TRADING TECHNOLOGY AND FINANCIAL MARKET STABILITY

by

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1. INTRODUCTION

An understanding of the role and functions of financial markets is a necessary precursor to understanding the effects of advances in trading technology. Markets serve the function of enabling parties to engage in trade. However this is not the only function of markets. Markets serve a price discovery function: providing and aggregating information across both active and inactive market participants. Financial market stability will be enhanced by changes in trading technology which improve the price discovery function.

2. MARKETS AS TRADE ENABLERS

A trading technology or a market place enables parties to trade. I will explain below how this is intimately related to the price discovery function. However, it is useful to begin with a brief summary of the more elementary function of bringing trading partners together.

For illustrative purposes, divide the potential market participants into three groups: brokers, market makers and final customers. Brokers, by definition, never desire a position in the security. Market makers, by definition, take a position only for short term trading profits, i.e., the average return from a position held for the long run will not reward them for the risk

of capital committed over the long run relative to other uses they have for their capital. Final customers, by definition, are willing to accept the average returns for the risk of their positions over the long run, and are trading perhaps with great current immediacy to achieve that position. This division of actors is obviously artificial, but it will help to explain some important concepts.[1]

Final Customers

The final customer could be a pension or mutual fund which wants to increase its equity holdings because of a change in its risk preferences regarding equity or because of an inflow of cash from clients of the fund. In this case it is buying equity to achieve a new (relatively) long run position. It could also be a bond dealer who sells bond futures to hedge a portfolio of bonds in its inventory.

Market Makers

The market maker could be a dealer buying at a price from which it expects high abnormal returns. The market maker buys the instrument in situations when the price is temporarily low, while the final customer buys the instrument because the long run average return is high relative to its risk. More precisely, the market maker takes positions because of the variability in the

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[1] See Sanford Grossman and Merton Miller, "Liquidity and Market Structure," The Journal of Finance, July 1988, Vol. 43, No. 3, p.617-37.

expected return, while the final customer takes positions based upon the long run average expected return. Many trading institutions who are usually final customers in the above definition, will function as market makers when there are clear variations in expected returns. For example an S&P 500 Index Fund may substitute futures for stock when futures are trading at a discount relative to stock. The fund is taking a position in the spread because it has a high (risk adjusted) expected return.

To better understand the role of market makers, consider the following example. For reasons unrelated to information about future payoffs, a group of equity holders desires to sell a substantial block of equity. Assume that a negligible price fall would be required to induce the rest of the economy to increase its equity holding by the amount that is to be sold. That is, if final buyers could be matched with final sellers, then there would be no price impact of the trade. However, the potential final buyers are dispersed throughout the economy (if not the world), and are not in constant communication with the market. A market maker will buy the offered stock into his inventory to bridge the time interval between the arrival of the sellers and buyers. He bears risk while the stock is in his inventory, and hence must, on average enjoy a reward.

A market maker (or final customer, behaving like a market maker) buys when expected returns are high (relative to the normal risk adjusted return for the asset), and sells when expected returns are low. A large unanticipated flow of sell

orders which occurs in the absence of information about future payoffs, will lower price and raise expected returns (in the absence of market maker intervention). It is the fall in price, in the absence of news, which signals to the market makers (and eventually the final buyers) that their intervention is necessary. The price move is a crucial signal for allocating resources. The buying activity of market makers trying to take advantage of the high expected returns will diminish the size of the price fall, and thus stabilize the market. Final customers would be made better off if a communications technology for firm bids and offers between themselves could be developed so that market makers are not needed. Unfortunately such a system is unlikely to be workable because of the risks inherent in leaving firm bids and offers on a screen in a volatile market.

Brokers

In the artificial division of market participants, brokers are agents who do not take positions on their own account. They use their information acquisition network to match buyers and sellers. Brokers must know where to find buyers who are willing to buy from the broker's selling clients at the highest prices. Brokers will look to an organized market to find these buyers, and also use their sales force to find sellers who are not signalling their intentions through active participation in an organized market.

The existence of brokers who actively search for contra-

parties to a trade is evidence of the importance of information flows for the smooth and efficient functioning of securities markets.

