Journal of Portfolio Management, vol. 21, no. 3, pp. 10-18, (Spring 1995).

Electronic Call Market Trading

by

Nicholas Economides
Professor of Economics
Stern School of Business, New York University
(212) 998-0864, Fax (212) 995-4218, e-mail: neconomi@stern.nyu.edu

Robert A. Schwartz
Professor of Finance and Economics
and Yamaichi Faculty Fellow
Stern School of Business, New York University
(212) 998-0344, Fax (212) 995-4233, e-mail: rschwart@stern.nyu.edu

Revised February 1995

Electronic Call Market Trading

Abstract

Despite its power as a transactions network, scant attention has been given to incorporating an electronic call into a major market center such as the NYSE or Nasdaq. An *electronic call* clears the markets for all assets at predetermined points in time. By bunching many transactions together, a call market increases liquidity, thereby decreasing transaction costs for public participants. After describing alternative call market structures and their attributes, we propose that an *open book electronic call* be held three times during the trading day: at the open, at 12:00 noon, and at the close. We discuss the impact of this innovation on an array of issues, including order flow and handling, information revelation, and market transparency. We also discuss the proposed changes from the perspectives of investors, listed companies, exchanges, brokers, and regulators.

Electronic Call Market Trading

INTRODUCTION

Since Toronto became the first stock exchange to computerize its execution system in 1977, electronic trading has been instituted in Tokyo (1982), Paris (1986), Australia (1990), Germany (1991), Israel (1991), Mexico (1993), Switzerland (1995), and elsewhere around the globe. Quite likely, by the year 2000, floor trading will be totally eliminated in Europe, predominantly in favor of electronic continuous markets.

Some of the new electronic systems are call markets, however, including the Tel Aviv Stock Exchange, the Paris Bourse (for thinner issues), and the Bolsa Mexicana's intermediate market. In this article, we consider the call market as an alternative trading environment that is particularly suitable to computerization.

Recognizing the combined power of the computer and the call, several proprietary trading systems have introduced electronic batched trading in the United States. The Arizona Stock Exchange (AZX) instituted an electronic call market in Spring 1992. Previously, electronic crossing networks (a form of call market trading) had been established by Reuters (Instinet's "Crossing Network," 1987), Jeffries (ITG's POSIT, 1987), and the New York Stock Exchange (its after-hours system, Crossing Networks I and II, 1990). Additionally, a British proprietary system, TradePoint, plans to inaugurate an electronic market that includes both call and continuous trading in 1995.

Scant attention has been given to incorporating an electronic call into a major market center so as to provide investors with an alternative trading environment (see Cohen and Schwartz [1989]). The innovation to market structure that we propose is: *incorporation of an* *electronic call market into a continuous trading system* such as the New York Stock Exchange's agency/auction market or Nasdaq's competitive dealer market.

Specifically, we propose that the electronic call be held three times per day: to open the market, to close the market, and once during the trading day. Incorporating an electronic call into the continuous market will increase the efficiency of the U.S. markets and enable them to compete more effectively in the global market for order flow.

ALTERNATIVE CALL MARKET STRUCTURES

The essence of call market trading is that orders are batched together for simultaneous execution, in a single multilateral trade, at a prespecified time, and at a single price the value that best equates the aggregated buys and sells. Buys at this price and higher, and sells at this price and lower, generally execute.

If, because of quantity discontinuities, an exact match between aggregate buys and sells does not exist at any price, buy orders placed at the clearing price do not execute in full (if buys exceed sells), or sells do not execute in full (if sells exceed buys). Time priority (the orders placed first execute first) or pro rata execution (an equal percentage of each order executes) is commonly used to determine which orders to execute among those that have been placed at the lowest executable bid (if buys exceed sells) or at the highest executable ask (if sells exceed buys).

Call markets may be structured in different ways, most notably with respect to the mechanism used for determining the clearing price. An auction where participants are physically present is typically organized as a *price scan auction*. In a price scan auction, an auctioneeer announces tentative prices and participants respond with their buy/sell desires. The price search procedure continues until the value that best balances the buy and sell orders is found. Examples of this type of call include art auctions, tulip bulb auctions, the old call market system of the Paris Bourse (*à la criée*), and the system currently used to open trading on the NYSE.

