Order Number 9304744

The effects of index arbitrage and margin requirements on volatility and liquidity in stock and futures markets

Wang, Ming-long Andrew, Ph.D.

City University of New York, 1992

U·M·I

300 N. Zeeb Rd.
Ann Arbor, MI 48106

The Effects of Index Arbitrage and Margin Requirements On Volatility and Liquidity in Stock and Futures Markets

by

Ming-long Andrew Wang

A dissertation submitted to the Graduate Faculty in Business in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1992

This manuscript has been read and accepted for the Graduate Faculty in Business in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

July 28, 1992 — Date
Harry Markowitz — Chair of Examining Committee

7-29-92 — Date
Ronald VanDenbergh — Executive Officer

Howard Ross

Terrence Martell

Steven Krull

Supervisory Committee

The City University of New York

Abstract

The Effects of Index Arbitrage and Margin Requirements On Volatility and Liquidity in Stock and Futures Markets

by

Ming-long Andrew Wang

Advisor: Professor Harry Markowitz

The purpose of this study is to simulate the effects of index arbitrage and uniform margin requirements on trading activities in the stock and futures markets. Simulation results show that index arbitrage does not affect volatility of return (long-term volatility), but it leads to greater intra-day high/low ratios (intra-day volatility), percentage bid/ask spreads and trading volume. Uniform margin requirements appear to have a trivial effect on market activities. Specifically, the results suggest that uniform margin requirements cannot serve the proclaimed policy purpose of curbing market volatility, and perhaps they even slightly increase volatility of return. The implications of this study are that the imposition of regulatory controls on index arbitrage would reduce market efficiency rather than decrease volatility. Investors with a long-term holding period should not be concerned about the trading practice of index arbitrage, and uniform margin requirements would be an ineffective regulatory control under the current market environment.

PREFACE

I would like to express my gratitude to the members of my dissertation committee, Professors Harry Markowitz, Howard Ross, Terrence Martell and Steven Krull, for their intellectual stimulation and guidance in this Research. I would also like to thanks Ms. Gautier Barbara for reading the manuscript many times for me. In particular, I am highly indebted to Professor Markowitz for the many hours he spent in discussing with me during regular semesters and during his sabbatical leave. The discussions and consultations with him have provided great inspiration, not only for this project, but for a lifetime of academic work. Any comments and suggestions will be greatly appreciated. Any remaining errors are, of course, my own responsibility.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

PURPOSE AND ORGANIZATION

I. INTRODUCTION

I.A. Recent History

The crash of 1929 prompted congress to impose margin controls on the stock market. However, in the wake of the 1987 market crash, regulatory controls are focused on the investment practice of program trading[1] and futures margin requirements. The Brady Commission has cited one popular form of program trading, portfolio insurance, for its role in exacerbating the market's decline and volatility. It also recommended that the index futures' margins be raised to a level comparable to that for stock.

Indeed, the futures' initial margins were increased from about 7% to 15% after "Black Monday". Furthermore, on July 25, 1990, the Securities and Exchange Commission (SEC) unanimously approved a one-year trial of the circuit breaker rule to curb program trading[2].

Program trading averaged 24.2 million shares per day, and

---

[1]"Program trading is defined as a wide range of portfolio trading strategies involving the purchase or sale of 15 or more stocks valued at one million dollars or more." See appendices in the NYSE Research & Planning Report, October 28 Through November 1, 1991. Some examples are index arbitrage, portfolio insurance, asset allocation and portfolio liquidation.

[2]The circuit breaker rule would require the NYSE to curtail program trading when the Dow Jones Average moves 50 points or more in a single direction during any one-hour period. It was formally adopted by the NYSE in October 1991.

accounted for 12.9% of the NYSE total trading volume for the week of October 28 through November 1, 1991. In particular, one form of program trading, index arbitrage, is still a very popular trading strategy employed by many institutional investors. The imposition of regulation on program trading will have a profound impact upon the markets' trading activities.

Futures' margins function well in the sense of preventing contract default. However, no consensus has been reached about its effectiveness as a policy tool in affecting volatility. More research is needed to answer how uniform margin requirements would affect market activities.

Markowitz [1988] develops a discrete-event stock market simulator (SMS1) consisting of two types of investors, Rebalancers and Constant Proportion Portfolio Insurance (CPPI) investors, and two securities, stock and cash. Kim and Markowitz [1989] use SMS1 to test the impact of CPPI and stock margins on market volatility. Krull [1990] incorporates option replicating portfolio insurance (ORPI) investor into SMS1.

This paper examines the impact of some regulatory changes on the performance of stock and futures market. Specifically, it will use the above research as a reference point, and simulate the effect of index arbitrage and uniform margin requirements upon markets.

I.B. Purpose of the Study

This study will extend SMS1 to include a new type of investor (index arbitragers) and a new security (index futures). New features such as short sales, margin call and marking to the market will also be included in the extended model. Then, the policy issues of uniform margin requirements and limits on index arbitrage will be simulated and analyzed. In view of recent advances in computer technology, the paper also seeks to advance the application of the discrete simulation model in the study of policy issues.

The impact of index arbitrage will be experimented with by controlling the level of arbitrage trading in six simulation runs. The same procedure will be repeated in nine more replications (each replication with six runs) with different random seeds. Finally, non-parametric tests will be applied to the aggregate results to detect the impact of index arbitrage.

The efficacy of uniform margin requirements will be simulated by raising futures initial and maintenance margin to 50% and 30% in ten replications. The total results are then compared with those from ten other replications with lower futures margins. Finally, the simulation results are analyzed to infer the effect of uniform margin requirements on market activities.

II. WHY SIMULATION?

II.A. Limitations of Theoretical Modelling

The combining effects of index arbitrage and uniform margin requirements are enormous in complexity and scope. In a discrete environment market price, volatility and liquidity are determined by various competitive orders placed by traders applying distinct trading strategies. These strategies may be heuristic[3], or have a non-differentiable "kink". It is extremely difficult, if not impossible, to analyze them mathematically. The immense complexities involved in discrete trading reduces the attractiveness of mathematical analysis.

A continuous-time model needs to make strong assumptions about the price dynamic of the underlying instrument. These assumptions will explicitly determine the volatility and contravene the purpose of the study. The price continuity assumption also completely ignores the liquidity problem in the market. Therefore, a continuous model cannot serve the purpose of this study.

II.B. Limitations of Regression Analysis

The regression analysis of index arbitrage requires detailed daily data, even intra-day data. Unfortunately, the NYSE now releases only weekly aggregate program trading data submitted by its member firms. The lack of detailed data excludes the use of the regression methodology in this study.

Virtually no change occurred in the index futures margin

---

[3]For example, Bookstaber and Langsam (1988) mention that" the constant portfolio insurance strategy is heuristic..... It does not contain a foundation for analytical study." (p. 18)

requirements before October 19, 1987[4]. After "Black Monday", there have been only two incidents[5] of index futures margin changes. A regression analysis of index futures changes would not have enough statistical power due to the low frequency of changes.

The margin changes mandated by uniform margin requirements are much larger than those which occurred in the past. The empirical study of those minor changes may not be sufficient to infer the impact of such a huge margin increase as proposed by the Brady Commission.

II.C. Simulation and Regulation Policies

Simulation is an experimental problem-solving approach. One or more variables in the simulation model may be deliberately changed, and the results analyzed to discern the effects. It accommodates both deductive and inductive approaches, and is widely applied to many scientific projects such as communication networks, aerospace and automobile design, and even national defense.

Through the years, there have been many attempts to

---

[4]Futures margins are specified in dollar amounts per contract, and are adjusted over time to reflect the change in the value of the contract. In this sense, it had not been changed before October 19, 1987.

[5]For example, the initial margin requirement on the major market index was $4500 per contract before October 19, 1987. It was increased in increments following "Black Monday". On February 4, 1988, it was increased to $15000 per contract. On February 23, 1989, it dropped to $6000. See Lockwood and Linn (1990) (p. 592).

simulate the efficacy of portfolio insurance, stock market trading mechanisms, portfolio selection and evaluation methods[6]. Usually, it has not been given as much emphasis as conventional research methods such as theoretical modelling and regression analysis.

Simulation avoids a costly trial period for a new regulation such as the circuit breaker rule adopted by the NYSE. It also quantifies the implications of imposing new rules on the market; thus it would provide the public with a clear picture of the impacts. The unique feature of simulation provides it with a strong edge over other methodologies in the study of market regulatory policies issues.

III. ORGANIZATION OF THE PAPER

The rest of the paper is organized as follows: Chapter II consists of a brief review of research, reports, events and background information related to program trading and margin requirements. In particular, it describes the major characteristics of Markowitz's [1988] stock market simulator [SMS1] and briefly summarizes Kim and Markowitz's [1989] simulation results. Chapter III defines and explains the specifications of the extended model, the functioning of simulated markets, trading mechanisms and parameter settings. In addition, it describes the research design followed in this

---

[6]See e.g. Black and Jones (1987), Zhu and Kavee (1988), Dreher (1988), Frost and Savarino (1986), Garman (1976), Cohen, Maier, Schwartz and Whitcomb (1983).

study. Chapter IV discusses and analyzes the simulation results. Chapter V contains conclusions, caveats and recommendations for further research.

CHAPTER 2

REVIEW OF THE LITERATURE

I. INTRODUCTION

In this chapter we will present an overview of the SMS1 model, margin regulations and the difference between the futures and stock margin requirements. Also the theory and research literatures relevant to volatility, program trading and margins will be discussed.

II. PROGRAM TRADING

The NYSE defines program trading as the purchase or sale of 15 or more stocks valued at one million dollars or more. In general, it refers to a trading technique for buying or selling many stocks simultaneously.

Program trading usually is implemented electronically through the NYSE's Super Designated Order Turnaround (DOT) System, an automated order-processing system that links the member-firms' order room directly to the NYSE trading floor. However, it also can be implement manually by sending the orders to the specialists' posts for execution.

Program trading is used to execute different trading strategies. Three basic strategies employed by institutions are index arbitrage, portfolio insurance and asset allocation. After "Black Monday", the popularity of portfolio insurance has decreased dramatically. Now, index arbitrage remains the most common and significant form of program trading prevailing

in the market[7].

Critics argue that program trading has little to do with the capital formation function that the markets are supposed to serve. Also it exacerbates the market's declines and volatility. However, its supporters claim that program trading adds liquidity to the market, thus, helping the capital-raising process and possibly damping volatility.

Since program trading can be implemented in many different forms[8], the street-proclaimed effect of program trading may be quite obscure. **In this study, only the largest component of program trading, index arbitrage, will be analyzed and examined.**

II.A. Index Arbitrage

Index arbitrage is a trading technique. It involves taking simultaneous offsetting positions in a derivative product (such as stock index futures) and a basket of stocks to profit from price discrepancy. Today, it is by far the largest component of program trading[9].

---

[7]For a rigorous description of program trading, please refer to Hill and Jones (1988) and various government reports.

[8]For example, Kim and Markowitz (1989) report that one form of program trading, the constant proportion portfolio insurance (CPPI), leads to greater market volatility in their simulations. Krull (1990) also reports a similar conclusion for option replicating portfolio insurance, but arbitrage - another form of program trading, tends to reduce market volatility.

[9]During Oct. 28 to Nov. 1, 54.1 percent of program volume executed by NYSE member firms was index arbitrage. See the NYSE Research & Planning, Program Trading Report, November 1991.

In practice, index arbitragers seek to capture a risk-free spread of 1% to 1.5% above the Treasury-bill rate. However, Kawaller [1987] claims because of tracking error, variation margin payments, uncertainty in the market impact cost, interest rate and dividend uncertainty, arbitrage trading is not a real risk-free trading strategy. Chung's [1991] study confirms that arbitrage profits are not risk-free.

Under some simplified assumptions, the cost of carry model defines an equilibrium relationship between futures and stock price. When stock is underpriced relative to the futures, a cash-and-carry arbitrage, which involves selling futures, buying stock and carrying it for the duration of the arbitrage, will be triggered to eliminate the price discrepancies. When the stock is overpriced, a reverse cash-and-carry arbitrage, which involves taking the opposite positions of a cash-and-carry strategy, will be triggered. For a rigorous description of index arbitrage boundary constraints, please refer to Gould [1988].

Index arbitrage helps to reduce basis error between two markets. It serves to enforce the "law of one price" and, thus, increase market efficiency. Indeed, Fama [1989] states that index arbitrage acts to link the stock and futures markets together. Thus it should reduce the combined noise from the two markets. Grossman and Miller [1988] assert that index arbitrage can transmit order imbalances from one market to market makers in the other. Since market makers' resources

in both markets can be jointly used to cushion order imbalances, therefore, price concession and transaction cost will be smaller in both markets.

Index arbitrage is a trend-neutral investment strategy. It neither buys on rising price nor sells on falling price. If index arbitrage cannot be triggered to eliminate price discrepancies in two markets, the selling or buying pressures created by other investment strategies will go directly to the stock market.

Some practitioners have been highly critical of index arbitrage. They have alleged that the interactions between portfolio insurance and index arbitrage can cause a downward spiral in stock prices. They also argue that the closing-to-closing daily return volatility cannot really catch the intra-day volatility created by the arbitrage activities.

What the practitioners worry about is not the volatility of rate of return, but the velocity of price changes. High short-term price volatility increases the risk of market making. Therefore, the market makers will act to protect themselves by widening the bid-ask spreads and reducing the size of orders to which they are committed.

Indeed, Miller [1990] states "the real case against index arbitrage might thus be not that it increases volatility in standard academic sense of that term, but that by increasing the risks, hence costs, of market making, it effectively imposes an exercise tax on market liquidity."[p.2]

Many studies concentrate on the empirical investigation

of violations of non-arbitrage pricing conditions or the profitability and returns of index arbitrage trading strategies (see, for example, Klemkosky and Lee [1991], Yadav and Pope [1990], Finnerty and Park [1988]).

Under the assumption of arbitrage profit following a continuous-time Brownian Bridge Process, Brennan and Schwartz analyze the optimal arbitrage strategies with transaction costs and position limits. Merrick [1989] examines the impact of unwinding and rollover of index arbitrage positions in futures expiration days. No work has been done to endogenize the stochastic behavior of arbitrage opportunity, and analyze its impact on markets[10].

II.B. Portfolio Insurance

Portfolio insurance refers to various hedging strategies. The basic idea is to combine a stock portfolio with a put option to ensure the portfolio against price decline through the insurance period. However, most of portfolio insurance is carried out through the dynamic hedging strategy.

O'Brien [1988] points out that investors have not used the option market for the following reasons: (1) mismatch of insurance period and option expiration date, (2) lack of a European option[11], (3) position limits, (4) mismatch of

---

[10]In Krull's (1990) model, investors are not allowed to take short positions in both stock and futures. What he simulated is in fact "quasi-arbitrage" activities.

[11]Early exercise is unnecessary for the purpose of insuring a portfolio through the insurance period, but the price of an exchange-listed option includes the early exercise

insurance floor and option striking price, (5) illusion of getting insurance for nothing.

Leland [1980] suggests that a portfolio can be insured against loss below a specified floor level by dynamically adjusting between the stock and Treasury-Bills position, such that a synthetic put position is created. In principle, the insurance strategy requires buying more stocks as the price rises, and selling them as the price falls. However, Rubinstein [1988] argues that, due to lower transaction cost and higher liquidity of the futures market, portfolio insurance should be implemented via trading futures.

Regardless of whether the portfolio insurers use either the stock or the index future as the underlying instrument, all forms of portfolio insurance models react to the same data in a similar way. Thus, when a high proportion of investors use it, a market decline could easily turn into a debacle. The simulations of Kim and Markowitz [1989] have explicitly demonstrated this effect.

One form of the portfolio insurance strategy is CPPI (constant proportion portfolio insurance) proposed by Black and Jones [1987]. CPPI investors seek to limit their losses to a fraction of the total asset value, while still participating in the potential appreciation of stocks during the insurance plan period. The minimum portfolio value the insurers wish to preserve is termed **floor**, and the maximum loss they wish to ensure is termed **cushion**. At the beginning

---

premium.

of a plan, the relationship between the floor and cushion is defined as:

$$Cushion_0 = Asset_0 - Floor_0 \quad \ldots\ldots(1)$$

or

$$Floor_0 = [1 - \delta] * Asset_0 \quad \ldots\ldots(2)$$

where $\delta = Cushion_0/Asset_0$.

Whenever the stock value changes, the total asset value and cushion will change also. Assuming the floor is a constant, the new relationship between the cushion and floor at time t could be rewritten as:

$$Cushion_t = Asset_t - Floor_0 \quad \ldots\ldots(3)$$

After a floor is chosen, the CPPI rule requires the target stock exposure at any time t to be a constant **multiplier** [M] of the cushion:

$$\text{Target value of stock}_t = M * cushion_t$$

If no cash deposits or withdrawals occur during an insurance plan period, stock appreciation will expand the cushion, and stock depreciation will reduce the cushion. Since the CPPI rule requires target stock exposure to be a constant multiple of the cushion, the CPPI investors will buy stocks as prices rise and sell stocks as prices drop. Therefore, if the CPPI investors dominate, they will reinforce the direction of price changes, and accelerate market volatility.

Imagine a CPPI investor with an initial wealth of $100, constant floor of $70, cushion of $30 and multiplier of 2. According to the CPPI rule, the investor will invest $60

(=2*$30) in stocks, and seek to limit the loss to, at most, $30 (i.e. $100 - $70) in the worst situation.

If the stocks appreciates 10%, the total asset value will become $106 (=$100 + $60*0.1), and the cushion will become $36 (=$106 -$70). Since the target stock position is supposed to be $72 (=2*$36) in accordance with the CPPI rule, the CPPI investor will purchase an additional $6 (=$72 - $60*1.1) worth of stocks. If the stocks fall 10%, the total asset value will be $94 (=$100 - $60*0.1) and the cushion will become $24 (=$94 - $70). The target stock exposure should be $48 (=2*$24), thus the CPPI investor will sell $6 (=$60*0.9 - $48) worth of stocks.

Another popular form of portfolio insurance is the synthetic option replicating strategy proposed by Rubinstein and Leland [1981]. Their theory is based on Black and Scholes' [1973] option pricing model. Since a stock position plus a European put option is equivalent to a European call option plus Treasury-Bills position, hence, option replicating portfolio insurance will use the stock hedge ratio in the Black-Scholes model to determine the proportion of money to be invested in the stocks (futures). The efficacy of ORPI, in particular, depends crucially on low transaction cost and the precise estimation of volatility[12].

As Rubinstein [1988] pointed out, the feasibility of portfolio insurance is based on the assumptions of price

---

[12]A more rigorous discussion of option-base portfolio insurance can be found in O'Brien (1988a, 1988b), and Rubinstein and Leland (1981).

continuity and low transaction costs. In theory, portfolio insurance strategies can provide downside protection for the value of an insured portfolio. However, they performed poorly during "Black Monday." The failure was caused by the violation of both assumptions.

Indeed, Grossman [1988] states that "if everyone follows the synthetic put strategy and attempts to sell stocks after a price falls, then the stock price will jump down (violating the price continuity assumption), and they will fail to achieve their desired goal." (p. 277)

Many researchers affirm that portfolio insurance accelerate market volatility. Grossman [1988c, 1988d] states that dynamic hedging strategies hide strategic market information. If many investors suddenly decide to use insurance strategies predicated on historic levels of price volatility, stock and futures price volatility will increase. Kim and Markowitz's [1989] simulation results demonstrate that the CPPI strategy leads to greater market volatility. Krull [1990] also finds a similar conclusion for the option replicating strategy.

II.C. Rebalancing Strategy

Rebalancers seek to maintain a stock exposure that is a constant proportion of the total asset value of the portfolio. Assuming no cash deposits or withdrawals during an investment period, stock appreciation will increase total asset value, and stock depreciation will reduce the total asset value.

Since the rebalancing rule requires target stock exposure to be a constant proportion of the total asset value, it will require selling stocks as prices rise and buying stocks as prices fall.

Consider an investor with initial wealth of $100 and constant proportion of 0.5. The investor will invest $50 (=$100*0.5) in stock and the rest in Treasury-Bills. If the stock appreciates by 10%, the total asset value will become $105 (=50*1.1 + 50), and the rebalancing rule will require the sale of $2.5 worth of stock. If the stock falls 10%, the total asset value will be $95 (=50*0.9 + 50). The rebalancing rule will require the purchase of $2.5 (=95*0.5-50*0.9) worth of stock. For a rigorous description of the constant proportion rebalancing rule and its pay-off properties relating to stock price changes, please refer to Perold and Sharpe [1988].

III. MARGIN REGULATIONS AND VOLATILITY

III.A. Stock and Futures Margin Requirements

The Securities Exchange Act of 1934 (SEA) gave the Federal Reserve Board (FRB) jurisdiction over the level of stock margin. The first margin control was invoked on October 1, 1934. It ranged from 100% on January 21, 1934 to 40% on November 1, 1937. The typical stock margin change was on the magnitude of 20% and occurred, on average, once every eighteen months. On January 3, 1974, stock margin was set at 50%. It has been kept at that level since then.

Before the introduction of the Securities Exchange Act of 1934, margin requirements were regulated by the private sector exchanges. The crash of 1929 prompted Congress to transfer initial margin requirement jurisdiction over to the FRB. The official margin regulation was imposed in the belief that excessive speculation fueled by inadequate margin had accelerated the crash of 1929.

After examining the Congressional hearing records about the Securities Exchange Act of 1934, Moore [1966] concluded that stock margin controls have three major goals: to reduce stock price fluctuation due to the pyramiding-depyramiding process, to dampen unwarranted speculative excesses, and to reduce the use of excessive credit.

Various issues of the Annual Report of the Board of Governors of the Federal Reserve System cited the official reasons for increasing margin requirements as follows: a substantial price advance, a rapid expansion in stock market credit, a suspected speculation, a high trading volume and an expanding economy. Market volatility, in particular, was never cited as an official reason for changing margins.

There are two kinds of stock margins: initial margin and maintenance margin. Initial margin refers to the percentage of the purchase price an investor must put up when the stock is purchased. The maintenance margin refers to the minimum proportion of equity an investor has to maintain in his margin account. Regulations T, U, and G of the SEA apply only to initial margin. The market professionals such as specialists,

market makers and brokers/dealers are subject to capital requirements but not regular margin requirements. Right now, the individual brokerage houses can set up their own maintenance margin. However, it has to meet the minimum standard of at least 25% as mandated by the NYSE Exchanges' rules.[13]

Margin requirements on futures contracts are still set by the Exchanges with no direct regulatory control. However, brokerage houses are free to require additional margins from their customers. Futures margins are specified in dollar amounts per contract, and are adjusted over time to reflect the change in the value of the contract. The futures' initial margin typically accounts for two to ten percent of the value of the contract in contrast with the 50% stock margin. The daily marking to the market and the function of futures margins as performance bond are often cited to justify the much lower level of futures margins.