3. Markets as Information Conveyors

The ideal market would be one in which everyone in the economy could costlessly, effortlessly, and continuously participate. In such an ideal market there would be no brokers (and they surly would disagree with this definition of ideal), because there would be no search for contra-parties. There would also be no market makers, since no one is needed to bridge the gap in time between the arrival of buyers and sellers at the market; all potential buyers and sellers are always costlessly and effortlessly present. Unfortunately, discussions of ideal markets can be sterile, as I feel are discussions about ideal worlds without wars, earthquakes, bad weather, or government regulators.

A major factor which causes markets to deviate from the ideal is the fact that continuous participation and information retrieval and evaluation is neither effortless nor costless. If one party wants to sell, this information is not costlessly disseminated to, and processed by all potential buyers. More importantly no single person is being made aware of the collective demand and supply schedules of the rest of the market. The fact that we are not all part of this fantastic telepathic network creates the need for information to be provided by

markets and brokers, as well as the need for market makers.

We can understand the role of technology by analyzing the extent to which it makes markets closer to the ideal. It is useful to divide technology into three broad classes:

1. General news, price, and quote delivery systems;
2. Order routing and delivery systems;
3. Order execution systems.

1. General news, price, and quote delivery systems

The revolution in news transmittal over the last 10 years has received little attention relative to innovations in order handling. Nevertheless, it has been extremely important. There has been a revolution in the extent to which large databases on companies and general economic conditions can be quickly and cheaply combined with current information. Ten years ago, there were no services which provided on line, real time, calculations of the current value of market indices (like the S&P 500), or the current bid and offer on the (cash side) of the indices. Since, there were no futures markets in stock indices, there was no real-time calculation of the basis.

The interest in real time calculation of market indices is to some extent a reflection of the growth of index options and futures markets. However, the growth in those markets is in turn a reflection of the growth of the institutional market's focus on trading large diversified portfolios. This has been associated with a change in the way institutional trades are routed and

executed.

2. Order routing and delivery systems

The NYSE originally created the DOT system to handle small retail orders. It allowed a retail broker to, essentially, transmit a market order directly to the specialist's post, and electronically receive a confirmation, usually, in less than two minutes. The broker is able to receive a market order from his customer, and often give the customer a confirmation, all in one short telephone call. At its inception, it was not anticipated that the DOT system would be used for large institutional orders. I believe, that at its inception, it was not contemplated that the DOT system would significantly impact on market prices or volatility. Brokers viewed it as a cheaper means of delivering and confirming orders. Market makers viewed it as an enhancement to the lucrative flow of retail market orders.

The trading of large orders through DOT was not anticipated because institutional orders were traded in a manner quite different from retail orders. In particular, an institution desiring to trade a block of shares in a single stock, would call an institutional broker who in turn would try to find the other side of the trade by telephoning other institutional clients. The brokerage firm might also take part of the trade for its own account. The trade would then be crossed on the NYSE between the parties that agreed to the trade off the floor. Alternatively, if a cross could not be arranged, a floor broker would be given

the order with instructions to "work it"- but only very rarely to trade it immediately as a market order.

The market impact of a trade clearly depends on how the trade is executed. There are two reasons for this. First, orders which demand immediate execution convey information to other participants. Market participants know that one reason that a trader demands immediate execution is that he has information, they thus offer to trade at adverse prices with the trader who demands immediacy. Of course, immediacy may be demanded for other reasons, such as a liquidity or hedging need. The weight put on the information motivation for the trade will determine the size of the market impact of the trade. The second reason for that the market impact of a trade depends on the method by which it is executed is that when immediacy is demanded, and a cross cannot be effected, then someone must earn a return from taking the other side of the order into inventory. This return is to cover the risks and other costs of maintaining an inventory, and the market maker earns this return by taking the other side of the trade at an adverse price to the customer. This adverse price move is the market impact of the trade.

In the decade beginning in 1970, institutions became increasingly interested in trading large diversified portfolios. The rise in S&P500 index funds is one example of this phenomenon. Futures markets provide a convenient method by which the equity risk present in a large basket can be transferred. Futures markets can accomplish in a single trade that which would require

trading in many different individual stocks on the Stock Exchange. Of course, the stock and futures markets represent one unified market in which equity risk can be traded. Thus the stock market must reflect the same information about equity valuation which is being expressed in the futures market.