An alternative to the price scan system is the sealed bid auction used by the U.S. Treasury. In general, in a *sealed bid/ask auction*, participants submit priced orders that are not disclosed to other participants. At the call, orders are arrayed by price and cumulated from the highest bid to the lowest bid for buy orders and from the lowest ask to the highest ask for sell orders. The cumulated orders are matched against each other, and the clearing price is determined. A limitation of the sealed bid/ask auction is that it hides orders that some participants may wish to expose and that others would like to see.

A *crossing network* also batches orders, but instead of determining the price within the batching process, it uses a price that has been set elsewhere. For example, POSIT, Instinet, and the two NYSE crossing networks all cross orders at prices that have been established in the primary market centers. Instinet and the NYSE's after-hours systems use closing prices, while POSIT's intraday crosses use current intraday prices. For this reason a crossing network cannot be used as a stand-alone system   it does not itself produce a clearing price.

Call market trading may also be structured as an *open order book auction*. This approach is used as the opening procedure in most electronic continuous markets. For example, the opening procedures for Toronto's CATS, Tokyo's CORES, Paris's CAC, and Australia's SEATS are structured as open order book auctions. So too is the Arizona Stock Exchange's electronic call market.

Aggregated buy and sell quantities at each price are displayed once they have been received by the market, and all participants can watch the market as it forms. Orders are continuously aggregated and sorted, and the price that would be struck if the call were held at that moment is updated and displayed. We consider the *open book electronic call* the most suitable transactions network for a major market center.

ATTRIBUTES OF THE CALL

A securities market should be designed with regard to two objectives: reduction of the costs of transacting for the participants in a trade, and enhancement of the accuracy of price discovery for the broad market (see Schreiber and Schwartz [1986]). With these ends in mind, we now consider the call market with respect to issues concerning the need for immediacy, the use of electronic technology, order handling, information revelation, market transparency, consolidation of order flow, and the problem of free-riding. While many of our comments hold for call markets in general, our discussion for the most part applies to the open book electronic call.

Immediacy

A perceived limitation of call market trading is that it does not allow for continuous access to the market. Alternatively stated, continuous trading is deemed desirable because participants can transact whenever they choose during a trading session. It has been widely believed that traders do demand transactional immediacy, and our securities trading systems are for the most part based on the principle of continuous trading. In this regard, dealers and specialists as suppliers of immediacy have been considered essential to the operations of the market.

These assumptions should be questioned in three respects. First, the demand for immediacy is in part endogenous to the continuous market. Once a participant decides to seek a trade, that individual might wish to trade quickly in order to gain anonymity and to avoid having his or her order front-run.

Second, dealers are not the only suppliers of immediacy and liquidity limit order traders can play an important role as well, depending on how the system is designed. In general, the need for intermediaries could be lessened as advances in electronic technology make direct access to the market increasingly feasible.

Third, some market participants do not choose to pay the price for immediacy when they have an alternative. These participants include limit order traders, passive investors, and others for whom lower trading costs are more important than transactional immediacy. For individual traders, the price of immediacy is the bid-ask spread, market impact, and higher commissions; for the market as a whole, it also includes less accurate price discovery and greater short-run price volatility.

We have elsewhere reported the results of a survey we have used to assess asset managers' demand for immediacy (see Economides and Schwartz [1994]). Responses from 150 equity traders at funds that in total had roughly $1.54 trillion of equity under management, indicate that the participants typically do not trade with maximum possible speed, that they commonly work their orders patiently over time.

For instance, nearly 25% of the respondents indicated that, for a $50 stock, they would regularly or frequently accept a trading delay of three hours if they could thereby save 25 cents in trading costs. Nearly 50% indicated that they regularly or frequently take more than one day to execute a large order broken into smaller pieces.

Use of Electronic Technology

Non-electronic calls do not fully exploit the potential of call market trading. With computerization, participants can see the order flow and interact with the system on a real-time basis, entering their orders while the computer broadcasts the orders and indicated clearing prices. At the moment of the call, the computer finds the single price for each stock that clears the market, and market clearing prices for all issues can be determined simultaneously.

Simultaneous clearing enables a customer's buy order for XYZ shares to depend on the price of ABC shares, the value of an aggregate market index, and/or simply the number of XYZ shares offered for sale at the customer's price or better.[1] This contrasts with the old non-electronic calls of Europe, where the markets for different shares had to be called sequentially, and the current NYSE opening procedure, where different stocks are handled individually by the various specialists.