Futures' initial margin requirement is lower for hedgers than for speculators, and T-Bills can be posted as margins. The maintenance margin on futures is usually set at about 75% of the level of the initial margins. Once the account balance falls below the maintenance margin requirement, a margin call will be issued. The customer has to deposit additional cash (not Treasury-Bills) to bring the margin ratio up to the level of initial margin (not maintenance margin), or choose to

---

[13] For a detailed description of margin regulations and procedures, please refer to Sofianos (1988).

liquidate the position within 24 hours.

Crucial differences do exit between stock and futures margins. Stock margin is down-payment on a purchase, so only buyers need to meet the margin requirements. Futures margins are performance bonds to prevent contract default, thus both buyers and sellers are mandated to meet margin requirements. Furthermore, futures contracts are marked to the market daily, and an intra-day margin call can be issued to investors in a time of highly volatile trading.

There is general agreement that futures margins function well in the sense of preventing contract default. However, no consensus has been reached about its efficacy as a regulatory tool for stabilizing prices.

III.B. Volatility and Factors Affecting It

Volatility is the measure of how quickly prices react to the arrival of new information. Fama [1989] claims that economic efficiency is best served by the quick adjustment of price to new fundamental value, and rational prices are not always less volatile prices.

What causes great concern is excessive price volatility unrelated to changes in fundamental value. Excessive volatility is undesirable in the following respects: (1) it increases the market-making risk, thus, increasing the transaction cost and reducing liquidity. (2) it increases the risk premium for holding stock, which implies higher cost of capital for the firms. (3) it can reduce investors'

confidence and affect the function of raising capital through equity sale.

Various researchers have analyzed changes in aggregate stock market volatility. Officer [1973] relates market variability to business fluctuation as reflected by the changes in industrial production. Black [1976] argues that volatility is typically high (low) when stock prices are falling (rising). Christie [1982] finds that equity variances have a strong positive relationship with both financial leverage and interest rate. Schwert [1989] finds that stock market volatility is higher (lower) during economic recessions (expansions), and attributes the phenomenon to changes in "operating leverage." Maberly, Allan and Gilbert [1989] claim that volatility is asymmetric, being significantly greater for bear than for bull markets. Shiller [1990] argues that changes in investment and "fashion and fad" strongly influence prices and volatility in financial markets. West [1988], and De long, Shleifer, Summers and Waldman [1989] claim that noise trading by naive investors may be important in explaining increase in volatility. Amihud and Mendelson [1987] conclude that the trading mechanism has a significant effect on stock price and volatility by comparing the behavior of open-to-open and close-to-close returns on the NYSE Stocks.

There is extensive research on the effect of stock margin[14]. But no consensus has yet been reached about its

---

[14]See, e.g., Hardouvelis [1988a], Seguin [1990], Hardouvelis [1990], Hsieh and Miller [1990], Luckwood and Linn [1990].

effectiveness on affecting market volatility.

III.C. Interaction Between Margins and Volatility

The volatile price movement of "Black Monday" has renewed interest in the role of margin requirements as a regulatory tool. The current regulation proposals, however, have focused on the low margins for index futures, and its effect on market volatility via arbitrage activities. Indeed, the Brady Commission [1988] has recommended that margin requirements should be made consistent across market places to control speculation and financial leverage.

Previous studies of stock margin requirements have produced controversial results. Moore [1966] argues that margin is not an effective regulatory tool in controlling margin credit. Officer [1973] does find an inverse relationship between stock margin requirements and stock volatility, but he concludes that margin is not an effective means of controlling stocks volatility. Douglas [1969] also finds a negative relationship between the level of margin requirements and stock price volatility, and suggests that "margin requirement tends to reduce price volatility" [p. 37]. Luckett [1982] argues that margin is effective in affecting investors' equity ratio. Hardouvelis [1988] finds a significantly negative relation between stocks' initial margins and volatility.

Among the recent studies, Hardouvelis [1990] confirms his earlier finding that higher margins are associated with lower

stock volatility, lower excess volatility, and less deviation from fundamental value. Contrary to his findings, Hsieh and Miller [1990], and Schwert [1990] find no evidence of a negative correlation between change in margin level and changes in volatility. By using the new list of OTC marginable securities as samples, Seguin [1990] reports no evidence that tightening margin restrictions reduces volatility.

There is no agreement upon the effect of futures margin on price volatility. Pliska and Shalen [1991] simulate the effect of extreme margins change on futures activities. They find that high margins are very effective in cutting down speculative volume, but do not always stabilize the price. Hartzmark [1986] claims that higher margins are as likely to drive out informed traders as naive ones. Thus, the effect is unpredictable. Brorsen [1991] argues that any measures that increases market friction, such as higher futures margins, will succeed in reducing short-run volatility, but will not affect long-run volatility.

IV. STOCK MARKET SIMULATOR (SMS1) AND THE KIM-MARKOWITZ PAPER

IV.A. Stock Market Simulator

The SMS1 is a discrete-event simulation model written in SIMSCRIPT II.5 (Kiviat, Villanueva and Markowitz [1983]). In SMS1, the events can happen at arbitrary future points in time, but not continuously. The passage of simulation time is driven by the sequence of events, and will always advance to

the time of the next significant event. These are the crucial differences between SMS1 and other continuous-time simulation.

SMS1 performs a simulation of a stock market composed of two kinds of investors - rebalancers and CPPI investors, and two securities - cash and stock. The model's simulation environment can be modified to reflect the model user's thinking of the investment environment. For example, the parameters regarding the number of investors, the prototype of investors, investors' initial attributes and investment strategies, and the parameters of random distributions can all be specified by the model user just by editing the input parameter file[15].

SMS1's physical limit is subject only to the computer's memory, disk space and microcomputer addressing limits. The recent advancement in PC technology and simulation language has dramatically diminished computing cost and time. Hopefully, further progresses in computer technology will encourage more application of simulation modelling in conventional finance research.

The SMS1 is a simplified model. Its main purpose is to show qualitatively the effects of margin and investment practice, rather than to quantitatively reproduce current market volatility.

IV.B. A Brief Summary of Kim-Markowitz Paper

---

[15]For detailed instructions about how to run the SMS1 on a PC and how to edit the parameters, please refer to Markowitz (1988) and PC Simscript II.5 Introduction and User Manual.

Kim and Markowitz [1989] used the SMS1 to test the impact of trading strategies and margin upon market volatility and trading volume. At the beginning of their simulations using SMS1, prototype 1 rebalancers have 70% of their wealth in stock; prototype 2 have 30%. Since Kim and Markowitz assume that both prototypes of rebalancers attempt to invest 50% in stock, both must trade at the start of simulation.

CPPI investors have only one prototype in the Kim and Markowitz runs. The length of the insurance plan is set at 65 days to increase the activity in the simulated market. When the simulations begin, the remaining insurance period for each CPPI investors is drawn uniformly before 1 and 65 days. Also the CPPI's investors' initial stock position is set equal to the target stock position. Thus, the change in market volatility will not be caused by the CPPI investors' start-of-simulation trading adjustment requirements.

In the Kim and Markowitz's runs using the SMS1, investors review their portfolios and deposit/withdraw cash randomly. The portfolio review time is exponentially distributed with a mean review time of 5 days. The cash flow is generated by a uniform distribution ranging between -$8,000 and $9,000. It occurs randomly with an exponential distribution with a mean time of 10 days.

There are 75,000 shares and 150 investors throughout all of their simulated runs. The stock price is $100 per share and all investors have the same initial wealth of $100,000 at the beginning of the simulation. During the simulations, if

an investor's wealth drops below $0.01, his trading is suspended immediately. If the stock price reaches 10^9 during the run, the simulation is termed explosive and halted.

Kim and Markowitz find that the quarterly standard deviation of daily returns and trading volume tends to increase as the proportion of CPPI investors increases. They also report that the effect of margin is highly related to the level of floor the CPPI investors seek to protect and to the number of portfolio insurers in the market. Specifically, they find that if the CPPI investors seek to protect 90% of their portfolio value (i.e. cushion = 10% of total value and multiplier = 5) and 33% of margin is allowed, runs with 50 or more CPPI investors out of 150 were explosive. Although runs with 5 or 25 CPPI investors were not explosive, the market was notably more volatile.

Tables 1 and 2 list the input parameter settings chosen by Kim and Markowitz. A brief review of those parameters will help to understand the discussion of model specifications and simulation results in Chapter III and Chapter IV of this paper.

V. COMMENTS AND SUMMARY

The purpose of limits on program trading and uniform margin requirements is to curb the "proclaimed" market volatility excesses, but critics argue that they will reduce liquidity and might even increase volatility. The debate over the effects of these regulatory policies on the markets

appears far from resolved, either empirically or theoretically. This study will serve to provide additional insight into these contentious policy issues, and be of practical importance.

CHAPTER 3

MODEL SPECIFICATIONS AND METHODOLOGY

I. INTRODUCTION

This chapter will present a detailed description of the model specifications such as investors' trading strategies, choices of trading instrument and order execution procedures. Then the experimental design of making changes in the model and the non-parametric test procedures used to analyze effects of these changes will also be discussed fully.

II. MODEL SPECIFICATIONS

A discrete-event simulation model written in SIMSCRIPT II.5 is used to analyze the impact of the index arbitrage and uniform margin requirement. Specifically, Markowitz's [1988] stock market simulator (SMS1) will be extended to include a new prototype of investor - the index arbitrageur, and a new market - the futures market. Other new features of the extended model include: short-sales, market orders and market-on-close orders, the index futures' cash settlement procedure, daily margin ratio calculation, marking to the market, futures variation margin call, stock margin call, interest rate, commission cost, the intra-day high/low volatility measure, percentage bid-ask spread and the Martin liquidity measure.

The extended model has three types of investors. They are rebalancers, CPPI investors and index arbitragers. Investors' portfolio holdings include three kinds of assets:

cash, stock index and index futures.

The pricing relationship between futures and stock, commission costs, interest rate, market impact costs and investment strategies jointly determines investors' trading actions. The discrete interactions between supply and demand created by different investors' actions endogenously determine prices, trading volumes, bid-ask spreads and volatility of return in both markets.

Table 3 lists a summary of the model's input parameter settings. A brief review of those parameters will be essential in understanding the following discussion of model assumptions and specifications.

II.A. Types of Investors: Arbitragers, Rebalancers and CPPI Investors

There are three types of investors in the extended stock market simulator: index arbitragers, rebalancers and CPPI investors. Investors of the same prototype have identical values for parameter settings such as portfolio review day, trading strategy, and initial wealth allocation.

There is no execution lag in the extended model. Thus arbitragers can observe mispricing signals and immediately execute orders at both markets. The model also assumes transactions in both markets will be settled immediately.

In the model, arbitragers adopt the dynamic trading strategy described by Finnerty and Park [1988] to improve

their profitability[16]. Arbitragers demand a target risk-free spread over the T-Bill rate. Only when the futures mispricing implies a risk-free spread of larger than or equal to the target spread, will an inter-market arbitrage be triggered. The amount of risk-free spread (arbitrage yield spread) will be used to control the level of arbitrage in the simulations[17].

Rebalancers and CPPI investors adjust their portfolios as required by their respective investment rules. It is assumed they would place orders only when their portfolio holdings deviate from the target holdings by more than 3%. It is assumed Rebalancers and CPPI investors are rational. They would consider commission costs, interest rate, and the mispricing between futures and stock, then choose to trade the security with the lowest overall transaction cost. As for arbitragers, they would also consider the market impact costs (of buying at the ask price and selling at bid price), then determine whether inter-market arbitrages should be triggered. The above rational assumption will induce enough liquidity in both markets.

As in the Kim-Markowitz paper, the length of the CPPI insurance plan is set at 65 days to increase trading activities. At the start of the simulation, each CPPI

---

[16]Finnerty and Park [1988] find that arbitragers would be better off to keep on trading instead of holding positions until expiration.

[17]As arbitrage yield becomes smaller, the non-arbitrage boundary will shrink. Thus more arbitrage trading would be possible.

investor's insurance expiration day is drawn randomly from an uniform distribution ranging between 0 and 65, so that all CPPI investors will not trade at the same day.

II.B. Three Kinds of Securities: Cash, Stock Index and Index Futures

In the extended model, cash always yields a constant rate. Also no distinction is made between cash in an equity account, cash in a margin account or short-sale proceed in a margin account. The three-month Treasury Bills' average annual return for the past twenty years (up to June 1, 1991) is 8.6 percent, and it is used to approximate the constant interest rate.

Investors always can lend and borrow at the constant rate. However, margin requirements will explicitly determine the maximum amount of money each investor is permitted to borrow. The stock index is the only security traded in the stock market. The stock index does not pay dividends, but short sales of it are allowed. The nearby three-month index futures is the only contract traded in futures market. The instant after the "old" futures expires, another "new" three-month futures is initiated.

The instant after the futures expired, the remaining outstanding contracts will be "settled in cash" by using the expiration day closing price[18] as the settlement basis. Due

---

[18]Beginning in June 1987, the last trading day for S&P 500 futures was changed from the third Friday of the contract month to the preceding Thursday, and the remaining outstanding contracts are settled based on the Friday opening price for

to the cash settlement of index futures, the arbitragers will need to unwind their positions via market-on-close orders on futures expiration day. The sudden orders imbalance created by their unwinding actions will induce a "single witching hour" effect in the extended model.

Since there are no specialists or market makers in the model, it is expected that some of the arbitragers' market-on-close orders would not be executed successfully. Consequently, immediately following futures' expiration, arbitragers will need to roll over their unhedged positions to remain fully hedged.

II.C. Stock and Futures Margin Requirements, Margin Calls and Marking to the Market

Margins will be allowed in both the futures and the stock markets. Stock's initial and maintenance margin are 50 percent and 30 percent respectively. They are 15 percent and 12 percent for futures. Those are about equal to the post-crash level of futures margin requirements. No difference is made between futures margin requirements for speculative and hedging accounts.

The daily margin ratios will be calculated every morning by using the previous day's closing price as the basis price. When an investor's margin ratio falls below the maintenance margin requirement, a margin call will be issued immediately. The investor is required to deposit money at least equal to the amount of margin call, otherwise, the extra position will

---

the underlying index.

be mandatorily liquidated via market orders. For a stock account, the equity balance has to be brought up to the level of the maintenance margin requirement. For futures, it has to be brought up to the level of the initial margin requirement.

Futures will be marked to the market each morning by using the previous day's closing price as the settlement basis. Any futures account balance that is more than the initial margin requirement will be withdrawn to the stock equity account.

II.D. Types of Orders and Sizes of Orders

Only three types of orders, limit order, market order and market-on-close order, are available in the extended model. Rebalancers and CPPI investors use limit orders only. Arbitragers place market orders to execute inter-market arbitrage trading, and use the market-on-close orders to unwind their arbitrage positions at the futures expiration day. If arbitragers need to roll over their unhedged positions due to the "cash settlement" of index futures at expiration, then, limit orders will also be available to them.

Rebalancers' and CPPI investors' order sizes are determined by their respective investment rules. Arbitragers' order sizes are set as the minimum of the bid size in one market and the offer size in the counterpart market. For example, if 30 shares of stocks are on the offer side, and 20

contracts of futures are on the asked side, the arbitrager order will be set as "buy 20 shares of stock and sell 20 contracts of futures" at market price.

II.E. Random Distributions of Portfolio Review Time, Cash Flow Arrival Time and Size of Deposit/Withdrawal

Rebalancers' and CPPI investors' portfolio review time is an exponential distribution with mean time of 5 days. Their cash flow deposit/withdrawal time is an exponential distribution with mean time of 10 days, and the sizes of their deposit/withdrawal is randomly generated by a uniform distribution ranging between +3000 and -3000 randomly determines. Arbitragers' portfolio review times are generated by an exponential distribution with mean time of 0.5 day. No cash deposits/withdrawals are allowed for them.

II.F. Placing and Executing Orders, and Settlement Procedures

As in the SMS1 model, investors will estimate the current market price before they place their orders. If both bids and offers exist, the estimate price will be the average of the bid and ask price. If only bids (offers) exist, the estimate price will be the bid (asked) price times a no offers price estimate factor (no bids price estimate factor). If neither bids nor offers exist, the estimate will be set to be the last sale price.

A limit order's offer (bid) price will be equal to the current price estimate times an offer factor (bid factor). A market order's price will be set to be the best price

available in the market.

If an order crosses the counterpart market quote, it will be executed and settled immediately[19]. An unfilled limit order will enter the limit order book and remain until it is either executed or canceled. Arbitragers withdraw their unfilled limit orders after half day, other investors withdraw their unfilled orders after one day.

II.G. Commissions and Other Transaction Costs

The transaction costs include commissions, bid-ask spread, market impact and the mispricing between futures price and "fair value." In the extended model, the prices, trading volume and bid-ask spread are determined endogenously by supply and demand. Therefore, no assumptions are made about bid-ask spread, market impact and futures mispricing. It is assumed that the one-way commission cost for trading stock is eighteen basis points[20], and that for trading futures is negligible.

II.H. Choice of Trading Instrument

CPPI investors and rebalancers periodically adjust their portfolio positions according to their respective rules. When an adjustment of their portfolio positions is necessary, the

---

[19]Normally, stock and futures transactions are settled in five business days and one business day respectively.

[20]Berkowitz, Logue and Noser's (1988) empirical study shows that the commission costs for trading NYSE stocks average eighteen basis points.

investors will rationally compare prices prevailing in both markets, and choose the trading instrument with lower overall transaction costs. For example, when the synthetic T-Bills position implies a higher yield than the T-Bill, and the investment rule also indicates to convert part of stock into T-bills, then, instead of selling stock and investing the proceeds into T-Bills, the investors will sell futures and refrain from selling stock to create a synthetic T-Bill position. The decision to sell stock and buy T-Bill or to create a synthetic T-Bill position is jointly determined by the commission costs and pricing relationship between stock and futures.

As Gould [1988], Merrick [1988], Hill, Jain and Wood [1988] pointed out, the pricing relationship between futures and stock is important in determining the trading instrument for implementing program trading. They find mispricing may induce rational investors to use a stock-base strategy instead of the conventional futures-base strategy. The above assumption of using both stock and futures as trading instruments is consistent with their findings.

In the extended model, the types of orders, sizes of orders and price quotes are determined by respective trading rules specified by the model users. The discrete-time interactions between different investors' orders endogenously determine the prices, trading volumes, bid-ask spreads and volatility of return in both markets. That explains the trading mechanism of the extended model.

II.I. Starting and Terminating Simulation

As the simulation begins, there are 150,000 shares and 220 investors in the simulated market. Rebalancers' and CPPI investors' initial portfolio holdings are equal to their desired target portfolio holdings. The futures and stock are in fair pricing relationship, such that no arbitrage opportunity is available. The random cash flows induce rebalancers and CPPI investors to place orders, thus, starting the simulation.

As in the Kim and Markowitz paper, every investor has the same initial wealth of $100,000, and the stock price is $100 per share at the beginning of the simulation. Whenever an investors' total value is less than $0.01, his trading is suspended immediately. If the stock price reaches $1,000,000,000, the simulation is termed explosive and halted.

III. METHODOLOGY

Our experimental design is to make changes in the model and use non-parametric tests to analyze the effects of these changes on the activities of the stock and futures markets. Specifically, the level of index arbitrage and futures margin requirements in the model will be changed to simulate the effects of regulatory policies.

The Kruskal-Wallis test is used to detect the market activity differences induced by the change in index arbitrage trading. Then the Jonckheere-Terpstra procedure is used to

test whether index arbitrage increases market activities. The Wilcoxon rank sum test is used to examine the effects of uniform margin requirements upon both markets.

III.A. Simulation Procedures

Arbitrage program trading is frequently implicated as a cause of market volatility. By deliberately controlling the level of arbitrage trading while holding other factors fixed, the claim that arbitrage increases volatility can be tested.

The arbitrage yield spread over the T-bill rate is used to control index arbitrage activities in each run. When the arbitrage yield spread is deliberately decreased, the range of the non-arbitrage boundary will be narrower. Thus, more arbitrage activities will presumably occur. The impact of index arbitrage will be experimented with by decreasing arbitrage yield spread in six simulation runs (one at a time), thus increasing the level of index arbitrage in them.

By purposely changing the initial and maintenance margin for index futures to 50% and 30% while holding other factor fixed, the implication of uniform margin requirements can be simulated. To catch the possible interactions between index arbitrage and margin requirements, the procedures will be repeated in six runs with increasing levels of arbitrage trading.

All of the simulations will be conducted over a twenty-five-year period to catch the long-term impact of these proposed regulation changes. In addition, the same procedure

will be repeated in nine more replications (each replication with six runs) to quantitatively confirm the results.

III.B. Measures of Market Activities

The "degree of effects" of regulatory controls on the market activities are determined by five measures: the period standard deviation of daily return, the period mean of intra-day price range estimator (the natural logarithm of the daily high divided by daily low), the period mean of percentage bid/ask spread[21], the period trading volume and period return. The period standard deviation and intra-day high/low estimator are respectively used to measure the long-term and short-term volatility in both markets. The percentage bid-ask spread and trading volume are used to measure the market liquidity. The purpose of two different volatility measures is to examine the sensitivity of the results to the adoption of volatility[22] definition.

III.C. Hypotheses and Testing Procedures

---

[21]The percentage bid-ask spread is defined as the daily average bid-ask spread divided by the daily closing price. Every trade and quote occurring on the same day will be used to compute it.

[22]Garman and Klass (1980) propose a volatility estimator which uses the daily high, low, open and close prices. It is shown to be 8.4 times more efficient than the classical estimator given closing price only. Parkinson (1980) also propose a high-low variance estimator. However, the derivations of these estimators depend critically upon the restrictive assumption of stock price following a Brownian Motion with zero drift. Since our simulations adopt the discrete-time approach, these alternative estimators will not be utilized to measure the price volatility.

Since our experimental design involves introducing changes in the level of index arbitrage and futures margins, the hypotheses will be statements about the effects of the changes proposed. Below is a description of the hypotheses to be tested and the procedures applied to them.

The Kruskal-Wallis test will be used to examine the null hypothesis that index arbitrage does not affect market activities. If the null hypothesis is rejected, the next step would be to determine the effects of index arbitrage. Since the purpose of limits on program trading is to curb market volatility, the Jonckheere-Terpstra test will be applied to test the effectiveness of such limits.

The one-sided Wilcoxon rank sum test will be used to test the null hypothesis that uniform margin requirements do not affect market activities. The level of significance will be set at 5% for all of tests mentioned above.

