace, a fund manager could decide to change the allocation of assets in his or her portfolio. A decision could be made to move out of a particular sector, say utilities, and instead increase exposure to technology stocks. This portfolio rebalancing decision would be considered profitable only if the trades are executed within a specific price range. The manager in addition, might be willing to pay a premium to be able to execute the whole transaction through a single trade.

Existing market mechanisms are organized around individual assets. Every asset has its own demand and supply schedules. These schedules might be interdependent; but the assets themselves are traded separately. In this paper, we propose a trading mechanism that would enable investors to trade combinations (or baskets) of assets.

The OptiMark system uses a supercomputer to process all orders. Our design of the basket (or portfolio) trading mechanism goes further; it is based

on elements of electronic commerce technologies. In the following sections, we discuss the use of technology to compete for order flows, decentralized trading over electronic networks, portfolio trading as a value-added service flow, and finally, present a prototype of a virtual market.

Competing for Order Flow

The New York Stock Exchange (NYSE) is the dominant stock exchange of the world financial system. As a trading center, it dates back to the 18th century; its current order matching mechanism based on specialists and floor traders dates back to the beginning of this century.

Any analysis of the business of market institutions has to contend with the fact that the liquidity provided by trading mechanisms is endogenous to the system; it is a function of the number and frequency of orders flowing into the system. As more orders are directed to a particular mechanism, the probability of any particular order being executed increases. This improvement in liquidity in turn attracts more new orders to the system. This positive network externality—every additional order improves market liquidity and thus benefits all other traders—has bestowed NYSE with increasing returns to scale.

Historically, the exchange has been able to exploit this promise of superior liquidity to attract order flows from investors with very diverse trading needs. But over the past couple of decades, select groups of investors have successfully moved their trades away from the trading floor of the NYSE. For instance, institutional investors prefer to trade large blocks of stocks.

As the NYSE mechanism–with its specialists and floor traders—is not considered suitable for processing such trades, these investors have been routing their orders to what is known as the "upstairs market." Smaller sized orders continue flowing to the trading floor—the "downstairs market"—for execution.

The downstairs market is also not suitable for trading combinations of assets. Trading in this market is organized around specialists who concentrate on specific stocks and thus cannot provide quotes for baskets of assets. A floor trader can roam around the trading floor in search of a suitable counterparty; but he would prefer to break up the order into individual components and attempt to trade each asset separately.

Despite NYSE's pre-eminent position, it is increasingly evident that certain trades could be executed more efficiently in other market centers. The need for alternative trading systems is reflected in the increasing reliance of institutional investors on mechanisms such as Reuters' Instinet, ITG's POSIT, Bloomberg's Tradebook, AZX, OptiMark, and others. The key feature of these mechanisms is that they utilize electronic networks to provide investors with an environment where they can trade anonymously. This facility helps investors economize on numerous moral hazard problems they encounter while routing orders through brokers on the NYSE trading floor.

Electronic Networks

The new trading systems described above are part of a larger trend towards order-driven mechanisms that operate over electronic networks. In 1987, the

London Stock Exchange (LSE) scrapped its trading floor and moved to a screen-based quote-driven system. On October 20, 1997, the LSE adopted an open electronic limit order book with automated trade execution features. On November 28, 1997, the Deutsche Börse in Frankfurt introduced a similar order-driven electronic trading system. [2] provides a systematic analysis of various automated trading systems.

Direct interaction

The auction mechanism at the NYSE too is order-driven. Traders submit their orders for execution with floor brokers and specialists. Given their affirmative obligation to maintain fair and orderly markets, specialists are given the authority to restrict access to the information in their order books. As specialists are required to trade on their own account to maintain stable prices and market continuity, it is typically argued that the privileged access to the order book places them in a better position to execute their responsibilities. If there is a shortfall of say buy orders, the specialist can add to his inventory, and vice versa.

Transparent markets

The shift to open electronic limit order books reflects an evolving belief that there are alternative ways of supplying liquidity and ensuring a stable marketplace. First, in an environment with a large number of active traders (most advanced market economies satisfy this requirement), increased access to the order book can change the dynamics of communication between investors. Bargains on the trading floor are struck by open outcry; reliance

on the human voice to publicize one's trading interests restricts the range of communication. Instead, the open order book allows a trader to communicate his trading interest to the whole market.

Second, one could argue that specialists and floor brokers on the trading floor are a legacy of times when primitive communication technologies required that all orders be routed to a single physical location. Modern communication technologies enable large numbers of investors to negotiate trades via entries in the order book. Electronic networks can completely alter the search process.

