Market Structures, Trading Strategies, and Feedback:
Rethinking Neoclassical Price Discovery

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ABSTRACT

This paper focuses on the financial markets crash of October 1987 to examine the effects of trading strategies and other institutional structures on price behavior during this period. It presents a system dynamics model which looks at average, aggregate stock prices. It specifies connections among various trading sites and techniques. In particular, it examines the influence of financial and technological innovations such as stock-index futures and other derivative instruments and high speed order execution and transaction systems on market performance. A major conclusion is that the financial markets are characterized by complex structures only partially economic in nature. This suggests that the interplay between market pricing behavior and institutional behavioral reactions are more complex than is currently believed.

October 19th, 1987 represented the single worst market crash in U.S. securities history. The Dow Jones Industrial Average (DJIA) lost 23% of its value, falling 508 points, with most of the loss in late trading. In the Standard & Poor's 500 futures pit, the S&P 500 lost an amazing 80.75 points, a 28.6% plunge from the previous close. The value of all outstanding U.S. stocks decreased by almost $700 billion during these 6 and 1/2 hours of trading.

Many reasons have been cited as causes of this equities violence, including a $15.7 billion August trade deficit, the introduction of unfavorable tax legislation, and U. S. government statements which placed the Lourve currency agreement in jeopardy. The result of these actions was to push the market down 261 points, or 10%, over the three days from the 14th to the 16th as risk arbitrageurs liquidated their positions and investors began switching from equities to bonds in anticipation of portfolio insurance trades at Monday's opening.

Clearly investor outlook had shifted. The question is not whether a market correction was on the horizon (it was), but what were the causes of the speed and severity of this correction. Armed with our economic models and historical expectations, we would have predicted a smooth and rational transition in response to investor sentiment, not the precipitous and discontinuous drop that occurred. As the Presidential Task Force report points out (1988:53), the market's rise of 102 points on Tuesday suggests that market structures, as well as investor sentiment, impacted significantly in the events of the 19th.

Over the past twenty years the financial services industry has experienced rapid and fundamental structural changes in response to erratic short run inflation, increased risk volatility, financial deregulation, and the explosion of innovative information technologies. The major structural and operational impacts of these trends have transformed the way we think about our financial markets. For example, institutions have now displaced individuals as the driving force on the NYSE. Pension funds, insurance companies, and other large institutions now dominate not only because they are well capitalized, but also because they are extremely active traders, turning over an average of 60% of the shares in their portfolios each year (Light, & Perold, 1987). Also, both markets and players are increasingly dependent on the cheap information provided by computers for effective performance. While widespread access to information has theoretically enhanced the ability of the financial system to quickly and efficiently price the risks faced by market players, it has also sharpened competition and narrowed profit opportunities as markets are made more transparent. Additionally, regulatory fragmentation, coupled with technology advances, has fueled the development of financial innovations such as options and financial futures.

SOCIO-ECONOMICS:

For much of their history, the financial exchange markets have been viewed as price discovery

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mechanisms; mechanisms which are somehow separate from the individuals and organizations that participate in them. This view of "markets as mechanisms" has diverted attention away from the institutions and structures which support the markets (and arguably affect price trends) and towards refining neoclassical microeconomic theory as the only legitimate method for investigating price behavior in the markets. The result is that only recently have organizational theorists begun to look at markets as something other than mere mechanisms and thus as areas worthy of investigation.

The neoclassical economic tradition assumes that markets are "complete and perfect", implying that in achieving, or more properly, maintaining equilibrium they are frictionless, or efficient. Economists posit that market equilibrating forces are technically efficient in that the market establishes prices which unbiasedly reflect the real worth of securities, and informationally efficient in that these prices are known to all participants at no cost. Since markets are competitive, they are peopled by rational economic actors who quickly and efficiently exploit all available information (the Rational Expectations Hypothesis-REH). In the equities-related markets, information exploitation occurs because all significant actors incur essentially equivalent opportunity costs (the Treasury Bill rate) and transaction costs (brokerage fees) and can therefore be expected to view any new information as paramount to their asset positions. Assuming that all economic agents act on new information according to the REH, equilibrium, in the form of price consensus, is quickly and efficiently achieved. In essence, the competitive motivation to exploit profit opportunities keeps cost frictions to a minimum. The behavior of the market is the aggregation of these optimizing choices across actors.