IV. SUMMARY

Markowitz's SMS1 has been extended to include a new type of investor, index arbitrageur, and a new security, stock index futures. New features such as short sales, margin calls, marking to the market are also incorporated into the extended model.

We are interested in examining the proclaimed efficacy of using regulatory controls to affect market activities. Experimentation with the extended model involves making changes (one at a time) in the model and using non-parametric

test procedures to analyze the effects of these changes. The effectiveness of regulatory controls upon market activities is defined by the changes in the markets' long-term volatility, short-term intra-day volatility, percentage bid/ask spread, trading volume and return.

CHAPTER 4

RESULTS OF THE SIMULATION

I. INTRODUCTION

This chapter will present the detailed results of our simulation with the extended model. In the preceding chapter we have defined the "degree of effects" in term of change in long-term volatility, short-term volatility, percentage bid/ask spread, trading volume and return. Thus the effects of regulatory controls will be discussed accordingly.

II. SIMULATION RESULTS OF INDEX ARBITRAGE

II.A. Market Volatility

II.A.1. Impact on Standard Deviation of Daily Returns

Table 4 compares the stock's quarterly standard deviation of daily returns for six runs with various levels of index arbitrage activities. No clear pattern can be detected visually from Table 4. Table 5 reports the summary statistics of the Kruskal-Wallis non-parametric test for ten sets of replications. Both stock and futures results support the alternative of arbitrage affecting volatility of return.

The Jonckheere-Terpstra test (hereafter J-T test) is then applied to 100-period standard deviation data. It is used to test the null hypothesis of arbitrage not affecting volatility against the alternative of it increasing volatility[23]. Table

---

[23]The Kruskal-Wallis test is not appropriate when the alternative is ordered, since it is not designed to detect differences in a particular direction.

6A summarizes the results of ten replications. Most of them support the alternative of arbitrage increasing volatility.

Figures 1 and 2 respectively plot the quarterly standard deviation of daily returns on stock and futures for 100 quarters, for four runs with various levels of arbitrage. Both of them displays a sharp and apparently permanent decline over time in market volatility for all four runs.

The decreasing volatility results from two reasons: (1) CPPI investors lose market shares to other investors. (2) Appreciation of portfolio values through time has reduced the random shocks created by investors' cash deposits/withdrawals.

After a detailed analysis of data, two violations of test assumptions are found. First, the time trend in quarterly standard deviation violates the assumption of independence within samples. Second, CPPI investors tend to go bankrupt in simulations. Since CPPI investors increase market volatility[24], the number of them going bankrupt could account for the volatility difference in each run. This violates the assumption of partial analysis.

Figure 3 plots the number of CPPI investors going bankrupt for four runs. It shows that CPPI investors start to drop out of the simulation after about forty quarters. Thus, the simulation results will be divided into two sub-periods, the first forty periods and the last sixty periods. It is

---

[24]Kim and Markowitz (1989) have showed that market volatility tend to increase as the number of CPPI investors increases. Thus, the number of CPPI investors going bankrupt will presumably affect volatility in each run.

hoped a split of data would reduce the volatility effect caused by bankruptcy of CPPI investors, and the violation of the assumption of independence within samples.

Tables 6B and 6C summarize the results of the Jonckheere-Terpstra test performed on the 40-period and 60-period samples. Surprisingly, the results no longer suggest that a high level of arbitrage causes volatility of return. In Table 6B, only three replications out of ten support the alternative that index arbitrage increases volatility over the null hypothesis of no effect. In Table 6C, four replications out of ten support the alternative. The aggregate results are not strong enough to suggest that index arbitrage destablizes the stock and futures markets.

Krull [1990] reports program trading by index arbitrage does not appear to be a source of market volatility. These simulation results are consistent with his finding.

II.A.2. Impact on Period Mean of Intra-day High/Low Ratio

Figure 3 plots the stock's period mean of intra-day high/low ratio for four runs with various levels of arbitrage. Figure 4 is equivalent to Figure 3 except it shows futures' results. Both Figures exhibit an increasing relationship between the intra-day high/low ratio and the level of index arbitrage.

Tables 7A through 7C summarizes the Jonckheere-Terpstra tests performed on the 100-period, the 40-period and the 60-period intra-day high/low ratio data. Results from all the

tests consistently indicate that the level of index arbitrage are positively associated with intra-day volatility. For example, in Table 7B, the results of the 40 period data, all replications suggest that index arbitrage results in increasing intra-day volatility in both stock and futures markets.

The sudden triggering of index arbitrage often results in a very rapid price move. This may explain the positive association between the level of index arbitrage and intra-day volatility.

II.A.3. Summary of Volatility

After adjusting the effect caused by the bankruptcy of CPPI investors and the violation of independence of samples, the simulations no longer support the alternative hypothesis that arbitrage increases the volatility of return. However, they do confirm the common complaint that arbitrage increases intra-day volatility (short-term price velocity) in both the stock and futures markets.

II.B. Market Liquidity

II.B.1. Impact on Period Mean of Percentage Bid/Ask Spread

Figure 6 plots the stock period mean of percentage bid/ask spread for four runs with different levels of index arbitrage. It does not show any apparent pattern to the stock percentage spread relative to arbitrage activities. Figures 7, the plot of the futures period mean of percentage bid/ask

spread, exhibits a similar pattern to that of Figure 6.

The summary statistics of the J-T test on percentage bid/ask spread are presented in Table 8A through 8C. In both Tables 8A and 8B, six replications indicate arbitrage tends to increase stock percentage bid/ask spread, and seven of them indicate it widens futures percentage spread. In Table 8C, eight replications out of ten suggest that stock and futures percentage bid/ask spreads are generally increased by the increasing levels of index arbitrage activities.

In theory, the limit-order traders provide liquidity to the market by committing themselves to trade at prices announced in advance. In contrast, market-order traders reduce market liquidity by consuming those limit orders placed by others. Since arbitragers in our model place market orders, they will, by nature, consume liquidity and increase bid/ask spread.

II.B.2. Impact on Period Trading Volume

Figure 8 and 9 respectively displays the stock and futures period trading volume for 100 periods, for 4 runs with various levels of index arbitrages. They show that trading volume tends to decrease through time. The reasons used in explaining the declining volatility pattern can also account for the decreasing volume pattern. Both Figures 8 and 9 clearly show that the trading volume is generally increased by increasing levels of arbitrage activities.

Tables 9A to 9C summarize the statistics of the J-T test

performed on 100-period, 40-period and 60-period volume data. The results strongly confirm the findings of Figure 8 and 9. All tests suggest increasing arbitrage results in increasing trading volume in both markets.

Index arbitragers place opposite orders in both markets to eliminate price discrepancies. Their trading actions would presumably add extra trading volume to markets. The results are consistent with expectation.

II.B.3. Market Liquidity Summary

The above simulations strongly suggest that index arbitrage tend to increase stock and futures trading volume. Results of percentage spread are not as powerful as those of trading volume. Therefore, it is conjectured that arbitrage trading, at most, slightly increases percentage bid/ask spread.

II.C. Security's Quarterly Return

Figure 10 plots stocks' period return for 4 runs with various levels of index arbitrages. It displays no clear pattern of period return relative to arbitrage trading. Figure 11 plots futures' period return. Again no significant patterns can be visually detected from it.

Results of the J-T statistics are contained in Tables 10A to 10C. Except for four tests in table 10A, the other fifty-six tests do not suggest index arbitrage affecting security's period return.

III. RESULTS OF UNIFORM MARGIN REQUIREMENTS

III.A. Market Volatility

III.A.1. Impact on the Quarterly Standard Deviation

Table 11A presents the summary of the Wilcoxon rank-sum test performed on 100-period standard deviation data. Tables 11B and 11C report the same statistics performed on 40-period and 60-period samples. The results do not indicate that higher futures margins effectively curb market volatility, and perhaps even slightly favor the opposite view of a higher futures margins destablizing prices.

Pliska and Shalen's (1991) simulations show that a higher futures margin is not necessarily accompanied by greater price stability. They also report further margin increases are bound to be destablizing when they pass a threshold level. Our results are consistent with their findings.

III.A.2. Impact on the Intra-day High/Low Ratio

Tables 12A to 12C summarize Results of the Wilcoxon rank-sum test on the period mean of intra-day high/low ratio. The conclusions are quite similar to those drawn from Tables 11A to 11C, namely, higher futures margins do not reduce intra-day volatility, perhaps even slightly increase it.

Higher futures margin requirements would induce more margin calls. That could force investors to liquidate their positions involuntarily. The extra noise created by higher margins could possibly explain the slight increase in intra-day volatility.

III.B. Market Liquidity

III.B.1. Impact on Period Mean of Percentage Bid/Ask Spread

The simulations do not suggest that futures margin changes affect percentage bid/ask spread in both markets. Specifically, the results from the stock market are extremely weak. For example, in Table 13B, Panel A, only two out of sixty tests indicate that arbitrage widens stock percentage spreads. Although Panel B of Table 13A have the strongest test results among Tables 13A through 13C, merely ten tests out of sixty suggest index arbitrage widens futures percentage spread.

III.B.2. Impact on Period Trading Volume

The results of the Wilcoxon test on the 100-period trading volume are contained in Table 14A. In Panel B of Table 14, nineteen tests out of sixty have a significant probability of 5% or less. The results are not strong enough to claim that higher futures margins reduce trading volume. Also they are likely to be biased due to the declining time trend pattern in trading volume.

After dividing the 100-period trading volume into two sub-periods, the test results change dramatically. For example, in Panel A of Table 14B, results of the Wilcoxon test on the 40-period stock trading volume, fifty-eight out of sixty tests are insignificant at 5% level. As for 60-period tests, almost identical results are observed. The aggregate results do not support the alternative hypothesis of uniform

margin requirements reducing trading volume.

III.C. Security's Quarterly Return

Uniform margin requirements appear to have a trivial effect on the security's return. The Wilcoxon test is performed on 100-period, 40-period and 60-period quarterly return for stock and futures. Out of one hundred eighty tests performed on stock quarterly return, only one test is significant at about the 5% level. Results of futures quarterly return are identical to those of stock.

IV. COMMENTS AND SUMMARY

Simulation results indicate that index arbitrage does not increase long-term volatility and the return in either the stock or futures market. They also show that index arbitrage tends to increase short-term intra-day volatility, the percentage spread and trading volume in both markets.

Uniform margin requirements appear to have a trivial effect on market activities. Specifically, the results suggest that it cannot serve the proclaimed policy purpose of curbing market volatility, and perhaps even slightly increases volatility of return.

Kim and Markowitz (1989) has shown that the effects of stock margins depend on the amount of margin permitted, the number of portfolio insurers and the level of CPPI floor. Ideally, we should like to test the effects of changes over a wide variety of market structures (with different numbers of

CPPI investors, different insurance floors, and so on). In this way, our results would achieve the highest degree of generality. This will be a topic for further research.

The simulations are conducted in a test tube economy of fifty-five CPPI investors (trend-following investors) out of two hundred twenty-five investors. Therefore, the precise interpretation of simulation results should be that uniform margin requirements are an ineffective regulatory policy in a market not dominated by the trend-following investors. Since the trend-following strategies such as CPPI do not prevail upon the market, it is believed that our results achieve a high degree of generality in interpreting the effect of regulatory controls upon both markets.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

I. SUMMARY AND CONCLUSIONS

The crash of 1987 prompted government agencies to recommend several policy proposals to tighten regulations in futures and stock markets. Of particular interest, in view of the intensity of publicized attention, are the limits on program trading and uniform margin requirements.

Simulation methodology has been used in the study of these regulatory controls because the complexity of trading strategies in markets makes it virtually impossible to use mathematical modelling. The lack of data rules out the alternative of regression analysis. More importantly, simulation avoids costly trials of new market regulations, and may achieve a high degree of generality about the impact of imposing new rules on the markets. The unique features of simulation make it a powerful methodology in the study of market regulations.

Markowitz's SMS1 model has been extended and used to simulate the effects of index arbitrage and uniform margin requirements on trading activities in both stock and futures markets. The results indicate that index arbitrage does not increase long-term volatility in either the stock or futures market. However, they suggest that arbitrage tends to increase intra-day volatility (intra-day high/low ratio), percentage bid/ask spread and trading volume in both markets.

As expected, uniform margin requirements have more of an impact on the futures market than on the stock market. However, the results are definitely not strong enough to suggest that it is an effective policy tool in affecting activities in both markets. Specifically, uniform margin requirements cannot serve its proclaimed policy purpose of curbing market volatility.

The results also suggest that neither index arbitrage nor uniform margin requirements affect returns in both markets, and the level of index arbitrage prevailing in the market apparently does not interfere with the effect of change in the futures margins.

II. IMPLICATIONS OF RESULTS

The results of this study have the following policy implications:

1. Since index arbitrage does not affect assets' long-term volatility and return, rational investors with a long-term holding period should not be concerned about it.

2. The complaint of program trading causing market volatility is only partly justified. Program trading by portfolio insurers does increase volatility of return as shown by Kim and Markowitz (1989) and Krull (1990). Nevertheless, program trading by index arbitragers does not result in higher volatility of return.

3. The imposition of control on index arbitrage would reduce market efficiency by interfering with the role of

inter-market arbitrage in enforcing "the law of one price," rather than to decrease market volatility.

4. Since index arbitrage increases short-term intra-day volatility, it would raise the risk of short-term trading. Specifically, the NYSE specialists' price-continuity obligations mandate that they cushion the sudden price change triggered by index arbitrage, thus, their risk of market making will increase significantly. It is implied that a very high level of index arbitrage would threaten the NYSE specialists' essential function of maintaining an orderly market.

5. In a bear market, short-term volatility imposes more risk on specialists than in a bull market. Should a bear market reemerge, it is likely that the NYSE would again be a primary critic of index arbitrage or program trading.

6. The ban or limits on index arbitrage would reduce trading volume substantially in both stock and futures markets. The futures market does not have the price-continuity rule. Therefore, limits on index arbitrage or program trading strictly implies a huge economic loss to its members. For the NYSE, the issue become much more intricate. It has to look for a delicate balance between Specialists' interest and a shrinking trading volume.

7. Super DOT almost guarantees that arbitragers will beat the NYSE specialists. This may explain the NYSE's motivation to adopt the circuit breaker rule. This will force program trading to be implemented manually, thus, giving

specialists more time to cushion price changes.

8. Index arbitrage widens the percentage bid/ask spread in both markets, which turns out to increase the transaction cost for implementing intermarket arbitrage. Therefore, there exists a natural force in curtailing arbitrage trading practices.

9. Since returns in both markets are not affected by the level of index arbitrage, the popular claim of interactions between portfolio insurance and index arbitrage leading to a downward spiral in prices is not supported by the results.

10. When the market is not dominated by trend-following investors, margin control appears to have little effect on market activities. Uniform margin requirements would be a ineffective regulatory control under current market environment.

III. CAVEATS AND FUTURE RESEARCH

III.A. Caveats

In this simulation, CPPI is used to represent the trend-following trading strategy instead of the strict sense of portfolio insurance strategy as proposed by Black and Jones [1987]. It is believed that the replacement of CPPI with other trend-following strategies would not slightly affect the results significantly.

In order to maintain a well-behaved simulation, the number of CPPI investors is deliberately limited to fifty-five investors out of two hundred twenty-five. In the model, CPPI

investors are the only type of investors inclined to extend financial leverage to the maximum ratios permitted by the regulations. Should their number increase significantly, the results would presumably be different.

Thus, even though the simulation results suggest that uniform margin requirements do not affect both markets. It should not be interpreted as contradicting Kim and Markowitz's (1989) finding about the effect of stock margins in curbing volatility of return.

Stocks and futures are settled within five and one business day respectively. This study assumes they are settled immediately. It also assumes margin calls have to be responded to immediately to avoid the mandatory liquidation of positions. It is unclear whether this model simplification affects the results.

Without specialists being built into the model, the stock market could face a substantial order imbalance when many arbitragers unwind their positions in the futures expiration day. Therefore, one would not expect arbitrage trading to be risk-free in the model.

III.B. Future Research

This paper has not considered the arrival of new information other than the flow of market prices. In the SMS1, a set of endogenous information is generated over time. This set includes: closing price, daily high, daily low, daily trading volume, period return, period volatility, total amount

of capital flow, and a variety of other statistics. This information could have a significant impact on the investment decision of investors.

A new prototype of investors who incorporate the arrival of new information into investment decisions would improve the model. Specifically, a utility maximizer who uses a mean-variance approximation approach (Levy and Markowitz, [1979]), or a technical trader who relies on technical analysis, would be possible candidates.

Specialists and competing market makers are crucial in affecting market liquidity, but they are not incorporated into the model. This makes arbitragers unable to unwind their positions smoothly at futures expiration day. Since the major focus of this study is the impact of arbitrage on market liquidity and volatility, it would be a significant improvement to include specialists into the extended model.

Rebalancers and CPPI investors are only allowed to place limit orders in the model. In the real world, one would expect that they place various types of orders. Different types of orders, specifically, the market order, should be made available to all investors.

"Delayed execution" is used by many arbitragers to increase trading profit. However, this study only allow the "immediate execution". It would improve the model's applicability to allow more varieties of arbitrage strategies.

In SMS1, investors only review their portfolios periodically at pre-scheduled times. Even when the market

situation changes dramatically, they do not adjust their portfolios other than at the scheduled times. The investors' inflexibility in responding to abnormal market situations contradicts the behavior of investors in the real world. The extension of SMS1 to furnish investors with more intelligence, judgement and flexibility in trading strategy would imply a big improvement for the extended model.

The choices of input parameters crucially affect the simulation results. An ambitious project would require simulation of the effect of policy changes under a market structure closely matching that of the real world. In particular, the interaction between margin regulations and market structure will be a topic for future research. More work is undoubtedly needed to uncover the potential implications of market regulations such as margin control and limits on program trading.

TABLE 1
KIM-MARKOWITZ SIMULATION SPECIFICATIONS

BASECASE A SPECIFICATIONS

	Rebal1	Rebal2	CPPI
1. Value of Starting Portfolio	100000	100000	100000
2. Initial Stock/[Stock+Cash]	.7	.3	.5
3. How often portfolio reviewed[days]	5	5	5
4. How often deposit/withdraw	10	10	10
5. Minimum deposit	-8000	-8000	-8000
6. Maximum deposit	9000	9000	9000
7. Target fraction of stock/total asset	.5	.5	
8. Rebalance if actual is less than	.46	.46	
9. Rebalance if actual is greater than	.55	.55	
10. Length of insurance plan			65
11. Target ratio of stock to cushion			2.0
12. Buy stock if actual ratio is less than this			1.7
13. Sell stock if actual ration is more than this			2.3
14. Cushion as a fraction of portfolio value: at start			0.25
15. Cushion: start of new insurance plan			0.25
16. Maximum ratio of stock to assets			1.5

TABLE 2
KIM-MARKOWITZ SIMULATION SPECIFICATIONS

BASECASE B SPECIFICATIONS

	Rebal1	Rebal2	CPPI
1. Value of Starting Portfolio	100000	100000	100000
2. Initial Stock/[Stock+Cash]	.7	.3	.5
3. How often portfolio reviewed[days]	5	5	5
4. How often deposit/withdraw	10	10	10
5. Minimum deposit	-8000	-8000	-8000
6. Maximum deposit	9000	9000	9000
7. Target fraction of stock/total asset	.5	.5	
8. Rebalance if actual is less than	.46	.46	
9. Rebalance if actual is greater than	.55	.55	
10. Length of insurance plan			65
11. Target ratio of stock to cushion			5.0
12. Buy stock if actual ratio is less than this			4.7
13. Sell stock if actual ration is more than this			5.3
14. Cushion as a fraction of portfolio value: at start			0.1
15. Cushion: start of new insurance plan			0.1
16. Maximum ratio of stock to assets			1.5

TABLE 3

BENCHMARK SPECIFICATIONS

INPUT PARAMETER	Reb.	Arb.	CPPI
1. Number of investors	135	35	55
2. Value of Starting Portfolio	100000	100000	100000
3. Initial Stock/(Stock+Cash)	0.5	0.5	0.5
4. How often portfolio reviewed(days)	5	0.5	5
5. How often deposit/withdraw	10	0	10
6. Minimum deposit	-3000	0	3000
7. Maximum deposit	3000	0	3000
8. Target fraction of stock/total asset	0.5		
9. Rebalance if actual is less than	0.4924		
10. Rebalance if actual is greater than	0.5074		
11. Arbitrage yield spread over T-bills rate		*	
12. Length of insurance plan			65
13. Target ratio of stock to cushion			2
14. Buy stock if actual ratio is less than			1.943
15. Sell stock if actual ration is more than			2.063
16. Cushion: at start of simulation			0.25
17. Cushion: at start of new insurance plan			0.25
18. Stock commission cost (pct. of value)	.18%	.18%	.18%
19. Stock initial margin	50%	50%	50%
20. Stock maintenance margin	30%	30%	30%
21. Futures commission cost	0%	0%	0%
22. Futures initial margin	15%	15%	15%
23. Futures maintenance margin	12%	12%	12%
24. Bid factor	.99875	.99875	.99875
25. Offer factor	1.00125	1.00125	1.00125
26. Change bid interval (day)	1.0	1.0	0.5
27. Risk-free rate of return	8.6%	8.6%	8.6%

* The arbitrage yield spread is 0%, 0.25%, 0.5%, 1%, 2%, and 100% respectively for each run out of total 6 runs.

