EXCESSIVE MARGIN REQUIREMENTS AND INTERMARKET DERIVATIVE
EXCHANGE COMPETITION: A STUDY OF THE EFFECT OF RISK
MANAGEMENT ON MARKET MICROSTRUCTURE

by

Hans R. Dutt
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Committee:

_____ Feb. 1, 2007 ___ Director

_____

_____

_____ Department Chairperson

_____ Program Director

_____ Dean, College of Humanities
                          and Social Sciences

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                           Fairfax, VA

Excessive Margin Requirements and Intermarket Derivative Exchange Competition: A
Study of the Effect of Risk Management on Market Microstructure

A dissertation submitted in partial fulfillment of the requirements for the degree of a
Doctor of Philosophy at George Mason University

By

Hans R. Dutt
Master of Arts
Binghamton University, 1990

Director: Willem Thorbecke, Associate Professor
Department of Economics

Spring Semester 2008
George Mason University
Fairfax, VA

DEDICATION

This is dedicated to those who have inspired me; my children, Krishna and Melissa, who not only supported me and sacrificed as I went through this program, but helped to understand myself better; my wife Diana who is the most amazing woman I have ever met; and Rabindranath Tagore. It is also dedicated to my late father, Romesh Chundra Dutt.

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Hans R Dutt, PhD

George Mason University, 2008

Dissertation Director: Willem Thorbecke

The S&P500 Index futures contract is traded on the Chicago Mercantile Exchange that is

regulated by the Commodity Futures Trading Commission. The S&P 500 Index options

contract is traded on the Chicago Board of Options Exchange that is regulated by the

Securities and Exchange Commission. The differing regulatory structures have led to the

S&P 500 Index futures and options contracts being subject to differing customer

margining (collateral) requirements.   Generally, S&P 500 Index options customer

margin requirements are higher than their futures counterpart for a comparably leveraged

position. This dissertation examines whether higher relative margin costs lead to trader

substitution between markets such that margin costs help determine relative market share.

The empirical result I find is that margin costs do not appear to affect market share

between options and futures markets. This result may not necessarily be a rejection of

economic theory that suggests traders will substitute between like assets based on

differences in these assets' costs, but may result from large illiquidity in options markets as characterized by the empirical finding of relatively large bid ask spreads in options markets for similarly leveraged positions. The finding of relatively large bid ask spread costs in the S&P 500 options market is consistent with the academic literature finding that price discovery occurs primarily in the futures market (Fleming, Ostdiek and Whaley (1996)).

1. Introduction

Market microstructure variables such as liquidity and volatility are important factors to understand for effective risk management. That is, market microstructure influences risk management practices. For example, the more price volatility an asset exhibits, the greater the capital that would be required to insure against default. A less discussed topic is how risk management practice affects market microstructure. This dissertation explores this issue, albeit in a narrow sense.

Specifically I explore how excessive option margin requirements in an equity options market (S&P 500 Index Options) affects the microstructure of this market and a related futures market (S&P 500 Index Futures). Of central importance is whether there is evidence of effects on competition between these markets due to risk management practices in one of the markets. The answer to this may have important policy implications to the extent the result can be generalized to the impact of collateral requirement across markets that are related, yet independently regulated. If there is little competition between seemingly rival derivatives exchanges, then regulation of these markets by different regulators may be appropriate. However, if there is significant cross market competition, there exists a potential for gaming. This in turn has welfare implications as it can result in transfers, deadweight losses, and may influence the price discovery process.

Most of these questions are beyond the scope of this research. However, the results of this research on financial intermarket competition has a bearing on these broader questions.

In the regulation of derivative financial markets, a common argument that is made is that futures and options compete with one another and, as a consequence, regulators should endeavor to construct an "even" playing field between the markets. For example, on the basis of this argument, new single-stock futures were mandated to have the same margining system as that which had existed in the equity options markets - a system that generally requires customers to provide higher margin requirements than the funds necessary to serve the economic function of a performance bond (Figlewski,1984).[1] In 2005, a provision to the Commodity Exchange Reauthorization Act was proposed to allow single-stock futures markets to determine customer margin requirements using a risk-based methodology. Equity options markets such as the Chicago Board of Options Exchange (CBOE) have opposed this unilateral change in single-stock futures markets due to concerns that this would lead to a loss in market share for equity options markets (Tan, 2005). In other words, CBOE has implicitly argued that their expected higher margin requirements to traders that transact options will result in the options markets losing market share to futures markets.

The Senate Banking Committee subsequently asked the President's Working Group on Financial Markets (PWG), consisting of the Federal Reserve Board (FRB), the

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[1] The Commodity Futures Modernization Act of 2000 lifted the ban on single-stock and narrow-based futures contracts that was implemented in 1982 (referred to as the Shad-Johnson Accord). Background issues, including those of margin requirements, are discussed in GAO (2000).

Treasury Department (Treasury), the Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) to examine the critical issues involved prior to an ultimate decision, *inter alia*. Unfortunately, because the extant literature does not address the nature of intermarket competition between derivatives exchanges, there is little empirical evidence to guide the PWG or anyone else contemplating similar issues involving the impact of changes in margin requirements in one market on intermarket competition between derivatives markets. This is of particular concern since regulators make rules (either directly or indirectly) that cause transfers among regulated exchanges and may also have broader welfare ramifications. To begin to understand the wider implications of such rules, microstructure effects must first be determined.

This study examines the nature of intermarket competition between two derivatives markets - the S&P 500 futures index ("SPI futures") traded on the Chicago Mercantile Exchange and the S&P 500 options ("SPI options") index traded on the Chicago Board of Options Exchange. Specifically, the study examines how margin requirements affect relative trading volumes and bid ask spreads between these rival derivative markets.