Thus, in a call market, the computer serves an important computational function. This contrasts with the continuous environment where computer technology has served largely to accelerate the pace with which orders are submitted to the market and translated into trades. Under stressful conditions, this acceleration may be destabilizing.

Order Handling

Commission costs can be lower in call market trading because order handling is facilitated in that environment. Execution costs can be lower as well. Because orders are bunched together for simultaneous execution at a common clearing price, the bid-ask spread does not exist, large orders have less market impact, and large traders are less apt to have their orders front-run. The risk of orders being front-run is further reduced if public traders are given direct access to the call.

Batching has further advantages for order handling. Because all orders execute at a common clearing price, participants can put limit prices on their orders without extending a free option to others or risking being "picked off" (as long as enough participants are present at the call). In an electronic call, participants can easily break an order up for entry at different prices, a process known as "scaling."

In addition, contingencies can be put on orders. For example, a buy order's exposure to the market can be made contingent on the existence of a counterpart sell order. Customers may also place conditions on their orders that limit their exposure at equilibrium in certain stock categories. At the same time, enabling participants to see the markets for individual stocks as they form may alleviate the need for customers to specify contingencies.

Information Revelation

In expressing a desire to transact, traders reveal information about the existence of their orders and, in some systems, their identity. Revealing this information before a trade can be detrimental to the participant seeking to trade, because a stock's price will rise (fall) in the market when it becomes known that a large buy (sell) order is in the offing.

Consequently, participants in a continuous market attempt to hide information about their orders and try to execute their trades as quickly as possible once their intention to trade has become known to others. As we note above, this is not an inherent demand for immediacy but a consequence of the trading process; the apparent demand for immediacy may in part be an attempt to prevent front-running.

When a trade is realized, information is produced concerning the particulars of the transaction (price, quantity, and time). Thus, a completed trade may be viewed as a joint product: the trade itself and information. In a continuous market, the produced information is of no benefit to the transacting parties, but, because of the complexity of price discovery, it is of considerable value to others who may be transacting in the near future.

In a call market, on the other hand, the production of price information is simultaneous with the execution of a multilateral, batched trade, and the value of this information does accrue to the participants in the trade.

Market Transparency

At least some participants must announce the prices at which others can trade if a market is to form. Participants who place their orders early provide information and liquidity to those who place their orders closer to the time of the call. But each individual, while preferring that the market be transparent, is reluctant to disclose his or her own order there are strong advantages to letting others be the providers of liquidity and suppliers of information. Once enough orders have been placed, however, the call provides a particularly transparent and orderly environment.

The problem of getting participants to reveal their orders early in call market trading can be handled in several ways. One way to encourage early order placement is to enable participants to enter orders with the contingency that their orders not be disclosed to the market unless counterpart orders of sufficient size have also been placed. Although a contingent order is not revealed to other traders until its conditions have been satisfied, it has, most importantly, been entered into the system.

Because the system knows of contingent orders on both sides of the book, trades will be made that might otherwise not have been found. And, because participants can easily scale and put contingencies on their orders, the need for transparency is reduced a trader can simply specify his or her parameters and rely on the computer to work out the trades (see Schwartz [1993]).

Early order disclosure can also be encouraged in call market trading by using time priorities and by charging lower commissions for orders that have been placed earlier in the entry period that precedes a call. For example, AZX's electronic call uses time priority rules and time-dependent commission rates for this purpose. (See Economides and Heisler [1994b] for a discussion of the fee schedule in a call market.)

Consolidation of Order Flow

For a trade to be realized, buyers and sellers must meet in two dimensions: time and place. The set of participants who meet to trade can be viewed as a network. When a transactions network includes a larger number of participants, counterparties can more easily find each other in time and in place, and transaction prices are expected to be in closer alignment with underlying equilibrium values.

Because the size of the network contributes positively to the value of the good that is being produced, the market may be said to exhibit *positive network externalities*.[2] Positive externalities in a trading network explain why order flow attracts order flow; they give a large market center such as the NYSE a strong competitive advantage.

For a given market size, consolidating the order flow increases the efficiency of a transactions network, stabilizes prices, and facilitates surveillance activities. Orders can be consolidated geographically (in one place) and temporally (over time). For the most part, recent discussions concerning market design have focused on the geographic consolidation of orders in a continuous market environment. But temporal consolidation also strengthens a transactions network by enabling counterparties to find and to trade with each other more easily.