TABLE 4
Period Standard Deviation of Daily Returns
6 simulation Runs with Various Levels of
Index Arbitrage Trading Activities
(130 Rebalancers, 55 CPPI investors and 35 Index Arbitragers)

Panel A: Stock Market Data

QTR.	Proportion of Index Arbitrage Trading Volume					
	.00100	.03600	.0710	.15700	.23000	.39500
1	.0074	.0073	.0071	.0070	.0073	.0068
2	.0081	.0089	.0087	.0091	.0089	.0102
3	.0131	.0142	.0153	.0189	.0197	.0200
4	.0093	.0126	.0110	.0142	.0125	.0134
5	.0066	.0071	.0083	.0048	.0112	.0071
10	.0128	.0124	.0120	.0121	.0127	.0149
20	.0106	.0158	.0159	.0119	.0174	.0136
30	.0130	.0105	.0084	.0085	.0135	.0161
40	.0122	.0130	.0119	.0082	.0111	.0102
50	.0090	.0078	.0072	.0086	.0104	.0098
60	.0066	.0079	.0087	.0060	.0068	.0101
70	.0084	.0066	.0070	.0074	.0071	.0072
80	.0068	.0074	.0074	.0055	.0063	.0069
90	.0066	.0062	.0074	.0055	.0053	.0061
100	.0061	.0051	.0054	.0056	.0061	.0066

Panel B: Futures Market Data

QTR.	Proportion of Index Arbitrage Trading Volume					
	.00100	.03500	.07100	.16600	.24100	.40800
1	.0070	.0071	.0072	.0076	.0067	.0077
2	.0096	.0107	.0105	.0111	.0107	.0117
3	.0121	.0137	.0142	.0177	.0177	.0188
4	.0104	.0148	.0131	.0166	.0146	.0153
5	.0065	.0058	.0069	.0039	.0097	.0085
10	.0119	.0102	.0096	.0100	.0119	.0134
20	.0089	.0143	.0142	.0111	.0200	.0121
30	.0113	.0097	.0073	.0073	.0159	.0140
40	.0104	.0111	.0102	.0082	.0128	.0088
50	.0070	.0064	.0069	.0106	.0123	.0092
60	.0052	.0082	.0088	.0065	.0084	.0115
70	.0086	.0088	.0079	.0076	.0071	.0081
80	.0070	.0068	.0084	.0068	.0068	.0082
90	.0073	.0063	.0073	.0064	.0065	.0068
100	.0069	.0062	.0055	.0065	.0065	.0072

TABLE 5
Kruskal-Wallis Test
Effect of Index Arbitrage on Quarterly
Standard Deviation of Daily Return
(100-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Statistic	Significance[2] Probability	Standardized Statistic	Significance[2] Probability
0	17.334	0.5%	14.059	2.5%
1	36.061	0.5%	17.761	0.5%
2	10.683	-	16.908	0.5%
3	60.936	0.5%	52.618	0.5%
4	49.485	0.5%	45.734	0.5%
5	62.632	0.5%	64.140	0.5%
6	8.345	-	13.670	2.5%
7	61.113	0.5%	63.080	0.5%
8	39.163	0.5%	38.895	0.5%
9	26.547	0.5%	26.596	0.5%

1. The Kruskal-Wallis procedure tests the null hypothesis that index arbitrage does not affect volatility of return against the alternative of it affecting that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 6A
Jonckheere-Terpstra Test
Effect of Index Arbitrage on Quarterly
Standard Deviation of Daily Return
(100-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	-0.441	-	0.087	-
1	5.393	0.5%	2.745	0.5%
2	2.587	0.5%	2.031	2.5%
3	5.535	0.5%	3.997	0.5%
4	6.834	0.5%	6.543	0.5%
5	7.165	1.0%	7.497	0.5%
6	1.659	0.5%	-1.292	-
7	6.636	0.5%	7.123	0.5%
8	5.805	0.5%	1.339	-
9	3.719	0.5%	1.703	2.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect volatility of return against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 6B
Jonckheere-Terpstra Test
Effect of Index Arbitrage on Quarterly
Standard Deviation of Daily Return
(40-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	0.896	-	1.213	-
1	0.628	-	-0.346	-
2	1.239	-	1.174	-
3	1.564	-	1.058	-
4	2.527	1.0%	2.675	0.5%
5	2.373	1.0%	2.220	2.5%
6	-2.052	-	-1.294	-
7	3.154	0.5%	4.350	0.5%
8	-0.119	-	-0.748	-
9	0.612	-	-0.387	-

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect volatility of return against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 6C
Jonckheere-Terpstra Test
Effect of Index Arbitrage on Quarterly
Standard Deviation of Daily Return
(60-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	0.165	-	0.883	-
1	2.311	2.5%	1.055	-
2	1.519	-	1.678	5.0%
3	1.418	-	0.261	-
4	3.676	0.5%	3.969	0.5%
5	4.808	0.5%	4.539	0.5%
6	-0.558	-	-1.116	-
7	4.942	0.5%	5.377	0.5%
8	1.164	-	-0.292	-
9	0.583	-	-0.767	-

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect volatility of return against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 7A
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Mean of Intra-day High/Low Ratio
(100-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	3.953	0.5%	3.881	0.5%
1	4.277	0.5%	4.210	0.5%
2	3.478	0.5%	3.646	0.5%
3	5.666	0.5%	5.899	0.5%
4	5.869	0.5%	6.062	0.5%
5	6.452	0.5%	6.982	0.5%
6	4.048	0.5%	3.999	0.5%
7	6.630	0.5%	6.925	0.5%
8	5.763	0.5%	5.437	0.5%
9	4.840	0.5%	4.465	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect intra-day high/low ratio against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 7B
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Mean of Intra-day High/Low Ratio
(40-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	4.237	0.5%	3.979	0.5%
1	1.714	5.0%	2.004	2.5%
2	3.092	0.5%	3.256	0.5%
3	2.981	0.5%	2.896	0.5%
4	2.572	1.0%	3.034	0.5%
5	2.657	0.5%	2.688	0.5%
6	0.597	-	0.499	-
7	4.954	0.5%	5.240	0.5%
8	2.287	2.5%	2.132	2.5%
9	1.671	5.0%	1.294	-

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect intra-day high/low ratio against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 7C
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Mean of Intra-day High/Low Ratio
(60-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	3.712	0.5%	3.615	0.5%
1	2.637	0.5%	2.879	0.5%
2	3.056	0.5%	3.268	0.5%
3	3.289	0.5%	3.442	0.5%
4	3.816	0.5%	4.330	0.5%
5	4.470	0.5%	4.601	0.5%
6	1.795	5.0%	1.641	-
7	5.621	0.5%	5.912	0.5%
8	3.409	0.5%	3.035	0.5%
9	2.467	1.0%	2.012	2.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect intra-day high/low ratio against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 8A
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Mean of Percentage Bid/Ask Spread
(100-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	3.281	0.5%	3.713	0.5%
1	0.217	-	1.880	5.0%
2	0.018	-	1.610	-
3	3.774	0.5%	4.480	0.5%
4	2.886	0.5%	2.721	0.5%
5	3.200	0.5%	2.078	2.5%
6	2.739	0.5%	1.437	-
7	1.396	-	1.107	-
8	1.533	-	3.323	0.5%
9	4.119	0.5%	4.860	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect percentage bid/ask spread against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 8B
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Mean of Percentage Bid/Ask Spread
(40-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	2.954	0.5%	3.780	0.5%
1	1.414	-	2.652	0.5%
2	-0.413	-	0.375	-
3	2.086	2.5%	1.770	5.0%
4	1.906	5.0%	2.022	2.5%
5	1.978	2.5%	1.893	5.0%
6	1.356	-	0.232	-
7	-0.088	-	0.799	-
8	2.364	1.0%	2.104	2.5%
9	2.993	0.5%	3.914	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect percentage bid/ask spread against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 8C
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Mean of Percentage Bid/Ask Spread
(60-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	3.886	0.5%	3.866	0.5%
1	1.662	5.0%	3.790	0.5%
2	-0.410	-	0.521	-
3	2.428	1.0%	3.515	0.5%
4	2.919	0.5%	2.012	2.5%
5	2.635	0.5%	1.999	2.5%
6	2.210	2.5%	0.888	-
7	1.041	-	2.111	2.5%
8	1.831	5.0%	3.472	0.5%
9	4.118	0.5%	5.323	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect percentage bid/ask spread against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 9A
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Trading Volume
(100-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	3.595	0.5%	3.702	0.5%
1	5.676	0.5%	6.463	0.5%
2	3.413	0.5%	3.620	0.5%
3	5.226	0.5%	6.000	0.5%
4	2.466	1.0%	3.140	0.5%
5	5.157	0.5%	6.013	0.5%
6	4.095	0.5%	4.618	0.5%
7	5.318	0.5%	6.017	0.5%
8	4.861	0.5%	4.570	0.5%
9	4.890	0.5%	5.638	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect quarterly trading volume against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 9B
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Trading Volume
(40-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	5.107	0.5%	4.864	0.5%
1	4.024	0.5%	4.144	0.5%
2	4.526	0.5%	4.472	0.5%
3	5.641	0.5%	5.295	0.5%
4	3.296	0.5%	3.980	0.5%
5	4.476	0.5%	4.670	0.5%
6	5.094	0.5%	5.272	0.5%
7	5.140	0.5%	5.266	0.5%
8	5.161	0.5%	4.848	0.5%
9	4.809	0.5%	4.913	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect quarterly trading volume against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 9C
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Trading Volume
(60-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	4.482	0.5%	4.614	0.5%
1	5.076	0.5%	5.599	0.5%
2	3.688	0.5%	3.864	0.5%
3	5.878	0.5%	6.087	0.5%
4	2.991	0.5%	4.054	0.5%
5	5.480	0.5%	6.261	0.5%
6	4.753	0.5%	4.927	0.5%
7	4.673	0.5%	5.474	0.5%
8	4.947	0.5%	4.749	0.5%
9	5.746	0.5%	6.116	0.5%

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect quarterly trading volume against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 10A
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Return
(100-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	-0.175	-	-0.101	-
1	0.842	-	0.842	-
2	0.379	-	0.438	-
3	0.666	-	0.682	-
4	1.515	-	1.474	-
5	1.896	5.0%	1.896	5.0%
6	0.421	-	0.472	-
7	1.751	5.0%	1.737	5.0%
8	1.170	-	1.086	-
9	0.840	-	0.848	-

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect quarterly return against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 10B
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Return
(40-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	0.269	-	0.256	-
1	0.188	-	0.186	-
2	0.166	-	0.166	-
3	0.385	-	0.388	-
4	0.320	-	0.356	-
5	0.442	-	0.437	-
6	-0.041	-	-0.052	-
7	0.266	-	0.251	-
8	0.243	-	0.225	-
9	0.238	-	0.220	-

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect quarterly return against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 10C
Jonckheere-Terpstra Test
Effect of Index Arbitrage on
Quarterly Return
(60-Period Data)

REPLICATIONS	STOCK MARKET RESULTS		FUTURES MARKET RESULTS	
	Standardized Rank	Significance[2] Probability	Standardized Rank	Significance[2] Probability
0	0.109	-	0.102	-
1	0.237	-	0.221	-
2	-0.064	-	0.041	-
3	0.350	-	0.349	-
4	0.726	-	0.695	-
5	0.814	-	0.817	-
6	0.178	-	0.156	-
7	0.732	-	0.682	-
8	0.323	-	0.337	-
9	0.476	-	0.466	-

1. The Jonckheere-Terpstra procedure test the null hypothesis that index arbitrage does not affect quarterly return against the alternative of it increasing that.

2. The significance probability listed in the table is a higher-bound estimate. For example, a 0.5% significance probability means the significance probability is at most 0.5%.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 11A
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Standard Deviation of Daily Return
(100-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	2.3896	2.8001	2.3799	0.6353	-2.0329	0.5913
1	1.4343	-0.0024	-0.9822	2.0671	1.5173	-1.3268
2	0.4985	1.5247	0.7892	3.0567	1.8741	1.2339
3	0.7355	-3.5942	-1.3121	-4.5838	-2.2357	0.7526
4	-0.3030	0.4154	1.2999	2.2479	0.3323	0.0757
5	-2.1526	1.2535	-1.5393	1.6786	2.0744	2.0060
6	1.1899	0.3176	-0.6719	1.8203	2.0744	0.7672
7	2.2968	-0.1222	3.0371	1.1240	-0.2590	1.2559
8	-0.5718	0.8381	0.7697	2.2406	-1.0360	1.8154
9	0.3396	0.9798	-0.3763	2.2650	0.6573	2.9516

1. see below comments in Table 11A, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.6444	2.3994	1.8252	1.7788	-2.1184	0.7232
1	-1.0189	-1.7739	-1.8570	-2.1771	-0.2957	-2.9198
2	-0.1124	1.1044	-0.0367	5.0187	2.4116	2.3774
3	-0.5424	-4.8941	-3.2839	-5.9765	-5.3535	-1.6420
4	0.1368	1.0678	1.4318	2.0549	0.9236	0.0709
5	-5.1213	0.9822	-1.2779	2.1282	2.2552	1.3707
6	1.0946	1.2461	0.4911	2.8270	2.7146	0.0171
7	1.0678	-0.4716	1.7201	0.8503	-0.0880	1.7446
8	0.3005	-2.0842	-4.1098	-0.6377	-4.3004	-0.6255
9	-0.9774	0.2908	-1.9010	0.1833	-0.6573	1.7470

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect volatility against the alternative of it reducing volatility.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 11B
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Standard Deviation of Daily Return
(40-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-0.3175	1.2317	-0.5196	-0.0962	-0.7121	-1.2798
1	-2.4730	-3.4256	-1.6936	0.1155	-4.9652	-1.1451
2	-0.5485	-0.6832	-0.0192	2.9541	2.2517	0.9526
3	-2.9156	-5.2250	-4.2724	-3.1369	-4.5130	-3.9452
4	-0.5485	-0.4138	0.2887	-0.5100	0.4330	-0.2309
5	-3.0407	0.4330	-1.3375	1.2028	1.3183	-1.2798
6	1.7898	0.7409	-0.9719	1.5973	1.5588	-1.5107
7	-0.4330	-1.4338	1.3183	0.0000	-0.6062	0.9045
8	2.0303	-3.1850	-3.6758	1.4530	-3.3390	0.5677
9	-1.9245	-2.2517	-3.7143	1.2124	-2.4537	-0.6832

1. see below comments in Table 11B, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-0.4811	0.9045	-1.0007	-0.0577	-0.2213	-1.2702
1	-2.6462	-3.6758	-1.5877	-0.2502	-4.9171	-1.5973
2	-0.8756	-0.8372	0.0962	2.7617	1.5107	1.6936
3	-3.4256	-5.8505	-4.8690	-3.5892	-5.3597	-4.8786
4	-0.5004	0.1925	0.5292	-0.6351	0.3272	-0.4619
5	-3.8105	0.3272	-1.3279	1.2894	1.4338	-1.9245
6	1.4915	0.4715	-1.1066	1.6454	0.9430	-1.2509
7	-2.1651	-1.4049	1.0489	0.0577	0.0096	1.6454
8	2.5403	-3.6373	-4.5033	1.2221	-3.9837	0.6928
9	-1.7898	-2.8001	-4.1377	0.9238	-2.8868	-1.1451

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect volatility against the alternative of it reducing volatility.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 11C
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Standard Deviation of Daily Return
(60-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.5169	1.9105	0.9762	0.3202	-1.7740	-0.1312
1	-0.9657	-3.8787	-3.6898	0.5091	-2.3356	-2.6138
2	-0.4356	0.2939	0.2414	3.8892	2.7975	0.6351
3	0.0840	-4.6923	-3.7633	-5.1489	-4.9127	-3.7003
4	-1.1180	0.5774	0.5669	0.2887	-0.4881	-1.1652
5	-5.0544	0.7715	-1.8055	1.3174	1.2964	-0.6088
6	1.9420	0.6823	-0.8923	1.9315	1.8580	0.5196
7	0.9920	-0.6771	1.3699	-0.2624	-0.3832	0.0787
8	0.5301	-2.5088	-2.8343	1.5379	-4.0152	0.0892
9	-1.1022	-0.4724	-3.0495	1.3384	-0.8975	0.7663

1. see below comments in Table 11C, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.8083	0.9605	0.1155	0.0997	-1.0392	-0.3044
1	-2.0365	-4.3144	-3.8368	-0.5616	-3.5428	-3.4694
2	-0.9133	0.1207	0.0682	4.2252	2.3356	2.5666
3	-0.7558	-5.4533	-4.9337	-5.1017	-6.0254	-5.2119
4	-0.8240	0.6823	0.9657	0.0262	-0.2834	-0.7086
5	-5.6055	0.3674	-2.0417	1.8895	1.3384	-1.1862
6	1.7740	0.7296	-0.7506	1.8108	1.0497	-0.7611
7	-0.4409	-0.9657	1.1495	-0.2834	0.0630	0.8608
8	1.2649	-3.9785	-4.3091	1.0497	-4.8340	-0.2782
9	-1.2019	-1.1390	-3.3486	0.6456	-1.7635	0.0472

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect volatility against the alternative of it reducing volatility.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 12A
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Mean of Intra-day High/Low Ratio
(100-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.7153	1.9181	1.1020	0.8161	-0.4203	0.1662
1	1.2583	-0.4105	-0.9358	-1.0287	1.1850	-2.7561
2	0.9456	1.4465	0.4056	2.3359	1.6957	1.0409
3	0.5815	-2.2113	-0.5204	-3.5600	-2.3188	0.7550
4	0.5156	-0.4985	0.7257	1.3390	-0.8088	0.6793
5	-1.4514	1.1313	-1.1655	1.0531	0.8161	0.3079
6	0.4545	0.4911	-0.7257	0.9749	1.2706	0.2101
7	0.8894	-0.0244	0.7403	0.1368	0.8723	0.9358
8	-0.1246	1.5051	-0.9041	-1.0189	-0.3079	-0.2908
9	0.9016	1.1704	0.4618	0.5082	-0.1466	2.6047

1. see below comments in Table 12A, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.5491	1.8252	1.1264	0.5962	-0.3323	0.3885
1	1.0922	-0.4618	-1.4685	-0.7697	1.3145	-2.2943
2	0.9603	1.2730	0.6695	2.4898	1.3805	1.3707
3	0.4960	-2.5216	-0.8283	-3.7042	-2.4458	1.0458
4	0.2761	-0.3665	0.9236	1.3097	-0.7477	0.8967
5	-1.9743	1.1875	-1.5784	0.8698	0.9089	0.8259
6	0.3005	1.3170	-0.7599	0.7403	0.7061	0.3836
7	1.0531	0.3176	1.1533	0.3299	0.9358	1.1924
8	-0.1686	1.7446	-1.3683	-0.6206	-0.6182	0.0367
9	1.1582	1.0507	0.3592	1.0336	-0.3128	2.7317

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect intra-day high/low ratios against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 12B
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Mean of Intra-day High/Low Ratio
(40-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-0.5581	0.4234	0.1347	-0.6832	0.3945	-0.9045
1	-0.6447	-1.7224	-0.9526	0.6928	-1.8283	-1.1162
2	-0.2406	-0.6158	-0.0385	2.0688	1.8283	0.2502
3	-2.2709	-4.0222	-2.1554	-1.1547	-2.7520	-2.5981
4	0.3849	-0.4234	-0.0192	-0.3368	-0.8179	-0.7121
5	-1.6839	0.5966	-1.3087	0.6351	1.2317	-2.0592
6	1.6070	0.7217	-0.1251	1.0681	1.2798	-0.9141
7	-1.1836	0.1828	0.5100	0.0192	1.0392	1.1066
8	0.6447	-2.0977	-2.3286	0.5389	-1.1836	-0.6255
9	-0.8853	-1.6936	-1.9149	0.4234	-1.9437	-0.2694

1. see below comments in Table 12B, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-0.7602	0.2117	-0.1058	-0.7217	0.1155	-1.1547
1	-0.9623	-1.8283	-1.1547	0.5870	-1.7705	-0.9815
2	-0.2887	-0.7794	-0.3272	2.0400	1.8090	0.3560
3	-2.1073	-4.0222	-2.0400	-1.4434	-2.9252	-2.6462
4	0.2887	-0.4234	0.0577	-0.3657	-0.6832	-0.5196
5	-1.9437	0.5292	-1.2702	0.4907	0.9334	-1.8956
6	1.7128	1.2894	0.2213	0.9526	1.2798	-0.8564
7	-1.5107	0.1925	0.7506	0.3753	0.9238	1.0777
8	0.8083	-1.6454	-2.5019	0.5196	-1.9822	-0.4426
9	-0.9430	-1.7224	-1.9053	0.8179	-2.4826	-0.0096

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect intra-day high/low ratios against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 12C
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Mean of Intra-day High/Low Ratio
(60-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.6508	1.0025	0.6246	0.0787	-0.1627	-0.0210
1	-0.6876	-2.7030	-2.7293	0.2204	-1.4591	-1.9945
2	-0.2204	0.6876	-0.1102	3.1702	2.6978	0.5196
3	-0.5196	-2.7293	-1.7635	-2.4826	-2.8972	-2.4616
4	-0.0997	-0.4986	-0.5301	0.0000	-1.3069	-0.8398
5	-2.8133	0.9448	-1.3699	0.9028	0.5196	-1.9525
6	1.6848	0.7453	-0.3097	1.6428	1.2124	0.7978
7	0.0577	0.4094	0.3307	-0.7243	1.1809	0.2257
8	0.0525	-1.6638	-2.0102	0.8765	-2.3829	-0.2572
9	-0.4094	-0.3254	-1.4381	0.1575	-0.8240	0.9343

1. see below comments in Table 12C, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.4671	1.0065	0.5196	-0.2204	-0.3509	-0.0420
1	-0.9920	-2.8605	-3.0442	0.2677	-1.5011	-1.7740
2	-0.1837	0.5196	-0.2309	3.2699	2.7240	0.8818
3	-0.5301	-3.2699	-1.8265	-2.7713	-2.8710	-2.2727
4	-0.1575	-0.3779	-0.0525	0.0262	-1.3699	-0.2572
5	-3.1964	1.1285	-1.5326	0.6351	0.3622	-1.4959
6	1.8475	1.3122	-0.0840	1.3069	1.0497	1.0235
7	-0.2152	0.5301	0.5774	-0.4566	0.9290	0.4566
8	0.1522	-1.5641	-2.2464	0.9185	-3.0180	-0.1207
9	-0.3832	-0.2047	-1.4276	0.4776	-1.1337	1.2597

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect intra-day high/low ratios against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 13A
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Mean of Percentage Bid/Ask Spread
(100-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-1.6151	-1.0189	1.0287	-1.6835	-0.3005	1.7055
1	-1.4098	-0.1955	-0.9260	-0.5180	-0.9847	-0.1417
2	0.1393	-1.3268	-0.0660	0.5986	-1.6639	-1.3365
3	-1.9278	1.6395	-1.0116	0.2761	-0.1490	1.2486
4	0.3470	-1.1728	-1.2706	1.4636	0.6915	-0.3274
5	0.7355	0.3787	1.9034	-1.1875	-0.6768	0.7013
6	-0.2419	-0.6280	-0.7794	-0.0562	-0.6402	-1.6859
7	1.2559	-0.5058	0.9529	0.0098	1.7739	0.5449
8	1.5222	0.8821	-0.1222	0.4936	1.1582	2.5118
9	0.0928	0.6573	-0.9334	-0.5546	1.9449	1.9645

