
Program Trading in Context

The Changing Structure of World Equity Markets

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*“It’s not what we don’t know that hurts,
it’s what we know that ain’t so.”*

—Will Rogers

Everyone knows that program trading causes stock price volatility and even stock market crashes. It is also common knowledge that futures markets are where speculators place bets on the stock market and that large institutions are taking over U.S. financial markets to the detriment of small investors. But there is solid evidence that what everyone knows about program trading, stock index futures, and the role of institutions in financial markets just is not so. This article focuses on program trading, one of the most controversial and least understood of financial innovations. Much of the reasoning herein extends to financial innovation in general.

For program trading, economic theory and empirical evidence are so clear that economists—famous for their disagreements—are nearly unanimous in

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the view that program trading plays a relatively neutral role with respect to stock prices. This is one of the few issues on which even John Kenneth Galbraith and Merton Miller see eye to eye. Miller has noted, “The observed variations in day-to-day volatility [do not] seem to be much related to changes in the intensity of program trading.” Meanwhile, Galbraith, in a discussion of the October 1987 market crash, called program trading a “superbly subordinate factor.”

But finance practitioners do not all agree with the economists. The views of the brokerage community, expressed in testimony before Congress, in the popular press, and even on Super Bowl television commercials, show a contrast with the economists’ view that would be comical for its hyperbole, if it were not dangerous for its misinformation. For example, David Wilson, head of Penn Mutual’s stock portfolio, observed, “Program trading is almost like sitting on a calm beach and have [sic] a tidal wave hit you.” A writer for *Barron’s* called program trading

"at best a parasite and at worst a cancer on the stream of useful business activity." And an editorial in *Investor's Daily* explained the October 1987 crash by reporting, "Program traders turned ugly—and the NYSE became a violent nuthouse." Full-page advertisements appearing in several national newspapers (and reported as news in one) bore the headline, "Never Have So Few Taken So Much From So Many." The ads continued, "The speculators and their political friends ruined the S&L industry. Now they have the power to ruin the stock market." Many people have accepted such statements as true, although the statements generally have come from sources whose business interests are challenged by innovations such as program trading.

So, economists and many practitioners disagree. But investors are the folks who matter. For the most part, individual investors are both uninformed and unconcerned about program trading.

In a 1990 survey sponsored by the New York Stock Exchange, investors were asked several questions about program trading. Most respondents had not heard about it. Investors were shown a list of 13 factors and asked which contributed most to their concerns about "economic conditions and investment trends." They chose program trading second-to-last, just above index futures and options trading. Topping the list of factors contributing to investors' concerns were questions about the "honesty and ethics of stock brokers." Are brokers paying for full-

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page ads and Super Bowl television commercials to shoot holes in their feet?

In the face of the controversy between the supposedly expert groups and the information vacuum among investors, two kinds of articles are being written. At one extreme, economists are writing in their jargon for each other—putting fine points on matters such as the path dependency of index arbitrage corrected for heteroscedasticity and discussing the possible effects of program trading on stock return kurtosis. At the other extreme, some

commentators substitute hyperbolic assertions about "wild, roller-coaster volatility" and "volcanic fluctuations" for rational debate. Neither approach is suited to gain the ear or trust of intelligent investors, who want to understand how markets are changing and how the changes affect them.

This article is intended to help fill the ground between the two extremes by explaining the economic motivations that underlie the new financial products and trading processes. When investors see the reasons for the changes and understand how innovation helps them, I believe they will welcome new products and processes such as program trading. We do not complain about cash machines because we see their benefits.

What Program Trading Is and Is Not

Program trading is only slightly more complicated than cash machines. Although it carries connotations of computers' trading without supervision or human control, program trading has nothing to do with computers.

In this context the term "program" is analogous to a school program in which the objectives are met by taking several courses. Similarly, a program trade is a trade in which the objective is met through transactions in several stocks. If for any reason I buy a portfolio of oil stocks or sell the stocks in the S&P 500—that is a program trade. More formally, the New York Stock Exchange defines program trading as any trade in 15 or more stocks with a value in excess of \$1 million.

Program trading does not have to be, and generally is not, computer-initiated. On each of the several trading floors I have seen, people make the trading decisions, not computers. In some cases computer algorithms facilitate the decision process, and in almost all cases computers help route the trade to each individual stock in the program, but traders make the decisions and implement them.