The stock and the futures markets are kept in equilibrium by two forces. First, if the S&P500 can be bought more cheaply in one market rather than the other, then all buyers that are authorized to trade on either market will go to the cheaper market tending to raise price there, and all sellers who are authorized to trade on either market will go to the more expensive market causing prices there to fall. Not all institutions can freely choose where to trade. Hence there is another force which keeps the market in equilibrium, namely index arbitrage, where the instrument(s) in the cheap market are bought, and (almost) simultaneously the instrument(s) in the expensive market are sold.

In accomplishing index arbitrage or a large diversified portfolio trade where execution delays create great risk, the trader is forced to use a very fast order delivery and execution system. Thus the DOT delivered orders arrive and express great immediacy to the marketplace. For reasons given above this demand for immediacy will create a price impact. My measurements of this price impact indicates that it is quite small- on the order of half of the size of the bid-ask spread on the cash S&P500, namely about .2% for the typical program order.

The technological improvements inherent in the DOT system interact with the informational function of markets in a complex manner. As a pure routing system for small orders, there is very little informational impact. However, as a routing system for large basket orders, the system begins to interact with the informational function of the market. The arrival of baskets which are not arbitrage related, poses a particular informational problem. Namely, at the instant at which the order is offered at the specialist post, how do the traders know that the trade is part of a basket trade? The specialist will often know that the order came from a DOT terminal which usually sends baskets, but no one contemplating taking the other side of the trade in the individual stock knows what was the whole basket of which the stock is a single component. This piece of information is very relevant because, under the assumption that the basket was not arbitrage related (i.e., futures are at their theoretical value), it "should" have a smaller market impact on the each individual stock if it could be identified as part of a large basket trade. Its impact should be smaller because the party contemplating the other side of the trade does not have to worry about it being a trade initiated by someone who is informed about the stock. Unfortunately, the institution which uses the DOT machine to send a basket market order to express (and achieve) immediacy about the <u>basket as a whole</u> must bear the a market impact cost which is the sum of a demand for immediacy in each of the stocks in the components of the basket. The latter market impact cost can be

larger than the former because the (1) the probability that the order initiator is informed about the stock is higher than that he is informed about the whole market, and (2) it is sometimes easier for a market maker to hedge an inventory of a diversified basket of stocks than it is to hedge a single stock.

The above remarks indicate that there are benefits to be derived from developing a technology to cross basket orders that are currently being sent through DOT. Of course, part of the "technology" is already in place, namely S&P baskets and MMI baskets can be traded directly on futures markets as baskets.[2]

The above remarks concerned non-index arbitrage basket trades. Index arbitrage related DOT orders, by themselves do not put any informational burden on the trading system. Quite the contrary, the absence of DOT delivered index arbitrage orders would put a burden on the system. Index arbitrage occurs because trading on one market is expressing a demand for the services of the other market. For example, if institutions as a group, sell futures in an attempt to reduce their equity exposure, then buyers must be found for equities. If the buyers are other

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[2] Under CFTC regulations, futures contracts cannot be crossed, and any sort of prearranged trade can be interpreted as a violation of CFTC regulations. Of course, since baskets can be traded directly, the market impact cost (even without a cross) will be much smaller than the spot transaction since the two problems mentioned above will not exit. Indeed, the bid asked spread on S&P500 futures is often one tenth that of the bid asked spread on the basket of S&P500 stocks. See Sanford Grossman, "Program Trading and Stock and Futures Price Volatility," Journal of Futures Markets, August 1988, Vol. 8, No. 4, p.413-419. Also, see Sanford Grossman, "Program Trading and Market Volatility: A Report on Interday Relationships," Financial Analysts Journal, July-August, 1988, p.18-28.

institutions or individuals who have access only to the Stock Market, then someone must transmit the selling pressure from the institutions expressing that pressure in the futures markets to the people who are the buyers in the stock market. Index arbitrageurs are the messengers which bring the orders from one market to the other. In the case of net selling of futures, index arbitrageurs buy the futures, and then sell the stock on the Stock Market where there are willing buyers.[3] The information that there are more willing buyers on the Stock Market than the Futures market is provided by the event which initiated the arbitrage in the first place, namely the fact that futures are at a discount relative to their cash equivalent theoretical value. The information needed to bring the correct buyers and sellers together is provided by market prices, namely the spread between futures and stocks. This is an example of a situation where technology is extremely important. The ability to accurately compute the buy price on the cash market and then transmit orders electronically makes the market function more effectively. Intermarket demand and supply is reflected by the prices and this brings forth the appropriate response.