1. see below comments in Table 13A, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-2.0207	-1.3145	-0.4960	-0.9529	1.1948	0.8185
1	-3.1007	-2.8099	0.8967	-2.7610	-2.7708	0.1906
2	0.5009	-0.9309	-3.2057	0.9431	0.4423	-0.3494
3	-2.6511	-0.5766	-0.1100	-0.6670	1.0042	0.8503
4	-2.2162	-0.1686	-1.9229	-0.5962	0.9089	-0.1686
5	1.2461	0.4642	1.2852	-0.7868	0.5375	1.9791
6	-0.1271	-2.6486	-3.4794	-1.5002	-1.4294	-1.8448
7	1.4905	-0.0880	0.3201	-0.6915	-0.4838	0.0831
8	-0.2468	-2.2039	-0.6475	-2.2577	-0.4887	3.4256
9	-1.9376	-1.9303	0.0367	0.3909	1.6811	1.6077

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect percentage bid/ask spread against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 13B
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Mean of Percentage Bid/Ask Spread
(40-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-1.5877	-0.2791	-0.1732	-0.0770	0.9430	1.2413
1	0.0096	1.0873	-0.4811	1.3953	-0.8468	1.0777
2	1.3856	-2.3286	1.0296	0.3175	-1.5588	0.6543
3	-2.0303	2.2902	-0.0674	1.0777	1.0970	-0.0770
4	-0.0289	-1.3375	-0.7217	1.5492	0.6928	-1.3183
5	0.9141	-0.1443	0.4715	-0.7506	0.3079	-0.8564
6	-0.4138	1.1355	-0.9623	0.1443	0.1251	-0.0770
7	1.1451	-0.6543	1.1258	-0.2694	0.0192	-0.7698
8	0.4907	0.0577	0.2598	1.4722	-0.6255	3.0022
9	-0.3945	1.1739	-1.3183	-1.3472	1.8860	1.6358

1. see below comments in Table 13B, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-0.0385	0.3560	-0.2694	-1.0104	1.1836	0.5196
1	-1.2894	-0.2117	1.5781	0.2694	-1.6358	1.5396
2	-0.1058	0.0192	-1.0585	0.7794	-1.0970	-0.1347
3	-0.2983	2.0977	1.8283	1.0392	-0.2406	1.1066
4	-1.3664	-0.8660	-0.3657	0.1925	1.3279	-0.5100
5	2.3960	0.7024	0.0289	-1.3568	-1.3953	1.9149
6	1.0873	-0.1732	-2.1939	-0.8372	0.0866	-1.7994
7	1.5781	1.2221	0.2598	-1.7224	0.6158	-0.7794
8	0.3657	-0.9815	-0.3079	-0.3945	-0.7794	1.5107
9	-1.2028	-2.5115	0.7602	-0.5774	2.7039	0.4907

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect percentage bid/ask spread against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 13C
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Mean of Percentage Bid/Ask Spread
(60-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-2.6506	-0.9343	-0.3359	-0.2939	-0.6351	1.4854
1	-1.4854	0.6508	-0.8135	0.5144	-0.8870	1.8003
2	-0.0630	-1.5536	0.2257	1.0025	-0.2834	-0.8083
3	-1.7583	3.9312	0.3936	1.7635	1.8160	0.8660
4	0.3779	-2.3986	-0.2992	1.4381	0.5144	-0.1837
5	0.7558	0.4724	1.6271	-1.5169	-0.3254	0.1575
6	-1.0235	1.3122	-0.4514	0.2467	-0.4514	-0.6561
7	1.3751	-0.2047	0.2152	-0.5249	1.0182	0.1890
8	1.7950	0.1732	1.6218	2.0627	0.9448	3.0075
9	-1.0182	0.4304	-2.1624	-0.1050	1.9945	1.7950

1. see below comments in Table 13C, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	-0.8870	-0.5721	-0.4251	-0.8555	-0.5511	0.5459
1	-3.1597	-2.1100	1.9682	-1.2124	-1.5851	2.2359
2	0.2782	0.2782	-1.5116	0.4356	-0.2624	-0.0682
3	-1.0077	2.7083	1.8370	1.3594	2.1100	2.0365
4	-1.0340	-1.1337	-0.4986	-0.0472	0.7138	-0.8240
5	1.2544	0.8293	1.0287	-0.6403	-0.3674	2.2254
6	-0.0945	-0.5091	-2.1834	-1.3069	-0.9133	-1.1599
7	2.3829	1.1127	0.4094	-1.5851	0.3202	-0.6823
8	0.4304	-1.9000	0.2204	-0.8713	-1.6428	3.4221
9	-1.6481	-2.4669	0.3727	0.2204	2.5456	0.9867

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect percentage bid/ask spread against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 14A
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly trading volume
(100-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.5662	1.7861	1.2583	0.7306	-0.0977	0.7990
1	3.8606	2.2088	1.6688	0.8503	3.8581	-0.4129
2	1.6371	1.5760	0.8430	0.8870	1.0946	1.9694
3	2.1306	0.1808	1.4269	-0.9700	0.8552	1.0849
4	1.3243	2.7097	2.2162	1.3512	0.4911	0.8161
5	-0.1735	0.9993	-1.1044	0.9138	1.3927	-1.2266
6	0.1026	1.4221	0.3665	0.2663	0.9529	0.8992
7	0.9431	-1.5100	2.0402	1.7788	-0.4080	1.5051
8	0.1808	3.2204	1.6200	-0.1539	1.7568	0.1686
9	2.0476	2.5362	2.3383	1.6249	1.1704	0.7794

1. see below comments in Table 14A, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.7715	2.1844	1.8961	0.6768	0.1759	0.8601
1	3.3548	2.3823	1.9791	1.3805	3.6602	0.2297
2	1.3414	1.8667	0.7135	1.4001	0.9456	1.7861
3	1.8741	-0.0293	1.7666	-0.2517	1.0898	1.5906
4	1.2583	2.9003	1.9889	1.7666	1.3952	1.2535
5	-0.2737	1.6762	-0.5546	1.2021	1.8765	-0.6108
6	-0.0318	1.3512	0.4691	0.4936	0.9456	0.9700
7	0.7013	-0.7868	1.6077	1.6982	0.2712	1.3414
8	0.0660	3.1960	1.5980	-0.1319	1.5320	0.1539
9	2.0353	2.3188	2.2039	1.5711	0.6866	1.3439

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect trading volumes against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 14B
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly trading volume
(40-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.2502	1.0489	0.7409	-0.6832	-0.4041	1.1547
1	1.3856	0.2887	0.3849	0.1636	1.1643	-0.7313
2	0.3657	0.2887	1.4722	1.4145	1.1547	0.6832
3	-0.2309	0.0385	0.7217	-0.0385	1.3183	0.5389
4	0.2309	1.1162	0.6928	0.5966	0.1540	0.2309
5	-0.3464	0.8083	-1.0200	0.7987	0.5196	-0.3464
6	1.1162	0.8083	-0.0866	-0.3368	0.7987	1.8090
7	-0.2887	-0.4619	0.7313	0.3560	0.3849	0.6255
8	0.5004	1.0392	0.2983	0.6736	0.4715	0.5774
9	0.5292	0.6158	0.9141	0.8853	0.9623	0.8468

1. see below comments in Table 14B, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.0296	0.7987	1.3856	-0.5774	-0.0962	0.8853
1	0.7794	-0.0192	0.3657	-0.1636	1.0681	0.1732
2	0.7890	1.1451	0.8853	1.8571	1.0007	0.0577
3	0.2117	-0.1636	0.4811	0.6255	1.0489	0.5581
4	0.6928	0.7602	1.4241	0.4811	0.3753	0.6928
5	-0.5774	1.4241	-0.0866	0.5485	0.4523	0.3753
6	0.2502	1.0873	0.6062	0.2309	0.5196	2.0015
7	-0.6640	0.0770	0.4715	0.7217	0.6543	0.4138
8	0.6640	0.5100	0.4041	0.5485	0.0577	0.8756
9	0.1828	1.0585	1.1547	0.9334	0.2117	0.4426

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect trading volumes against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 14C
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly trading volume
(60-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.9133	1.5588	1.0340	-0.0105	-0.2152	1.0077
1	2.3724	0.5826	0.2519	0.1575	2.2674	-0.7138
2	0.8870	1.1704	1.1652	1.1442	1.5011	1.2282
3	0.8293	0.5511	0.2677	-0.7768	1.6113	0.4146
4	0.5301	1.7058	0.9972	0.5564	0.2519	0.1627
5	-0.4251	1.0707	-1.2019	1.5221	0.8135	-0.6981
6	1.0655	1.0707	-0.3044	0.7715	0.6246	1.6166
7	0.5091	-1.2807	1.4644	0.4094	-0.3097	0.3202
8	0.1575	1.6323	0.0630	0.2047	0.7348	-0.1470
9	0.8713	1.5116	1.3174	1.4591	1.0550	0.9762

1. see below comments in Table 14C, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	1.3594	1.6638	1.6743	0.1050	0.0945	1.1022
1	1.6113	0.6193	0.2572	0.4251	1.9630	0.4304
2	1.0550	1.4906	0.9028	1.7793	1.4644	0.8398
3	0.5878	0.1417	0.7401	-0.4041	1.4696	0.6666
4	0.5721	1.5903	1.0970	0.8713	0.7925	0.6771
5	-0.4041	1.7898	0.0787	0.9762	0.9343	-0.1627
6	0.6718	1.1599	0.1260	0.5196	0.4881	1.8160
7	-0.3149	-0.2519	0.9605	0.3149	0.3989	0.2152
8	0.1155	1.5431	0.3517	0.7506	0.4619	-0.0840
9	0.9290	1.1390	0.9972	1.7373	1.1809	1.2754

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect trading volumes against the alternative of it reducing them.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 15A
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Return
(100-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.0880	0.1246	-0.0195	-0.2248	-0.1955	0.4007
1	-0.0195	-0.0049	-0.0709	0.7306	-0.0660	0.8356
2	0.0855	-0.1075	0.1808	0.5620	-0.0538	0.3592
3	-0.1075	-0.1833	-0.1100	-0.0049	0.1588	0.6719
4	0.0904	-0.1002	0.1319	0.2834	-0.1319	0.1686
5	-0.1002	0.0049	0.0391	0.2443	0.0269	1.6468
6	-0.0489	-0.4129	0.4618	0.0684	0.2199	0.0293
7	0.1686	0.1490	0.2712	0.7355	0.1246	0.6157
8	-0.0440	-0.0953	0.4667	0.6475	0.1637	1.1777
9	0.1197	0.1051	-0.0049	0.5644	-0.0977	1.1631

1. see below comments in Table 15A, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.2346	0.1271	0.0953	-0.3030	-0.1613	0.4447
1	-0.0709	-0.0464	-0.0977	0.7281	-0.0855	0.8136
2	0.3347	0.0195	0.0831	0.4765	0.0415	0.3494
3	-0.0318	-0.1881	-0.1564	-0.0220	0.0660	0.6915
4	0.2175	-0.1148	0.0904	0.3054	-0.1393	0.1368
5	-0.1881	-0.0269	0.0415	0.2590	0.0269	1.6591
6	-0.1368	-0.3738	0.5375	0.2126	0.2004	-0.0220
7	0.0318	0.0464	0.0733	0.8454	0.2028	0.5620
8	-0.0440	-0.1222	0.3128	0.4936	0.1026	1.1533
9	-0.0195	0.1833	0.0049	0.4105	-0.1124	1.1753

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect quarterly returns against the alternative of it reducing that.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

TABLE 15B
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Return
(40-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.0481	-0.0674	-0.0866	-0.0962	0.0000	0.0096
1	0.1443	-0.1058	0.0192	0.0674	0.0385	0.1251
2	0.1058	0.0962	0.1155	0.1636	-0.0385	0.2791
3	-0.0674	-0.0192	-0.0096	-0.0096	0.1636	0.2309
4	-0.0096	0.0289	-0.1347	0.0481	-0.1443	-0.0192
5	-0.1155	-0.0289	-0.1540	0.0577	0.1251	0.0770
6	0.0000	-0.0385	-0.0096	0.2213	-0.2117	-0.1828
7	0.1636	-0.0192	0.1828	0.0385	-0.1058	0.1058
8	0.0192	0.1443	0.1540	0.1443	-0.0385	0.1347
9	-0.0674	0.0962	0.1058	0.1540	-0.0192	0.1925

1. see below comments in Table 15B, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.0866	-0.0770	-0.0866	-0.1058	0.0577	0.0096
1	0.1636	-0.1058	0.0289	0.0577	0.0289	0.1540
2	0.0770	0.0192	0.1732	0.1636	-0.0481	0.2694
3	-0.0481	-0.0385	-0.0289	0.0000	0.1540	0.2309
4	0.0000	0.0192	-0.1155	0.1058	-0.1443	0.0000
5	-0.1155	-0.0192	-0.1443	0.0770	0.1828	0.0962
6	0.0000	-0.0289	-0.0577	0.2117	-0.2213	-0.1540
7	0.1443	-0.0481	0.1347	0.0289	-0.1443	0.0962
8	0.0289	0.1058	0.1732	0.1251	-0.0289	0.1251
9	-0.0674	0.1058	0.1058	0.1732	-0.0289	0.2021

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not effect quarterly returns against the alternative of it reducing that.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected

TABLE 15C
The Wilcoxon Rank-Sum Test
Effect of Uniform Margin Requirement
on Quarterly Return
(60-Period Data)

Panel A: Stock Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.0787	0.0262	-0.0577	-0.1942	-0.2099	0.1575
1	0.1207	0.0997	0.0472	0.3674	0.1837	0.1365
2	0.2099	-0.0315	0.1102	0.3674	-0.0892	0.1522
3	0.0052	-0.0052	-0.0262	0.0315	0.1365	0.3412
4	-0.0420	-0.0472	0.0052	0.1260	0.0262	-0.2624
5	-0.0367	0.0262	-0.0945	0.1365	0.0997	0.4724
6	-0.1522	-0.2782	0.0735	0.1890	-0.0787	-0.0315
7	0.1417	0.0262	0.1365	0.3464	0.0262	0.1312
8	-0.0315	0.1050	0.1785	0.1575	0.0052	0.1942
9	-0.0577	0.0892	0.1207	0.1994	0.2257	0.5196

1. see below comments in Table 15C, Panel B.

Panel B: Futures Market Results

Rep	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
0	0.0840	0.0052	-0.0420	-0.2152	-0.1890	0.1522
1	0.1312	0.0735	0.0472	0.3727	0.1522	0.1680
2	0.2204	-0.0367	0.0997	0.3936	-0.0735	0.1470
3	0.0052	-0.0420	-0.0262	0.0262	0.1207	0.3149
4	-0.0840	0.0000	0.0000	0.1470	0.0367	-0.2572
5	-0.0472	0.0262	-0.0630	0.1470	0.1207	0.4724
6	-0.1155	-0.2467	0.0892	0.1732	-0.1207	-0.0525
7	0.1522	-0.0367	0.1312	0.3517	0.0105	0.1417
8	-0.0105	0.0735	0.1470	0.1837	-0.0262	0.1994
9	-0.0577	0.0840	0.0997	0.1837	0.1942	0.5354

1. The one-side Wilcoxon rank sum procedure tests the null hypothesis that uniform margin requirement does not affect quarterly returns against the alternative of it reducing that.

2. The Wilcoxon statistic has been standardized. Thus 1.645 indicates a 5% significance probability, 2.326 is a 1% significance probability, and 2.576 is a 0.5% significance probability.

3. When a test's significance probability is less than 5 %, the null hypothesis is rejected.

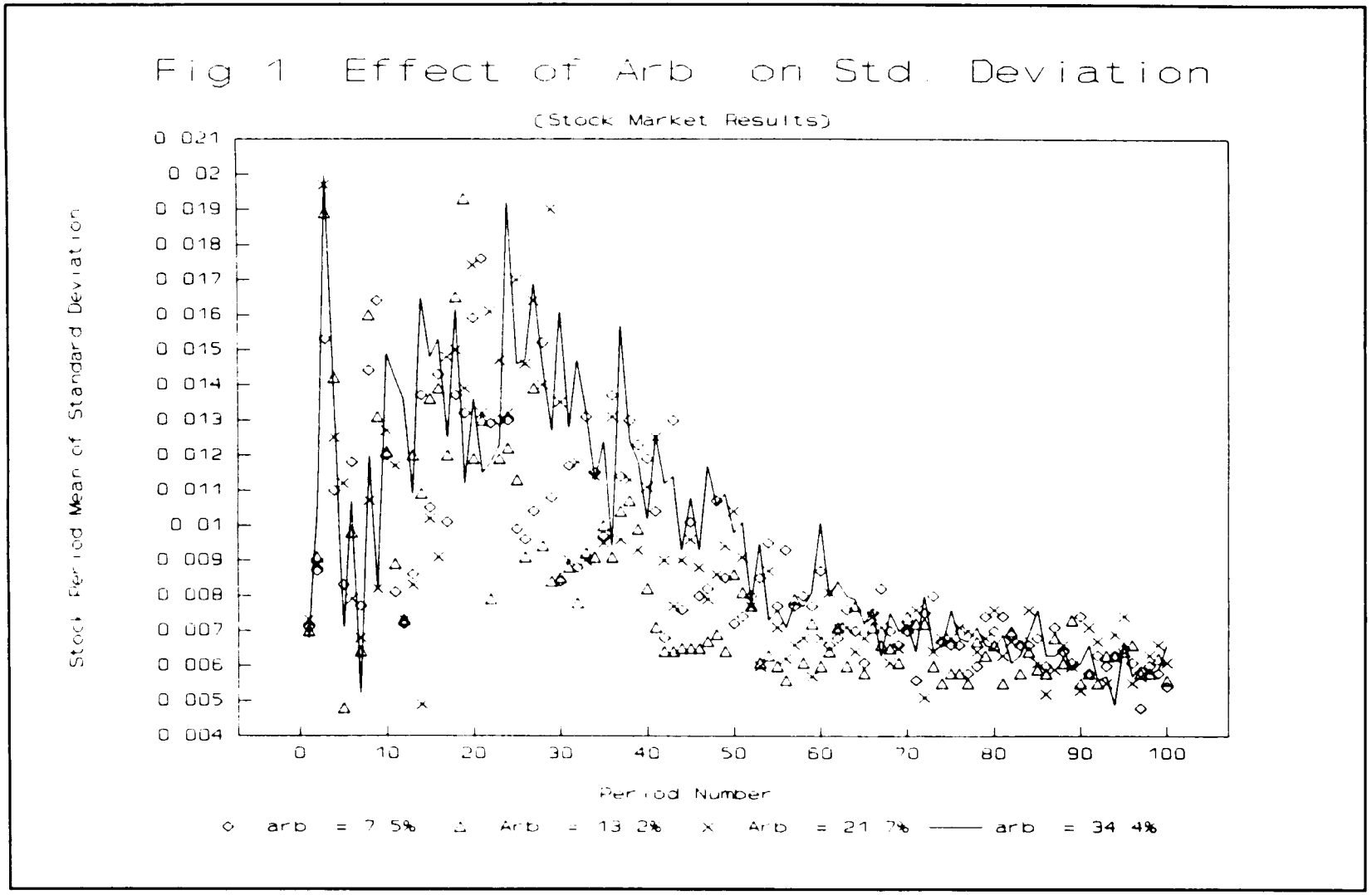
Fig 1 Effect of Arb on Std. Deviation
(Stock Market Results)
Stock Period Mean of Standard Deviation
0.021
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ arb = 7.5% △ Arb = 13.2% × Arb = 21.7% —— arb = 34.4%

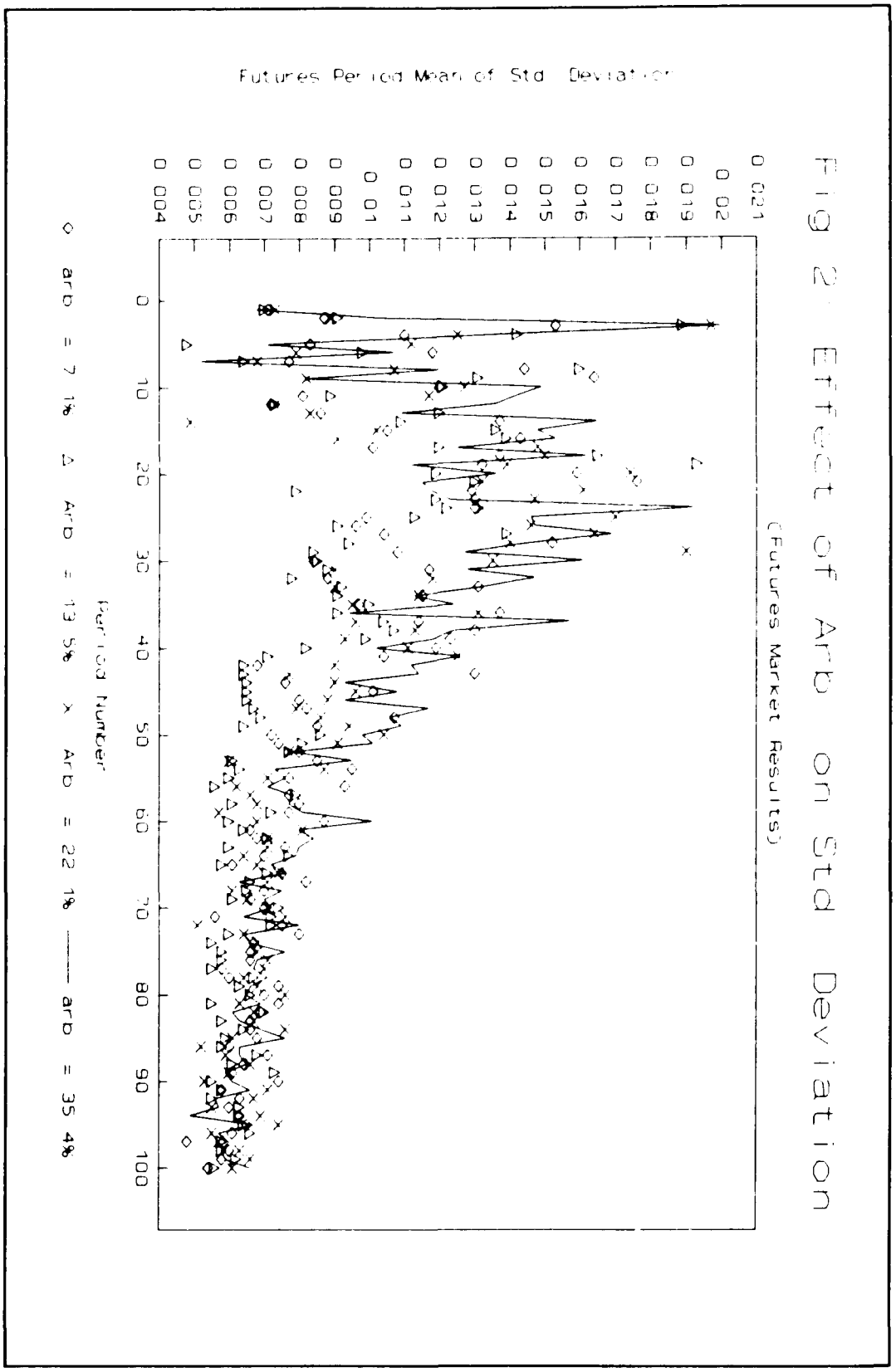

Fig 2. Effect of Arb on Std Deviation

(Futures Market Results)