Figure 1 about here

Given rational expectations and technical efficiency, figure 1a presents a neoclassical economic dynamic hypothesis for price discovery behavior in the financial markets: The dynamics of fundamental trading are compensating in their effect. Since both buying and selling loops are operating simultaneously, over time an equilibrium is reached where the quality/price ratio is equal to 1 and price is stabilized. Additionally, although fundamentalists are by nature long term players, they do trade according to market moves when these moves approach their psychological support or resistance levels. They have also been known to trade on near term volatility.

Two characteristics of this system are worth mentioning. First, trading behavior seems reactive, almost passive. There is only a small indication that the trading strategies themselves can influence price discovery. Second, institutional distortions such as trade channeling or the micro-dynamics of the auction crowd are unaccounted for.

Some researchers are beginning to question both the structural indifference and micro-behavioral decision assumptions of this asocial market system. These researchers suggest that markets are inherently social in nature. Market actors are seen as embedded in a series of formal and informal social complexes whose influences can both constrain and protect their activities (Abolafia & Biggart, 1989; Baker, 1984; Burk, 1988; Granovetter, 1985), and by extension the behavior of prices . For the organized markets, the formal complexes include the auction-process coordinating systems and the administrative and managerial control systems (Abolafia, 1984) which support trading and trade related activities.

This shift of focus away from the individual actor and towards the market as a system signals a shift in the role of analysis in investigating markets. Whereas neoclassicists aggregate actor activity to elicit market behavior, institutionalists and others are beginning to look at the overall market structure to investigate the individual actor roles. Thus, the institutional structures which are assumed away in neoclassical economics play a fundamental role in assessing the impact of relations on actor behavior in the emerging socio-economics tradition.

THE MARKETS:

The New York Stock Exchange (NYSE) is America's dominant stock exchange, with NYSE listed stocks accounting for over 90% of the exchange based stock volume in the U.S. (Light et al., 1987). Trading on the exchange is organized around seventeen "specialist posts" where approximately fifty specialist firms act as *market makers* in one or two to several of the 1700 presently listed companies. By NYSE regulation, specialists are required to maintain a fair and orderly market by 1) standing ready to take the opposite side of an order (if none in the crowd is willing), and 2) stabilizing market trends by selling into a rise and buying into a decline. In essence, they are the exchanges frontline guarantors of market liquidity. The crowds who gather around these trading posts consist of commission brokers, who handle public orders, and individuals trading for their own accounts. Price setting occurs through a modified auction system as members of the crowd react to the specialist's price quotes.

The NYSE is a "cash market" where investors participate by either purchasing (going long) to hold stocks or selling stocks they already own. The exchange provides a location (the floor) and a process (market auction principles) for easy and efficient transference of stock ownership among participants. It is a non-zero sum game. If I sell my position at a profit and the position continues to rise in value the buyer also profits. Everybody can win or lose.

Unlike cash markets, futures markets do not provide the commodity underlying the transaction. Contracts are traded to purchase or sell a specified amount of a commodity at a specified time at a price agreed to now. In essence, futures contracts constitute obligations, on the part of the purchaser to take delivery and on the part of the seller to make delivery of an amount of commodity on the expiration date.

Because parties entering into a futures transaction incur necessarily opposite obligations, futures markets are zero-sum games. If someone wins, someone else must lose. If the price goes up during the contract, the seller is paid less than the market and the buyer receives a bargain. If the price drops, the seller is paid more than the market and the buyer loses the difference between the market price and the futures price.

Financial futures, such as stock-index futures and bond or Eurodollar futures, are contracts for the delivery of the underlying financial instrument at a specified price at a specified time. Because of the more speculative nature of these instruments, individuals tend to be non-participants in financial futures markets. Instead, futures exchanges are dominated by heavily capitalized institutional investors and "locals", professional speculators who make money on the bid/ask spread over time.[1] Trading in these markets occurs in the "pits", multistepped arenas where price setting occurs through an open-outcry auction bidding process. In essence, every trader in the pits is an auctioneer, shouting out bids if they are buying or asks if they are selling. The use of these derivative instruments allows fund managers to hedge or transfer quickly, and efficiently very large asset positions, in effect reducing the inherent risk of their portfolios.