After describing the way I was introduced to program trading and discussing some of what I have learned in my research, I shall examine three fundamental changes in the structure of our financial markets and how they have combined to make innovations such as program trading inevitable. Program trading only makes sense in light of these changes. First, investors are learning that portfolio diversification increases returns without concomitant increases in risk. Second, institutions such as mutual funds and pension funds are becoming more important in managing investors' portfolios. Third, technological advances have lowered the costs of

financial innovation. Given these three changes, financial innovation is not surprising. It would be astounding if we did not see such innovations as program trading.

Program Trading and the October 19, 1987, Crash

I first paid attention to program trading on October 19, 1987, the day the Dow Jones Industrial average fell an unprecedented 508 points on New York Stock Exchange volume of 604 million shares. At the time, I was an economist in the Office of the Chief Economist of the Securities and Exchange Commission, and I had been working on an unrelated topic. That day my focus shifted to program trading. Did program trading cause the crash? Did program trading make a bad day worse? Or was program trading just a scapegoat for an otherwise inexplicable event?

Certainly, the circumstantial evidence implicated program trading: program trading had been seen with the weapon (sell programs) at the scene of the crime (the New York Stock Exchange). On October 19, program trading accounted for 18.9 percent of NYSE volume and \$3.9 billion of the \$20.8 billion of overall NYSE trading, an all-time high in both relative and absolute terms. During some five-minute intervals, program trading accounted for more than 60 percent of all volume in the S&P 500 stocks.

Market professionals, policymakers, and the news media were happy to find a plausible culprit for the crash. In the next day's headlines, the *Washington Post* reported, "Plunge Blamed on Anxieties and Computerized Trading," an unfortunate misnomer for program trading. On October 22, the NBC nightly news commentary contained the following misinformation: "The crash of '87 might have been much worse, the market's decline even steeper, had the New York Stock Exchange not moved against computer trading. . . . The technique of computer trading, or program trading, . . . uses sophisticated computer programs which trade enormous amounts of stock in seconds, without human command, which create big shifts in the market. . . . [C]omputer trading . . . makes no assumptions about the health or sickness of the market, no judgment on the intrinsic worth of companies; it is, essentially, mindless. . . . The computers were at work on Monday; the Dow Jones Industrials went down 508 points."

A few months after the crash, the official reports began appearing. The reports from the New York Stock Exchange, the Brady Commission, and the SEC's Division of Market Regulation all blamed

trading methods or market structure in one way or another. Of the three, the SEC's Division of Market Regulation report was most directly critical of program trading. It concluded that program trading was a "significant factor in accelerating and exacerbating the declines." That conclusion was supported within the report primarily by reference to two facts: there was a lot of program trading on October 19, and prices fell significantly on October 19. The facts are beyond dispute; the logical and empirical connection between them is not.

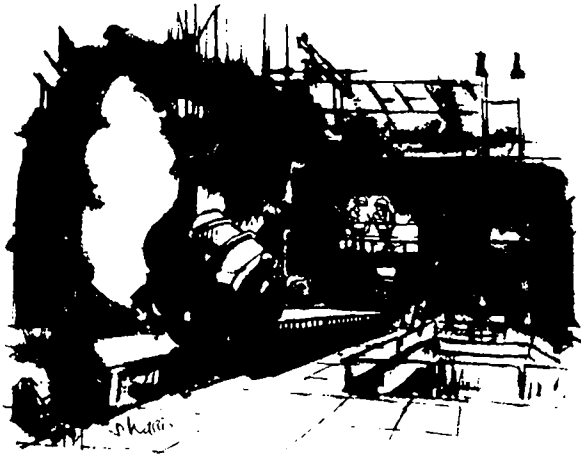
When the SEC's Division of Market Regulation report appeared, I was still in the early stages of an economic and statistical analysis of program trad-

An SEC study of program trading's role in the stock market crash of 1987 found that despite the increased volume of program trading, greater price declines did not systematically occur at times of more intensive selling by portfolio insurance or any other program trading strategy.

ing's role in the crash—to examine the connection between program trading and price movements. The logic of the connection is complicated by the fact that there are many types of program trading, and the effect of a trade on prices depends on what motivates it. I addressed the connection empirically by testing to see whether the five-minute intervals during which program trading was heaviest were the intervals during which stock prices fell the most. My study was not released by the SEC until May 1989, after months of intermittent negotiations over the language that I would be allowed to use to communicate my results.

The report describing the results of my research on program trading was delayed, but it was not censored. The conclusion finally read: "Despite the increased volume of program trading on October 19, 1987, this study does not find that greater price declines systematically occurred at times of more intensive selling by portfolio insurance or any other program trading strategies." As the *Wall Street Journal* observed, my conclusions "appear[ed] to place the SEC's Office of Economic Analysis in conflict with the agency's Market Regulation Division."