Order flow is necessarily fragmented temporally in continuous market trading. Moreover, order flow can fragment spatially in a continuous environment as satellite markets offer fast execution and charge low commissions while free-riding on the price discovery and other services provided by a major market center, as is suggested by Bloch and Schwartz [1978]. The problem may be eliminated with call market trading. Introducing a call into a continuous market will naturally focus orders at specific points in time. This temporal consolidation in turn encourages spatial consolidation because it counters the free-riding problem. Because orders are less apt to fragment spatially, the need for an order focusing rule such as NYSE Rule 390 is obviated.[3]

The Free-Riding Problem

Prices can be pirated with relative ease in a continuous market because trading takes place while prices are being set. A trade in the continuous market establishes a price, and the posting of quotes gives the price continuing validation until new quotes and/or a new transaction price are set. Hence, prices established on the NYSE can become the benchmarks against which orders can be executed on the regional exchanges or through proprietary trading systems.

These off-board trades do not contribute to price discovery and are of no benefit to those participants who have actively participated in price discovery by posting quotes on the market. On the contrary, free-riding diminishes the extent to which the positive externalities of a trading network can be realized.

Because trading in a call market results in all orders collectively determining the price, it reduces the possibility of free-riding on price discovery. The indicated clearing price before the call is only tentative. At the call, orders are batched together, the clearing price is found, the trades are made, and the market is closed. After the call, the clearing price has rapidly diminishing validity.

PROPOSAL

The introduction of an electronic call in a major market center such as the NYSE or Nasdaq would be one of the most far-reaching, powerful innovations that could be made in the design of a trading system. The innovation would provide important benefits for both institutional and retail investors, as well as listed companies and securities firms. We suggest that an open book electronic call be integrated with continuous trading three times a day at the market's opening, at noon, and at the market's close.

- *At the open.* An electronic call at the market opening would facilitate order entry and price discovery at this particularly critical moment in the trading day. Institutional investors who currently wait for the market to open before submitting their orders would be more likely to participate in an interactive, electronic opening. This would improve the accuracy of price discovery for the aggregate market.

- *Mid-day.* A mid-day call would counter free-riding on price discovery. It would help assure investors that their orders will not be front-run, would facilitate price discovery, and would contribute to the overall stability of the market.

- *At the close.* Closing the market with an electronic call would also sharpen the accuracy of price discovery at a time of critical importance because of the broad use to which closing prices are put (such as accounting and regulatory reporting, portfolio performance evaluations, derivative benchmarks).

INVESTORS' PERSPECTIVE

The continuous market is a difficult and expensive environment in which to operate: bid-ask spreads exist; commission costs are higher; the market impact of individual orders is accentuated; orders are more easily front-run; satellite markets free-ride on prices set in the major market centers; and so forth. In behavior symptomatic of the difficulty of working orders in the continuous market, exchange specialists commonly stop orders, and do not display all limit orders to the market. Because of the high cost of trading in the continuous market, order flow is increasingly being diverted to alternative markets such as Instinet's Crossing Network, POSIT, and AZX.

Instinet offers one cross per day. The Crossing Network enables matched orders to execute after the markets have closed at closing transaction prices for NYSE issues, and at the midpoints of the bid-ask spreads for OTC securities. Instinet does not provide volume figures, but one may presume that The Crossing Network has experienced appreciable growth since 1988, its first full year of operations.

POSIT offers crosses during the regular trading day in four preannounced, seven-minute trading windows. Each of the four crosses is held at a randomly selected point within its seven-minute window. Orders are executed only to the extent that matches are found, and trades are priced using the midpoint of the bid-ask spread at the time of the match established in the major market centers. During 1988, its first full year of operations, POSIT averaged 152,000 shares per day. For 1994, the system averaged 4.1 million shares per day, single-counted.[4]

AZX holds an open book electronic call that executes trades at 5:00 p.m. EST. AZX has also experienced some sizable trading volume since its opening on March 30, 1992. In its first quarter of operations, the second quarter of 1992, it traded an average of 143,000 shares per day. For 1994, the system averaged 487,000 shares per day, single-counted.[5]

In the current stage of their development, these proprietary systems do not enable customers to know in advance if they will realize an execution. POSIT and Instinet Crossing

Network customers do not know precisely when the trades will take place. And, except for Instinet's Crossing Network, the customers do not know the prices at which they will trade.