Stock-index futures (SIF's), most notably the Standard & Poor's 500 future (traded on the Chicago Mercantile Exchange- CME), are single instruments that can be used as surrogates for portfolios or baskets of stock. The Spooz (as this contract is known) is 500 times the value of the underlying index and represents about 3,500 shares of stock. The Spooz allows fund managers and other investors to quickly and cheaply buy or sell the cash market, as represented by the Standard and Poor's 500 index. For example, an index fund manager who currently has a 60-40 equity to Treasury Bill (T-Bond) asset ratio can quickly switch her asset allocations by 1) selling SIF's to lock in a price to be received for the portfolio of stocks now, 2) buying T-Bonds or T-Bond futures, and 3) slowly "unwinding" her stock position to take advantage of market pricing opportunities.

PROGRAM TRADING

The major participants in the stock and futures exchanges are large, well capitalized institutional investors who employ trading strategies which rely heavily on computers to track indicators (price trends and spreads) across markets. In popular usage such "programmed trading" refers to the automatic buying and selling of stocks through the use of computer programs. In reality, "program trading" is an umbrella term covering several quite distinct automatic and/or semi-automatic investment strategies, each using somewhat dissimilar investment paths to achieve profits. Such strategies include capturing or "locking in" profits through arbitrage opportunities, insuring existing profits through hedging practices designed to minimize portfolio value loss, and asset reallocation to capture higher rates of return. Each of these strategies relies heavily on index related trading, either buying or selling financial futures, to accomplish their aims.

[1] Because of their willingness to acquire and dispose of contracts for very small price differences, locals are the market makers on futures exchanges and provide both the depth and liquidity necessary for the efficient functioning of these markets. However, unlike the specialists in New York, they are not required to accomplish either of these functions.

PORTFOLIO INSURANCE

Although several portfolio insurance strategies are used, each is designed to protect against portfolio losses. They accomplish this by disciplined buying into a rising market or selling into a declining one, reinforcing existing price trends (figure 2). It is a relatively conservative strategy designed to reduce downside losses while maintaining the ability to participate in upside moves. For example, in a market decline, as a gap develops between the desired and actual portfolio values insurers have two options, selling stock or selling SIF's. Selling stock weakens the stock price (thus decreasing the actual portfolio value) but increases cash reserves, which increases the actual portfolio value (and provides liquidity for upside participation).

A more prevalent dynamic hedging strategy during market declines is to sell SIF's short in lieu of sell the actual stock. Selling the SIF's depresses the futures price while increasing the cash reserves and the actual portfolio value. When the broad market decline stalls, insurers buy back SIF's (to close out their short positions) which decreases, through dwindling cash reserves, the actual portfolio value. The total insurance effect makes up for market losses in the underlying S&P position through gains made in the futures market (the difference between the price insurers sell short at and the level they buy back at).

Although the positive feedback relationship for this transaction is less obvious, it is just as potent. Index futures prices are viewed as indications of future underlying index levels. Given that historically the S&P 500 and SIF prices track reasonably close, decreasing futures prices signals to other market actors that the index itself will trend down, inducing arbitrageurs, technicians and others into stock selling which decreases the actual portfolio value of portfolio insurers.

INDEX ARBITRAGE

The theoretical value of an index future is a function of 1) the value of the index itself, 2) the time remaining to expiration, and 3) the "cost of carry", which relates to the difference between the Treasury Bill rate and the dividend stream of the portfolio through contract expiration (United States Securities and Exchange Commission, 1988a:I-3). In a completely efficient system, the prices in these two markets would differ by no more than the "costs to carry" plus the transaction costs of market participation. Since markets are not frictionless, present and future prices stray from their theoretical equilibrium. When sufficient price abnormalities exist, either as SIF premiums or discounts to the underlying stocks, index arbitrageurs buy in the lower priced market and sell in the higher priced one, thereby insuring a "riskless" profit, albeit in a smoothly functioning system, a small one.

