JULY/AUGUST 1994

ECONOMIC PERSPECTIVES

A review from the
Federal Reserve Bank
of Chicago

FEDERAL RESERVE BANK
OF CHICAGO

Contents

ECONOMIC PERSPECTIVES July/August 1994 Volume XVIII, Issue 4

ECONOMIC PERSPECTIVES is published by the Research Department of the Federal Reserve Bank of Chicago. The views expressed are the authors' and do not necessarily reflect the views of the management of the Federal Reserve Bank.

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ISSN 0164-0682

Remember—central bankers are paid to worry!

Silas Keehn

The following is a transcription of a speech presented by Mr. Keehn, President of the Federal Reserve Bank of Chicago, to the International Swaps and Derivative Association on March 18, 1994.

It is a pleasure to be here and to have a chance to review my thoughts on the derivatives markets with you. I firmly believe that these exchanges between regulators and industry participants serve an important and mutually beneficial purpose, and I think a good deal has been accomplished by the recent discussions. As you are all aware, the derivative markets are without question the fastest growing and most exciting area in the financial industry, but that growth is beginning to attract some unwanted yet perhaps healthy attention. To put it mildly, your press has not been very good lately. Between Metallgesellschaft, the recent case of Gibson Greetings, the cover of a major business magazine, and a blizzard of government and industry reports, it seems as though everyone is suddenly worried about derivatives.

This shouldn't come as a big surprise. The complexity and rapid pace of change in your markets has simply outstripped the ability of all but the most qualified specialists to keep up. Even sophisticated individuals can feel overwhelmed when confronted with concepts such as digital and embedded options, "swaptions," caps and collars, and the seemingly endless variety of clever new combinations. It's easy to understand why an outsider, or more to the point, a legislator, would find these markets confusing and perhaps even sinister.

But my viewpoint is somewhat different. As a central banker, I am concerned not so much with the complexity of the market but with its underlying integrity. The Federal Reserve, as the nation's central bank, has the ultimate responsibility for the health and efficient operation of the financial system. In that role, our job is not to eliminate risk, but in cases where there are conflicts, to make tradeoffs between risk and efficiency.

Having said that, let me clearly emphasize that I have no doubt that derivatives play a useful role in modern financial strategies. Today, to an extent that would have been hard to imagine just twenty years ago, it is possible for a firm to separate different risks—currency, interest rate, and commodity—and sell off those that the firm doesn't want to retain and keep those it does. The flexibility and low costs of these products have allowed firms to manage risk and pursue new business in ways that were simply impossible in earlier times. The very real and significant advantages of these financial strategies have demonstrated themselves dramatically in the marketplace.

Legitimate concerns

But legitimate concerns have developed, and remember—central bankers are paid to worry, and high growth rates and high concentrations are two hot buttons that always get our attention. One need hardly repeat the standard if admittedly flawed numbers about the incredible growth in derivative activities to understand why there are calls for significant regulatory controls.

In the five-year period ending 1992, the notional value of swap contracts outstanding increased from an estimated $865 billion to some $4.7 trillion. This compares to the $3.6 trillion in total corporate debt outstanding in the U.S. Within the banking system, the use of swaps over this same period increased from a notional value of $705 billion to $2.1 trillion, a level equivalent to seven times the aggregate amount of bank capital. These growth numbers are matched by even more worrisome concentrations of risk in the dealer market. According to the 1993 Swaps Monitor Survey, the ten largest dealers account for about half of the outstanding interest rate swaps, and the ten largest dealers in currency swaps account for 40 percent of the market. Such numbers, even if somewhat overstated, have an unfortunate resonance with previous problems in the financial system. As the historical record demonstrates over and over again, high growth and undue concentration of risk are a recipe for trouble.

Lending to less developed countries (LDCs) in the 1970s is a good example. While it was advertised by some as a low-risk way of recycling the massive inflow of petrodollars, that argument was less than compelling. In hindsight, bankers underestimated the risks and saw an elusive opportunity to increase earnings by aggressively expanding their LDC lending.

Another classic example was the energy area. If you go back to the period when energy lending really began to escalate, bank management was convinced that this was an appropriate way to build up earning assets at comparatively high rates of return and with little perceived risk. Unfortunately for those banks and for the deposit insurance agencies, it turned out that energy prices could go down as well as up. Once again, high growth combined with an insufficient appreciation of the risks involved led to disastrous results for many banks. I am not saying that very rapid growth per se is necessarily fatal, but rather, it is a warning signal. As growth accelerates, even small mistakes can grow into major problems.

Some perspective

But before the parallels between the growth in derivatives and LDC and energy lending become overdrawn, it is important to remember, first, that notional value is at best only a rough guide to the true size of the market and the actual risks being undertaken. Better data, based on market value and segmented by type of contract, and adjusted for double counting and netting, are clearly necessary in order to understand the actual risk exposures that have developed in these markets. Second, it is important to remember that derivatives are primarily a risk management tool, not a risk acquisition tool—and that even what may seem like a significant derivative risk of an individual institution may be offsetting an equivalent but opposite risk in the rest of its portfolio.

This is not to say that there aren't risks, but rather, that much of the risk associated with derivatives arises not from their existence but from their possible misuse—a very important distinction. A product that allows firms to eliminate large risks quickly and easily also allows them to acquire those risks, and thus in turn to expose others in the system. This raises both counterparty and systemic issues that the Federal Reserve cannot ignore.

Certainly the market understands these issues. The development of triple-A-rated subsidiaries, as well as the high capital and collateral requirements that the market is demanding of dealers, is clear evidence of just how seriously the market takes these risk management issues. After all, no borrower would ever require that a bank have a triple-A credit rating before accepting an energy loan from it. From the standpoint of central bankers, the prudence demonstrated by customers in the derivatives markets is a good sign that the market is working and managing risk on its own.

While some would advocate significantly restricting off-balance-sheet activity, I believe we need to avoid burdensome regulation. On the basis of both our supervision of individual banks and our research, it's our judgment that banks are using derivatives to manage risk better, and that if anything, the growth in derivatives represents a positive development in overall portfolio risk management. It is this belief that leads me to try to make clear to you what I think is necessary if these markets are to continue to grow and develop without significant and potentially burdensome regulation being imposed from the outside.

The necessary changes

Let me comment on the changes that I think are necessary on the part of the industry, the Federal Reserve, and others if these markets are to continue to innovate and to meet the growing demand for risk management tools. The critical question we need to answer is how best to deal with the real and perceived risks posed by these markets in a way that will allow the innovation necessary to compete in this very competitive marketplace and yet protect the system from major disruptions.

In my view, we must begin by understanding the difference between regulation and supervision. While some tend to use these words fairly interchangeably, there is a very important distinction between the two. Supervision is institution-specific and relies heavily on the industry and the institution to define and follow good business practice. It is the fundamental element in the examination process. Regulation relies on rules to prevent "bad practices." In my experience, regulation in rapidly evolving markets is either too little too late, frequently overreacting after the problems have already developed—or too much too soon, stifling innovation and hampering the market's ability to provide needed services. While this may be an overgeneralization, I think that for almost any financial activity, the more that official regulation can be displaced by effective supervision and industry standards, the better off the financial system will be.

Self-regulation

In this vein, I would urge that the industry provide for self-regulation to the greatest extent possible. You know the competitive requirements of your markets and the current and future needs of your customers better than we do, and you are in a better position to assess the operational implications of alternative systems of control. I would also urge that you continue to develop and improve standards (regulations) that will provide for safety and soundness in these activities. The Group of Thirty report was a good first step, but only a first step. Eventually, the rules will need to be far more specific.