Despite these uncertainties, the proprietary trading systems are attracting significant volume. This is testimony to investors' need for a better trading system. Simply put, customers are using the proprietary trading systems because these systems help them gain anonymity and reduce the cost of trading. Preliminary evidence suggests that call market trading is indeed a desirable alternative for some participants at least.

THE LISTED COMPANIES' PERSPECTIVE

Holding calls three times a day would directly improve the performance of the equity markets for the listed companies. Because liquidity and price stability are, ceteris paribus, associated with higher share prices, more liquid and stable secondary markets should facilitate the capital-raising ability and result in lower costs of capital for the listed companies. Listed companies would also benefit from efficient secondary market operations because they themselves are investors. Corporate pension funds, postretirement medical plans, and other corporate-sponsored funds are becoming ever more important as their pools of investment capital continue to increase.

Therefore, the listed companies should themselves be free to commit capital to market-making if they so choose (see Schwartz [1988, 1991]). The concern about corporate involvement in market-making is that firms would use the procedure inappropriately to manipulate their share prices. Therefore, formal market-making has been left to independent third parties. The manipulation problem can be dealt with, however, by having the corporate orders entered according to a prescribed procedure, and a third-party fiduciary could be used to run the corporate stabilization programs (see Schwartz [1991]). A system to do this, PIBAL, is currently being implemented in France (see Jacquillat, Schwartz, and Hamond [1994]). PIBAL enables corporations to provide additional liquidity to the market for their own stocks through a liquidity fund.

The objective of stabilization is to damp excess volatility caused by temporary buy/sell imbalances. The electronic call provides the most suitable environment for capital to be committed to this end. For this reason, in France, PIBAL call orders will be entered for execution in CAC's call market only. Liquidity trades cannot be made effectively in a continuous market because the liquidity orders would retard the adjustment to a new equilibrium and, in so doing, benefit some traders unjustifiably.

For example, suppose a stock's equilibrium price falls from 50½ to 49½ with stabilization. Further suppose that a liquidity order of a given size has been entered at 50. In the continuous market, the liquidity-providing purchase would be made at 50; in the call, it would be made at 49½.

There is no reason to enable some public trader to sell at 50 when the new equilibrium price is 49½, and a transaction at 50 would be misleading for the market and costly for the liquidity provider. In a call market, clearing prices simultaneously reflect all orders, including those entered for liquidity-providing purposes, and all orders transact at the same price.

The difference between the call and the continuous markets is that the call market is an explicit price discovery mechanism, and price discovery and the provision of supplemental liquidity are effectively integrated in the call. That is why, in the situation just described, the liquidity-providing order would execute at 49½ even though it were entered at 50.

THE EXCHANGES' AND BROKERAGE HOUSES' PERSPECTIVE

Exchanges have traditionally been institutions where *intermediaries* meet to trade on behalf of their customers, and a market center such as the NYSE does not allow direct access by customers. The NYSE, of course, does not itself participate in the trading. It provides the floor and the systems that exchange members (specialists and other floor traders) use.

In electronic call market trading, on the other hand, public orders are batched and executed in multilateral transactions without the intervention of intermediaries, and the electronic call itself makes the trades. Public participants could continue to access the market through a member firm if they want. Many customers, especially smaller retail clients, would no doubt choose to have their orders entered for them by their brokerage firms.

But those who want to, should be able to route an order through a member's account (and via its wire connection) to the exchange so that the order may be placed without the brokerage firm's knowledge or intervention (subject, of course, to the enforcement of prespecified trading limits and control over access to the system).

Because the electronic call, not the intermediary, makes the trades, customers could be charged an exchange fee for call market transactions. Exchange fees should be set according to a uniform schedule that applies to all customers. The fee per share should be a decreasing function of the size of an order. And, as discussed, to encourage early order placement, the exchange fee should also be a decreasing function of the amount of time before the next call that an order has been placed. That is, the fee should be lower for an order placed one hour before the call than for an order placed one minute before the call.

The overall fee structure should be set high enough to ensure adequate profitability for the exchange and its member firms. Part of the exchange fees should be passed back to the brokerage houses to compensate the member firms for having provided the securities information and other services that brought the customers to the market. Brokerage house revenues from their share of the exchange fees could be substantial, and the income would be relatively riskless. Moreover, the cost to the brokerage houses of providing trading services would be greatly reduced because of the economies inherent in call market trading.