In theory, index arbitrage brings SIF and cash market values back into line by increasing the value of the under priced market and weakening values in the over priced market. Figure 3a depicts the information and resource influences for this stabilizing or goal seeking behavior. Since arbitrageurs make profits on price differences at a point in time between assets, they tie the primary and derivative markets together, providing greater depth and liquidity for each of the markets. By exploiting these profit opportunities arbitrageurs consciously transfer selling pressures between the markets. In so doing, arbitrageurs can be considered the principle components of a negative feedback loop between the markets. Component loops I and II involve the classic index arbitrage of buying the future and selling the stock which involved the majority of arbitrage activity for October 19th (component loops III and IV comprise an index substitution strategy of buying the stock and selling the future).

Figures 3 and 4 about here

What dynamic hedgers count on as a moderating relationship can, in fact, result in reinforcing behavior. Since the majority of insurers use SIF's as surrogates to quickly hedge or enhance their positions, these actors assume that others (specifically index arbitrageurs) will be available to take the other side of the trade. Given a market decline, figure 4 links these strategies and graphically illustrates both the reinforcing behavior of portfolio insurance and the stabilizing behavior of index arbitrage. Note, however, that both insurers and arbitrageurs are selling into the stock decline. If insufficient demand exists, this pressure will drive prices even lower in New York, increasing the portfolio insurance value gap, forcing insurers to hedge by selling short in Chicago.

Through necessity, arbitrageurs design strategies to create profits over the very short run. Their window for profit opportunities can be shut in minutes as better prepared investors anticipate and act on the pricing spreads. However, even some of the more "conservative" strategies like portfolio insurance can operate on near term trends. This is especially true when markets display a high degree of volatility as in the weeks preceding the October crash. In combining these trading strategies, the feedback in figure 4 reveals a structure which, under normal circumstances, appears both compensating and reinforcing. It implies that there will be sufficient arbitrage activity to absorb portfolio insurance selling in Chicago. Under abnormal conditions, however, this structure suggests that the following "cascade" scenario (Mayer, 1988) might develop: Computer guided portfolio insurance programs sell heavily into the futures pits triggering index arbitrage. The result is to push the price of stocks lower while having little effect on raising SIF prices. As stock prices drop, portfolio insurance is again triggered, resulting in arbitrage stock selling, setting off yet another round of insurance selling.

THE INTERMARKET NETWORK MODEL:

Over 80% of the NYSE's stock volume is directly attributable to large, well capitalized institutions (Light, et al., 1987). At the same time, the S&P 500 stock-index-future is the preferred futures hedging and speculation instrument of these same institutional investors. Participants in these markets trade instruments which represent the unbundling of the inherent claims in securities. Since the derivative instrument can have value only to the extent that the underlying stocks have value, these products constitute an inherent link between the exchanges. Both these exchanges have flourished as investors have developed complex trading strategies employing stocks and stock-index-futures to reallocate their portfolio risk and realize higher rates of return. These strategies capitalize on and make explicit the inherent links between the exchanges.

To summarize, we are arguing that exchange markets are embedded in a very dense network of interorganizational linkages which binds them in complexes of structures only partially economic in nature. Although we recognize that during periods of normal volatility the equities-related markets respond largely to broader exogenous economic conditions (most notably the bond market trend), we also assert that intra-session volatility can be strongly affected by the relationships within the intermarket system such as trading strategies and information feedbacks.

The dynamic model used to simulated the intermarket network focuses on the interplay between the aggregate Standard and Poor's 500 index and the S&P 500 future. It specifies connections among various trading sites and trading techniques. The model also reflects the limits of processing in the system, such as constraints on processing volume, handling of information, and other factors that arguably played a role in the October events. While the model will respond partly to broader exogenous economic conditions, it recognizes that on the 19th the relationships within the trading systems affected prices independent of the underlying economic or legal conditions.