There needs to be an industry self-policing system that has teeth and that will, through its actions, be respected. Clearly, the International Swaps and Derivative Association has an important role to play in this process. Such an organization will significantly lessen the need for external sources to impose restraining regulations, a very real danger as long as some view these markets, no matter how unfairly, as free-wheeling gambling casinos. In this light, I would also suggest that the industry should spend more time discussing the real economic benefits produced from the use of derivatives and depend less on the general defense of the need to compete. This will help make much clearer the trade-offs implicit in restricting these activities.

The Federal Reserve has been actively doing what we can to help. We have consistently promoted the development of industry groups and provided them with the necessary legislative and regulatory tools to help them manage the risks on their own. Following the passage of the Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA), which altered the treatment of derivatives for bankrupt institutions covered by deposit insurance, the Federal Reserve, among others, sought and achieved significantly broader and more legally secure treatment of netting agreements. The Federal Deposit Insurance Corporation Improvement Act (FDICIA) extended netting to securities brokers, dealers, and nonbank participants on the Clearing House Interbank Payments System (CHIPS), as well as to appropriate financial institutions as determined by the Federal Reserve. On February 1 of this year, we released the final rules for use in determining which institutions will be covered by the FDICIA netting provisions; these new rules took effect on March 7. As a result of these actions, it will be substantially easier for firms to manage their credit risks and to resolve insolvency problems in these markets in the future.

We have also recently approved an extension of the hours that our wires for moving funds electronically will be open in order to reduce temporal risk and to allow institutions to work at reducing Herstatt risk. I am pleased to say that the Chicago Fed played a major role in promoting these changes. But I will also have to admit to having been surprised by the industry's response when the extended hours proposal was going through the comment phase. Particularly in a Chicago context, I had thought that this would be enthusiastically supported, but frankly, the comments we received were underwhelming.

Accounting standards

Beyond Federal Reserve actions, there is a lot to do in terms of the functioning of market mechanisms and just as importantly, improving the public's perception of these markets, if they are going to be free to prosper in the future. At the broadest level, I think we need to see better accounting standards. Hopefully, the Financial Accounting Standards Board's new recommendations on derivatives and hedge accounting will be a significant first step in this direction. Well-designed accounting standards can substantially aid both the supervisors' and the market's ability to monitor these activities. If market discipline rather than regulation is to provide the basic control mechanism for these markets, then it is imperative that financial reporting provide the information required for informed assessments.

Good financial reporting standards with extensive disclosure can also help reassure the markets that derivatives are in fact assisting financial institutions and customer firms to manage their risks better rather than allowing them to gamble with their stockholders' money. Further, good accounting practices will help taxing entities get a better handle on the appropriate tax treatment of derivative activities. Such changes will allow market participants, supervisors, and legislators to understand and monitor the markets better as well as provide a basis for the outside auditing of these activities. But this is not the whole solution, since such accounting information is available only at specific points in time.

The strength and weakness of the derivatives market is that it allows institutions to make radical changes in their market exposure almost instantaneously. But this advantage must be supported by the development and enforcement of internal procedures within individual institutions so that problems do not develop between financial statements. With this as a lead-in, let me shift from broad industry concerns to some important institution-specific issues.

At the firm level

To limit the development of potentially damaging problems, some absolutely essential elements must be a part of any organization's basic thinking.

First, risk measurement systems are paramount. The institution simply has to know on a current basis the magnitude of the risks that are going onto its books. For many of the newer participants in these activities, this may seem very complicated, but without a good risk measurement system an institution is bound to get into very serious trouble.

Second, effective controls need to be in place. Management needs to establish limits for various categories of risk, and the controls dealing with these risks must be adequate to the task.

Third, there must be clear organizational separation for those generating the risks (the marketing or sales side of the business) from those approving the risks or changing the limits for individual categories. While this may seem pretty basic, there have been any number of banks that have gotten into trouble—sometimes fatally—because they did not effectively separate these two fundamental aspects of the credit or risk extension process.

Fourth, the management information systems must be accurate, understandable, and available on a current basis at senior levels of the organization. With activities evolving at very great speeds as derivatives do, a 200-page report two weeks after the fact just won't do. A real-time exposure monitoring system, or at the very least, an end-of-day monitoring system that provides accurate, understandable reports of risk and exposure measurement to senior management is a sine qua non.

Fifth, for any of this to work in practice, senior management must have a fundamental understanding of these derivative activities. Choosing the right people to work in and manage these areas is important, but it is not enough. It is too easy and far too simplistic to view derivatives as a purely specialized function that the specialists can be trusted to do right. For some, I will admit that esoteric derivative activities are very complex and very challenging. But as a management precept, it just makes sense that if you don't understand it, don't get involved.

Sixth, as a related management issue and a thought that will probably strike this group as totally unacceptable, if I were in the senior management of an organization dealing heavily in these activities, I'd very carefully watch the compensation schemes that are in place. While bonus and incentive plans that are driven by the institution's overall success are appropriate and beneficial, those that provide for very heavy incentive motivation on a highly individual basis, almost regardless of the institution's total results, are fraught with peril. And finally, I also think it is important for the industry to develop outside auditing standards for firms' risk management procedures. Prudent management practice, as well as the demands of public and investor confidence, will require that such audits be done in a credible and regular fashion.

The Federal Reserve's role

Even with the best control mechanisms and procedures in place, there are still concerns at both the institutional and system level, particularly those that relate to the integrity of the payments mechanism—the pipeline through which our entire economy flows. We at the Federal Reserve, who in my view have the ultimate responsibility for the integrity of the financial system, cannot in good conscience ignore these issues.

Derivatives and other innovations in the financial industry have generated an explosion in the flows through the payments system. What was once a simple loan involving monthly payments between two parties can turn into a veritable parade. Starting with a loan, an interest rate swap, and maybe a currency swap, the loan can then be sold off directly or securitized. Each of these contracts in turn may spur offsetting hedges on the part of the financial intermediaries, or secondary loans as the pieces are sold off to investors. To get some idea of the potential systemic implications of this explosion in financial activity, you only have to look at the massive increase in transactions running through the payments system. In 1970, there were $15 of financial transactions for every dollar of gross domestic product (GDP). By 1980 the ratio had increased to $30 to one, and by 1990 it was $78. Over half these transactions are cleared through CHIPS, which didn't even exist in 1970. And this is not solely a U.S. phenomenon. In Japan, for example, the growth in financial transactions has been even more staggering, going from 15 yen of financial transactions for each yen of their GDP in 1970 to a ratio of over 115 yen to one by 1990. Almost all of the growth has been in large dollar settlement systems related to securities and foreign exchange transactions.

One can only imagine the chaos that would ensue if anything seriously impeded these rapid movements of money in which the equivalent of our annual GDP flows every three business days. Clearly, there is sufficient risk here to warrant careful monitoring and extreme care on the part of Federal Reserve to make sure that no single failure or pattern of financial entanglements can seriously damage the payments system. It is precisely this risk that clearly and dramatically explains why the Federal Reserve remains so interested in the orderly development of the financial system and why we continue to argue that our responsibility for monetary policy and for the underlying stability of the financial system implies a direct and continuing role in the supervision and regulation of the major players.

Regulatory consolidation

Let me conclude with a few comments about the Federal Reserve's future role in the supervision and regulation of financial activity. As you know, the Administration has proposed that the current federal regulatory process for depository institutions be consolidated into a single agency. If this were done, the Fed would cease to have supervisory responsibilities but would continue, of course, to have responsibility for monetary policy. We have strongly objected to this proposal and have counterproposed a structure that would simplify the current fractionalized system and eliminate duplicative examinations for most institutions. Our view on this issue stems from our monetary policy responsibilities and our need to react to a variety of events and circumstances with an appropriate monetary policy response.