New sources of liquidity

Third, the income earned by a specialist on the NYSE trading floor (and a market maker on quote-driven systems like the NASDAQ market) is a compensation for the risks borne in the process of executing his or her duties. A rational individual will be willing to perform the required tasks only if he or she expects to receive adequate returns. Once one accepts the view that these intermediaries are not in the market for altruistic motives, it opens up the possibility of acquiring liquidity and stability services from alternative sources.

In a recent paper, [8] provides an interesting analysis of reasons why specialists at the NYSE should be stripped of their affirmative obligations. The task of buying when prices move below equilibrium, and selling when they move above equilibrium—an otherwise very profitable trading strategy—need not necessarily be restricted to specialists. An electronic open limit order book will place a broader group of traders in a position to profit from

such arbitrage opportunities. Their act of placing competing limit orders will supply liquidity and continuity to the marketplace.

Portfolio Trading

As we discussed earlier, new entrants to the business of executing orders for financial assets have adopted strategies that rely on network technologies and innovative trading structures. In a business where incumbents are protected by positive network externalities, competitors aim at capturing order flows by offering value-added order matching mechanisms. We discussed the OptiMark system and the proposed basket trading mechanism as examples of such attempts.

Execution risk

Investors are interested in holding and thus trading combinations of assets; but the clearing mechanisms are set up to execute trades in individual assets. To ensure that the complete transaction is executed within the target range, price limits could be set for the individual orders in the asset reallocation strategy. But given the fact that various assets are traded individually, the investor is exposed to considerable execution risks. It is conceivable that by the end of the trading day, a broker would have executed only a subset of the orders placed. The investor could then find himself holding a combination of assets with risk-return characteristics he would rather avoid.

Large institutions do have arrangements (part of the upstairs market) to trade large baskets of assets. But these transactions tend to be expensive

and in addition, not available to the average household. More important, trading blocks of assets through intermediaries exposes the fund manager to moral hazard problems; the costs associated with preventing such problems lowers expected returns and reduces trading volumes (see [1], [3], [5], and [6] for discussions on block trading by large institutions).

It now seems obvious that existing trading arrangements have not been designed with investor preferences in mind. As exchanges are not willing to offer suitable order execution systems, they recommend that households instead invest in mutual funds.

Automated smart markets

In order to match orders to trade combinations of assets, all orders will have to be accumulated at a central point. Here, the order can be crossed using a mathematical algorithm written to compute prices and assign allocations such that an optimal number of trades can be executed (see [7] for a detailed description of the portfolio trading model). Assume that as part of his or her asset reallocation strategy, an investor wishes to execute the following trades: buy 100 units of IBM shares, 200 of Microsoft, 125 of Cisco Systems, and sell 200 units of General Motors, 150 of Ford and 50 of Chrysler. The mechanism will accept a net limit price for the whole bundle order. Given a preference for trading combinations within certain price ranges, it is likely that this limit price will be different from a weighted average price computed using individual stock prices. As we have argued earlier, the investor might be willing to pay a premium (receive a discount) in case of a net purchase (net sale) in return for lower execution risks.

Implementation issues

The basket trading mechanism is designed as a closed order book; contents of orders placed with the mechanism will not disclosed. This is in contrast to most other new electronic trading systems that have open limit order books. One reason for adopting this structure is that as the algorithm can match a single order with a totally different set of orders, the details of individual orders will not necessarily supply any additional information to other traders in the market. In addition, we can also argue that the complete anonymity of the order book will encourage traders to reveal their true valuations.

As orders are transmitted, the system will continuously attempt to execute trades. Though bundles of assets are traded, the system will generate prices of individual assets based on executed trades and, in case there are no matches, prices indicated by unexecuted orders in the system. As with any other market, investors will receive information of changes in demand for and supply of various assets from movements in their prices. The algorithm can also be designed to generate information about transaction and order volumes.

Multiple markets

More by to accident rather than design, equities and derivative contracts are traded in separate market centers. Finance theory suggests that derivative instruments can be used to hedge certain risks from investing in equity and debt instruments. But the separation of the trading mechanisms increases the costs of acquiring trading different assets. Ideally, investors should be

given the flexibility to trade these diverse instruments via a single order.