There are several aspects of these contracts that make them uniquely suitable for this analysis. First, they have a common underlying and have clear similarities and differences. Second, they are margined differently.[2] This difference can be analytically exploited once it is recognized that margin requirements are an opportunity cost to the

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[2] Effectively, (single-stock) equity options and single-stock futures are margined the same way (i.e., by strategy-based margins) so they cannot be used in this study.

trader. Given the fact that these differences reflect differences in costs, the effect of

margin requirements and intermarket competition can be examined to provide us with

evidence on the impact on one derivatives market from changes in costs in a rival

derivatives market.

The results of this analysis are directly relevant to quantifying the impact on

competition from differences in margining systems on the S&P 500 derivatives contracts.

The results may also be pertinent to the argument that single-stock futures markets are

currently making, i.e., their strategy-based margining system is hindering the ability of

their contract to trade. Finally, the results provide an empirical test of some aspects of

market microstructure theory.

Chapter 2 provides a background of important institutional details and literary

findings germane to this analysis. Chapter 3 provides the framework to empirically test

the main questions that are addressed in this study. This includes the methodology to

construct liquidity estimates, excess option margin requirements, and models of trading

volume and bid ask spread determination.

2. Literary and Institutional Background

Forward and options contracts can trade on over-the-counter (OTC) markets where two parties come together to engage in a trade. Although this gives the benefits of a customization of an agreement, there are several costs to this type of contract. The most significant of the costs of forming an OTC or otherwise customized contract is establishing the counterparty's creditworthiness. This is because, as Kupiec (1997) points out, the ability to default has value and it is equal to a put option written on the underlying instrument. Thus, if one wished to take a position in a contract over a significant time frame, the value of this default option would be relatively large. The counterparty would be required to set a collateral level consistent with this put option default value to ensure contract performance. Consequently, traders without large amounts of collateral would not be able to participate in these contracts.

Futures and options exchanges provide a vehicle for allowing greater participation in these types of instruments by providing generic contracts that are designed to substantially mitigate the need to establish the creditworthiness of the parties to a trade. The way in which this has been accomplished is by creating a clearinghouse system. This system provides a method of trading by which traders do not have to be concerned about counterparty default as the clearinghouse takes the opposite position as the buyer and seller on all contracts. This, combined with other techniques such as daily marking-

to- market, whereby profits and losses to all positions are realized daily, has the effect of substantially reducing the collateral necessary to engage in a derivatives contract. In effect, this dramatically reduces the value of the put option. In other words, it dramatically lowers the strike on this implicit default option. The exchange problem then comes down to collecting enough collateral, called margin, to offset the residual put option. Since the option is a function of underlying price volatility, among other variables, it is clear that the expected underlying price volatility should be an important factor in determining the appropriate margin requirement on a derivatives position.

Under the clearinghouse system, on a futures or options exchange, every trade that is made must be made through a clearing member of the exchange. That is, a member of an exchange that has met sufficient capital and other requirements to allow him to be a clearing member. If a clearing member clears trades for a non-clearing member, he collects customer margins on a gross basis, i.e., all long and short position margins are passed through to the clearing member from the non-clearing member. The clearing member also retains the margin collected from the trades that it has collected from its own customer trades as well as those it has made. For the portion of the trades that have offsetting positions within the clearing firm, the firm is responsible and retains the associated customer margins. For trades that do not balance within the clearing firm, the clearinghouse takes responsibility and assigns a margin requirement from the clearing member. In effect, the clearinghouse is the clearing member of clearing members. It guarantees that, if one clearing firm should default on its trades, the clearing house will cover the position. Thus, it pools the risk of default across clearing firms.

This clearinghouse structure reveals that there are two levels of margin collection. One is collection of margin by the clearing member. This includes collection of margin from retail customers as well as those from such traders as market makers. The second level is the collection of margin of the clearinghouse from its clearing members. In establishing margin requirements from clearing members, the futures markets such as the Chicago Mercantile Exchange (CME) and equity options markets such as CBOE allow margin requirements to be calculated from risk-based systems, called TIMS (in equity options markets) and SPAN (in futures markets). In futures markets, market makers and customer's margin requirements are both calculated using the SPAN system. However, in equity options markets, while traders such as market makers may be margined using SPAN, retail customers must be margined using a strategy-based system – a system that does not, in general, account for underlying risk.

Exchange Portfolio Margining Systems

The Options Clearing Corporation (OCC) developed a risk-based margining system called the Theoretical Intermarket Margin System (TIMS) that is designed to assess an organization's exposure to credit risk. It is designed to measure the risk in portfolios of options, futures, and option on futures positions. It was developed to allow the clearing organization to monitor member portfolios. This is required because the clearing organization guarantees all trades between clearing members. The TIMS uses portfolio theory on a limited basis. That is, TIMS will use portfolio theory to margin same-underlying asset positions only (in the same class group). Class groups with high correlations may be placed in the same product group. The final margin requirements of

the product group will be adjusted for the lack of perfect correlation within the group. There are subjective parameters that are determined by OCC policy.

Similarly, the Standard Portfolio Analysis of Risk Margin System (SPAN) was created by the Chicago Mercantile Exchange (CME). It is used extensively by foreign derivatives exchanges as well as the CME, Chicago Board of Trade, and Board of Trade Clearing Corporation. The systems are very similar in nature and, for the purpose of this analysis, have no significant differences. Therefore, only the SPAN will be examined in greater detail. CFTC (2001) provides a concise review of the SPAN system.

Fundamentally, it is designed to calculate maintenance margins for derivatives positions in a common or highly related underlying. The margins that result from SPAN are determined by the input parameters set by the individual exchange. Because different exchanges will use different input parameters, margin requirements can differ even if the instrument is essentially the same.