As the nation's central bank, the Federal Reserve System has the overriding responsibility for the integrity of the financial system in its many dimensions. This responsibility extends into parts of the system where we do not have specific supervisory or regulatory authority. Over the years that I have been president of the Federal Reserve Bank of Chicago, I have seen any number of examples where this authority and responsibility, either explicitly or implicitly, has been important in dealing with some genuinely systemic issues. Happily, most of the instances that come to mind have been invisible because we were able to contain them before they exploded onto the public scene. But they had the potential of becoming damaging in a systemic sense and would have become so had we not responded. In 1987 and again in 1989, in both Chicago and New York, the Federal Reserve through its supervisory apparatus played an important role in making sure that the financial system continued to function.

As you well know, the state of the art in derivative activities is rocketing ahead at breathtaking speed as depository institutions become more heavily involved in these increasingly complex activities. Our supervisory responsibilities, already very difficult, will become even more so, but by having the level of involvement that we do, we can reach judgments on the safety and soundness of individual institutions as well as the controls, procedures, and management information systems that are in place. This involvement is essential to maintaining the integrity of the financial system, which in turn directly relates to our overriding monetary policy responsibilities.

In my view, and it's one that I feel very strongly about, there is an absolutely direct interrelationship between these two very fundamental and very important responsibilities. If anything, the increased rate of innovation and interconnection between markets and the phenomenal speed at which modern trading systems operate argue that the Federal Reserve needs, at the very least, to maintain its current level of involvement in order to live up to our obligations to the financial community and to the country. We need to be able to count on the sound and continued smooth operation of the payments system and on our ability to unwind problems and continue to operate even under severe stress. Our margin for error is continually narrowing, and careful monitoring is necessary.

I believe that the Federal Reserve's approach based on supervision and on industry input, combined with our strong desire to promote economic efficiency, will lead to the best solutions. It has been argued that such responsibilities are inconsistent with our role in monetary policy. Personally, in addition to the obvious and important connections I just noted, I think it's a good thing to have a supervisor who cares about economic outcomes as much as safety. As Chairman Greenspan commented at the Federal Reserve Bank of Chicago's Bank Structure Conference last year, "zero bank failures is not the optimal number"; the system needs to provide for risk and innovation. The key is to stop problems that develop at individual institutions from growing into larger systemic problems. Supervision must always be tempered by the desire for growth, both in the financial sector and in the economy as a whole.

While it is difficult to judge just how the legislative process on this issue will develop, I think the proposal that the Fed has put forward is a good one, and I hope that wisdom and sound judgment will prevail.

Again, it has been a very great pleasure for me to be with you this morning, and I appreciate having this opportunity to review my thoughts with you. Thank you.

The impact of lean manufacturing on sourcing relationships

Thomas H. Klier

During the last decade, U.S. manufacturing has experienced various changes in its cyclical and structural environment. Among them are the severe back-to-back recessions of the early 1980s and the widespread restructuring efforts undertaken in its wake, as well as increased foreign competition, great exchange rate volatility, and most recently, the build-down in the defense sector. In addition, the very core of manufacturing has been changed by the introduction of a new paradigm, the so-called lean manufacturing system. It deserves special attention because of its potential long-term effects.

Since the early 1980s, manufacturers have moved away from the traditional Fordist system of mass production toward a system of lean production.[1] Fordism separated intellectual and manual work and broke down the latter into easily learned, repetitive steps. Based on a continuously moving assembly line, Fordist manufacturing could mass-produce a limited number of models at very low cost and therefore came to dominate most of the world's manufacturing from the mid-1950s through about 1980. Lean manufacturing, by contrast, emphasizes quality and a speedy response to market conditions, using technologically advanced equipment and a flexible organization of the production process. By all accounts, lean manufacturing is a more efficient system of production. Aoki (1988) suggests this is because its methods of organizing and coordinating production allow a speedier and more timely horizontal coordination between different manufacturing operations and a subsequent reduction in costly inventory.

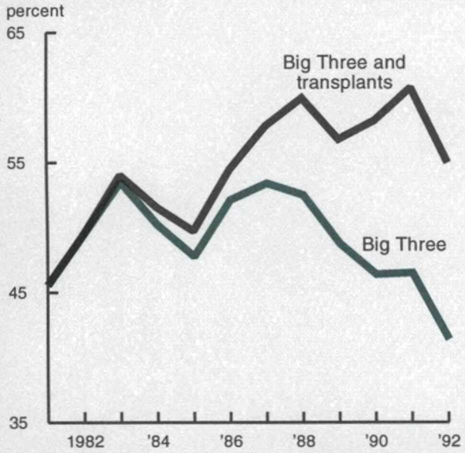
Lean manufacturing was pioneered and first applied successfully by Toyota Motor Company in the 1950s; since then it has become the practice of many Japanese manufacturing companies.[2] Recently American manufacturers have adopted it in order to compete effectively both at home and abroad. Adopting lean manufacturing also affects the way a company is managed and how it structures its relations with customers, employees, and suppliers; the ramifications of this change extend far beyond the shop floor of the assembly plant.[3]

U.S. automakers introduced lean manufacturing rather quickly. In turn, they greatly influenced the way many other businesses organized their factories, especially auto suppliers. The Midwest felt the greatest impact from these developments since it is the center of automobile assembly in the U.S. (see figure 1).[4] Complementing recent work by Ballew and Schnorbus, this article examines how the introduction of lean manufacturing affected the structure of the auto supplier industry and the relationships between assembler and supplier companies.[5]

Thomas H. Klier is a regional economist at the Federal Reserve Bank of Chicago. He would like to thank Bob Schnorbus, Bill Testa, and Janice Weiss for their helpful comments.

FIGURE 1

Midwest's share of U.S. car production



Source: *Ward's Automotive Yearbook* (1982-93).

and stampings.[6] As it is almost impossible to describe the industry by means of published census data, the following analysis draws on other sources of information.[7]

The structure and development of the automobile supplier industry must be analyzed in the context of developments in the automobile industry, since the demand for suppliers' products is derived from the demand for automobiles. Cyclical and structural conditions of the auto industry also tend to shape the supplier industry.[8] The major recent structural change to affect the auto industry has been the implementation of lean manufacturing techniques. Lean manufacturing is characterized by an emphasis on product quality; quality controls are incorporated into the production process, for example through the use of "lean" inventory stocks for intermediate and finished goods, and through including multiple responsibilities in individual job descriptions and encouraging worker participation in production management. Lean manufacturing takes an integrated approach to the various aspects of manufacturing. The idea of a concurrent design process forces everyone who at some point has a stake in the product to work closely with designers instead of coordinating the various functions sequentially from design to assembly. For example, production engineers can voice their concerns during the design process and that way improve ease of manufac-

The changing structure of the automobile supplier industry

The U.S. automobile supplier industry is large and diverse, encompassing firms that produce thousands of different parts, from a simple gas cap to a complex engine. Table 1 outlines the recent trends in the motor vehicle parts and accessory industry as defined by standard industrial classification (SIC) 3714, "motor vehicle parts and accessories." The establishments in SIC 3714 account for about two-thirds of all shipments of automotive parts

TABLE 1

Employment, shipments, and value added for the auto supplier industry*

Year	Total employment (thousands)	Shipments (million dollars)	Value added (million dollars)	Value added per employee (thousand dollars)
1979	459	39,807	18,034	39.3
1980	369	32,881	14,719	39.9
1981	359	37,081	17,254	48.0
1982	321	36,293	16,765	52.2
1983	338	44,415	21,593	63.9
1984	382	52,583	23,888	62.6
1985	385	57,931	26,094	67.7
1986	377	57,394	24,374	64.7
1987	389	62,007	26,426	67.9
1988	401	69,049	28,731	71.7
1989	393	65,683	26,458	67.3
1990	389	64,875	26,871	69.1
1991	370	63,604	25,213	68.2

*Defined as SIC 3714.