Accordingly, both the exchange and the brokerage houses should find the system attractive. There is no reason why a market that is highly efficient should not be profitable for its necessary constituents.

THE REGULATORS' PERSPECTIVE

Just as the call market facilitates operations from the users' points of view, it simplifies governance from a regulatory point of view. The role of intermediaries is lessened; the market is harder to manipulate; and the audit trail is less complicated. To date, however, regulatory issues have been assessed in the context of the continuous market, and they have remained murky.

Issues concerning market structure, competition, fragmentation, and transparency have been debated for the past two decades by government regulators, practitioners, and academicians, never with adequate resolution.[6] Perhaps the regulatory emphasis has been misplaced:

- Attention has focused primarily on the cost of immediacy in an environment structured around its provision, while the accuracy of price discovery has received little attention. Unfortunately, the provision of immediacy can impair the accuracy of price discovery.
- Much emphasis has been given to strengthening interdealer competition, and relatively little to intermarket competition. Yet, intermarket competition is the primary spur for the development of superior technology.
- The debates concerning the consolidation of order flow have dealt with the geographic dimension, not the temporal dimension. Consolidating orders at a particular time is of equivalent importance, and it also counters the tendency for orders to fragment spatially by eliminating the free-riding problem.
- Transparency has been considered with regard to the display of quotes and transaction prices, not to the submission of orders by traders. Although little discussed, participants' reluctance to disclose their orders is perhaps the greatest impediment to transparency.

In short, if the provision of immediacy were de-emphasized, and domestic intermarket competition encouraged, we expect that trading systems will naturally evolve so that orders will be appropriately consolidated and markets will be adequately transparent. The end result will be lower transaction costs and more accurate price discovery for the broad market.

This will not occur if competition is stifled in the securities industry. Currently, for both exchange and dealer markets, public traders do not have direct access to participants on the other side of the market, but must use intermediaries. Listed companies are not free to make markets in their own stocks, but must rely on third-party market makers. Various rules hinder the use of limit orders by public traders (primarily on the Nasdaq, but to an extent on the NYSE as well). And, emerging systems such as Instinet, POSIT, and AZX are hindered by regulation (such as the requirement that prices established during the trading day be integrated with the Intermarket Trading System).

The major anti-competitive barriers are not the ones that weaken interdealer competition, but those that shield the profitable operations of broker/dealer firms as a group. Because of these barriers, innovations that could be highly desirable for traders and the listed companies are not occurring.

CONCLUSION

We have proposed that an electronic call be used three times a day by a market center such as the NYSE or Nasdaq: to open the market, at noon, and to close the market. Ironically, the proposal could be resisted for either of two opposing reasons. First, the call may be thought to be an *inefficient environment* that does not cater to the needs of customers, primarily because it does not allow traders immediate access to the market. Second, the call may be thought to be such a highly *efficient environment*, which would reduce the profits of the suppliers of trading services (exchanges, securities firms, and other sell-side traders).

We have argued that a call market is a highly efficient transactions network. We question the importance of immediacy for many public traders, and suggest that a significant proportion would choose not to pay the price of immediacy if a viable alternative were available.

The call is the only environment within which meaningful capital can be committed to supplying liquidity and stability to the market, and it provides an environment within which the listed companies could themselves be the source of this capital if they so choose and if so allowed. A call market is also a far simpler environment from a regulatory point of view.

As for the SEC's concern with strengthening competition, the most serious barriers are those that prevent innovations that are highly desirable for buy-side traders and the listed companies from getting made. But new technology is a powerful force. If payments for services are efficiently structured, meaningful innovations can be made. If so, important constituencies on both the buy and sell sides of the market will benefit.

In the meantime, the efficiency of the U.S. equity market is best improved, and the challenge of international competition for order flow is best met, by streamlining the regulatory environment, removing competitive barriers in the industry, and letting competition accomplish the rest.

REFERENCES

Bloch, Ernest, and Robert A. Schwartz. "The Great Debate over NYSE Rule 390." *Journal of Portfolio Management,* Fall 1978.

Cohen, Kalman J., and Robert A. Schwartz, "An Electronic Call Market: Its Design and Desirability," in H. Lucas and R. Schwartz, eds., *The Challenge of Information Technology for the Securities Markets: Liquidity, Volatility, and Global Trading,* 1989.