THE CRASH

As discussed, in theory index arbitrage should bring the SIF and cash market values back into line by increasing values in the underpriced market and decreasing values in the overpriced market. A reasonable trading scenario might be as follows: Because of changes in fundamental and/or other predictors, large institutional investors and broker-dealers perceive a significant market downturn, creating a desire to hedge their portfolios. They do this by selling SIF's which drives the SIF price to a discount to the underlying index, triggering index arbitrage strategies. Arbitrageurs sell the underlying basket of stocks and buy the now discounted SIFs. As a result of the arbitrage, stock prices fall while SIF prices rise, so that prices are brought more nearly in line.

Exactly how and what happened October 19th is still unclear. What failed to materialize was the smooth price adjustment scenario just described. Without a doubt, portfolio insurance strategies contributed heavily to the market break. And it appears that while index arbitrage had some mitigating effect on prices during the morning hours, arbitrageurs were largely absent during the price free falls in the late afternoon. Both the DOT and the Limit Order computerized transaction systems encountered afternoon delays as the volume of orders overwhelmed system capacities. Orders experienced delays of up to 75 minutes as the unprecedented volume backlogged card printers. Significantly, the Automated Pricing and Reporting system was delayed for up to two hours in the processing of odd lot orders (a major avenue for retail orders) because of the unprecedented round lot order volume (United States Securities and Exchange Commission, 1988a).

Figure 5a presents the historical time-series for the S&P 500 Index and futures contract on October

19, 1987. Figure 5b presents the simulated behavior of the intermarket network model. When we focus on the actual time-series several observations stand out. First, the futures contract opened at a 21 point discount to the actual index. This discount was a reflection of not only the immense sell pressure that had built up since the close on Friday, but also of the difficulty encountered on the NYSE in finding sufficient demand to open some stocks in the index (United States Securities and Exchange Commission, 1988). As such, some of this discount was illusory since the benchmark was the Standard and Poor's close on Friday and not the actual index on Monday. Second, it appears that the index trend lagged the futures contract trend by about 45 minutes during morning trading hours, with this lag gap narrowing as trading continued through the afternoon. This would seem to provide some support for those who believe that price discovery now occurs in the futures pits, rather than on the NYSE. However, because arbitrageurs were largely absent during the afternoon hours, the contention that their activities primarily provide this feedback needs reconsideration. Third, arbitrage does appear to have created a demand for futures contracts during the early morning hours, as indicated by the steep rise in the contract between 10:30 and 11:00 A.M.. However, both markets turned significantly bearish immediately following the noon hour.

Figures 5a & 5b about here

Reconstruction of the trading behavior for the 19th by the Securities and Exchange Commission (1988) reveals that from 12:00 to 1:00 portfolio insurers sold over 3,700 contracts into the futures pit representing 33 percent of the total volume for this period. They also sold over 22 million shares on the NYSE from 12:00 to just before 2:00, representing 36 percent of the volume in index related stocks for this period. For the day, arbitrage and portfolio insurance programs accounted for over 21 percent of index related selling on the NYSE. This compares with programmed trades involving 4% of total volume during normal sessions. In Chicago, portfolio insurers accounted for 20 percent of S&P 500 futures selling (compared with less than 1% during normal sessions).

Figure 5b displays remarkably similar behavior. Although the simulation was initiated with a 21 point contract discount, the rest of the time-series is endogenously generated through the behavior of feedback structures within the model. Time-lags and general price trends, including arbitrage and portfolio insurance trading behaviors, appear consistent with the actual trading data.

The simulation begins with prices in both markets depressed by portfolio insurance selling pressure generated through the unfinished programmed hedges from Friday's close. During the first two hours, arbitrage activity is significant, contributing to a stabilizing in the contract price. However, arbitrage selling on the NYSE coupled with portfolio insurance stock sales exacerbates the steady S&P index decline. This increases the potential for portfolio insurance sales as their programmed hedge overhangs become unmanageable. When the prices between the markets finally realign themselves, portfolio insurers unleash heavy sell orders into both the futures pits and the NYSE depressing both the index and futures contract. This triggers arbitrage activity which seems to stem the downward trend for futures. However, by this time (1:30, simulation time) some of the NYSE computerized transaction systems are beginning to experience delays as they reach over 50% of their designed capacities. As a result price assurance on the NYSE, a fundamentally important factor for both arbitrageurs and portfolio insurers, becomes unreliable.