There are eight parameters that need to be defined by the exchange. They are:

1. Initial to Maintenance Margin Ratio – This is the percentage increase from the SPAN defined maintenance margin that new portfolios of speculative accounts must meet. The resulting amount is referred to as the initial margin.[3]

2. Margin Interval Rate – This is the minimum maintenance margin requirement for the underlying contract.

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[3] It is interesting to note that the margin ratio (initial to maintenance) that has been required for the S&P 500 futures contract has fluctuated considerably over time (from 112 percent to 500 percent). Pre-SPAN, on average, margin ratios were in the neighborhood of 200 percent and the ratio was volatile. After SPAN is has stabilized and is now consistently set to about 125 percent. SPAN began to be used in 1988.

3. Volatility Scan Range – The range within which the implied volatility might reasonably be expected to move in one day.

4. Intra-Commodity Spread Charge – There exist commodities that are mostly comprised of the same product. After taking offsetting positions in these assets, some risk remains. This parameter allows a margin charge to be applied. [4]

5. Inter-Commodity Spread Charge – There are commodities that are not, for the most part, comprised of the same asset, however, exhibit high correlations none-the-less. This parameter allows the exchange to credit margin for opposite positions. For example, the CME has determined that the NASDAQ 100 and S&P 500 exhibit very high correlations and consequently allows margin offset.

6. Extreme Move Multiplier – There is a risk in a deep out-of-the-money short option position. This parameter tests for the effect of an extreme move. For example, a three times movement in the scanning range.

7. Short option minimum charge – Allows a minimum charge to account for the risk inherent risk of associated with short options positions.

8. Spot month add-on change – This is an add-on charge to account for additional risk in the spot month due to physical delivery.

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[4] The phrase "offsetting positions" is a bit vague. If a trader holds a long position in a certain futures contract (e.g., March 2006 S&P500 futures contract) and then takes a short position in the same futures contract, the positions are said to offset and the trader eliminates his position. If, however, there are any differences in the legs of the "offsetting" positions, both positions remain alive although the risk of the trader's position has may been greatly reduced. The term "offsetting" here refers to the latter notion of offset.

There are two steps in calculating SPAN margins. The first is to determine "risk

arrays" that are the profit or loss that an individual derivatives contract will face under

sixteen defined scenarios.[5] Risk arrays are determined by the exchange and provided to

firms. Then, in step two, firms calculate minimum margin requirements of their

customer's account. This second step combines derivatives with the same (or related)

underlying into a single portfolio and identifies the scenario that generates the greatest

potential loss. The margin requirement of that account for the derivatives with the same

(or related) underlying is determined after a series of adjustments that are defined by the

exchange-specified parameters. The total (minimum) margin requirement of the account

is the sum of the margin requirements for all such underlying groupings.

Simplified Example

Portfolio margining systems such as TIMS and SPAN are more accurately

referred to as risk-based systems. That is, the systems use data on market risk but, to a

significant extent, do not take into account correlations between largely unrelated assets

as portfolio theory would suggest. To the extent that they take market risk into account,

they do so for portfolios of derivatives which include futures and options.

The SPAN system is based upon scenario analysis. In short, the SPAN

methodology varies price and volatility and examines what will happen to the value of

each derivative. For example, varying price will change the value of both a future and an

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[5] The risk array conveys how much a contract will gain or lose over a timeframe under
16 scenarios of changes in market conditions. The scenarios allow volatility to go up or
down. In either case, the profit (loss) is determined that is associated with the price
traveling down (or up) by 0, 1/3, 2/3 and 3/3 of the worst case price movement based
upon a 95-99 percent confidence.

option. Varying volatility will only change the value of an option. Thus by varying the underlying price and the volatility in likely magnitudes, one can see likely changes in value for each derivative. When a trader holds a position in multiple derivatives on a common or highly related underlying, the system sums the likely values of these portfolio constituents to see how the value of the overall portfolio of common underlying or highly related underlyings will change. By examining the changes of all likely scenarios of a derivatives portfolio, the worst loss that will occur from likely market moves can be estimated. Conceptually, requiring this amount in the form of a performance bond will nullify the trader's incentive to default in the event of normal adverse market moves.

Since a derivative is based upon where the underlying price will be in the uncertain future, it is important to understand the expected distribution of prices. In practice, this is frequently estimated by examining the historical distribution of the underlying prices or, equivalently, the distribution of the underlying asset's return.

Generating the bound of underlying movements can be accomplished in many ways. For example, this can be done by examining the percentiles of the historical price movements. There are also distributional assumptions that can help establish the bound for underlying movements. Under the assumption that the distribution of returns is normally distributed and the process that generates this distribution will continue in the future, where the underlying price is likely to end up can be completely characterized by the return distribution's mean and volatility (i.e., its standard deviation). Gay, Hunter and Kolb (1986) show that futures exchanges set margins consistent with this assumption. However, techniques of extreme value theory have been put forth to quantify risk due to

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fat tails. For example, Cotter (2001) uses a "block maxima' approach while Bytrom (2006) uses a "peaks over threshold" method. The "block maxima" approach assumes asymptotic convergence to a Generalized Extreme Value distribution. The "peaks over threshold" method relies on the asymptotic convergence to a Generalized Pareto distribution. Regardless of the specific approach, historical price movements are a major component in establishing bounds of likely price movements.

The underlying price in conjunction with the terms of the contract determine the derivative's payoff. While the terms of the contract are fixed, the stochastic nature of the underlying distribution makes the contract's payoff stochastic.

To determine a payoff to a derivative, in advance, it must be estimated from a model. A futures model conveys a symmetric gain and loss to the buyer and seller. An options model conveys an asymmetric payoff to the long and short. The specific model used to value a derivative is irrelevant for the purposes of this example. The essential point is that there exists a function that maps an underlying volatility measure and an underlying price to a futures and options price. The futures price function is denoted as F and the option price function is denoted as O. Correspondingly, the change in the futures price function is denoted by f and the change in the options price function is denoted by o. Let i represent a discrete volatility possibility of I possible realizations. Likewise let j represent a discrete price possibility of J possible realizations. Further assume the there is only one future and one type of option (call options) possible and the trader's account consists of λ_f futures contracts and λ_o options contracts.