Sources: U.S. Department of Commerce, (1979-1991, 1987).

turing of the product early on in its life cycle. Finally, lean manufacturing relies on subcontractors to produce a greater proportion of the value added and emphasizes speed in order processing, production, and delivery. The successful start-up of Japanese transplant assembly facilities in North America and Europe demonstrated the transferability of lean manufacturing to other socioeconomic environments. Resulting competitive pressures forced its adaptation by the Big Three. In turn, the automobile supplier industry in the U.S. has been undergoing a transition of its own.

Coinciding with the arrival of Japanese transplant motor vehicle assembly plants, about 260 transplant supplier companies have set up shop in the United States since 1981 (see figure 2).[9] The vast majority have located in the Midwest, close to the Japanese transplant assembly plants (see figure 3). While at the outset transplant suppliers mainly supplied the transplant assembly plants, they have since been competing for business from the Big Three. The presence of supplier companies with experience in the application of lean manufacturing increased the pressure for domestic suppliers to adopt the new techniques.

Given lean manufacturing's emphasis on low inventories and frequent deliveries, sourcing relationships based on lean manufacturing can function best when supplier and receiver are located fairly close to each other.[10] An analysis of the geographical pattern of the locations of Japanese auto assemblers and suppliers in the U.S. bears this out.[11] Japanese suppliers operating in the U.S. are typically located within about a 200-mile radius, or five hours' driving time, of their main customer.

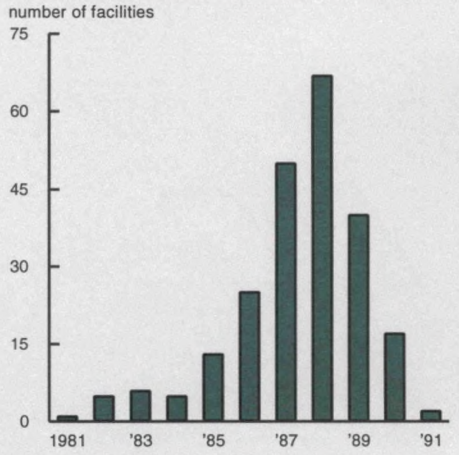
As table 2 indicates, the domestic auto industry is still dominated by captive parts companies that are part of the corporate structure of the assembler (see figure 4).[12] Domestic supplier companies also show less evidence of a changed location pattern since the arrival of lean manufacturing. That is not surprising, since it would require a change in already existing locations. Yet empirical studies have found a break in the location of auto supplier companies away from the pattern which prevailed until the 1970s.[13] The change is ascribed to several factors.

First, lean manufacturing has brought an increase in the purchase of parts from independent suppliers rather than from captive parts companies. Whereas captive suppliers tend to be heavily concentrated in urban areas of Michigan, Ohio, and Indiana, newly established plants of independent suppliers are usually located in smaller communities in nonmetropolitan or outlying metropolitan counties.[14]

A second reason for the changing location pattern of domestic suppliers is that the geographic structure of auto assemblers itself underwent a restructuring, starting in the late 1970s. According to James Rubenstein, the branch assembly plant system, which was set up to minimize transportation costs by producing identical vehicles at multiple locations, was

FIGURE 2

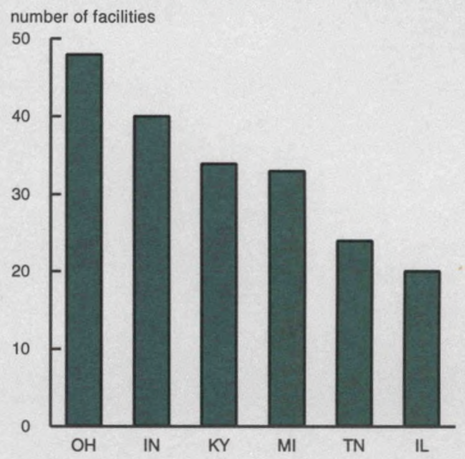
Transplant auto supplier start-ups



Source: McAlinden and Smith (1993).

FIGURE 3

Transplant suppliers, 1991, top six states



Source: McAlinden and Smith (1993).

TABLE 2

The ten largest first-tier suppliers in North America
(1992)

Rank	Company	Total North American automotive sales, 1992	Products
		(million dollars)	
1	GM Automotive Components Group	19,500	Systems and components: power-train, lighting, chassis, steering, braking, HVAC, batteries, engine management
2	Ford Automotive Components Group	7,200	Automotive glass, electronic controls and systems, climate controls and systems, engine accessories, trim and plastics
3	DuPont Automotive	2,500	Fibers, finishes, plastics, elastomers, composites, lubricants
4	Magna International Inc.	2,260	Systems: seating and bumper, door and panel, engine and transmission, metal body
5	Nippondenso America Inc.	1,600	HVAC, electrical and electronic products, fuel management systems, radiators, instrumentation, filters
6	United Technologies Automotive	1,600	Electrical, interior and exterior trim systems, steering, wiring products
7	Robert Bosch Corp.	1,400	Communications technology, fuel management systems, anti-lock braking systems, electronics, starters, alternators
8	The Budd Co.	1,250	Steel stampings and frames, truck wheels, hubs and drums, composite body-engine parts
9	Kelsey-Hayes Group	1,190	Anti-lock brake systems, brake components, wheels, electronic components
10	Lear Seating Corp.	1,100	Seating systems, door panels

Sources: Fleming (1993a), Payne and Payne (1990).

swept away with the fragmentation of the U.S. auto market.[15] Multiple regional assembly plants were gradually replaced by plants that produced one particular platform for the entire market.

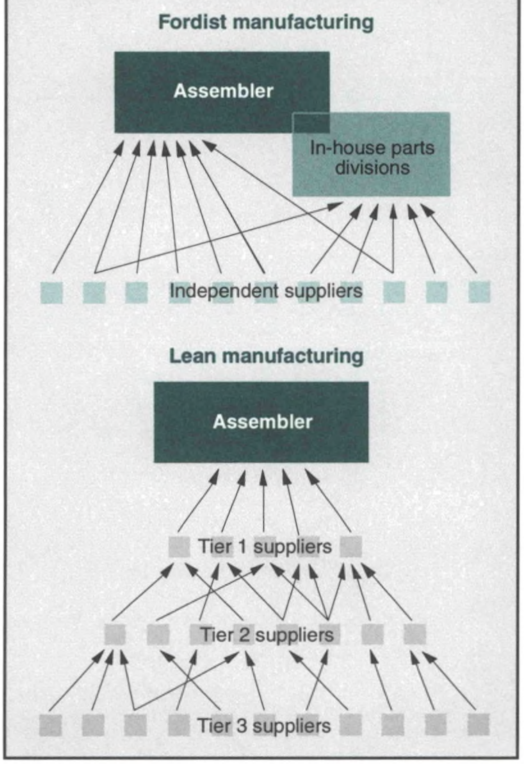
Finally, suppliers that deal directly with assemblers (so-called first-tier suppliers), providing especially large, complex, and high-value components and services, have been locating near their customers. In contrast, lower-tier suppliers, who tend to produce low value-added parts, relocated to low-wage areas in order to reduce production costs.[16]

Assembler-supplier relationships within lean manufacturing

With the arrival of lean manufacturing, the relationship between assembler and supplier companies has changed considerably. Under the Fordist system, U.S. auto manufacturers procured most parts and components from their own parts divisions (see figure 4). These sourcing relationships were supplemented by purchases from independent suppliers in arms-length transactions. Typically, a car assembler dealt with 1,000 to 2,500 suppliers directly.[17] Contracts with independent suppliers usually

FIGURE 4

Assembler-supplier relationships



ran no longer than a year. The assembler relied on hierarchical coordination of information and control over technology in order to solve the complex task of manufacturing cars.