With increasing delays in processing time, arbitrageurs become more hesitant in employing their strategies. Portfolio insurers are, in the early afternoon, somewhat less reluctant to employ theirs', with the result that futures prices have no sustainable programmed support level. Thus, delays in order processing on the NYSE do appear to sever the price adjustment linkage between the exchanges. What ensues during the late afternoon is institutional panic, with portfolio insures and other large institutions selling heavily into the decline on both exchanges.

DISCUSSION

As a decision tool, the simulation sheds some light on the debate about what actually happened on October 19th. The simulation suggests a shift of causal dominance between trading strategies. It appears to support Mayer's (1988) "cascade" scenario, especially during the morning and early afternoon hours, as arbitrageurs prop up prices in the futures pits by absorbing portfolio insurance selling pressure. Their stock selling has the opposite effect on the NYSE which, in turn, triggers portfolio insurance selling.

However, as the NYSE transaction systems become clogged during the mid to late afternoon hours, feedback pressure shifts due to the inability of institutions to effectively arbitrage their positions. The trading strategy that portfolio insurers and other institutions had counted on to support contract prices vanished. With no support, contract prices fell rapidly and institutions, seeing their portfolio positions rapidly becoming worthless, overwhelmed both markets with sell orders. For the simulation, while the morning hours followed a "cascade" scenario, the afternoon hours seemed to follow an institutional panic scenario.

This would suggest that the interplay between market pricing behavior and institutional behavioral reactions are more complex than is currently believed. These complexities, which are embedded in the institutional networks encompassing the exchanges, may significantly distort the intended results of regulatory interventions.

In conclusion, this study has argued that the financial markets are characterized by complexes of structures only partially economic in nature; structures whose feedback relationships are not always obvious or well understood yet whose confluence propelled the markets to the crash of 1987. Simulation modeling appears useful for investigating such intermarket networks by allowing researchers to expressly model feedbacks between trading strategies, organizations, and markets. Explicit recognition of these institutional, cultural and technological linkages will help us more fully explain financial markets behavior.

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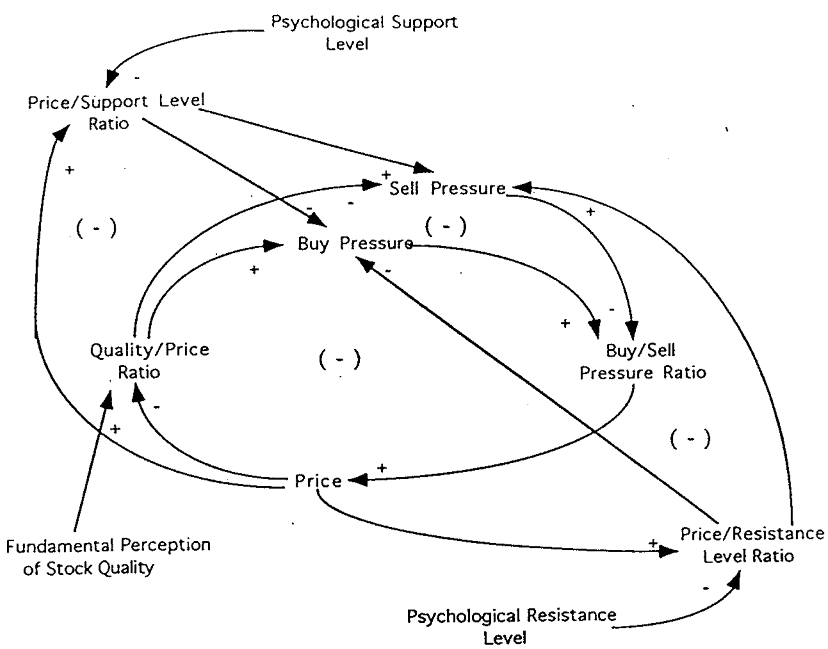