For volatility scenario i and price scenario j, the change in the value of a futures contract is:

$$F_{i,j} = f(\sigma_i, P_j) \Rightarrow \begin{bmatrix} F_{L,L} & F_{L,H} \\ F_{H,L} & F_{H,H} \end{bmatrix}$$

Likewise, the change in the value of an options contract is:

$$O_{i,j} = o(\sigma_i, P_j) \Rightarrow \begin{bmatrix} O_{L,L} & O_{L,H} \\ O_{H,L} & O_{H,H} \end{bmatrix}$$

Each of these are known as risk arrays and establish profits and losses under various scenarios. Risk arrays can be concisely represented by the matrix R.

$$R = \begin{bmatrix} F_{i,j} \\ O_{i,j} \end{bmatrix}$$

Note that the risk array is composed of a series of pricing models and assumptions of alternative scenarios which are defined by the exchange.

The position futures and options position that person k has is:

$$\lambda_k = \begin{bmatrix} \lambda_f \\ \lambda_o \end{bmatrix}$$

In this simplified world, the minimum margin for the account of k is defined as the element of the V_k with greatest loss:

$$V_k = \lambda_k' R = \lambda_f [F_{i,j}] + \lambda_o [O_{i,j}] = \begin{bmatrix} (\lambda_f F_{L,L} + \lambda_o O_{L,L}) & (\lambda_f F_{L,H} + \lambda_o O_{L,H}) \\ (\lambda_f F_{H,L} + \lambda_o O_{H,L}) & (\lambda_f F_{H,H} + \lambda_o O_{H,H}) \end{bmatrix}$$

for derivatives with a common underlying.

To convey the essence of SPAN, the model is simplified further. Instead of the 16 scenarios that SPAN considers, two possible states of volatility and 2 possible states

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for prices ($I=2$ and $J=2$) are considered. Trader k purchases the future at price X and volatility σ. The two possible states for each of the variables are arbitrary symmetrically below (designated by L) and above (designated by H) the initial values. Consider the circumstance where this account simply holds one long futures position. So,

$$\lambda_k = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

Since the contingent state does not affect the value of the future: $F_{H,L} = F_{L,L} = F_{.,L}$ and $F_{H,H} = F_{L,H} = F_{.,H}$. The minimum margin for trader k's account is defined as the element of the V_k with greatest loss is:

$$V_k = \lambda_k' R = 1[F_{i,j}] + 0[O_{i,j}] = \begin{bmatrix} (F_{.,L}) & (F_{.,H}) \\ (F_{.,L}) & (F_{.,H}) \end{bmatrix}$$

Thus in this case, the largest loss is $F_{.,L}$ which will be designated as the margin requirement. The model can generally be depicted graphically as in Figure 1. The model shows that if P_L occurs then this agent will owe funds. Consequently, he has an incentive to default. By charging the trader $F_{.,L}$, it effectively moves the payoff function leftward, meaning that the price would have to be below $(P_{L\text{-}} F_{.,L})$ before he has an incentive to default. In this example, the trader possessed only one derivative contract so there was no benefit of "portfolio" modeling conveyed.

In the next case, Figure 2, a trader holds a position where he is short the futures contract and purchases an at-the-money call option. So the trader's account is $\lambda_k = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$

A moment of thought reveals that this trader's position is simply a long at-the-money put option. It immediately follows that the trader cannot lose money from this position. The mechanics of this reveals itself by a diagrammatic model in Figure 2.

Profit

$F_{.,H}$

0   P_L X P_H

$F_{.,L}$
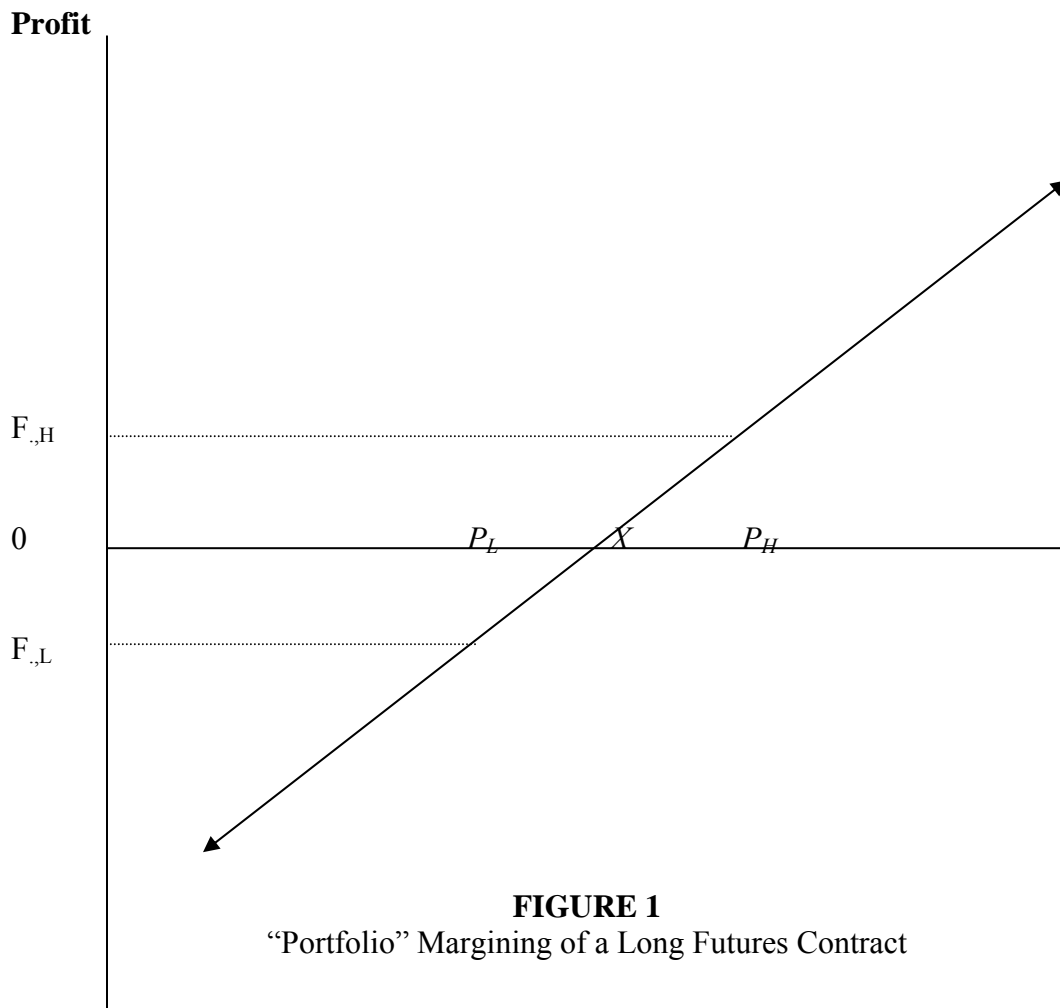
FIGURE 1
"Portfolio" Margining of a Long Futures Contract