The tier system

Today, rather than centrally coordinating almost its entire supply structure, an assembler deals directly with only a small number of supplier companies, referred to as first-tier suppliers. Most first-tier suppliers deliver fairly aggregate parts or entire systems rather than individual bits and pieces. Such an arrangement has greater informational efficiency and therefore appears to have a competitive advantage over the Fordist system.[18] Indicative are the results of a study conducted in Japan in 1977 to establish the supply tiers for one particular auto assembler. While the company's supplier pyramid contained over 35,000 suppliers, the company dealt directly with only 122 of them, its first-tier suppliers.[19] The remainder fell into the second and third tiers.

U.S. assembler-supplier relationships have also become organized in tiers.[20] In 1980, for example, Ford Motor Company dealt directly with about 2,400 North American suppliers. It has since reduced that to about 1,400 first-tier suppliers and is committed to a target of 1,150 by 1995.[21] Similar changes are occurring at the individual platform level. For Ford's recently introduced world car, called Mondeo in Europe and Contour/Mystique in the U.S., the company is working with only 227 first-tier suppliers in the U.S. That compares to 700 suppliers for the Tempo/Topaz platform, which the Contour/Mystique will replace.[22] Chrysler produces its Neon with 289 first-tier suppliers, down from 425 for the Sundance/Shadow which it replaces.[23] Changes such as these have increased the potential roles of full-service supplier companies such as Magna International, which produces entire systems for seating, bumpers, doors and panels, engines and transmissions, and metal bodies.[24] The development of the tier system has also forced changes in the relationships between suppliers. For example, as recently as 1985, Manchester Stamping, located in Manchester, Michigan, obtained its steel supply from more than 30 different companies. It has since reduced that number to five. With bigger orders it can now demand faster service.[25]

Mutual commitment

Compared to the Fordist system, lean manufacturing requires a high degree of communication and interaction between manufacturers and fist-tier suppliers, resulting in more closely-knit relationships to which both sides make various commitments. Rather than carrying large amounts of inventory for the downstream customer, supplier companies change their organization of production so as to produce "just in time." In addition, they take on responsibility for quality control and, often, research and development, activities that were traditionally the task of the assembler. Accordingly, suppliers must invest in quality control training and equipment and maintain their own product design staff. The assembler, in turn, uses single suppliers rather than multiple suppliers for each part of the platform. A recent study of the Big Three showed that for a list of 30 automotive parts, in 85 of the 89 observations the part was single-sourced.[26] In addition, the assembler makes a commitment to longer-term relations through both longer-term contracts and the extension of informal contract-renewal promises, contingent on continuous quality improvement by the supplier.

The degree of mutual commitment between assembler and supplier cannot be observed directly, but it becomes apparent in various specific aspects of sourcing relationships. A recent study measured this commitment as the number of years during which assembler and supplier work together before actually starting production.[27] During this time, supplier and assembler must reach agreement about the part's technical features, quality standards, price, and delivery schedules—an undertaking requiring significant cooperation. The more time spent on pre-production communication between assembler and supplier, the stronger the mutual commitment to the relationship. For example, Chrysler's new JA platform is scheduled to go into production later this year, yet by 1992 every major system in it had already been sourced.[28] Some supply relationships in the automobile industry are now so established that suppliers play a role in designing the automobile.

The following shows the importance of mutuality in the commitment to sourcing relationships. In the mid-1980s, Lucas PLC, a British supplier of mechanical and electrical components to the automotive and aerospace industries, began adopting lean manufacturing principles. As a result, the company reduced lead times and in-progress inventories significantly while vastly improving the percentage of orders delivered on time. However, one of Lucas's electrical component factories soon ran into problems because some of its large customers had not converted to lean manufacturing and continued to place their orders in an unpredictable manner.[29]

Knowledge transfer

Domestic suppliers are now more likely to provide detailed information to their customers than just a few years ago.[30] This reflects the need for increased communication in a lean manufacturing environment. Most notable has been the dramatic increase in information exchanged on statistical process control (see table 3). Statistical process control is a technique for generating continuous reductions in defect rates. It involves taking samples of output, recording the results, analyzing them to determine the causes of defects, and redesigning product and process to eliminate those causes.[31] According to a survey of 964 first-tier suppliers, 16 percent of the 453 respondents provided that kind of information to their customers in 1984, while in 1989 the share had increased to 92 percent.[32] There had also been a significant increase in the number of visits by representatives from the assembler to the supplier in order to provide technical assistance. Finally, the majority of suppliers had become responsible for at least part of the design of their product, as opposed to using customer-provided blueprints and specifications. The specific arrangements varied from suppliers performing all the research and design to the customer and supplier contributing equally. Only 5 percent of the respondents in the survey said they had no design responsibility.

TABLE 3

Suppliers providing the following information to assemblers
(percent)

	1984	1989
Statistical process control charts	16	92
Breakdown of production costs	3	19
Production scheduling	50	78
Breakdown of production steps	39	75

Source: Helper (1991).

The importance of quality

Much of the increased information exchange between assemblers and suppliers is motivated by the assemblers' desire to reduce production costs by having suppliers share the responsibility for quality control. To this end, assemblers have given suppliers the tasks of testing parts and components and certifying that they meet the assemblers' specifications. In turn, suppliers have retrained their employees, upgraded their equipment, and worked to make their own suppliers comply with the more demanding standards. Not surprisingly, quality has become more important to the selection of supplier companies; according to one study, it moved up from the third most important criterion in awarding contracts in 1984 to the first in 1989.[33] Performance to quality standards has become very important for continuing a supply relationship over time. Assemblers closely monitor their suppliers' quality records and dependability, with the understanding that continuous high production quality will lead to continuing relationships. Every major auto manufacturer now bestows quality awards to recognize its top supplier companies.[34]

Contract duration

In a lean manufacturing environment, supplier contracts frequently extend over the particular model's lifetime. For example, when Chrysler made sourcing decisions for the production of its Neon, rather than putting contracts out for bid, the company awarded lifetime contracts to suppliers that met a given target cost.[35] In the five years between 1984 and 1989, the average length of written sourcing contracts in the U.S. auto industry doubled.[36] During the same period the percentage of contracts written for more than three years rose from 4 to 40 percent. Helper also reports that the percentage of suppliers doubled who said their customers would help them rather than switch if a rival supplier came up with a superior product.[37] This finding is consistent with the reported increase in single-source contracts. Not only does it make sense for an assembler to strengthen its reduced number of supplier relationships; a commitment to a long-term contract also serves as an incentive for the supplier company to take on the increased responsibilities described earlier.

Outlook and public policy implications

The above analysis suggests a compelling momentum toward a system of longer supply relationships based on mutual commitment. However, evidence from individual companies does not always square with that picture. That is because complex adjustment is required to change organizational structures and approaches that worked well in the past, as did the Fordist system of production. There is ample evidence of the stress this adjustment causes, and not every company deals with such stress equally well. For example, Helper (1991) reports cases where a manufacturer threatened to cut off suppliers that did not provide the new services such as product design and just-in-time delivery for free.[41] It is unclear how frequently such situations occur, but there is ample evidence that auto assemblers and suppliers can more smoothly implement this more efficient way of doing business with each other. For example, Chrysler has integrated suppliers into its planning process by making them full-fledged members of its vehicle platform teams. About 300 supplier personnel have offices in Chrysler's Tech Center, where the company develops its vehicles. In September 1989 Chrysler began a program to reduce sup-

The new auto supplier: Lean manufacturing from a supplier's point of view

Lear Seating Corporation, based in Southfield, Michigan, is one of the largest independent suppliers of seat systems in North America. The company switched to lean manufacturing in 1984. Its sophisticated just-in-time system enables it to deliver products to a customer's factory on as little as 90 minutes' notice. As soon as the vehicle body leaves the paint shop in the assembly plant, its seating specifications are electronically sent to a Lear plant, where the seats are assembled and loaded for delivery. The company counts 16 auto assemblers among its customers. It currently operates 25 plants, with three more slated to open soon.[38] All of these plants are located near the customers' assembly plants to reduce turn-around time from order to delivery.[39]