Elsewhere, I have argued that the information provided by the price of the futures or cash instrument only reveals current

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[3] Index arbitrageurs link the market makers on the Futures Market with those on the Stock Market, to in effect, double the liquidity of the market. The ability of institutions to make use of this enlarged market making capacity, lowers the market impact cost of their orders.

demand and supply conditions.[4] It is of course useful to know that at the price of the last trade, demand is different that supply. However it would be more useful if this was known in advance so brokers could search for the other side of the trade. I have argued that the implied volatility in option prices is one useful signal regarding the future order flow at price away from the current market price. Unfortunately current position limit regulations limit significant institutional participation in the options market.

Alternative technologies should be explored for conveying information regarding future order flows at prices away from the current price. This could be accomplished by making public an aggregate statement of what is in the limit order book. A facility could also be developed for the acceptance and dissemination of basket limit orders on the DOT system. Presumably the system could net out the demand and supply of baskets at the same price and sent to the specialist post only the excess of demand over supply.

An exploration needs to be made regarding automated order routing for futures markets. This is clearly a very different issue than automated routing for the stock market. First, each Exchange has only one or two pits in which equity futures are traded, unlike the stock market where orders have to be routed to

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[4] See Sanford Grossman, "An Analysis of the Implications for Stock and Futures Price Volatility of Program Trading and Dynamic Hedging Strategies," The Journal of Business, July 1988, Vol. 61, No. 3, p.275-298.

many physically separated posts. Second, there is no specialist to whom orders could be electronically routed for execution. For these reasons order routing innovations are likely to be less important for futures markets than they have been for stock markets.

3. Order Execution Innovations

Thus far we have discussed order routing, but only touched upon the issue of order execution. The area in which execution technology needs the most improvement is in multiple instrument and/or multiple security trades. By this, I mean not only basket trades, but also intermarket futures, options, and stock trades. We cannot have a single physical market in which all intermarket trading takes place. As long as there are distinct physical markets, some form of electronic, off-the-floor intermarket trading will be demanded by customers. A customer who wants to simultaneously trade Yen futures, IBM stock, US T-bond futures, and Japanese T-bond futures, presently must either put one leg of the trade on at a time, or call various brokerage houses to get bids on the overall trade. The latter, in effect, gives the customer a search market, rather than an organized (low search cost market). An alternative, to the current system is the development of a computerized market in intermarket portfolios. In such a "market" trades could display bids and offers for intermarket portfolios. I am not sanguine about the liquidity of such a market, and conjecture that it will simply turn into a

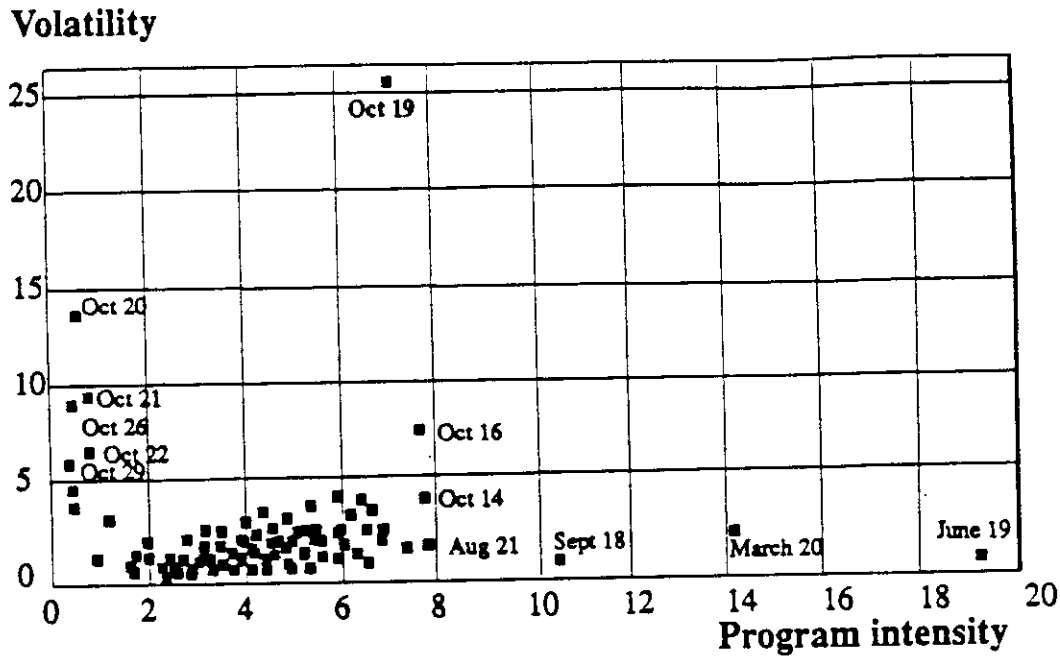
telephone market where traders look at the screen and then make telephone calls to find out what are the "real" offers.