Call

$F_H \sigma_H$

$F_H \sigma_L$

$F_L \sigma_H$

$F_L \sigma_L$

0

Future

F_H

0

F_L

Effective

$F_L \sigma_H$

$F_L \sigma_L$

$F_H \sigma_H$

$F_H \sigma_L$

0

P_L X P_H
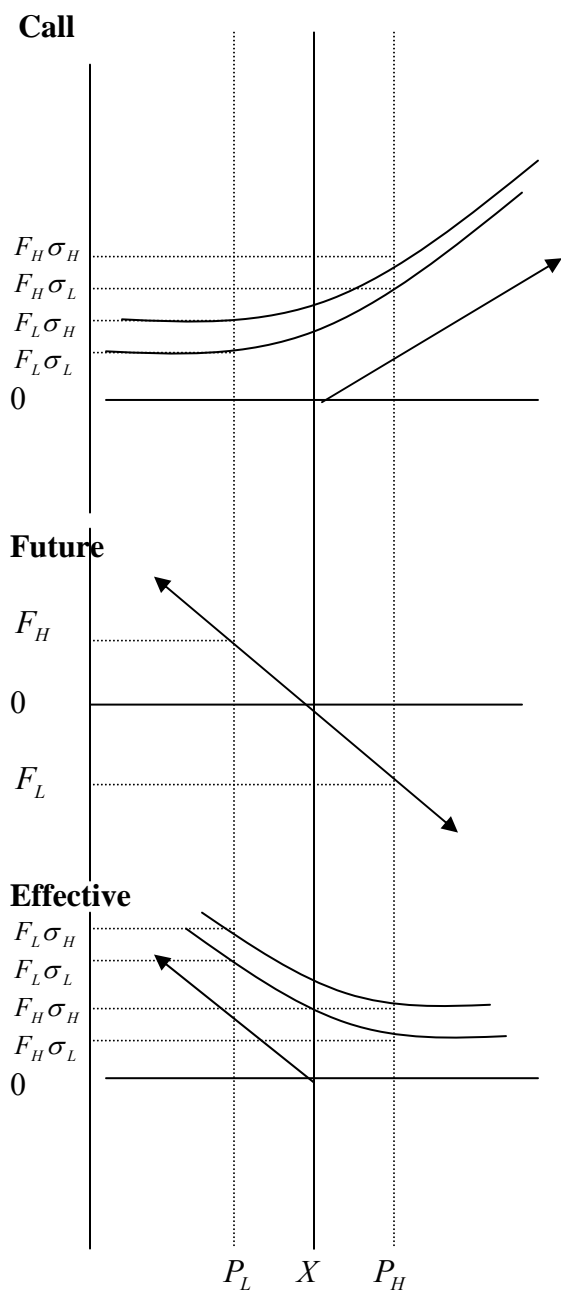
FIGURE 2

"Portfolio" Margining: Combined Long At-The-Money Call Plus Short Future

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The implication of this model is that, if the trader had to margin these contracts separately, he would not have to pay margin on the long call. However, he would have to pay significant margin on the short future as if he were exposed to market risk. When his position is taken together, it reveals that he is not at risk to the market so the logic of the requirement of presenting a performance bond breaks down. In this case, a margin requirement is economically unnecessary.

The third case to consider is the opposite position $\lambda_k = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. From the previous example, it is clear that this is really a short put option position in the market. It is therefore exposed to significant risk and a performance bond is warranted to reflect this potential loss.

In addition to explaining how risk-based margining systems function in the exchange setting, this example explains how margins reduce the incentive default; why positions need to be taken together to examine their true risk profile; and how not doing so will generate unnecessary margins. It does not address the question of whether these unnecessary margins have an impact on the microstructure of these markets which is addressed in this study.

Customer Margin Requirements

Futures Markets

Traditionally futures markets have employed a risk-based margining system. According to Gay, Hunter and Kolb (1986), commodity futures exchanges form committees that set customer margin requirements. These committees examine market

risk when setting minimum margin requirements. In determining the level of market risk, margin committees look at many factors. A prominent factor that they examine, and one that is amenable to modeling, is recent historical volatility. Based on this information, they establish margin levels which are changed when the committee feels that the underlying market risk has changed. The manner in which margins are determined is consistent with the manner scholars such as Figlewski (1984) and Telser (1981) have argued they should be. That is, these authors have argued that the economic purpose of derivatives margins is to act as a performance bond to ensure that parties abide by the terms of their contract. Setting margin requirements significantly below this level will likely result in trader default, reducing the usefulness of the instrument and thereby reducing trading and putting exchange clearing members at risk, since exchange clearing members ultimately personally guarantee contract obligations will be met. Setting margins significantly higher than these levels are likely to hamper trading.