Freudenberg-NOK was established in 1989 as a partnership between Freudenberg & Company of Germany and NOK Corporation of Japan to serve the North American market. Headquartered in Plymouth, Michigan, the company employs 3,600 employees in its 14 North American facilities and produces seals, molded rubber and plastics, and vibration control products. Lean manufacturing techniques have given the company significant competitive advantages in terms of cost, quality, and service. Freudenberg-NOK doubled sales during the past five years, while North American auto production was declining by 20 percent. To pursue its lean strategy further, in 1992 the company launched a program called GROWTTH ("get rid of waste through team harmony"), which fosters ongoing, employee-driven efforts to use space, people, and materials more efficiently without adding jobs or floor space. According to the company's president, early results are encouraging. Cycle times have fallen by 82 percent, product lead time by 46 percent, and inventories by 77 percent, while productivity has risen 48 percent and the company needs 44 percent less production space.[40]

plier-related production costs; it has since received almost 6,000 ideas from suppliers that generated $400 million in annual savings.[42] Lean manufacturing sourcing relationships such as these have developed throughout the manufacturing sector; in fact, they are also spreading to areas such as retailing and services.[43]

From a public policy perspective, the introduction of lean manufacturing raises the question of whether the necessary skills will be available at both assembler and supplier companies. Lean manufacturing seems to have raised the educational requirements for jobs in the auto industry. For example, 97 percent of hourly employees that Ford hired between 1991 and 1993 were high school graduates. That compares to about 81 percent for all of Ford's hourly employees.[44] Changing demands for workers' skills might become more noticeable soon, since the average age of an assembly worker in today's auto plants indicates retirement shortly after the year 2000. A number of assemblers are setting up their own supplier support and training programs; here and there, suppliers of one assembler have begun cooperating to pursue a competitive edge and share research.[45] Some have proposed state or regional involvement, for example, to promote technology centers that could transfer the required skills to workers in parts and assembly plants.

Some have suggested building a local economic development strategy around a lean manufacturing scenario.[46] For example, the state of Alabama offered significant financial incentives to attract Mercedes' first North American auto plant, suggesting that the state expects to benefit from supplier employment it assumes will be generated near the assembly plant. However, one needs to analyze the evidence carefully in order to evaluate the regional distribution of benefits and costs of lean manufacturing activity.

Summary

The previous discussion outlined in broad strokes the current trends in the supplier industry and the relationship of that industry to downstream customers. The adjustment process is still under way. The introduction of lean manufacturing has brought with it an increase in outsourcing, the elimination of multisourcing in favor of single sourcing, tiering of the supplier structure, a reduction in the number of first-tier suppliers, and longer-term contracts between suppliers and assemblers. In a lean manufacturing environment, assemblers and first-tier suppliers tend to have close working relationships.

Successfully implemented lean manufacturing sourcing relationships, as described above, enable both parties to benefit from the incentive advantages of longer-term contracts. The assembler can save monitoring costs and cut down on inventory; the supplier is no longer exposed to the risks and costs of annual contract bidding. Under Fordism, assemblers typically had short-term, arms-length relationships with multiple suppliers, relationships not designed to reward commitment.

NOTES

[1]The Fordist system is named after Henry Ford, who introduced interchangeable parts and the moving assembly line to the manufacturing process. Lean manufacturing is also frequently referred to as just-in-time manufacturing.

[2]In developing the lean manufacturing system, Japanese companies, most notably Toyota, were influenced by their own analysis of the Fordist system as well as by the quality-enhancing ideas of the American consultant W. Edwards Deming.

[3]See, for example, Milgrom and Roberts (1990), Helper (1991), Bechter and Stanley (1992), and Klier (1993). The recent gains in market share by the Big Three may well be related to strong gains in manufacturing productivity that occurred during the last few years. For example, Chrysler's remarkable recent success in developing cars quickly and efficiently is reported to be the result of reorganization efforts patterned on development and production techniques employed by Honda. In addition to the automotive industry, applications of lean manufacturing are reported for the consumer and electronic goods, metal products, aircraft, aerospace, and computer industries; see Hollingsworth (1991).

[4]The Midwest is defined as the states of Illinois, Indiana, Michigan, Ohio, and Wisconsin. Currently, about 500,000 workers are employed in auto assembly in the Midwest. When suppliers and related industries are added, the number rises to over 1.25 million (Ballew and Schnorbus 1994).

[5]Ballew and Schnorbus (1994).

[6]U.S. International Trade Commission (1987), p. 3-2.

[7]Automotive products can be found in over 20 additional four-digit SICs. In addition, not all output classified within a particular SIC is necessarily produced for automobile assembly; for example, SIC 3519 encompasses all internal combustion engines. Nor can census data distinguish between supplies to the assembly process and to the so-called aftermarket—items sold to consumers through retail or service outlets.

[8]For an overview of the major changes since World War II, see Ballew and Schnorbus (1994).

[9]These operations are either subsidiaries of Japanese supplier companies or joint ventures, usually of U.S. and Japanese companies.

[10]Estall (1985), p. 130.

[11]Mair et al. (1988). The authors analyzed 12 transplant assembly plants and about 250 transplant parts factories. Practically all of them were greenfield sites.

[12]This pattern is almost entirely absent from the Japanese transplant system. See McAlinden and Smith (1993), p. 38.

[13]Rubenstein and Reid (1987), Rubenstein (1988).

[14]Rubenstein (1988), p. 290.

[15]The number of distinctive platforms built in North America increased considerably, reducing demand for each particular model. Platform refers to the structural underbody of a car. The vehicles that share a particular platform have the same wheelbase and other dimensional characteristics and thus can be produced relatively easily on a common line (Luria 1990, p. 143).

[16]See Glasmeier and McCluskey (1987).

[17]Womack et al. (1990), p. 146.

[18]Helper (1991), Aoki (1988).

[19]Aoki (1988), p. 204.

[20]The tiering effect would not be detectable in the census SIC data since those data do not distinguish different tiers of suppliers. In fact, a shrinking base of first-tier suppliers may well be consistent with the observed increase in the overall number of supplier establishments (see McAlinden and Smith 1993, p. 29). The change toward a tier structure might have led to an increase in the number of second- and third-tier establishments, overcompensating the reduction in first-tier supplier establishments.

[21]Fleming (1993c).

[22]"Ford stands by CDW27 program" (1994).

[23]Chappell (1994).

[24]In a way, this decentralized sourcing structure is similar to the organization of work in the lean manufacturing assembly plant: As work teams require workers to take on wider roles, first-tier suppliers are required to play wider roles as well.

[25]See Treece (1992).

[26]Klier (1994).

[27]Klier (1994). The study estimated an econometric model; in it the variable measuring mutual commitment was statistically significant in explaining a reduction in the probability of vertical integration. The average value for that variable is reported as 2.68 years. Even though no direct comparison to pre-lean manufacturing data is possible, it seems reasonable to expect that number to be lower in a system that relied mainly on annual price bidding.

[28]Ward's Communications (1992), p. 53.

[29]Womack and Jones (1994).

[30]Helper (1991).

[31]Helper (1991), p. 27.

[32]Helper reports that the survey was mailed to "virtually every domestically owned first-tier automotive supplier in the U.S."

[33]Helper (1991).

[34]While these awards tend to favor large suppliers who are able to muster sufficient resources to produce the very best quality, see Treece (1992) for a brief description of four small suppliers that earned quality awards from at least two of the Big Three and also from one Japanese transplant.

[35]Ingrassia and Lavin (1993).

[36]Helper (1991).

[37]Helper (1991).