Technology cannot solve a fundamental problem faced by market makers or customers who are searching for the best prices. This problem is that a deep liquid market requires firm bids and offers for large sizes. But, anyone giving such firm bids and offers for large size is giving the market a free option to hit his bid. The potential losses associated with bids left on the screen can cause a computer market to be thin and lead customers to telephone in order to find out the true bids. The screen is used to advertise interest, rather than as a mechanism for revealing true bids and offers when markets are volatile. I believe that the prices of completed trades provide the best signal about the markets willingness to trade at that price. Advertisement of the fact that someone has been willing to trade at a particular price is often the best mechanism for attracting the buy or sell interest which is necessary for market stabilization and efficiency.

Plot of Volatility vs. Program Intensity

Exhibit 1

1/2/87-10/30/87



15 Minute Program Trading and Price Change Statistics

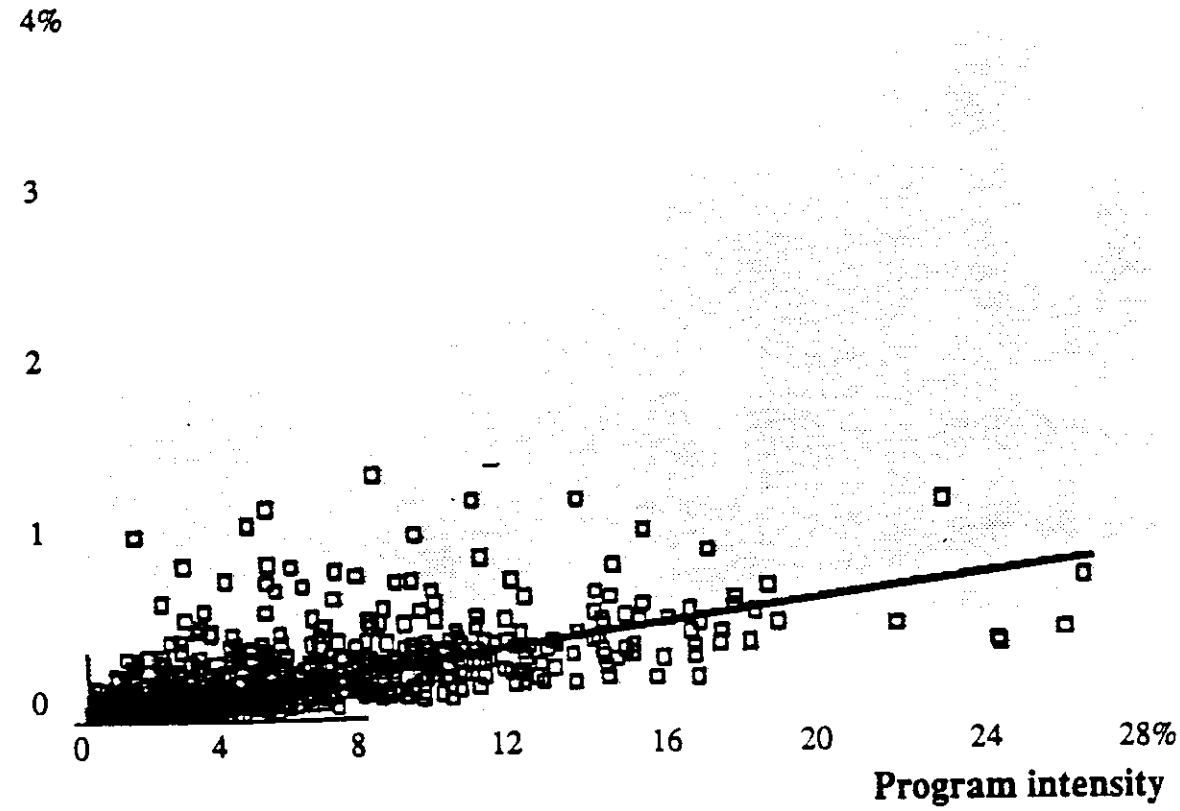
Exhibit 2

	Net progam buy intensity	15 minute percentage price change	Program order intensity	15 minute S&P 500 (high-low/low%)
Mean	-2.64%	-0.02%	4.21%	0.18%
Std. deviation	9.32	0.23	4.01	0.17
Minimum	-43.99	-1.23	0.07	0.02
Maximum	33.18	1.31	26.50	1.33

15 Minute Volatility vs. Program Intensity

Exhibit 3

•15 minute periods (8/24/87 - 10/16/87)



% intra-minute volatility = 0.0250% program intensity
(0.0011)

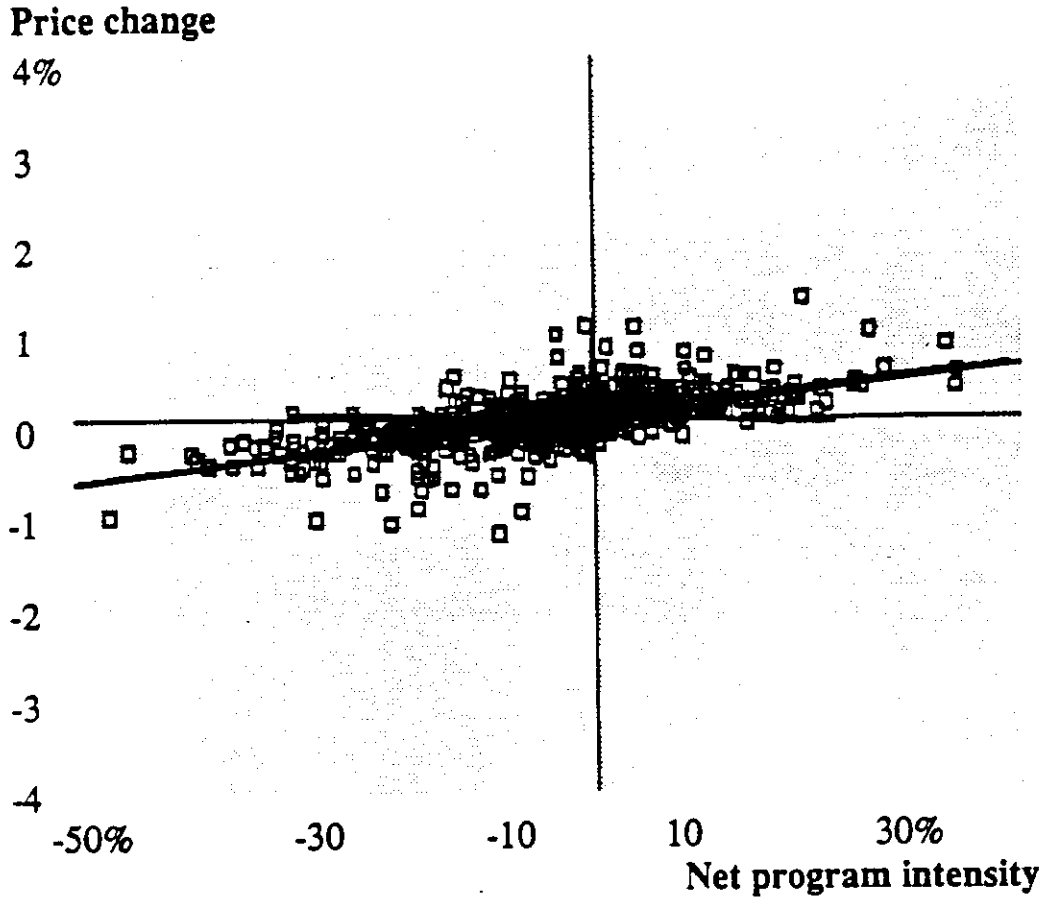
R^2 = 0.35

Number of observations = 1,014

Net Program Intensity vs. Price Change

Exhibit 4

•15 minute periods (8/24/87 - 10/16/87)