Figure 1 - Neoclasical Dynamics of Price Discovery

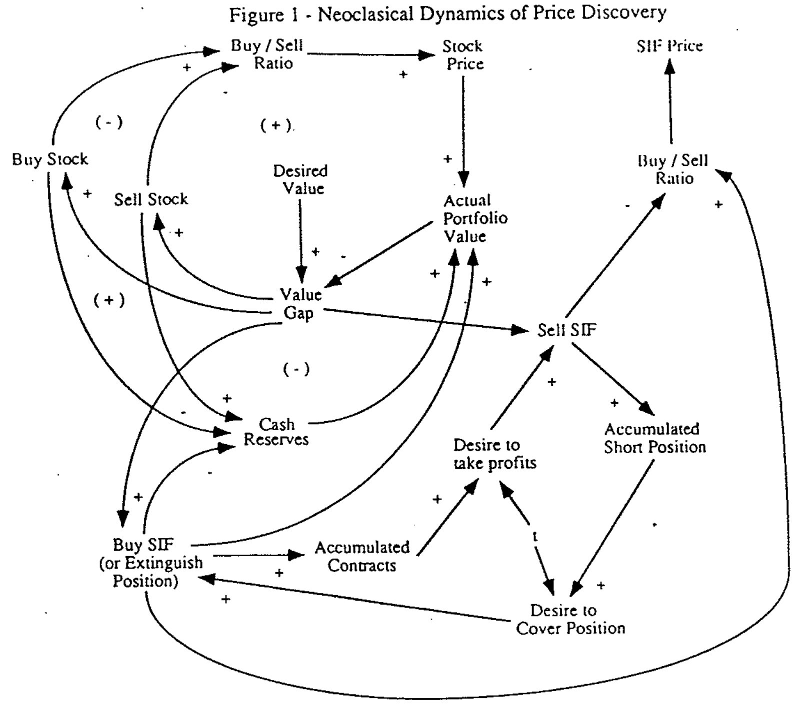


Figure 2 - The Dynamics of Portfolio Insurance

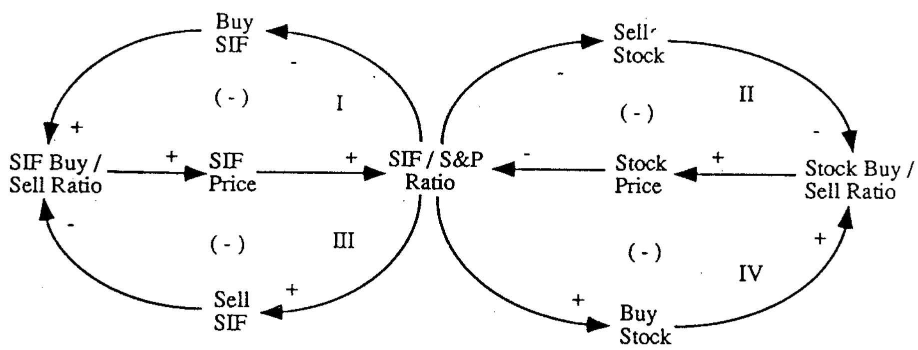


Figure 3 - The Feedback of Index Arbitrage

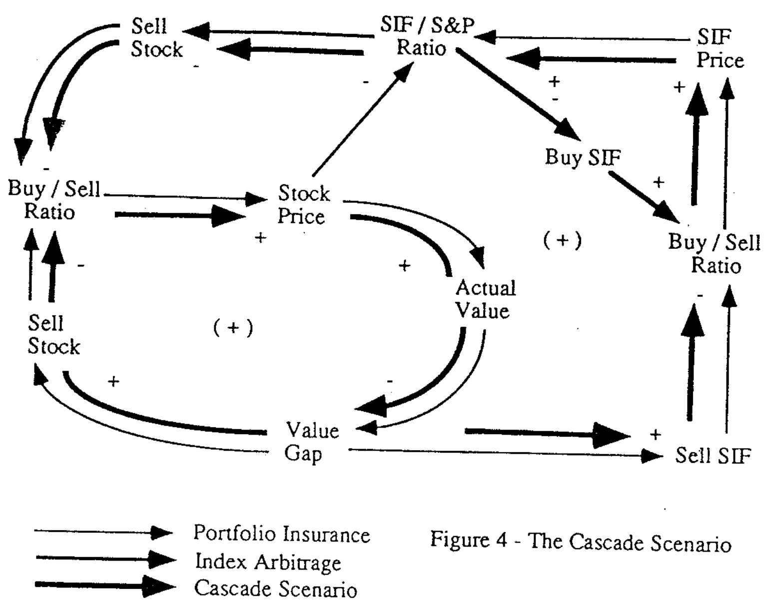