[38]In April, Lear Seating announced its decision to build a seat plant in Hammond, Indiana, to manufacture seats for Ford's Torrence Avenue auto plant in Chicago, less than 25 miles away (Maclean 1994).

[39]"Supplier profile: Lear Seating targets European market" (1993), and Simmons (1994).

[40]Fleming (1993b), "Supplier profile: Lean production keys growth at FGNP" (1993), and Treece (1993).

[41]In a recent survey of supplier companies, GM's supplier relations were ranked worst among 12 auto manufacturers with plants in North America. This fact seems mostly due to the aggressive cost-cutting approach taken by GM's former purchasing czar, Jose Ignazio Lopez (Gardner 1993).

[42]Bohn (1994).

[43]"Tying the knot" (1994).

[44]Templin (1994).

[45]For example, 24 mostly small parts companies formed such a strategic alliance in Michigan (see Chappell 1993).

[46]Mair (1993).

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Does program trading cause stock prices to overreact?

James T. Moser

Program trading constitutes a substantial fraction of the trading activity in the New York Stock Exchange. The volume of stocks exchanged in orders labeled program trades typically averages 10 percent of total volume. This article investigates the claim that program trading causes stock prices to overreact. Stock price overreaction is important because investors are thought to use stock prices as guides to the best uses of their capital. If prices overreact to new information, they cannot provide accurate guidance. Evidence of such stock price overreaction would be indicative of excessive volatility.

Previous researchers have considered the possible effect of program trading on volatility, a proposition which requires a model for the natural evolution of volatility. Because such a model lacks general acceptance, this article offers an alternative approach. I investigate whether program trades increase the odds of price reversions.

Prices reverse when previously encountered price decreases are immediately followed by an increase in price; or when a previously encountered price increase is immediately followed by a price decrease. Price reversions can be expected to occur when price changes are larger than the value changes warranted by new information, that is, when prices overreact to new information. In instances of overreaction, informed traders will find current prices out of line with their valuations. The trades of these informed traders will then bring prices back toward their original levels. This depiction follows that of Black (1985).

This article examines whether program trading should be classified as a type of noise trading or as a type of information trading. If levels of program trading increase the likelihood that a price reversal will occur, we can conclude that program trading is a type of noise trading. On the other hand, if program trading is unrelated to the likelihood of encountering a price reversal, then program trading should be categorized as information trading. I examine a 34-month period of daily program trading activity and stock prices and use a logit specification to consider the proposition that trading activity changes the probability of stock price reversals. The results do not support the claim that program trading causes stock price overreactions.

Literature review

Much of the literature on program trading considers its effect on stock price volatility. Stoll and Whaley (1986, 1987, 1988, 1990) examine the consequences of program trading occurring on "triple-witching days," that is, dates when multiple derivative contracts on stocks simultaneously expire. As heavy program trading frequently occurs on these expiration dates, Stoll and Whaley's evidence of higher volatility suggests that program trading can be linked to increased volatility. Edwards (1988) studies the impact of stock-index futures and finds that volatility does not increase

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after the introduction of multiple derivative contracts. Since these contracts are frequently involved in program trading strategies, an increase in stock price volatility would be consistent with a program trading effect. Maberly, Allen, and Gilbert (1989) note that this result depends on the sample period. Harris (1989) finds only a slight increase in volatility during the 1980s, suggesting that the increased program trading activity that was facilitated by futures trading had, at most, a very modest effect on volatility. Martin and Senchack (1989, 1991) find that the volatility of stocks included in the Major Market Index (MMI) rose after the MMI futures contract was introduced. Their risk decomposition indicates that the systematic risk of these stocks rose. Since the MMI futures contract is frequently involved in program trading, this finding suggests that program trading led to higher volatility.

Program trading grew rapidly during the 1980s. If this activity increases volatility, then the 1980s should have shown higher than usual volatility. Several investigators have examined the period for changes in volatility. Froot, Perold, and Stein (1991) investigate returns on the Standard and Poor 500 since the 1930s. They find that changes in volatility are conditional on the length of the holding period. There is strong evidence of an increase in return volatility during the 1980s for 15-minute holding periods. When longer holding periods are examined, it is much less evident that volatility has changed. Miller (1990) suggests a conceptual distinction between the volatility of price changes and price-change velocity. While statistical tests frequently demonstrate no change in volatility levels, the speed of price adjustments does appear to have increased during the 1980s. Froot and Perold (1990) decompose price changes into bid-ask bounce, nontrading effects, and noncontemporaneous cross-stock correlations. They demonstrate that price adjustments occurred more rapidly during the 1980s.

Direct investigation of the effects of program trading finds temporary increases in volatility which are most prominent in index arbitrage activities. Much of this evidence is reviewed by Duffee, Kupiec, and White (1990). Grossman (1988) regresses various measures of daily price volatility on program trading intensity, finding no significant effect. A Securities and Exchange Commission study (1989) finds a positive association between daily volatility of changes in the Dow Jones Index and levels of program trading activity. Furbush (1989) finds a significant relationship between price volatility and program trading activity in the three days prior to the October 19, 1987, market break. Harris, Sofianos, and Shapiro (1990) and Neal (1991) investigate intraday program trading, finding that responses to program trades are similar to those found for block trades. Using "GARCH" estimation procedures, Moser (1994) finds a modest increase in the volatility of returns for one-day holding periods associated with sell program activity. Thus, the evidence is inconclusive. The logit specification developed in the next section offers an alternative approach to examining this question.

Data sets and sample description

Trading activity data for this study are from the New York Stock Exchange (NYSE).[1] The data set includes aggregate trading volume and share volumes involved in programmed trades. The sample consists of 717 daily observations from the period January 1, 1988, through October 31, 1990. Program trades are presently classified as buys, sells, and short sales.

Program trading activity is the number of shares included in orders identified as program trades. The NYSE defines program trades as orders involving 15 or more stocks having a combined market value in excess of one million dollars. The program trades of this sample include shares exchanged through SuperDOT.[2]

Price reversals are constructed from a data set of percentage changes, denoted R_t, in the Dow Jones Industrial Averages. This stock index is useful in that it is computed from prices for heavily traded stocks which are frequently involved in program trades. Thus, if program trading does lead to price overreaction, this effect should be most pronounced in these stocks. Reversals, denoted r_t, are computed for the stock return sample as follows:

$$(1)\quad r_{t-j} = \begin{cases} 1 \; if\, \tilde{\varepsilon}_{t-j} \cdot \tilde{\varepsilon}_{t-j-1} < 0 \\ 0 \;\; otherwise \end{cases}$$

where

$$(2)\quad \tilde{\varepsilon}_t = \tilde{R}_t - E(\tilde{R}_t \mid \phi_t)\,.$$

Equation 1 specifies an indicator variable assigned a value of one on sample dates when the unanticipated portion of the return at $t-j-1$ has the opposite sign as that of the unanticipated return realized at $t-j$ for the holding period from $t-j-1$ through $t-j$; on other dates, the indicator variable is set to zero. Equation 2 states that unanticipated returns are computed as actual returns minus their corresponding expectations. Expected returns are generated assuming that stock prices can be described by a martingale; that is, $E(R_t) = 0$. As the next section points out, considering various values of the lag j permits longer intervals for prices to correct following a price overreaction.