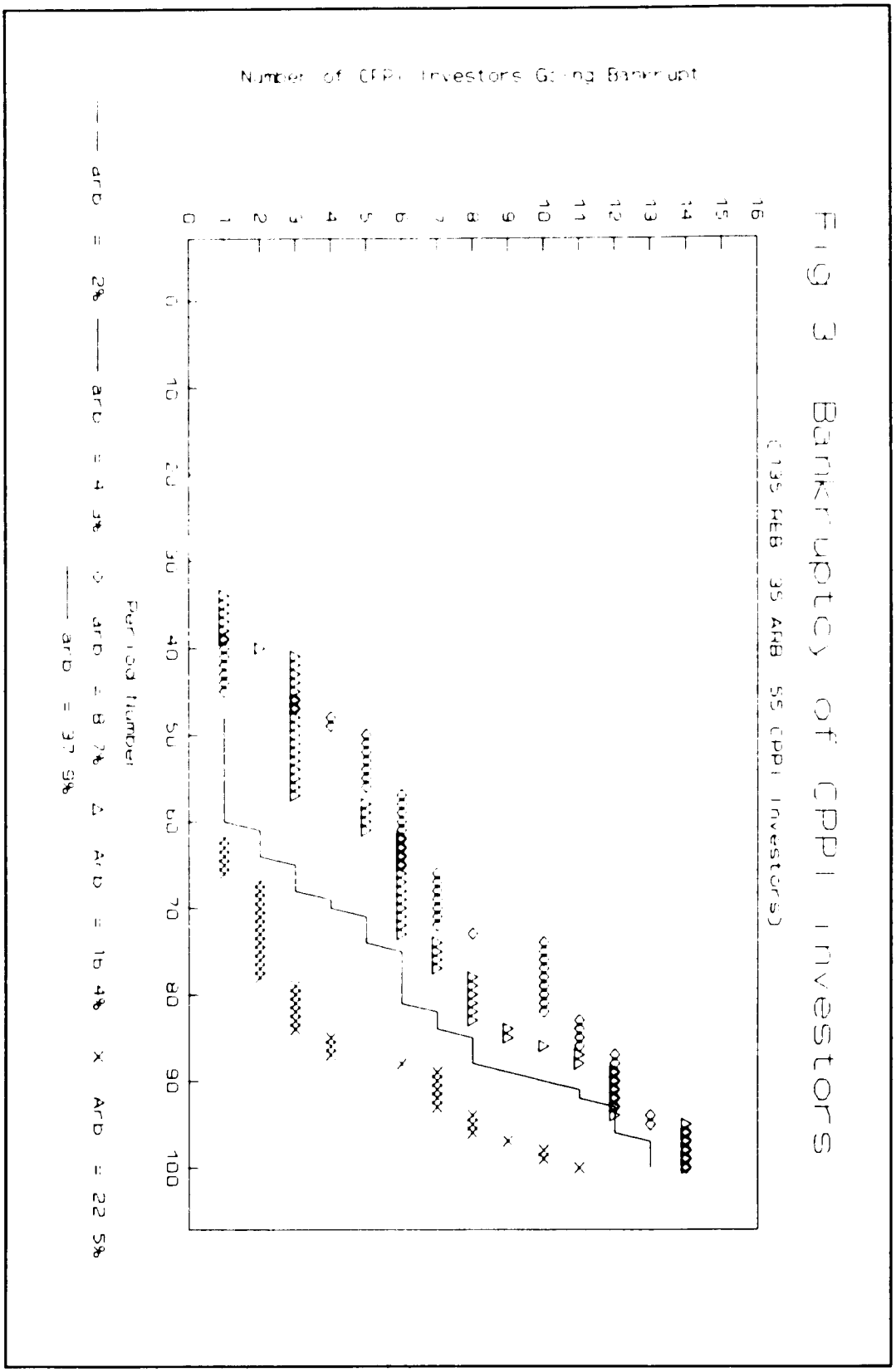
Fig 3 Bankruptcy of CPPI investors
(135 HEB 35 ARB 55 CPPI Investors)
Number of CPPI Investors Going Bankrupt
Period Number
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
0
10
20
30
40
50
60
70
80
90
100
arb = 2%
arb = 4.3%
arb = 8.7%
arb = 15.4%
arb = 22.5%
arb = 37.9%

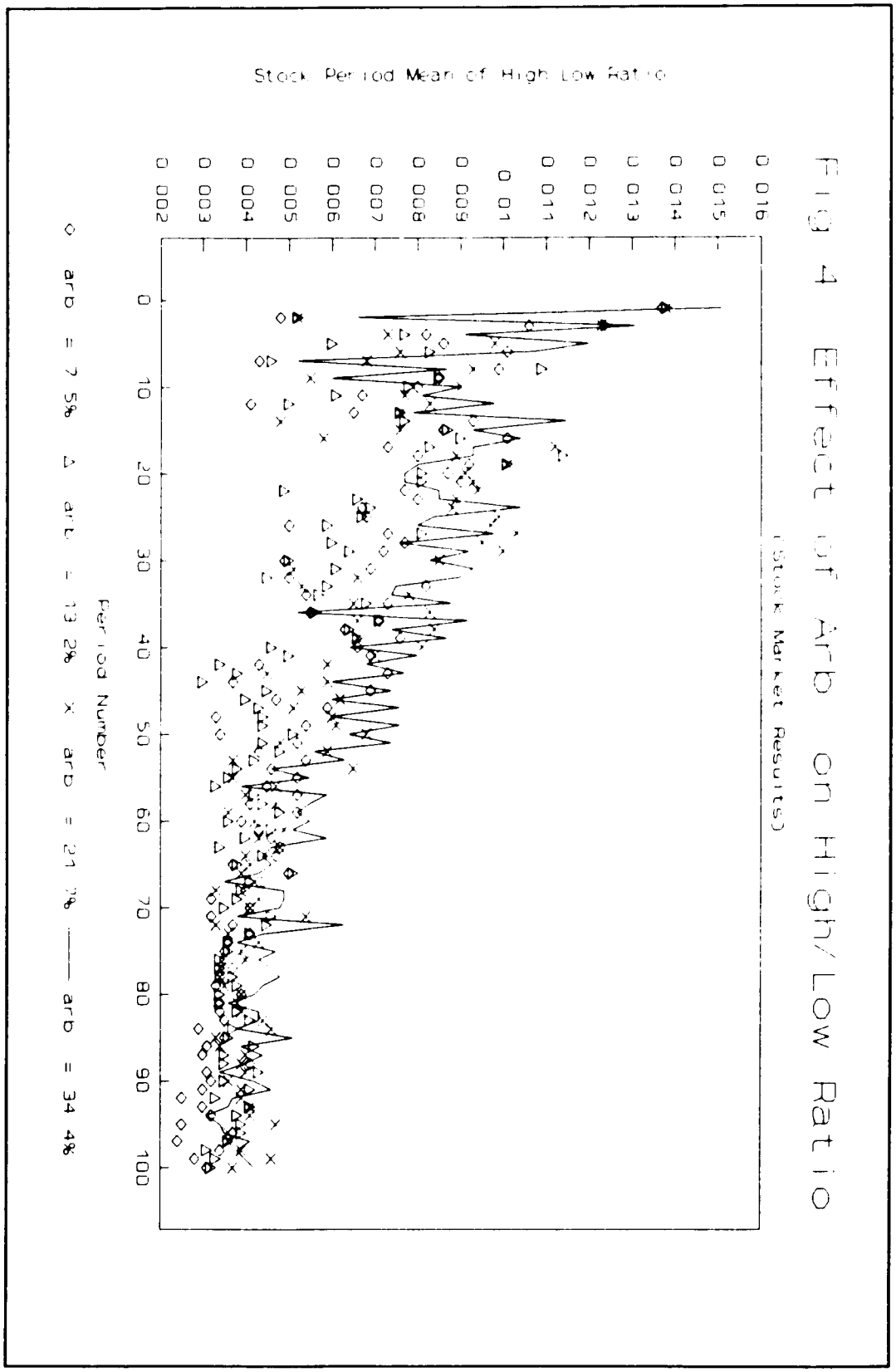
Fig 4 Effect of Arb on High/Low Ratio
(Stock Market Results)
Stock Period Mean of High Low Ratio
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ arb = 7.5% △ arb = 13.2% × arb = 21.7% —— arb = 34.4%

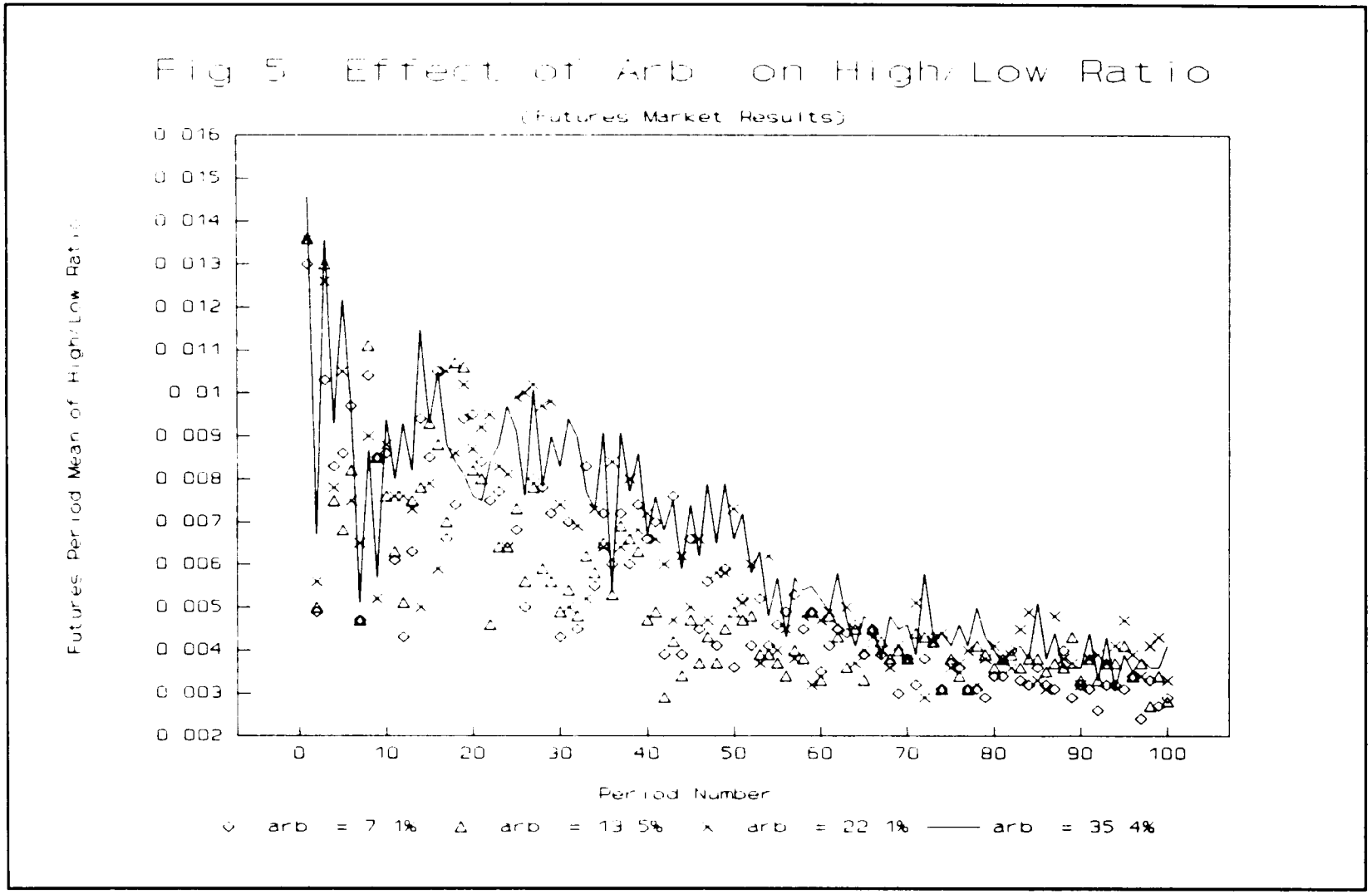
Fig 5 Effect of Arb on High/Low Ratio
(Futures Market Results)
Futures Period Mean of High/Low Ratio
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ arb = 7.1% △ arb = 13.5% × arb = 22.1% —— arb = 35.4%

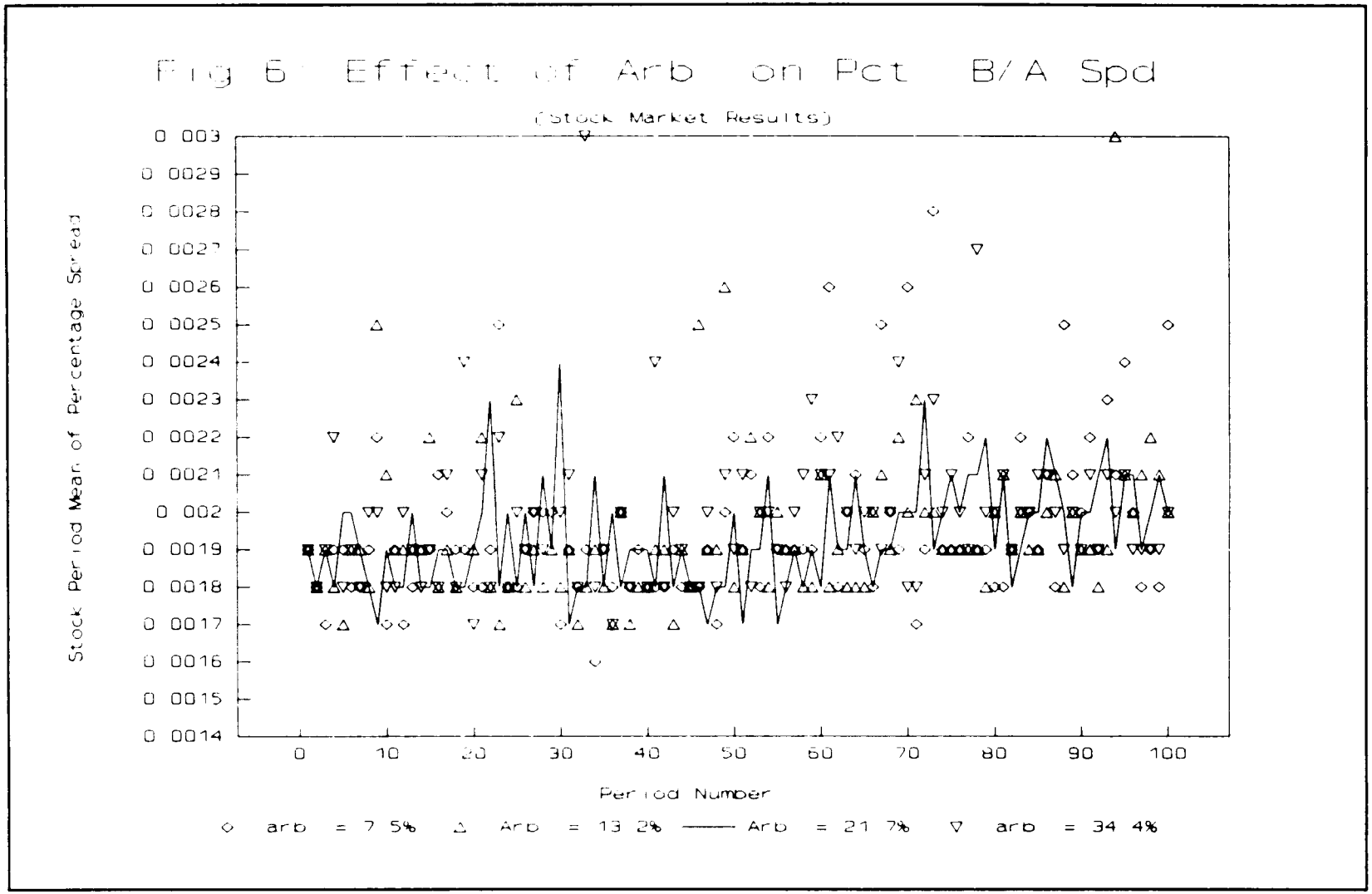
Fig 6 Effect of Arb on Pct B/A Spd
(Stock Market Results)
Stock Period Mean of Percentage Spread
0.003
0.0029
0.0028
0.0027
0.0026
0.0025
0.0024
0.0023
0.0022
0.0021
0.002
0.0019
0.0018
0.0017
0.0016
0.0015
0.0014
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ Arb = 7.5% △ Arb = 13.2% —— Arb = 21.7% ▽ Arb = 34.4%

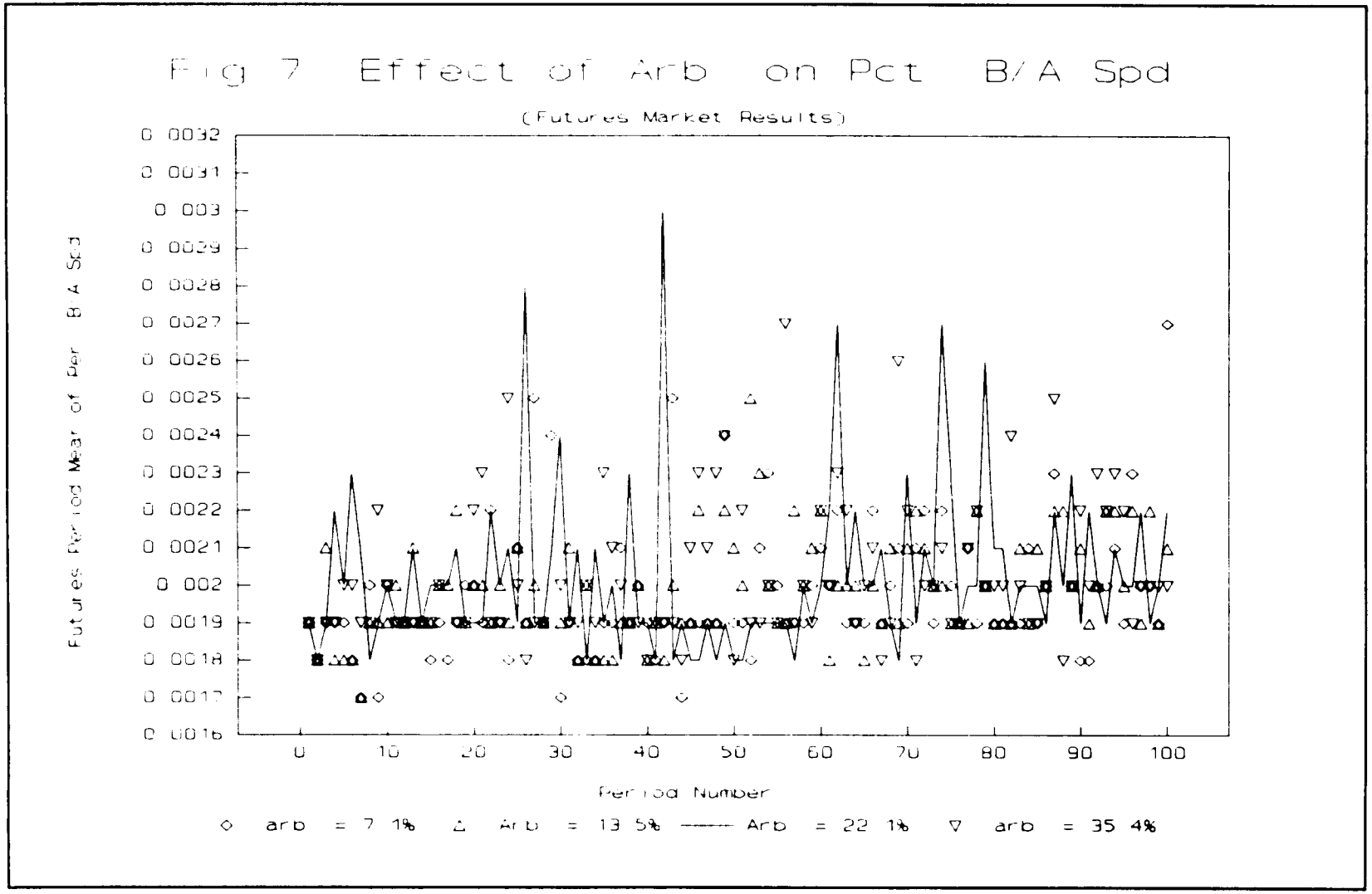
Fig 7 Effect of Arb on Pct B/A Spd
(Futures Market Results)
Futures Period Mean of Per B/A Spd
0.0032
0.0031
0.003
0.0029
0.0028
0.0027
0.0026
0.0025
0.0024
0.0023
0.0022
0.0021
0.002
0.0019
0.0018
0.0017
0.0016
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ Arb = 7.1% △ Arb = 13.5% —— Arb = 22.1% ▽ Arb = 35.4%