Gay et al. (1986) provides evidence that exchanges set margins so that each contract has a probability of customer margin exhaustion Z that is relatively constant over time. The authors found that, with daily marking to the market, margins *M* were set consistent with the following model:

$$Z = 2\left[1 - \Phi\left(\frac{M}{\sigma}\right)\right]$$

where Φ is the cumulative normal density function and σ is the standard deviation of prices.

Technically, traditional futures account margining works as follows. Exchange margin committees evaluate an underlying's market risk and require a margin that is expected to withstand daily price movements to a high degree of confidence. As an example, consider the S&P 500 Index futures E-Mini contract. The notional value of this contract is $50 time the value (price) of the underlying index. Assume that the CME requires an initial margin amount for an S&P 500 E-Mini futures of $5000. A trader takes a long position of one contract. If the funds in the trader's margin account fall below the required minimum $3000, the margin account must be replenished or his position will be closed.

Table I illustrates how a futures account operates.

TABLE I
Example of Futures Margining
S&P 500 Index E-Mini Futures Contract

Event	Day	Price	Initial	Maint.	Notional Value	Value Change	Margin Account	Deposit
(a)	Day 1	$900	$5,000	$3,000	$45,000	NA	$5,000	$5,000
(b)	Day 2	$890	$5,000	$3,000	$44,500	-$500	$4,500	$0
(c)	Day 3	$859	$5,000	$3,000	$42,950	-$1,550	$2,950	$0
(d)	Day 3	$859	$5,000	$3,000	$42,950	$0	$4,450	$1,500
(e)	Day 3	$859	$8,000	$4,800	$42,950	$0		

On day 1, the trader establishes a long futures position where the underlying price is $900 for the S&P 500 E-Mini futures contract (event (a)). On day 2, the price

falls to $890, causing a notional change of $500 which is withdrawn from the long position holder's account (event (b)). On day 3, the price falls to $859 and the margin account falls to $2950 – below the $3000 minimum. To keep the position open requires the trader to replenish the margin account. He does so by adding a deposit of $1500 (event (d)).

Note that, if later in that day, the margin committee determined that underlying market volatility had significantly increased, without notice, they can increase the original required margin substantially requiring the trader to again replenish the margin account or have his position closed (for example, event (e)). For example, say the exchange increased the initial margin to $8000 and the maintenance margin to $4800. Since the trader only has $4450, he must replenish his account or it will be closed. Note that, if the position is closed, the trader will owe the broker to settle his position. Therefore, while futures markets performance bonds are not credit, there is an element of credit extension that exists.

Options Markets

The method of margin account determination in equity options markets varies considerably from the traditional futures mechanism. Conceptually, uncovered written options positions should be margined as a performance bond for the same reasons as futures. However, the Chicago Board of Options Exchange requires customer margins to be determined by a strategy-based margining system.

For written uncovered options, the margin requirement is fifteen percent of the underlying stock value plus the premium received less any out-of-the-money amount. As

an example, consider writing one uncovered call option that has a strike price of $115, trades with a premium of $6 whose underlying is currently trading at $112. The required margin would be ($112/share times 100 shares per option contract times 15 percent) + premium received of ($6/share times 100 shares per option contract) – (($115 minus $112) times 100 shares per option contract) = $1,680 (straight margin) + $600 (premium) – $300 (out-of-the-money) = $1,980. Because this option is out-of-the-money, $300 subtracted from the straight margin plus premium. For at-the-money and in-the-money options, the out-of-the-money component that is subtracted is $0.

The central point to note is that futures and options contracts have different margining systems and, in general, there is no reason to expect that margin requirements will be consistent across these derivatives exchanges.

Margins and Trading Volume

Telser (1981), Figlewski (1984) and others have argued theoretically that an inverse relationship between trading volume and margin changes must exist in derivatives markets. However, studies empirically estimating this relationship have generally failed to detect it in a consistent fashion.

Hartzmark (1986), for example, examined 13 contract-days calculating whether volume changed significantly from 15 days prior to the change to 15 days following the change, he found that in only four of thirteen occurrences did contract volume move negatively and significantly in the opposite direction. He therefore found that the relationship between margin changes and trading volume was negligible. His study

therefore did not support the proposition that increased margin requirements will decrease trading volume.

Fishe and Goldberg (1986) also attempted to measure the impact of margin changes on both open interest and volume. They examined smaller windows around margin changes (3- to 5- day windows). The contracts they examined were corn, iced broilers, wheat, gold, silver, oats, plywood, soybean meal, soybean oil and soybean futures from 1972 to 1978. They found that increased margin requirements had only a small effect on open interest. Specifically, they found that a ten percent increase in margin requirements would reduce open interest by approximately one-third of one percent. They also found, somewhat perversely, that increases in margin requirements had a positive effect on trading volume. They found that a ten percent increase in margins would increase volume traded by 14.62 percent. The result was explained by suggesting that, as margin requirements increased, volume surges as traders move to unwind their futures positions, ultimately causing a net reduction in open interest.