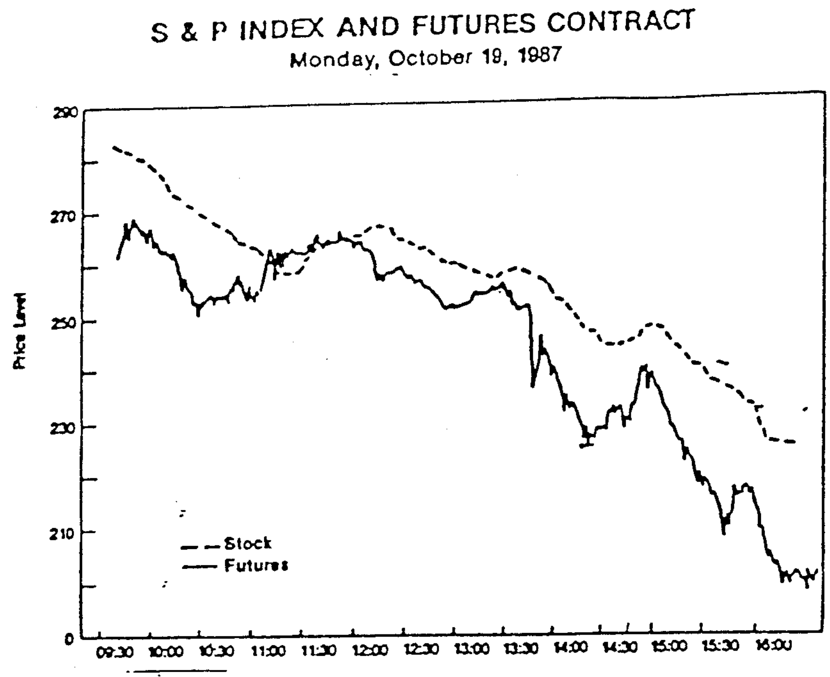
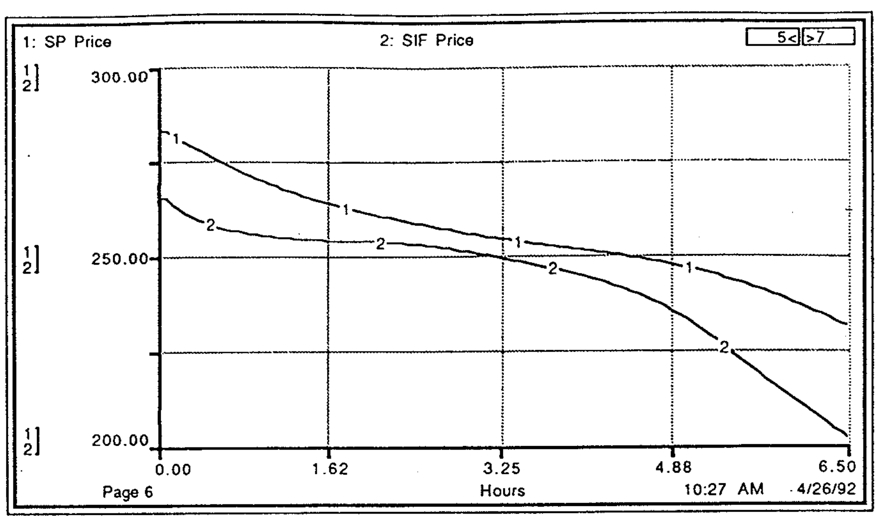


Figure 4 - The Cascade Scenario



Source: United States Presidential Task Force
on Market Mechanisms III-18, 1988

Figure 5a



Simulated Time-Series for
Market Behavior

Figure 5b