The results of my research make sense when one understands the direction of causality between program trading and volatility. Program trading



"How the devil did all thts go down 7^{3/8} today?"

(specifically index arbitrage) responds to volatility, not the other way around. An observer of a forest fire will see lots of fire fighters. They did not cause the fire; they responded to it. Furthermore, if one analyzes the intensity of fire fighting over the entire time of the forest fire, he will find that the fire burned most out of control when there were the fewest fire fighters. This is likely to be true even when the number of fire fighters in that particular location over the entire time of the fire broke all previous records. Index arbitrageurs are the market's fire fighters; they provide liquidity.

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Index arbitrage trading between the stock market and futures and options markets accounts for about half of all program trading. Because the financial products sold in the futures and options markets are derived from a cash product—stocks in this case—their prices are mathematically related. (Similarly, the price of a dozen eggs should be roughly 12 times the price of one egg.) When the price in one market falls relative to its mathematical relation to prices in another market, index arbitrageurs can buy the first, sell the other, and lock in a gain. This

process keeps prices across markets in line. But when there is not enough index arbitrage, the markets become unlinked and less liquid. In an illiquid market trade execution is slower. As a result, individual price movements are larger than in a more liquid market.

Large price movements occurred on October 19, 1987. Index arbitrage volume, which had been massive throughout the morning, tapered off in the afternoon as the risks, uncertainty, and other costs of trading skyrocketed. The market burned out of control in the afternoon, declining twice as fast as it had in the previous three-and-a-half hours. From 1:00 P.M. until 4:00 P.M., above-average price changes tended to occur when index arbitrage volume was *below* its average. The precipitous price declines occurred when the normal index arbitrage relation was most disrupted, not when index arbitrage was most prevalent.

Looking from day to day, rather than within a day, the rule of fire fighters generally applies—more volatility, more program trading. In a June 1989 SEC memorandum sent to Congress in response to questions about program trading, I reported my research on the daily relationship between program trading and stock market volatility. I had examined seven relatively quiet months in 1988 and 1989, and I had found a positive and statistically significant relationship between program trading and volatility—the volatile days were the ones with above-average program trading. In contrast to my findings on the crash, this result was well received within the SEC. In fact, the SEC's director of market regulation asked me to turn the memorandum into a study. On its surface, but only on its surface, the positive correlation seemed to buttress the view that program trading should be limited to inhibit volatility—a measure comparable to limiting fire fighting to inhibit fires.

But there is a layer of complexity here that I have ignored so far. One could reasonably argue that fire fighters do not set fires, but index arbitrageurs do sell stocks at precisely the time that markets are falling. Is the analogy flawed? No. In fact it can be extended. Remember that forest fires are routinely controlled by burning swaths of timber to keep the fire from spreading. The blaze set by the fire fighters seems counterproductive until one understands its local effects in the context of its overall purpose.

Arbitrage is just buying what is cheap and selling what is expensive, and, in theory, doing so for profit without risk. Stock index arbitrage attempts to do this by using the relation between an index of stocks,

such as the S&P 500, and a derivative product, such as the S&P 500 futures contract. But arbitrage is not an unusual event. It happens every day. Suppose that one stands in a long line at McDonald's and sees a short line nearby. Quickly, he will move to the short line. As a result, the long line gets shorter and the short line gets longer. That is arbitrage: gain for no pain while equalizing prices—line length at McDonald's.

Now suppose that one line is next to the door so that people naturally step to that line first. When a bus full of hungry tourists arrives, the door line may lengthen before people realize that they can save time by switching to a less accessible line. The tourists get their orders filled faster (liquidity is higher) if they are allowed to switch lines (arbitrage) from the door line (the futures market) to the short line (the stock market). The futures market is the door line in this analogy because prices move faster there; the door line lengthens first.

If line switching were not allowed, there would be two effects: one cash register would be less active than the others, and it would take longer to feed the whole busload. If the success of McDonald's service was measured entirely by examining the level of calm or distress at the short-line cash register, the policy decision would be clear: discourage arbitrage because it makes the short line longer. But if effectively imposed, the rule would slow service throughout the restaurant. Tomorrow the bus would go to Kentucky Fried Chicken. Actions that discourage liquidity lower the use of the market.

There are currently rules in U.S. financial markets that allow arbitrage generally but limit it when the tour buses roll in. Just when market liquidity is most important, NYSE rule 80A inhibits liquidity by discouraging arbitrage. Such a rule calms the activity at the short-line cash register to the detriment of the service provided by the whole market as investors respond to the increased cost of trading (illiquidity) by taking their business elsewhere.