Dutt and Wein (2003a) argue that the Fishe and Goldberg (1986), Hartmark (1986) and other studies made a critical error in their methodology that led to their findings. Their study focused on the Fishe and Goldberg study. Fishe and Goldberg examined changes in margins implemented by margin committees. Margin committees would only change margins when they believe that the underlying asset's volatility has changed. As Gay et al. (1986) demonstrates, margin committees will attempt to set the margin requirement in such a way as to hold the margin requirement to volatility ratio constant (therefore leaving the probability of margin exhaustion constant). Dutt and Wein

point out that the interest in derivatives is a positive function of uncertainty (Cornell, 1981). Therefore, although, margin requirements are a cost of holding a derivates contract, increased volatility increases the benefit of holding a derivative contract as well. If margin committees change margin requirements to hold the margin to volatility ratio constant, then one would expect no stable relationship between endogenous changes in margins (i.e., margin changes by the exchange committee) and trading volume. Exogenous margin changes that change the ratio of margin requirements to volatility would be expected to negatively affect trading volume. After adjusting the model appropriately, Dutt and Wein found that, in all cases, exogenous changes in margin requirements changed trading value in the opposite direction, in line with Telser's and Figlewski's argument.[6]

Margins and Regulation

In equity markets, margins are considered loans. In derivatives markets, margins are considered bonds to ensure contract performance. Consequently, the Federal Reserve Board under the Securities and Exchange Act of 1934 was given the responsibility to set margins on stock purchases. Currently, the Federal Reserve has set margin requirements

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[6] An interesting finding of this paper was that financial futures contracts were more sensitive to changes in margins than storable agricultural futures contracts. The authors explained this finding by noting that a storable agricultural commodity is subject to shortages. At times of shortage, the convenience yield of having the commodity today becomes extremely high. Committees change margin requirements rapidly at these times. However, the cost of margins is dwarfed by the large convenience yield in times of shortage. Financials are not subject to shortages. Thus, financial contracts are more sensitive to margin costs than agricultural contracts (see, Working , 1948; Dutt, Fenton, Smith and Wang , 1997).

at 50 percent.[7] For example, under Regulation T a person cannot borrow more than fifty

percent on a stock for its purchase. On the other hand, derivatives exchanges have

generally been given free reign to set performance bonds as they see fit and they have

chosen risk-based margining systems in practice.[8]

According to Kupiec (1997), " the 1934 US Congress established Federal Margin

Authority with three apparent objectives: to reduce the use of "excessive" credit in

securities transactions, to protect investors from over-leveraging and to reduce volatility

of stock prices". Thus, the notion that leverage causes price volatility and the justification

for the Federal Reserve Board to control margins was that it could reduce such volatility.

The proposition that excessive speculation leads to price volatility has also been

codified by the Commodity Exchange Act (CEA) in relation to futures derivatives. For

example, Section 4a of the CEA provides that the CFTC or regulated futures exchanges

establish limits on speculative futures trading under the presumption that excessive

speculation may lead to excessive price volatility.[9]

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[7] The Federal Reserve Board sets margin requirements on securities lending through
Regulations T, U, G and X.
[8] Kupiec (1997) notes that while the CFTC, the regulator of futures markets, has been
given the power to approve margining systems, it was expressly denied the power to set
margin requirements for futures and options contracts under their jurisdiction.
[9] Sec 4a.[7 U.S.C. 6a] says "Excessive speculation in any commodity under contract of
sale of such commodity for future delivery made on or subject to the rules of contract
markets or derivative transaction execution facilities causing sudden or unreasonable
fluctuation or unwarranted changes of the price of such commodity is an undue and
unnecessary burden on interstate commerce in such commodity." On this premise, it
proceeds to justify speculative position limits.

Regardless of the differences in margining requirements in different financial markets, a continual governmental concern surrounds the systemic risk that inadequate margining is deemed to present.

The contracts examined in this analysis have a few complications of importance. Although derivatives contracts are generally margined in a risk based framework, margin regulation in the US equity options markets, including the SPI options, are notable exceptions. Equity options markets use a strategy-based approach to margining. As previously noted, this system is more similar to the margining of a stock transaction rather than derivatives transaction margining.

With regard to SPI futures, margining is effectively risk based. However, it has arrived in that circumstance in a peculiar manner. Although futures contract margins had not been set by the government historically, in 1992, Congress transferred margin setting authority of the SPI futures to the Federal Reserve Board. In practice, the FRB has delegated the authority to the CFTC who relies on the exchanges to determine margin requirements. Thus, while the government technically regulates S&P 500 futures margins, in practice, the exchange still does.

Margins and Excess Volatility

The impact of margin requirements has understandably been researched in both securities and derivatives markets. Of particular interest has been the effect of margin levels on price volatility (i.e., the excess volatility hypothesis).

In general, the findings in both the securities and futures markets has shown little support for the contention that increases in credit margins in the stock market or performance bond margins in the futures market lead to decreases in price volatility.

Federal Reserve Board, through Regulations T and U, provide limits as to the amount of margins that may be lent for the equity purchases. Although Hardouvelis (1988, 1990), in examining the influence of these credit margin requirements, concluded that credit margins appeared to be positively associated with price stabilization, many academics disagree on theoretical and empirical grounds (Telser, 1981; Figlewski, 1984; Schwert, 1988; Hsieh and Miller, 1990; Kupiec, 1989). For example, Hsieh and Miller (1990) showed that Hardouvelis' findings were a result of spurious correlations due to his estimation procedures.

Likewise, studies have been conducted in the futures markets to examine whether low margins are associated with price instability. Fishe et al. (1990) examined ten commodity contracts traded on the Chicago Board of Trade and Kupiec (1993) examined stock index futures. Both studies were unable to find the negative association between margin changes and price variability. Hence, they did not find consistent evidence in futures markets that margins could be used to stabilize prices.

The assertion that increases in margins decrease price volatility can be decomposed into three components. The assertion suggests that increases in margins will decrease trading volume, which will in turn reduce speculation, which will in turn reduce price volatility (since speculators are alleged to cause price volatility). Many of these

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connections have been examined in the futures markets since, unlike in the equities

markets, margin changes occur with relative frequency.[10]

As previously mentioned, a presumption of the CEA was that excessive

speculation may lead to excessive price volatility. However, the consensus of academic

work does not support this assertion as a general proposition.[11] For example, Gray

(1967) found that it is lack of speculation that leads to increased price volatility. Gray

(1979) did not find evidence that short speculation leads to depressed prices to add to the

existing literature that long speculation does not lead to inflated prices. Rutledge (1979),

in examining the temporal relationship between price volatility and speculation, found

that price volatility does not temporally follow increases in speculative trading. Nathan

(1967) found that high levels of speculation were associated relative price stability, while

low levels of speculation was associated with relatively volatile price behavior (Kuhn,

1980).