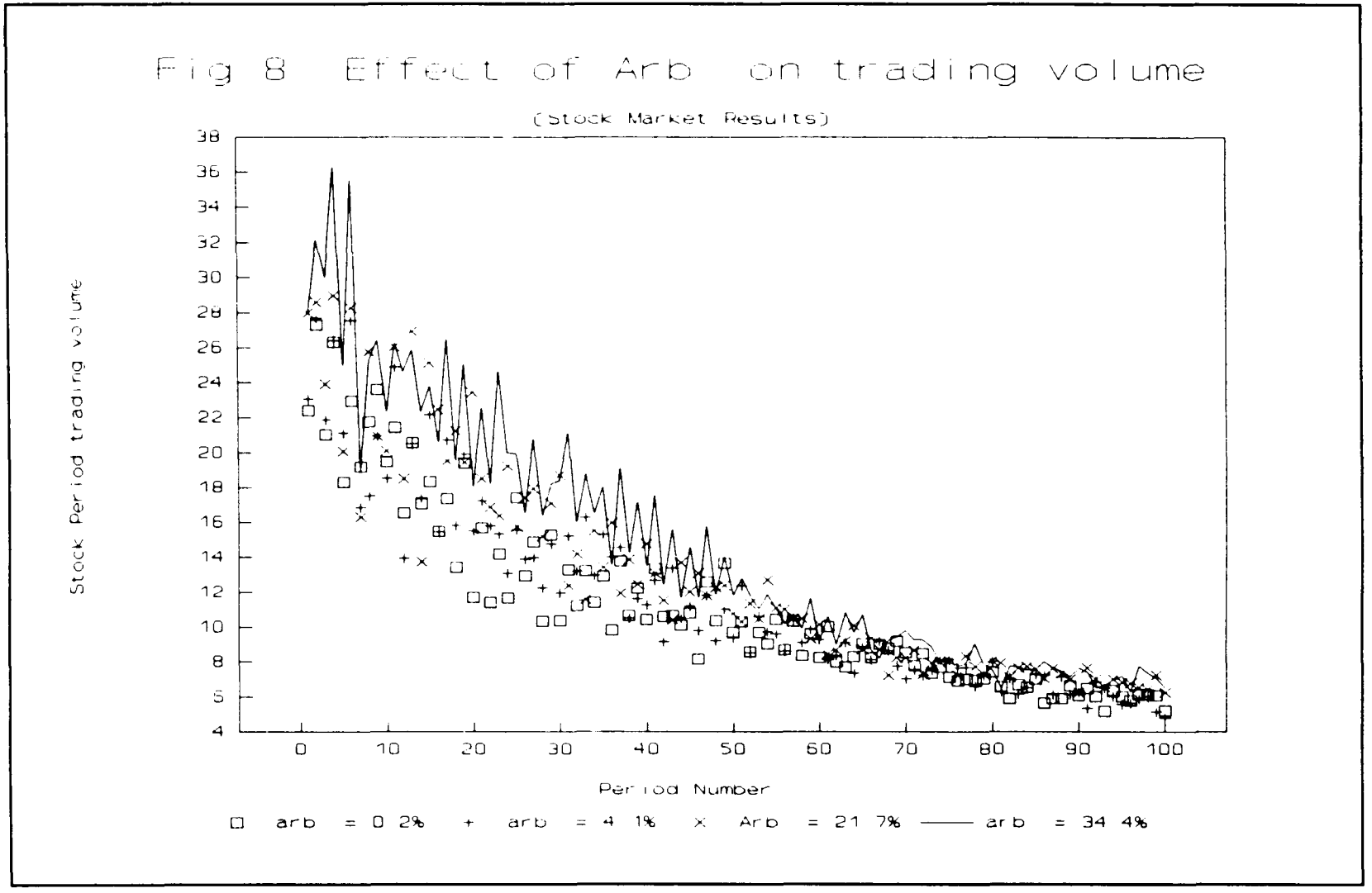
Fig 8 Effect of Arb on trading volume
(Stock Market Results)
Stock Period trading volume
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
0
10
20
30
40
50
60
70
80
90
100
Period Number
□ arb = 0 2% + arb = 4 1% × Arb = 21 7% —— arb = 34 4%

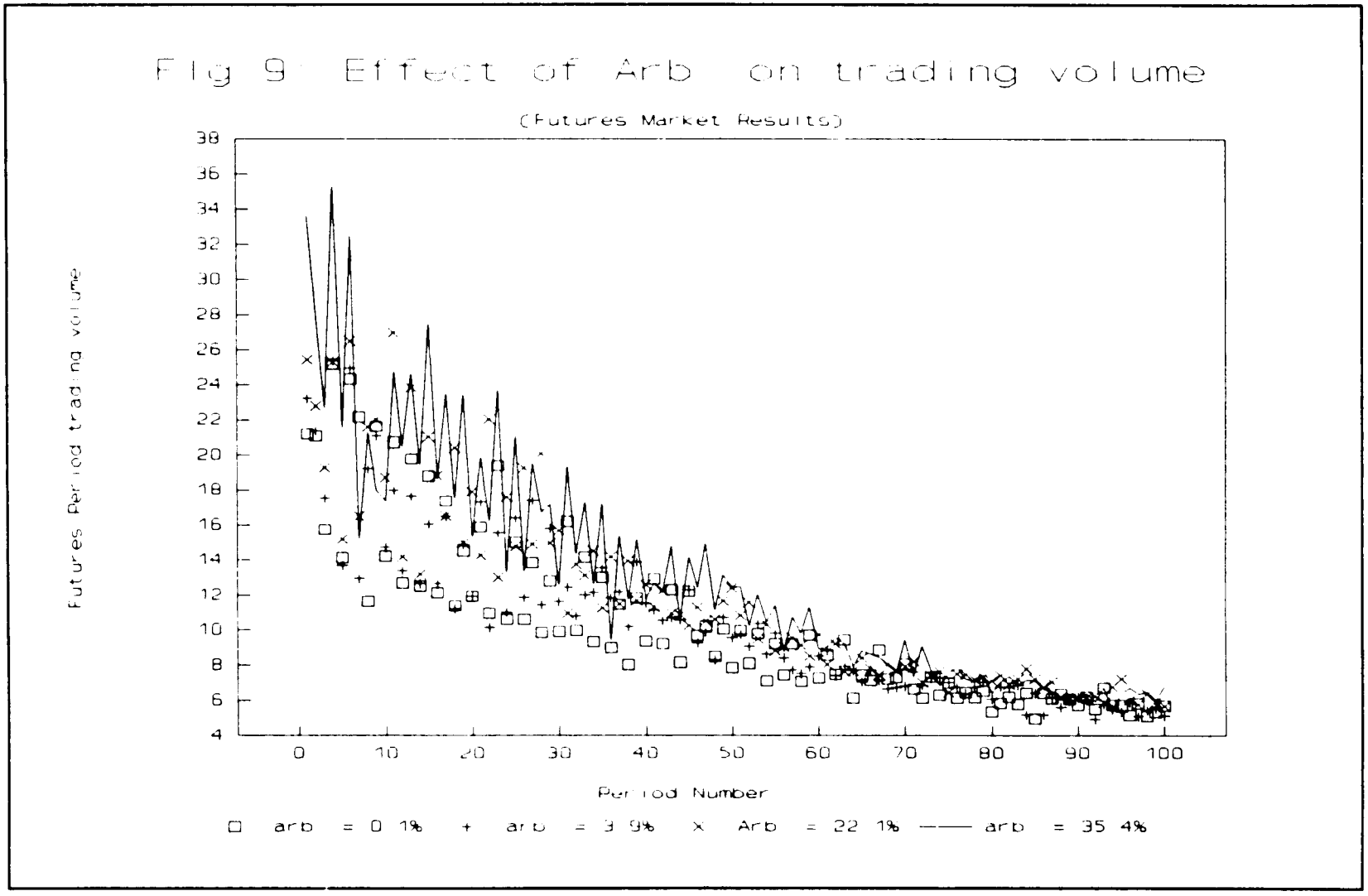
Fig 9: Effect of Arb on trading volume
(Futures Market Results)
Futures Period trading volume
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
0
10
20
30
40
50
60
70
80
90
100
Period Number
arb = 0 1%
arb = 3 9%
Arb = 22 1%
arb = 35 4%

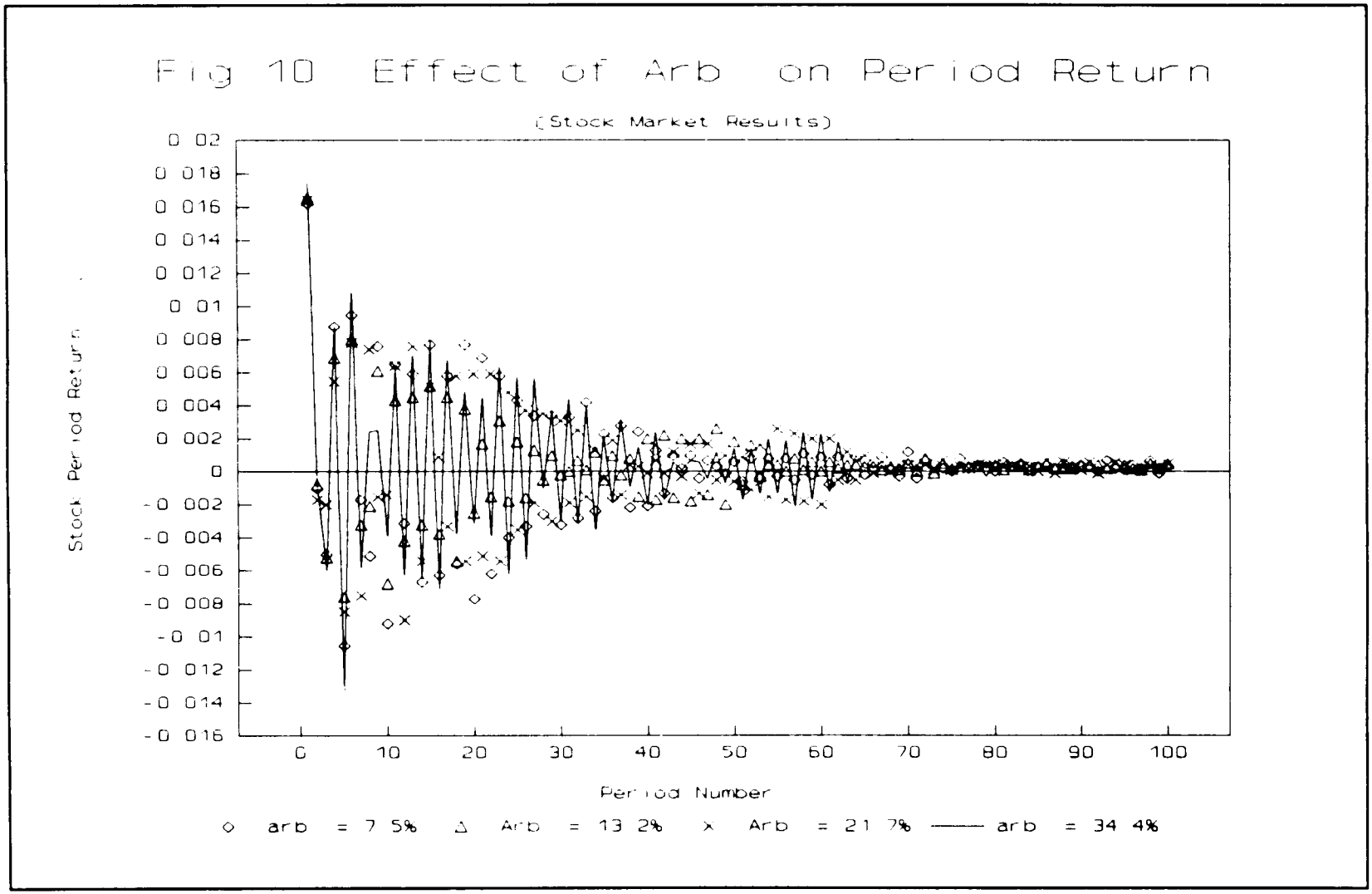
Fig 10 Effect of Arb on Period Return
(Stock Market Results)
Stock Period Return
0 02
0 018
0 016
0 014
0 012
0 01
0 008
0 006
0 004
0 002
0
-0 002
-0 004
-0 006
-0 008
-0 01
-0 012
-0 014
-0 016
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ arb = 7 5% Δ Arb = 13 2% × Arb = 21 7% —— arb = 34 4%

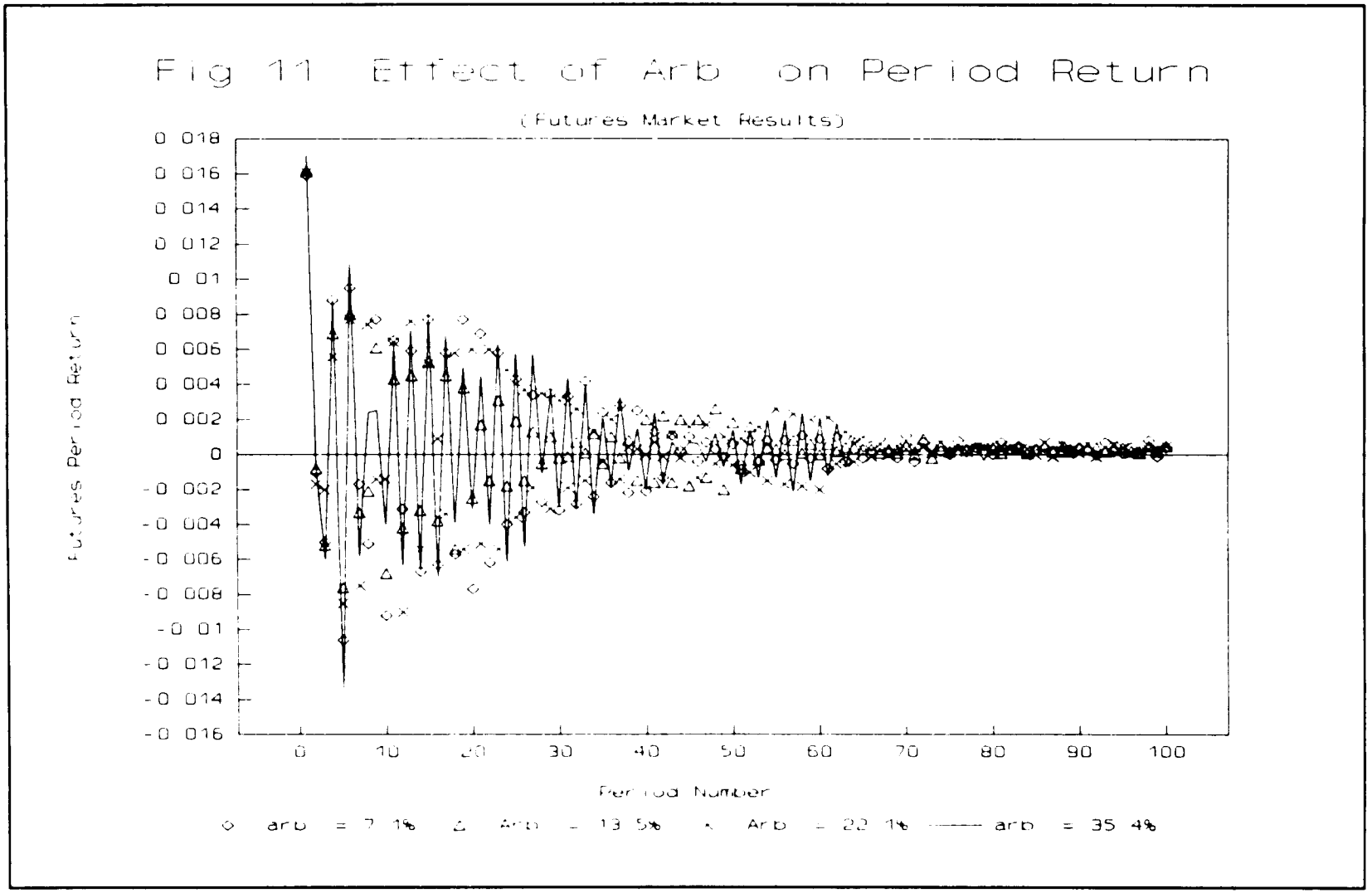
Fig 11 Effect of Arb on Period Return
(Futures Market Results)
Futures Period Return
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
-0.012
-0.014
-0.016
0
10
20
30
40
50
60
70
80
90
100
Period Number
◇ arb = 7.1% △ Arb = 13.5% × Arb = 22.1% —— arb = 35.4%

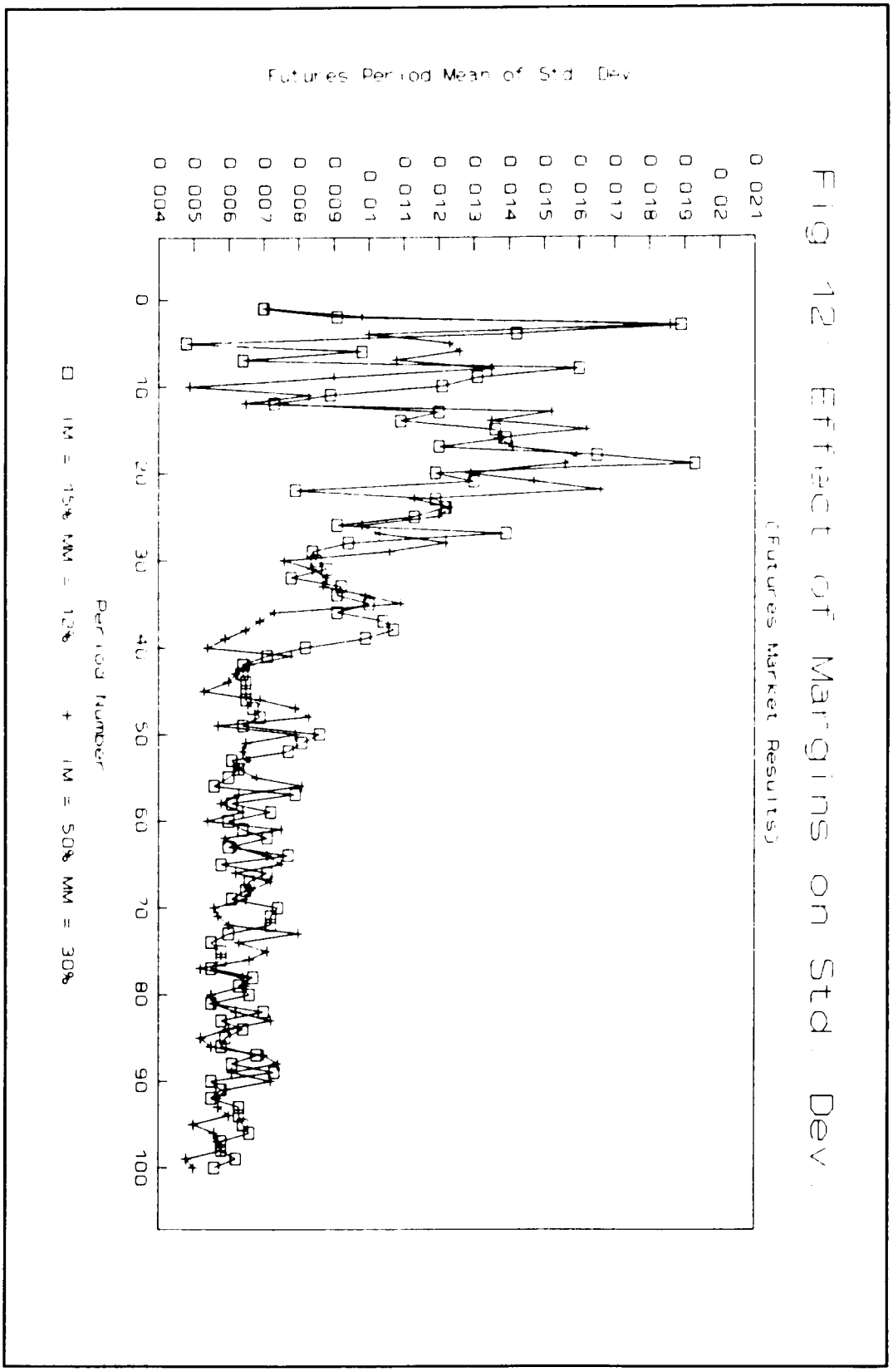

Fig 12. Effect of Margins on Std. Dev.

(Futures Market Results)

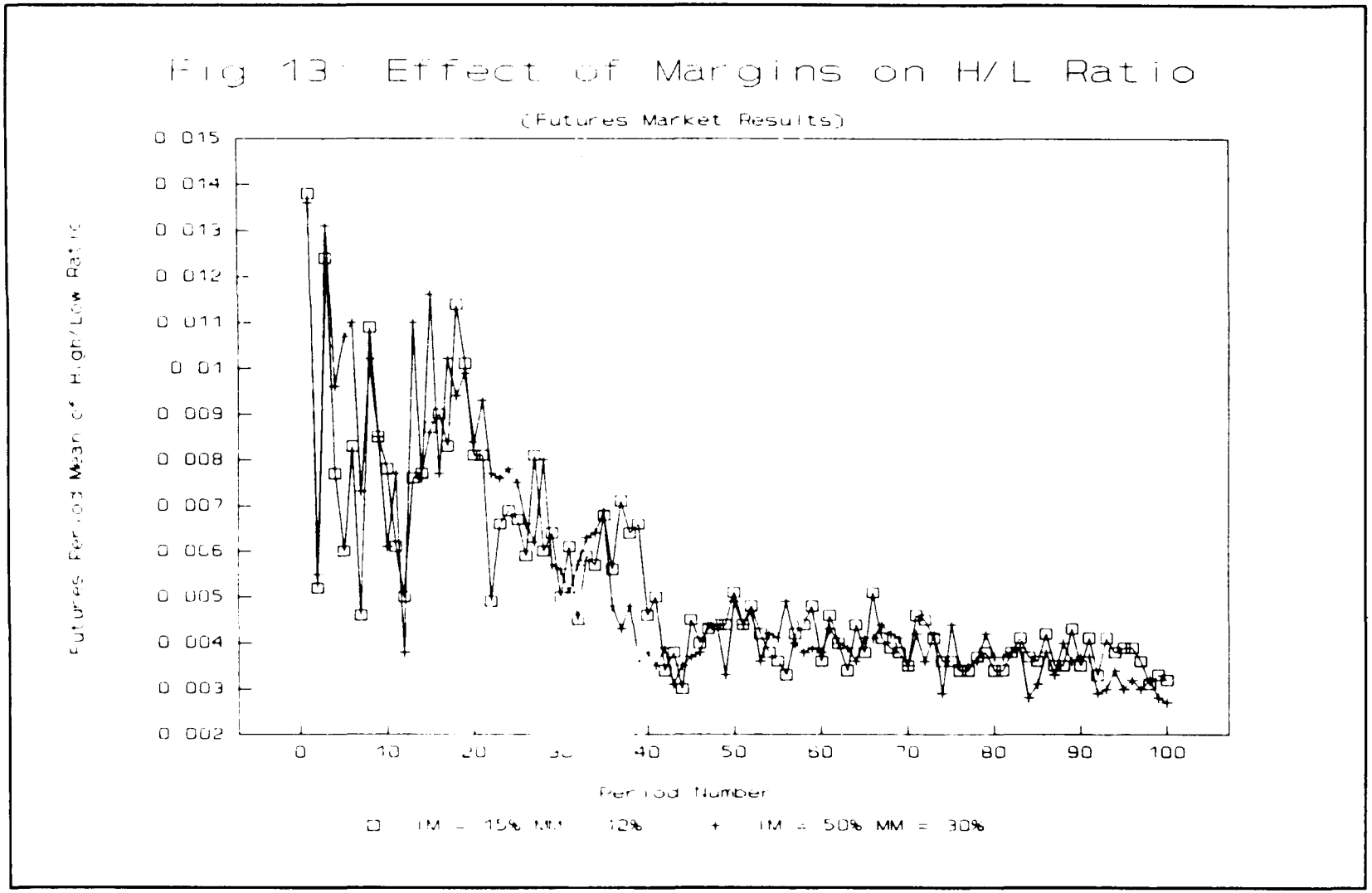
Fig 13: Effect of Margins on H/L Ratio
(Futures Market Results)
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0
10
20
30
40
50
60
70
80
90
100
Period Number
IM = 15% MM = 12%
IM = 50% MM = 30%