Despite being the most visible equity marketplace, the New York Stock Exchange is no longer the whole U.S. equity market. Increasingly, the NYSE is just another cash register. The NYSE's share of U.S. equity trading has been falling gradually, reaching an all-time low in 1990 of 47 percent in terms of share volume and 64 percent in terms of dollar volume. Nor do U.S. markets dominate world equity markets as they once did. Since 1975, the U.S. share of direct stock trading in world equity markets has fallen from about 75 percent to just under 25 percent.

Despite these facts, some members of Congress and the retail brokerage community, which never cared much for tour buses in the first place, would go well beyond the current rather limited restrictions. But limiting marketwide liquidity further would cut off the nose of the U.S. financial industry to spite its face.

The NYSE, on the other hand, is responding to the challenge of increased competition by working to strengthen its linkages with the rest of the market. The official NYSE view of program trading has evolved toward acceptance. The day after the October 1987 market crash, John Phelan, then

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NYSE chairman, blamed several factors including the "impact of computerized trading maneuvers." Two-and-a-half years later, Phelan accepted the finding of the Smith panel he had sponsored: "Arbitrage is a natural feature of the linkage between the equity and equity derivative markets and is not, in itself, undesirable."

The view on the floor is also sympathetic to program trading. I have talked to several NYSE market makers (specialists), and they smile when I mention it. In small doses program trading represents a money-making order flow with very little risk. When a specialist sells to a program buyer or buys from a program seller, he does not have to worry that the party on the other side of the trade knows more about the stock than he does; the trade is being made for programwide, not stock-specific reasons. By watching price movements in the futures market on his computer screen, the specialist can predict to the minute the arrival of index arbitrage trades.

Evolving Financial Markets

To understand changes in today's equity markets, trading must be considered in at least three dimensions beyond the market provided by the NYSE: location, time, and product.

Trading at other U.S. exchanges and around the world has mushroomed. In fact, trading no longer needs to be linked to any specific location at all.

Increasingly, equity and equity-related products are traded, not on any physical exchange, but on computer screens and over the telephone. The NASDAQ stock market is an important U.S. example of a screen-based, geographically decentralized market. Furthermore, the globalization of trading means that the market never really closes. The sun is always shining on someone who wants to change

Three factors assured the growth of program trading: individual investors' trading diversified portfolios to reduce risk, institutions' holding or trading higher fractions of equity than before, and technological advances' facilitating global trading.

his exposure to Exxon, the oil industry, or the U.S. equity market. Finally, the growing array of financial products used to trade equity exposure extends far beyond the stock markets to include futures, options, various combinations thereof, and even low-grade debt. The liquidity that matters pertains to a global, multiproduct equity market—an international 7-11 of finance. Global, multiproduct liquidity depends on global, multiproduct linkage. That is what arbitrage provides.

The genesis of program trading can be traced to changes in demand and supply. On the demand side, two factors are salient. First, individual investors are learning that trading a diversified portfolio eliminates some of the risks of investing. Second, institutions hold and trade a higher fraction of equity than ever before. On the supply side, costs have fallen because of technological advances that speed the flow of information, tighten market linkages worldwide, provide alternative trading mechanisms such as screen-based trading, and vastly improve the clearance and settlement processes. Given the increase in demand for program trading and the reduction in its costs, the absence of program trading would be more surprising than its increased presence.

Central to the 1990 Nobel prizes for economics was an idea that the owner of a diversified portfolio of stocks earns a higher return for a given level of risk than the owner of an undiversified portfolio. Further, investors will only be compensated for risks they cannot diversify away. That idea, which has been slowly gaining ground for the past 25 years, is supported by the growing body of evidence that ad hoc stock-picking strategies and chartist analyses do not outperform the market.

Widespread acceptance of the benefits of diversification have much to do with the second factor affecting demand—the growing role of institutions in equity markets. The growth of mutual funds sales (which missed a beat following the 1987 crash but is now back on track) is one manifestation of diversified portfolio investment. The massive equity investments of pension funds and insurance companies also indicate diversification. In this light the trends revealed by the Federal Reserve Board's flow-of-funds data are not surprising. First, households are not participating directly in the stock market so much as they did in the past. Following a decline that began in the mid-1970s, household participation in the stock market is down to about 15 percent from its 1968 high of 33 percent. Second, the retreat of households from direct equity market participation has been balanced by an increase in households' use of institutional intermediaries. The share of household assets managed by institutions has trended upward since 1966, with the pace quickening somewhat since 1982. Third, the participation of institutions in equity markets has been growing relative to their investments elsewhere.