Estimating reversal probabilities conditional on trading activity

Let Z represent a vector of index values with each element measuring the propensity of the market to produce a reversal. The proposition that program trading encourages overreaction as demonstrated by stock price reversals, implies that the index should be related to levels of program trading activity. If this is true, the data should allow us to reject the null hypothesis that program trading has no effect. Defining X as a matrix of k measures of the trading activity variables, we write

$$Z = X\beta ,$$

so that levels of the index are predicted by activity levels and their coefficients. The overreaction null predicts that β will differ from zero. The level of this index can also be described as determining the probability of encountering a reversal conditional on trading activity. The vector of these probabilities can be written as $P=F(Z)$. Taking $F()$ to be the cumulative logistic probability function, these probabilities of reversals are given by

$$P_t = F(Z_t) = \frac{1}{1+e^{-z_t}} = \frac{1}{1+e^{-x_t\beta}} .$$

Taking logs and rearranging gives the following logit specification:

$$(3)\quad \log \frac{P_t}{1-P_t} = X_t\beta + \tilde{e}_t .$$

Equation 3 is estimated using the method of maximum likelihood. The expression for the log likelihood is

$$\log l = \sum_{t=1}^{T} r_t \log[F(x'_{t-j}\text{b})] + (1-r_t)\log[1-F(x'_{t-j}b)],$$

where T is the number of observed changes in returns and x_{t-j} are the activity variables observed at dates $t-j$. Lagging the activity variables coincides with the null under investigation. When j=1, the null hypothesis under investigation asks, does heavy trading activity at date $t-1$ consistently cause stock prices to overreact? If program trading activity caused an overreaction on this date, and if a price correction occurred in the one trading period since the overreaction, then a price reversal is realized, provided the information arriving at t does not overwhelm the amount of price correction. If these conditions hold, then the coefficients on the activity variables will differ from zero, reflecting the average impact from trading activity. Thus, the test specification jointly considers three questions:

1) Does overreaction occur?
2) Are price corrections realized the following day?
3) Is the amount of the price correction masked by the value of newly arriving information?

The null hypothesis of no effect can be rejected only if the answer to each of these questions is yes.

The third of these conditions is addressed *a priori*. Amounts of price corrections are masked by valuations of new information only if the value of new information is larger and has the same price change implications as the previous overreaction. As the distribution of value changes based on new information is likely to be symmetric, it is not likely that more than half of the overreactions will be masked by value changes attributable to new information. Further, if price changes due to overreactions are generally smaller than those caused by value changes due to new information, then the problem of overreaction may not be as large as often portrayed. These considerations reduce the problem of new information masking overreactions to an efficiency concern rather than a bias concern. This leaves two conditions. As the inferences that can be drawn regarding the primary question of overreaction depend on the answer to the second question, I attempted to lessen the dependence on the length of the correction interval. I did this by examining longer correction intervals. Specifically, I extended the hypothesis to consider whether trading activity at $t-j$ produces overreactions on that date which are corrected over the interval from $t-j$ to t. Thus I considered the possibility that correction intervals last longer than one day. This still left open the possibility that corrections occur in less than one day.

Table 1 reports estimates of the logit specification given in equation 3 for price correction intervals of one through five trading days. Coefficients on the activity variables are generally small. Evidence of price reversals attributable to buy program activity is present for correction intervals of four trading days. Though statistically significant, the impact on price reversal probabilities is small. To gauge the relevance of this coefficient, I evaluated it at average levels of trading activity. Price reversals for this correction interval occur in 19.69 per cent of the sampled trading days. Taking this as the unconditional probability of a reversal, the conditional probability of a reversal increases by approximately .00037 for each increment of 1,000 shares executed in buy programs above the sample-average level of 8,044,000. At one standard deviation above this average level of trading activity—17.5 million shares—buy programs increase the probability of a reversal by 3.49 percent, with the reversal from this activity being realized over the succeeding four trading days.

Comparing the coefficients across the three categories of trading activity included in these regressions, nonprogram trading appears to be a more reliable cause of price reversals. Coefficients on nonprogram trading differ reliably from zero for the two-, three-, and five-day correction intervals. Again the magnitudes of these effects are small. At one standard deviation above average nonprogram trading activity, the probability of a reversal increases by 3.4 percent for the three-day correction interval. The magnitudes of impacts on reversal probabilities for the four- and five-day correction intervals are similar.

Pseudo R^2 values are computed following Judge *et al.* (1985) for each specification. The

TABLE 1

Maximum likelihood estimates of logit specifications for price correction intervals of one to five days

January 1, 1988 - October 31, 1990

Parameter	Price correction intervals				
(x10,000)	1	2	3	4	5
Constant	3,242.5 (0.324)	−15,179** (−3.724)	−18,823** (−4.340)	−18,738** (−4.048)	−24,817** (−5.261)
Buy program	−0.07746 (−0.782)	0.00178 (0.017)	0.17976 (1.640)	0.23766* (2.075)	0.07580 (0.626)
Sell program	0.12082 (1.098)	0.16371 (1.444)	−0.16985 (−1.354)	−0.20134 (−1.509)	−0.03613 (−0.267)
Nonprogram	−0.02039 (−0.803)	0.05158* (1.942)	0.05740* (2.033)	0.03795 (1.262)	0.07042* (2.311)
Pseudo R^2	0.0021	0.0074	0.0095	0.0088	0.0084
Log *l*	−494.24	−457.66	−408.40	−371.07	−349.74

Note: t-statistics in parentheses.
*p < .05.
**p < .01.

low values of these R^2 values implies that trading activity explains a very small portion of the overall variation in reversals. To consider the explanatory power of our specifications, I conducted a likelihood ratio test. Under the null hypothesis of no effect, the maximum value of the likelihood function is

$$\log l = n\log (n/T) + (T-n)\log (T-n/T),$$

where n is the number of reversals and T the number of sample dates. Specifications can be tested using a likelihood ratio test for the difference between this maximum log likelihood and the log likelihood obtained from the estimation procedure. For the sample of one-period correction intervals, the maximum log likelihood under the null hypothesis is –495.29, which is only slightly smaller than the actual value of –494.24. The critical value of twice this difference is 7.81 for the 95 percent level of confidence. Thus, the data fails to reject the null hypothesis; that is, the results for the one-day correction interval do not support an association between trading activity and price reversals. These differences are 6.85, 7.85, 6.56, and 5.96 for the two-, three-, four-, and five-day correction intervals, respectively. The critical value is exceeded only at the three-day correction interval. This implies that trading activity does lead to price overreactions which are subsequently corrected in three trading days. The individual coefficients indicate that it is nonprogram trading which produces these overreactions rather than buy or sell trading activity.

Recall that the price correction intervals considered in this paper are whole trading days. Fractional trading days are not considered. Thus, overreactions with a subsequent correction within the same trading day cannot be detected using a sample of daily returns as in this article. Previous research does investigate within-day reversals. Harris, Sofianos, and Shapiro (1990) and Neal (1991) find that the price impact of an average program trade is similar to that found for block trades. We conclude that price reversals, where found, are generally small. This implies that current trading mechanisms are usually quick to resolve those price overreactions attributable to program trading. Given the current effectiveness of these mechanisms, changes such as the imposition of transaction taxes or other institutional arrangements appear to be unwarranted.

Conclusion

Descriptions of stock market results frequently give the impression that program trading causes prices to overreact to current information. Some have proposed policy changes intended to dampen the effects of the extent of these overreactions. This article introduces a procedure to test the proposition that program trading causes price overreactions. Given the evidence presented, it appears that program trading activity does not cause price overreactions.

NOTES

[1]I am indebted to Deborah Sosebee and her staff at the NYSE. They provided the data on program trading and patiently answered many questions.

[2]Most but not all program trades at the NYSE are routed through SuperDOT, a computerized routing system. Large brokerage houses can arrange to have their program trades executed by floor brokers, but this method is more costly and slower. The weekly summaries of program trading reported in the financial press include program trades executed off the SuperDOT system. These data are unavailable on a daily basis. Program trading reported in the weekly summaries for the period 1/1/88 through 9/22/90 averaged 16.4 million shares per day. Program trades in this sample over the same period averaged 15.9 million shares. This suggests that program trades executed off the SuperDOT system account for only about 3 percent of program trading activity.

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