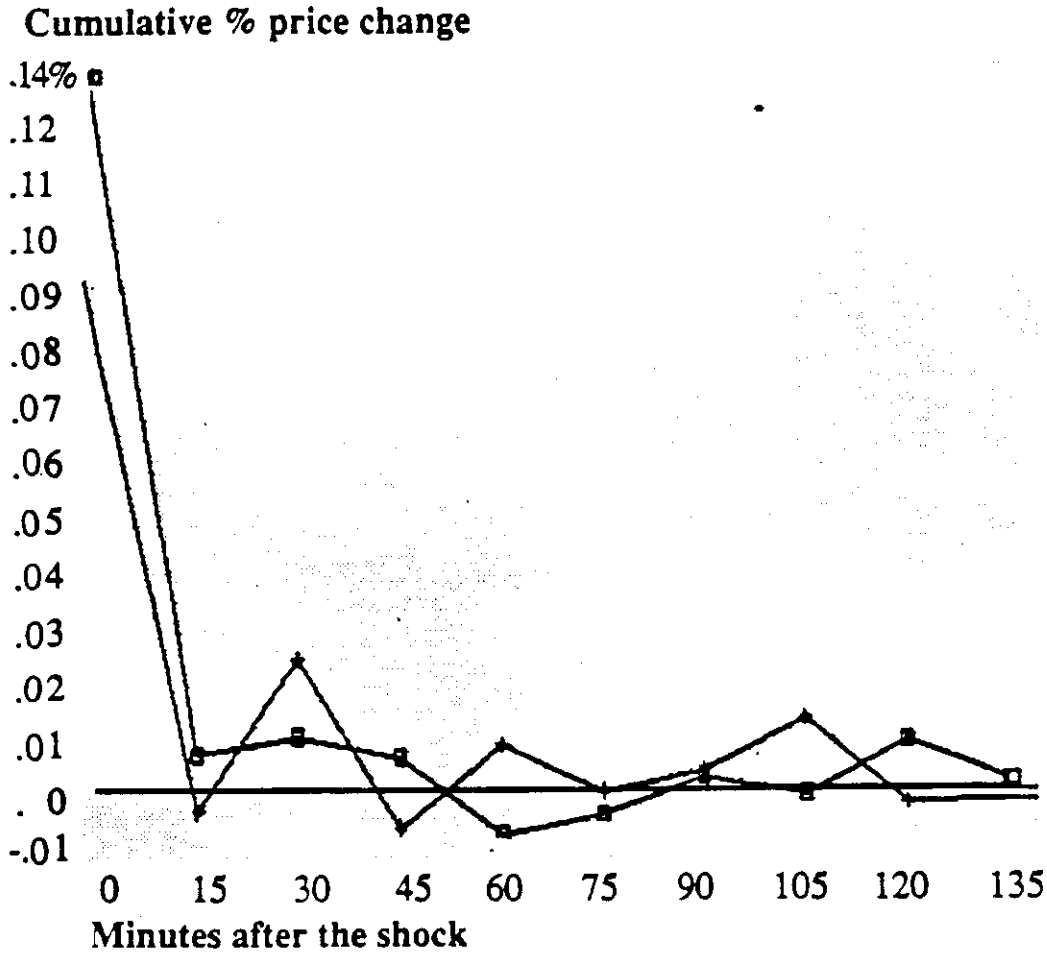
% price change = 0.0163% net program intensity
(0.0006)

R^2 = 0.45

Number of observations = 1,014

Impulse Response Analysis

Exhibit 5



□ Cumulative price response to 1 standard deviation shock in net program buying, 1SD = 7.6%

\+ Cumulative price response to 1 standard deviation shock in the basis (futures - cash), 1SD = $0.42