The first step towards this ideal would be to merge their trading mechanisms. Markets in Europe appear to be moving in this direction. For instance, the Stockholm Stock Exchange and OM Stockholm, the derivatives market, have been holding discussions to merge their operations. The Deutsche Börse Group manages the stock exchange as well as the futures and options market in Frankfurt. Interestingly, the November 7, 1997 edition of the Financial Times (London) reported that there had been rumors in the press about a possible merger of the London Stock Exchange with the London International Financial Futures and Options Exchange (LIFFE).

These mergers have been motivated by a range of motives. But there is one critical reason why such strategic moves are considered feasible today: these trading centers operate over electronic networks, and it is easier to merge similar networks than trading floors. These mergers then require linking electronic trading and settlement systems (a technically and politically feasible task) once all parties agree on a single trading system, and do not involve the moving of trading floors to a common location (a politically impossible task).

A portfolio trading mechanism operating over these linked electronic networks would enable investors to trade internationally diversified baskets of equity, debt and derivatives contracts. Investment advisers recommend that investors hold such diversified portfolios. But the trading mechanisms available today do not support trades necessary to acquire such diversified portfolios.

Fractional quantities

The minimum investment necessary to acquire a highly diversified portfolio of stocks and bonds is typically beyond the reach of the average household. The average household simply cannot afford to manage an adequately diversified portfolio by trading individual assets. This is largely due to the fact that current trading systems are not capable of processing orders for fractional quantities of stocks and other instruments.

Market centers restrict trades to certain minimum quantities specified in terms of odd and round lots. These restrictions are legacies of ledger-based accounting systems and the practice of issuing title certificates on pieces of paper. Restricting trades to minimum quantities make sense when relying on human intermediaries to execute orders and settle transactions. But they appear incongruous in a world where ownership records are maintained as digital entries electronic databases, and most transactions are processed electronically.

An automated order matching system similar to the basket trading mechanism described above will be able to execute trades in infinitely small quantities. Introduction of such systems could potentially act as catalysts and lead to regulatory changes that would allow firms to issue financial contracts that are freely scaleable in size at the option of the holder of the security. Such a development could alter the institutional setup of the financial system. Instead of investing in mutual funds and other pooling vehicles, investors could use electronic trading systems to acquire and manage highly diversified portfolios; they will be able to acquire all the stocks in the S&P

500 index for a nominal investment.

Electronic Commerce

The NYSE structure reflects the technologies available in the eighteenth and nineteenth centuries. OTC (or over-the-counter) markets like the foreign currency, bonds, and money markets, have evolved from phone- and telex-based to phone- and screen-based trading systems. The similarly structured Nasdaq stock market reflects the advanced state of telecommunications technology of the 1990s, and at the same time, the relatively primitive state of information technology and computation systems used in the 1970s.

On the other hand, the OptiMark system described above is based on state of the art supercomputing technologies. Like the proposed bundle trading mechanism, it also reflects an increasing comfort in using advanced computing systems to conduct financial transactions. Structures being designed today logically try to take advantage of the latest technological developments. It is anyone's guess whether the pioneers who developed the NYSE structure more than two hundred years ago would have come up with the same design if they had had access to all the trappings of modern society.

Continuing with the theme that new market structures reflect contemporary technological developments, in this section we will try to understand the impact of electronic commerce, the technology of the 1990s, on financial markets in general and trading systems in particular.

Proprietary to open networks

A distinctive feature of all trading mechanisms has been their reliance on expensive proprietary networks like Reuters and Bloomberg for the communication of orders, quotes, prices, and trade confirmations. The commissions and fees collected by brokerage firms and other financial institutions, cover the costs of subscribing to these systems. Investors thus economize on certain transaction costs by hiring the services of these intermediaries.

The higher cost of proprietary systems places the individual investor at a distinct disadvantage. He or she learns about market prices with a delay. In addition the need to route orders through intermediaries exposes the investor, especially institutional investors, to additional costs from having to disclose one's trading interests.

The Internet is an open electronic network and thus provides a platform for households and other small investors to participate directly in the trading process at a much lower cost. In the past couple of years, increasing numbers of investors have taken to the Internet to manage their finances: research investment opportunities, get price quotes (real time stock prices are increasingly available for free), place orders with brokers, and access their accounts with banks, brokerage firms and mutual funds. The interesting aspect of this development is that it has changed the attitude of individuals and households about their finances. Empowered by the increased availability of information over the Internet, investors appear to be taking a more active interest in managing their savings.