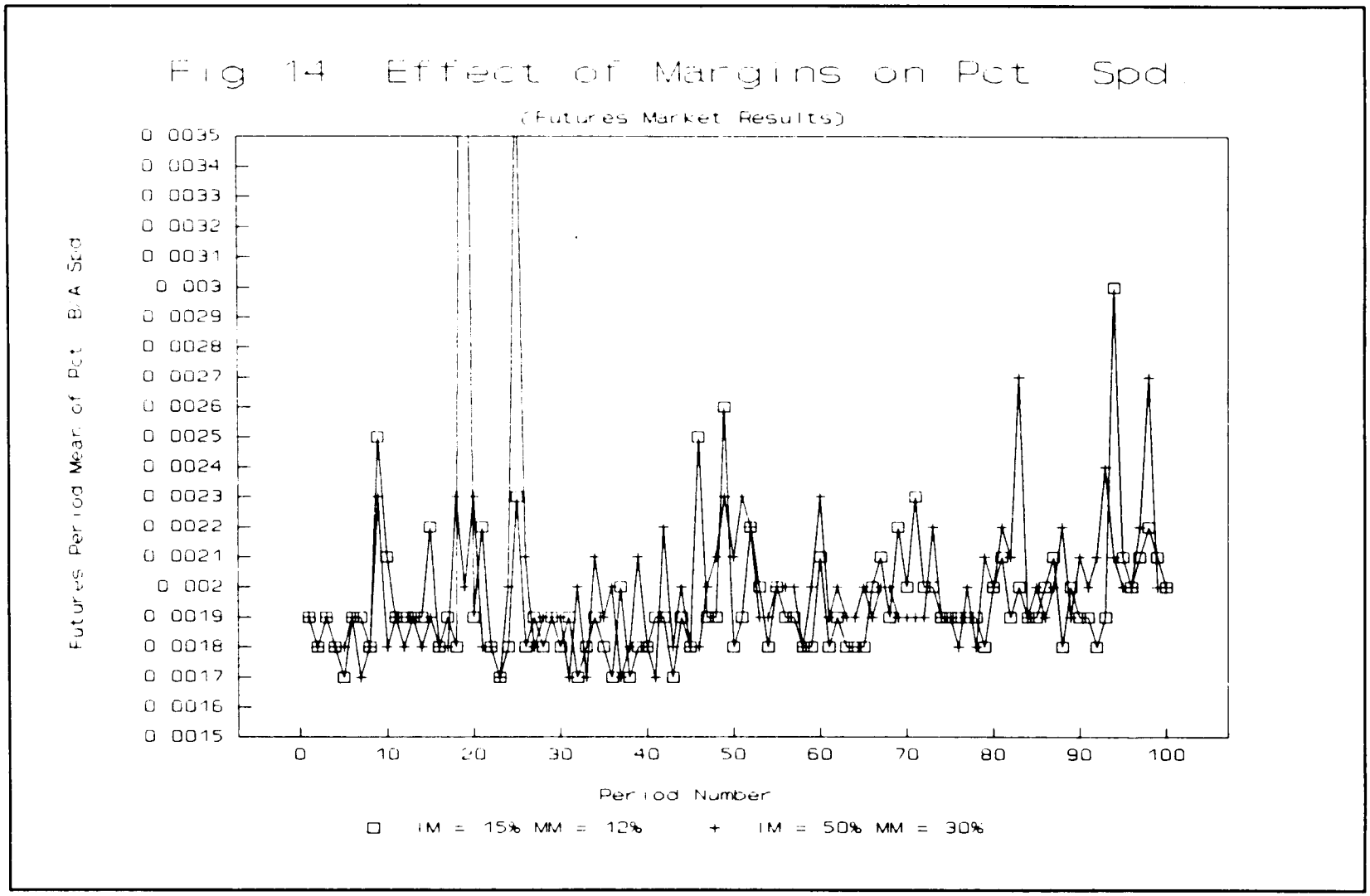
Fig 14 Effect of Margins on Pct Spd
(Futures Market Results)
Futures Period Mean of Pct B/A Spd
0.0035
0.0034
0.0033
0.0032
0.0031
0.003
0.0029
0.0028
0.0027
0.0026
0.0025
0.0024
0.0023
0.0022
0.0021
0.002
0.0019
0.0018
0.0017
0.0016
0.0015
0
10
20
30
40
50
60
70
80
90
100
Period Number
IM = 15% MM = 12%
IM = 50% MM = 30%

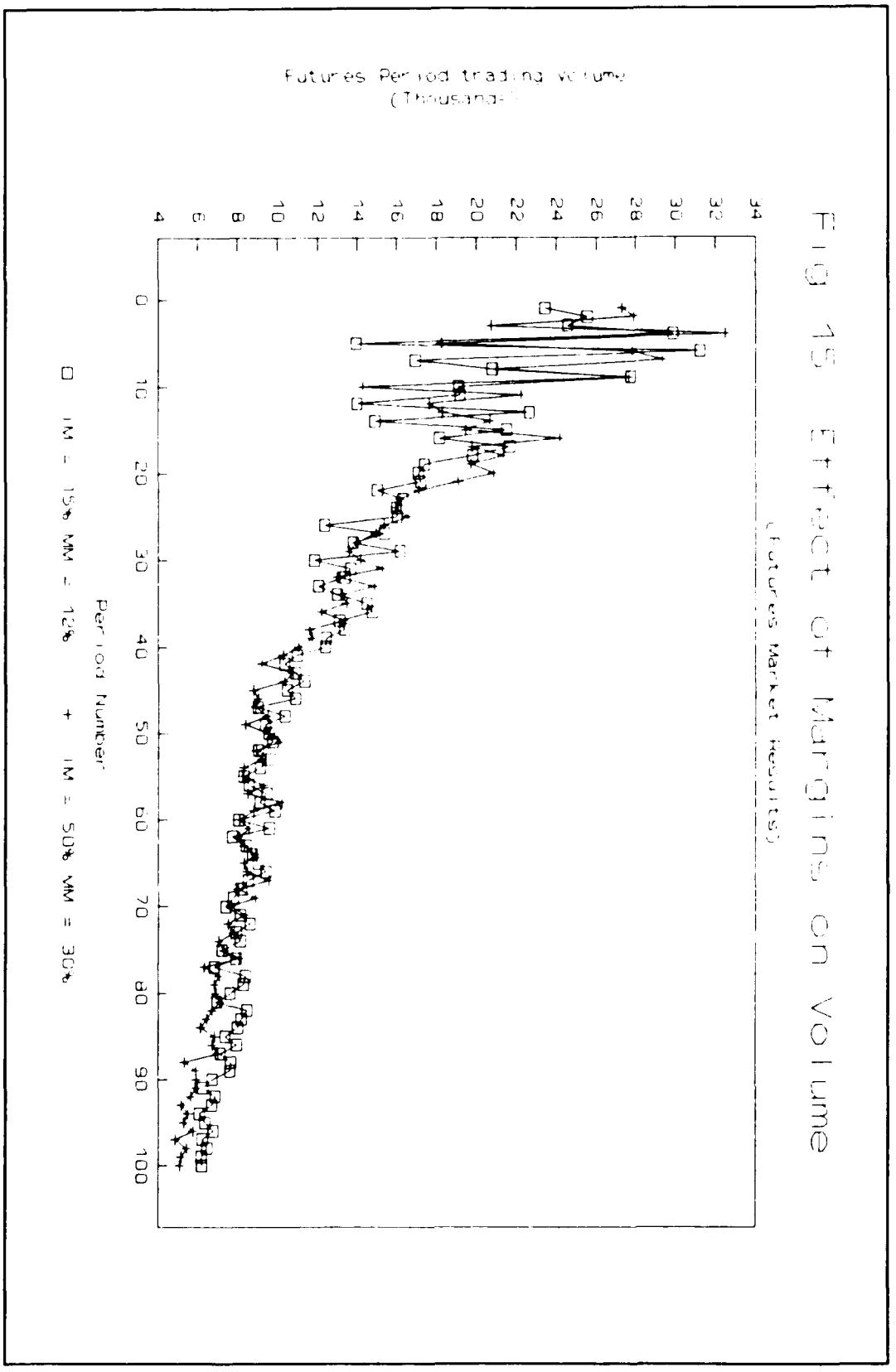

Fig 15 Effect of Margins on Volume

(Futures Market Results)

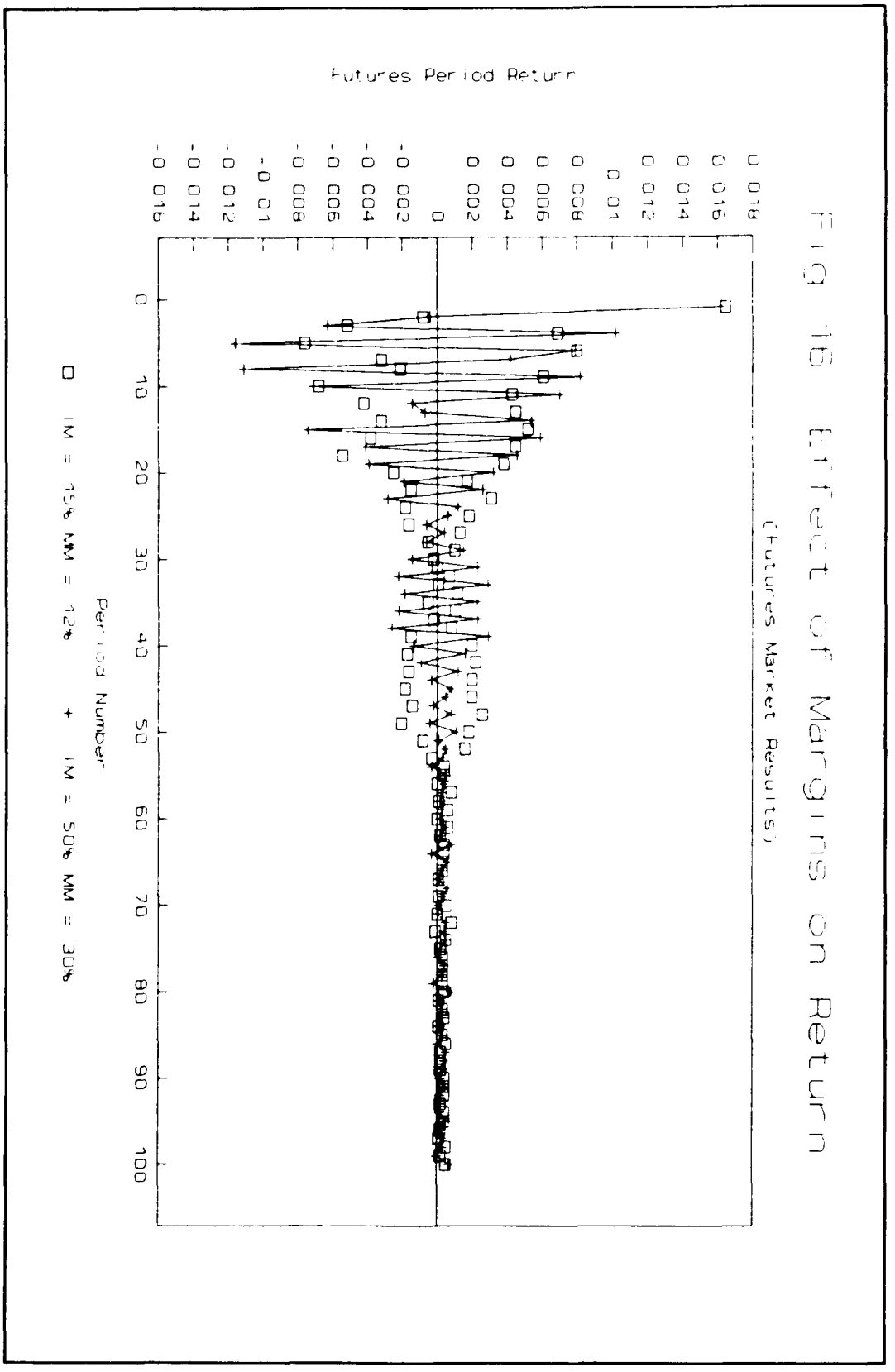
Fig 1B Effect of Margins on Return
(Futures Market Results)
Futures Period Return
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
-0.012
-0.014
-0.016
0
10
20
30
40
50
60
70
80
90
100
Period Number
□ IM = 15% MM = 12%
+ IM = 50% MM = 30%

REFERENCES

Amihud, Y. and Mendelson, H. [1987]. Trading Mechanisms and Returns: An Empirical Investigation. Journal of Finance, 42, 533-553.

Amihud, Y., Mendelson, H. and Wood, R [1990]. Liquidity and the 1987 Stock Market Crash. Journal of Portfolio Management, Spring, 65-69.

Anderson, R. and Tutuncu, M. [1988]. The Simple Price Dynamics of Portfolio Insurance and Program Trading. Center for Studies in Futures Markets-Columbia University, Working Paper #173, 1988.

Beckers, S. [1983]. Variances of Security Price Returns Based on High, Low, and Closing Prices. Journal of Business, 56, 97-113.

Berkowitz, S. , Logue, D. and Noser, E. [1988]. The Total Cost of Transactions on the NYSE. Journal of Finance, 43, March, 97-112.

Black, F. [1976]. Studies of Stock Price Volatility Changes. Proceedings of the 1976 meetings of the Business and Economics studies Section, American Statistical Association, 177-181.

Black, F. and Jones, R. [1987]. Simplifying Portfolio Insurance. Journal of Portfolio Management, Fall, 48-51.

Bookstaber, R. and Langsam, J. [1988]. Portfolio Insurance Trading Rules. Journal of Futures Markets, 8, February, 15-31.

Brennan, M. and Schwartz, S. [1990]. Arbitrage in Stock Index Futures. Journal of Business, 63, S7-S31.

Brorsen, B. [1991]. Futures Trading, Transaction Costs, and Stock Market Volatility. Journal Futures Markets, 11, 153- 163.

Christie, A. [1982]. The Stochastic Behavior of Common Stock Variances: Value, Leverage and Interest Rate Effects. Journal of Financial Economics, 10, 407-432.

Chung, Y. P. [1991]. A Transactions Data Test of Stock Index Futures Market Efficiency and Index Arbitrage Profitability. Journal of Finance, 46, December, 1791-1809.

Cohen, K., Maier, S., Schwartz, R., and Whitcomb, D. [1983]. A Simulation Model of Stock Exchange Trading. Working Paper Series, No. 295, Solomon Brothers Center for the

Study of Financial Institutions, N.Y.U.

De Long, J., Shleifer A., Summers, L. and Waldmann, R. [1989]. The Size and Incidence of the Losses from Noise Trading. Journal of Finance, 44, July, 681-696.

Dreher, W. [1988]. Does Portfolio Insurance Ever Make Sense? Journal of Portfolio Management, Summer, 25-33.

Dubofsky, D. A. and Groth, J. C. [1984]. Exchange Listing and Stock Liquidity. Journal of Financial Research, 7, Winter, 291-302.

Edwards, F. R. [1988]. Futures Trading and Cash Market Volatility: Stock Index and Interest Rate Futures. Journal of Futures Markets, 8, August, 421-439.

Fama, E. [1989]. Perspectives on October 1987, or, What did We Learn from the Crash? Black Monday and the Future of Financial Markets, Mid America Institute for Public Policy Research, Inc., 71-82.

Finnerty, J. and Park, H. [1988]. How to Profit from Program Trading. Journal of Portfolio Management, Winter, 40-46.

Frost, P. and Savarino, J. [1986]. Portfolio Size and Estimation Risk. Journal of Portfolio Management, 12, 60-64.

Garman, M. [1976]. Market Microstructure. Journal of Financial Economics, 3, 33-53.

Garman, M. and Klass, M. [1980]. On the Estimation of Security Price Volatility from Historical Data. Journal of Business, 53, 7-78.

Gould, F. [1988]. Stock Index Futures: The Arbitrage Cycle and Portfolio Insurance. Financial Analyst Journal, January-February, 48-62.

Grossman, S. [1988a]. Program Trading and Stock and Futures Price Volatility. Journal of Futures Markets, 8, August, 413-419.

Grossman, S. [1988b]. Program Trading and Market Volatility: A Report on Intraday Relationships. Financial Analysts Journal, July-August, 18-28.

Grossman, S. [1988c]. An Analysis of the Implications for Stock and Futures Prices Volatility of Program Trading and Dynamic Hedging Strategies. Journal of Business, 61, 275-298.

Grossman, S. [1988d]. Insurance Seen and Unseen: The Impact

on Markets. Journal of Portfolio Management, Summer, 5-8.

Grossman, S. and Miller, M. [1988]. Liquidity and Market Structure. Journal of Finance, 43, July, 617-633.

Hardouvelis, G. [1988]. Margin Requirements and Stock Market Volatility. Federal Reserve Bank of New York Quarterly Review, Summer, 80-89.

Hardouvelis, G. [1990]. Margin Requirements, Volatility, and the Transitory Components of Stock Prices. American Economic Review, 80, 736-762.

Hartzmark, M. [1986]. The Effects of Changing Margin Levels on Futures Market Activity, the Composition of Traders in the Market, and Price performance. Journal of Business, 59, 157-180.

Hill, J. and Frank, J. [1988]. Equity Trading, Program Trading, Portfolio Insurance, Computer Trading and All That. Financial Analysts Journal, July-August, 29-38.

Hill, J., Jain, A. and Wood, R. [1988]. Insurance:Volatility Risk and Futures Mispricing. Journal of Portfolio Management, Winter, 23-29.

Hsieh, D. and Miller, M. [1990]. Margin Regulations and Stock Market Volatility. Journal of Finance, 45, 3-29.

Kawaller, I. [1987]. A Note: Debunking the Myth of the Risk-Free Return. Journal of Futures Markets, 7, 327-331.

Kim, G. and Markowitz, H. [1989]. Investment Rules, Margin and Market Volatility. Journal of Portfolio Management, 16, Fall, 45-52.

Kiviat, P., Villanueva, R. and Markowitz, H. [1983]. The SIMSCRIPT II.5 Programming Language, ed. E. Russell, CACI.

Klemkosky, R. and Lee, J. H. [1991]. The Interday Ex Post and Ex Ante Profitability of Index Arbitrage. Journal of Futures Markets, 11, 291-311.

Krull, S. [1990]. Market Volatility and Trading Strategies. Unpublished Doctoral Dissertation, Baruch College, CUNY.

Leland, H. [1980]. Who Should Buy Portfolio Insurance? Journal of Finance, 35, May, 581-594.

Levy, H. and Markowitz, H. [1979]. Approximating Expected Utility by a Function of Mean and Variance. American Economic Review, 69, No. 3, 308-317.

Lockwood, L. and Linn, S. [1990]. An Examination of Stock Market Return Volatility During Overnight and Intraday Periods, 1964-1989. Journal of Finance, 45, June, 591-601.

Luckett, D. G. [1982]. On the Effectiveness of the Federal Reserve's Margin Requirement. Journal of Finance, 37, June, 783-795.

Malkiel, B. [1988]. The Brady Commission Report: A Critique. Journal of Portfolio Management, Summer, 9-13.

Maberly, E., Allen, D. and Gilbert, R. [1889]. Stock Index Futures and Cash Market Volatility. Financial Analyst Journal, 45, Nov./Dec., 75-77.

Markowitz, H. [1988]. Stock Market Simulator SMS1: Program Description. Baruch College, CUNY, Unpublished manuscript, working paper series No. 88-24.

Merrick, J. Jr. [1988]. Portfolio Insurance with Stock Index Futures. Journal of Futures Markets, 8, August, 441-455.

Miller, M. [1990]. Index Arbitrage and Volatility. Financial Analysts Journal, July-August, 6-7.

Moore, T. G. [1966]. Stock Market Margin Requirements. Journal of Political Economy, 74, 158-167.

NYSE Research & Planning [1991]. Program Trading Report, October 28 Through November 1, 1991.

O'Brien, T. [1988a]. The Mechanics of Portfolio Insurance. Journal of Portfolio Management, Spring, 40-47.

O'Brien, T. [1988b]. How Option Replicating Portfolio Insurance Works: Expanded Detail. Monograph Series in Finance and Economics, Monograph 1988-4, Solomon Brothers Center for the Study of Financial Institutions, N.Y.U.

Officer, R. R. [1973]. The Variability of the Market Factor of the New York Stock Exchange. Journal of Business, 46, July, 434-453.

Parkinson, M. [1980]. The Extreme Value Method for Estimating the Variance of the Rate of Return. Journal of Business, 57, 61-65.

Perold, A. and Sharpe, W. [1988]. Dynamic Strategies for Asset Allocation. Financial Analysts Journal, January-February, 16-27.

Pliska, S. and Shalen, C. [1991]. The Effects of Regulations on Trading A ctivity and Return Volatility in Futures

Markets. Journal of Futures Markets, 11, 135-151.

Roll, R. [1989]. The International Crash of October 1987. Black Monday and the Future of Financial Markets, Mid America Institute for Public Policy Research, Inc., 35-70.

Rubinstein, M. [1985]. Alternative Paths to Portfolio Insurance. Financial Analysts Journal, July-August, 42-52.

Rubinstein, M. [1988]. Portfolio Insurance and the Market Crash. Financial Analyst Journal, Jan-Feb, 38-47.

Rubinstein, M. and Leland, H. [1981]. Replicating Options with Position in Stock and Cash. Financial Analysts Journal, 37, No. 4, 63-72.

Schwert, W. [1989]. Why Does Stock Market Volatility Change Over Time. Journal of finance. 44, December, 1115-1153.

Schwert, W. [1990]. Stock Market Volatility. Financial Analyst Journal, May-June, 23-34.

Seguin, P. [1990]. Stock Volatility and Margin Trading. Journal of Monetary Economics, 26, 101-121.

Shiller, R. [1990]. Market Volatility and Investor Behavior. American Economic Review, 80, 58-62.

Sofianos, G. [1988]. Margin Requirements on Equity Instruments. Quarterly Review, Federal Reserve Bank of New York, Summer, 13(2), 47-60.

West, K. [1988]. Bubbles, Fads, and Stock Price Volatility Tests: A Partial Evaluation. Journal of Finance, 43, July, 639-656.

Yadav, P. and Pope, P. [1990]. Stock Index Futures Arbitrage: International Evidence. Journal of Futures Markets, 10, 573-603.

Zhu, Y. and Kavee, R. [1988]. Performance of Portfolio Insurance Strategies. Journal of Portfolio Management, Spring, 48-53.