Thus, program trading is not driving individuals from equity investments. In fact, individual investors are participating more and more in equity products, but their assets are now being professionally managed as diversified stock portfolios. Each of these trends has been gradual, and their roots go back many years. They antedate program trading and stock index futures. They are the causes rather than the effects of today's financial innovations. The growth of large holdings of diverse bundles of equity made it inevitable that methods would be developed to trade bundles efficiently. A program trade is one method by which a mutual fund money manager can quickly move funds into or out of the stock market for an entire portfolio of stocks.

Conditions governing the supply of program trading have also changed: the cost of implementing new ideas has tumbled. Technological advances enable news to arrive, to be analyzed, and to be traded on more quickly than in the past. Many of the trading innovations depend on screen trading, global linkages, and low-cost hedging. For example, the U.S. market now has access to stock products in Japan, and Wall Street firms that offer those products can hedge their sales worldwide. This market, started first in overseas securities, is now working its way to U.S. securities. The list of market advances allowed by technological improvements is impressive, ranging from the Chicago Mercantile Exchange's Globex system to clearance and settlement on U.S. futures exchanges that now occur two

or three times each day. Technological advances at the NYSE allow order volume in excess of 100 million shares per *hour*—more than double the average *daily* volume just 10 years ago. And the NYSE's DOT system has substantially lowered the cost of translating a program trade to each individual stock in the bundle. In the context of these changes, program trading and other financial innovations are both natural and essential to the newly linked world markets.

Conclusion

Although there are lots of fancy names for the different kinds of program trades, there are just two reasons why people use program trading: first, for arbitrage purposes, to profit from the price discrepancies between the stock and derivative markets, and second, to accommodate investment objectives. Each of these reasons for program trades accounts for about half of all program trading.

Index arbitrage accounted for 46 percent of program trading in 1990, about the same level that it has maintained since July 1988 when the NYSE began to collect program trading data. Index arbitrage trades really act as messengers, bringing the information impounded in prices from the futures market to the stock market. Suppose that prices are stable and in equilibrium when there is good macroeconomic news. That news will be transmitted to the markets by trading in both the stock and futures markets, and prices will rise in both markets. But for several reasons prices move faster in the futures markets than in the stock market, so that the futures price will rise above its fair value relation to the stock index. Enter index arbitrageurs, selling what has become expensive—futures—and buying what has become cheap—stocks. The effect is to bring prices back to their fair-value relation at the new level that takes account of the good news. It is true that the buy order was triggered solely by an observed price discrepancy. Index arbitrageurs may not have known and certainly did not care what moved prices. But the effect of the buy order was to transfer the news in futures prices to the stock market.

We can understand program trading resulting from pursuit of investment objectives by considering an investor who puts, say \$1,000 in a mutual fund. When an investor buys stock from a mutual fund, that is a message to buy a portfolio of stocks; similarly a redemption is a message to sell a portfolio of stocks. Both are in effect retail program trades. This other half of program trading, then, is motivated by individual investors' decisions being

channeled through institutional investors, such as mutual funds, to the market.

Much of the political tumult over program trading, and certainly complaints by brokerage firms, have painted things very differently—as another way for big companies to manipulate prices at the expense of small investors. The truth is that the institutions and their trading serve smaller investors in more ways than ever before.

Fifteen years ago, equity investors were dependent on their full-service brokers and did not have the vast menu of opportunities available today. There have been major changes in the way financial markets are organized. And these organizational changes, which have led to new financial products and trading methods, benefit the small investor. Working families can now participate in U.S. equity markets through their pension plans, or they can own a diversified stock portfolio by investing as little as \$1,000 in a mutual fund. As usual, economic change has occurred first where institutions respond directly to customer demand. Change is also occurring up the line as the exchanges adapt to provide greater trading access and market liquidity.

Government policies, however, are slower than these institutions to adapt and often inhibit change. The task for U.S. regulators is to self-consciously adapt to facilitate the transformations of financial markets.

Every new financial product or trading method is linked to stock markets through arbitrage, for example, portfolio insurance and Supershares from Leland O'Brien and Rubinstein, auction trading from Wunsch Auction Systems, and even the NYSE's own basket product. To expect, hope, or legislate otherwise is to turn our backs on the future—indeed on the present—and to watch our financial markets go overseas to countries with a more forward-looking flexible approach than that in the United States.

Selected Readings

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