Economides, Nicholas. "Desirability of Compatibility in the Absence of Network Externalities," *American Economic Review*, vol. 78, no. 1, (1989), pp. 108-121.

. "Network Economics with Application to Finance." Financial Markets, Institutions and Instruments, Vol. 2, No. 5 (1993), pp. 89-97.

. "The Economics of Networks," plenary address, EARIE conference, Discussion Paper No. EC-94-24, Stern School of Business, New York University (September 1994).

. "Network Externalities and Invitations to Enter," *European Journal of Political Economy*, (1995).

Economides, Nicholas, and Jeff Heisler. "Co-existence of Call and Continuous Markets." Stern School of Business, New York University, 1994a.

. "Equilibrium Fee Schedules in a Monopolist Call Market," Discussion Paper no. EC-94-15, Stern School of Business, New York University, 1994b.

Economides, Nicholas, and Robert A. Schwartz, "Making the Trade: Equity Trading Practices and Market Structure," Report of the TraderForum Research Service of the Institutional Investor, (1994).

Economides, Nicholas, and Aloysius Siow, "The Division of Markets is Limited by the Extent of Liquidity," *American Economic Review*, vol. 78, no. 1, (1988), pp. 108-121.

Economides, Nicholas, and Lawrence J. White, "Networks and Compatibility: Implications for Antitrust," *European Economic Review*, vol. 38, (March 1994), pp. 651-662.

Farrell, Joseph, and Garth Saloner, "Standardization, Compatibility, and Innovation," *Rand Journal of Economics*, vol. 16, (1985), pp. 70-83.

Jacquillat, Bertrand, Robert A. Schwartz, and Jacques Hamond, "A Program to Increase the Liquidity of Shares in the French Equity Market," In R. Schwartz, ed., *Global Equity*

Markets: Technological, Competitive and Regulatory Challenges. Homewood, IL: Richard D. Irwin, 1994.

Katz, Michael, and Carl Shapiro, "Network Externalities, Competition and Compatibility," *American Economic Review*, vol. 75, no. 3, (1985), pp. 424-440.

Market 2000: An Examination of Current Equity Market Developments. Washington: U.S. Government Printing Office, January 1994.

Rohlfs, Jeffrey, "A Theory of Interdependent Demand for a Communications Service," *Bell Journal of Economics*, vol. 5, (1974), pp. 16-37.

Schreiber, Paul, and Robert A. Schwartz, "Price Discovery in Securities Markets," *Journal of Portfolio Management,* (Spring 1986).

Schwartz, Robert A., "A Proposal to Stabilize Stock Prices," *Journal of Portfolio Management,* (Fall 1988).

. *Reshaping the Equity Markets: A Guide for the 1990s*. New York: HarperBusiness, 1991 (reissued by Business One Irwin, Homewood, IL, 1993).

. "Competition and Efficiency." In Kenneth Lehn and Robert Kamphuis eds., *Modernizing US Securities Regulation: Economic and Legal Perspectives*. Homewood, IL: Business One Irwin, 1993.

ENDNOTES

The authors thank Laura Garbuz for her assistance in producing this aritcle.

1. Finding simultaneous solutions to demand/supply equations for all stocks when various contingencies are put on the orders requires a complex algorithm.

2. Markets with *network externalities* have received increasing attention in the industrial organization literature in recent years. The approach has yielded new insights in telecommunications, electricity networks, and other high technology industries. Applications are not limited to traditional "network" industries, but also include industries that use compatible components such as IBM-compatible software and hardware, picture telephones, and facsimile machines. See Rohlfs [1974], Farrell and Saloner [1985], Katz and Shapiro [1985], Economides [1989, 1993, 1994, 1995], and Economides and White [1994]. Also see Economides and Siow [1988], Economides and Heisler [1994a, 1994b], and Economides and Schwartz [1994].

3. Note that Bloch and Schwartz's [1978] analysis of how the order flow can fragment the absence of an order focusing rule applies to the continuous market.

4. The single-counting of transaction volume means that a share changing hands is counted just once (rather than adding together the number of shares purchased and the number sold). The data on share volume here are provided by POSIT.

5. Because of its low volume, AZX has functioned predominantly like a crossing network. Its price discovery capability would naturally operate at larger volumes. These data on share volumes are provided by AZX.

6. Most recently, The U.S. Securities and Exchange Commission's Division of Market Regulation grappled with these issues in its Market 2000 study [1994].