Though there are numerous unresolved issues relating to the conduct of

financial transactions over the Internet (security and the legality of electronic communications), financial institutions have been rushing to create a wide variety of products and services to be delivered over the Net. A logical move would be to use the encryption technologies that back various browser-based systems, to provide investors with access to the trading systems of various market centers. The AZX for instance, has taken the lead by publishing its order book over the Internet; investors though have to route their orders through traditional communication channels.

Settlement and custodial services

Allowing investors to communicate their orders directly to electronic trading systems throws up the problem of settling transactions. Investors today rely on brokerage firms, to process their orders and settle trades.

A key service provided by these institutions is the management of default risk: the risk that a trader could place an order to buy a certain amount of stocks without having sufficient resources to pay for the purchase. The shrinking of settlement time could reduce the possibility of default risk by investors and in turn, reduce the need to use brokers to settle trades. The Swiss Exchange has recently implemented a system that can settle trades on a same-day basis, i.e. T+0. This is in contrast to the minimum of T+3 (three business days from the date of the transaction) in most other leading exchanges. Such systems can be successfully implemented only if titles to financial contracts are held in the form of digital entries in computerized databases. The trend in financial markets around the world appears to be towards de-materialization; in other words, doing away with printing stock

and bond certificates on pieces of paper.

Further technological developments should enable us to design and implement real-time settlement systems. With changes in attitudes among investors, aided by improvements in encryption technologies, virtual settlement systems can be seamlessly combined with Internet-based payment systems. It appears as if we will eventually be in a position to implement highly disintermediated trading systems where investors could directly access electronic trading systems over the Internet and settle trades on a real-time basis.

Virtual trading - an example

Let us assume that an individual investor wishes to trade certain securities. Using a secure browser, he connects to the server of an electronic trading system and transmits the following information along with the limit price-quantity details for the assets he wishes to trade: a digital signature verifying his true identity; a digital certificate representing the assets he wishes to sell; an electronic check to cover the costs of the assets he wants to buy including trading fees. The system accepts this information, confirms their authenticity, and attempts to execute the orders. On completion, the investor receives the following: information about trades executed, along with prices, time-stamps, and quantities; a digital certificate for the assets purchased along with those assets that could not be sold; an electronic check covering the proceeds from sale plus any amounts not utilized for asset purchases; a digital certificate authenticating that the trading mechanism tried optimally to find the best possible trades, and that the transaction information is true.

Our goal is to demonstrate the possibilities of using electronic commerce technologies to support electronic trading of financial assets. The illustration above is based on numerous technologies currently under development. Visa, MasterCard, IBM, commercial banks and other information technology and financial services firms have collaborated to develop the Secure Electronic Transaction (SET) protocol. Based on state-of-art encryption technologies, firms like VeriSign are creating digital identification systems, tools similar to the ones referred to in the example above, that will authenticate the veracity of information exchanged over open electronic networks. An incredible number of information technology and financial services firms are attempting to develop electronic payment systems: digital cash, smart cards, micropayment systems, digital wallets, electronic checks, etc. There are scores of Web-sites that offer online financial analysis tools for free. Investors could use these tools to solve their asset allocation problems.

The OptiMark trading system has hired the services of the Computer Assurance Services Group of Deloitte & Touche to attest to the secrecy, security and optimality of the system. Deloitte is responsible for independently assessing the design of information security and controls within the OptiMark system, and is required to examine and report on OptiMark's assertions about related aspects of the system.

Conclusion

The increased competition witnessed in the market for markets is the result of efforts to develop new trading mechanisms using contemporary technolo-

gies. There is growing recognition that any successful strategy to win order flows from incumbent exchange institutions should be based on execution mechanisms that meet the true needs to the investment community. We have demonstrated such a strategy by proposing a portfolio trading mechanism that could be used by investors to acquire and manage diversified portfolios of assets.

The new trading systems rely on electronic network technologies; this enables them to develop market environments where large numbers of investors can express their interests and participate actively in the trading process. In the sections above, we have argued that electronic commerce technologies can be exploited to develop market systems that operate over open electronic networks. We present a prototype of a virtual trading system where investors can trade directly with each other and settle trades on a real-time basis.

The market microstructure literature has demonstrated that the structure of trading systems influences trader behavior. Following this logic, we have argued that mechanisms similar to the bundle trading mechanism can permanently alter how households manage their finances. New structures will enable new trading strategies; these strategies could then result in new financial instruments. For instance, institutions like mutual funds could exploit these mechanisms to develop customized portfolios for their customers. These contracts can be created by combining equity, debt and derivative instruments using mechanisms similar to the portfolio trading system.

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