Margins and Systemic Risk

Systemic risk can generally be defined as an externality in which crisis in one area

of the financial system propagates to other areas of the financial system.   The process

can be envisioned as follows.   If large customers default on their derivative positions,

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[10] In addition, aggregated hedger/speculator data is available from the CFTC to help aid analysis.

[11] However, academic arguments have been made to justify position limits to mitigate the incentive to manipulate the market. Kyle (1984) argues that position limits may prevent corners/squeezes for physically settled derivatives contracts. Dutt and Harris (2005) argue that position limits may prevent manipulation of cash settled derivatives contracts with illiquid underlyings. Thus both analyses argue that position limits can be potentially welfare improving. These arguments, however, presuppose that exchange surveillance is inadequate.

and the clearing members and clearinghouses do not have sufficient capital to cover those positions, the exchange would collectively default on large bank lines of credit. This in turn would require banks to sell assets and decrease their loans supplied and therefore contract the supply of money in the economy. Ultimately, this type of monetary contraction is known to lead to substantial contractions in real economic activity (e.g., financial accelerator theories).

Whether equities or derivatives, the key underpinning behind the notion that inadequate margin requirements will result in systemic risk appears to emanate from the power of leverage. Leverage can be defined as the ability to purchase an asset though debt rather than equity financing. In a world of efficient capital markets and symmetric information (and no taxes), the Miller and Modigliani Theorem has shown that leverage does not matter. This is essentially the logic behind Black's (1976) argument that the level of margining requirement does not matter. Despite this, in reality, there is a presumption that increase leverage in financial markets may lead to systemic risk to the economy.

The notion that leverage can cause price volatility is essentially the debate as to whether speculation is stabilizing or destabilizing. Leverage creates the ability for agents to speculate on directional movements in price in order to earn a profit. Friedman has argued that speculation is stabilizing. In Friedman's view, speculators who buy when the price is under the true value and sell when prices are above the true value will earn profits and financially survive. On the other hand, speculators that engage in trading that move prices away from equilibrium values will be penalized in the market and forced to exit.

Thus, speculation is stabilizing. In this view, greater leverage may entice speculators to enter the market and reduce price volatility as prices will not be allowed to move far from true values.

This is contrasted to the general conception of herding. In a world of asymmetric information, traders may rely on the price as a signal of information since they lack fundamental information. Thus, as an asset's price rises, speculators will buy and force the price away from the asset's true value. On the other hand, when the price falls, speculators will sell forcing the price away from the asset's true value. Herding therefore generates increased price volatility. To the degree that speculators are more likely to use leverage and herd, higher margin requirements can reduce price volatility.

Increased price volatility can cause systemic risk by increasing the chances that traders default on their contractual obligations if the defaults are of such a magnitude that they threaten the solvency of clearing members and clearinghouses. Some argue that increases in margin requirements would increase the chances that a clearing system will remain solvent. Bernanke (1990) argues that the use of margin requirements to protect against macroeconomic risk is inappropriate and that this approach has profoundly negative economic consequences. Instead, in Bernanke's view, market crashes are not privately insurable. He argues it is the job of the government to act as the insurer of last resort and, with respect to financial markets, this duty has been assigned to the Federal Reserve. Bernake examined the 1987 market break. He noted that exchanges are really financial intermediaries that have banking and insurance functions. They delegate much of their work to banks and rely heavily on the availability of bank lines of credit. During

a market break, banks reduce lines of credit for fear of further default. During the 1987 market break, he noted the Federal Reserve stepped in to support bank credit lines. Thus, he concluded that the Federal Reserve played a vital roll in protecting the integrity of the clearing and settlement systems during the crash.

Costs in Financial Markets

The first law of demand says that, as the price of an asset increases, the quantity demanded per unit of time falls. This reflects the fact that economic agents will avoid cost increases to preserve finite wealth. It also indicates that time is a critical element in the demand for an asset. At any point in time, the number of buyers of an asset may not equal the number of sellers and thus, an order imbalance will occur. Given the imbalance, an opportunity exists for a middleman to hold inventory to sell to buyers when they require the asset immediately or to buy from sellers when they wish to sell the asset immediately. In order for a middleman to provide this service, he must defray a number of inherent costs. The existence of these middlemen is evidence that it is difficult for buyers and sellers to find each other and paying the middleman his half-trip spread is more cost effective than the costs of search.

Demsetz (1968) explored the existence of middlemen in securities markets and examined the impact of transaction costs in these markets. According to O'Hara (1995), this study was a critical building block for what is known today as financial market microstructure. A critical observation of Demsetz is that the transaction costs depended, among other things, on the industrial organization of the markets.

Following Demsetz (1968), the components of a major transaction cost in financial markets, that is, the bid ask spread, has been analyzed acutely. Various models identified different aspects of how the bid ask spread was determined. The fact that buyers and sellers face uncertainties about when they will find matching sellers and buyers is part of the reason that buyers and sellers will pay a premium for dealer services. The dealer therefore faces these uncertainties in order flow and therefore he faces uncertainties in inventory accumulation. These aspects have been examined by Garman (1976), Ho and Stoll (1981) and Cohen, Maier, Schwartz and Whitcomb (1981).

Another branch of bid ask spread analysis examined the effect of the informed traders on the bid ask spread. Specifically, from a dealer's perspective, there are two types of traders that he can face, but cannot distinguish. The first is the uninformed trader and the second is the informed trader. Since the dealer is presumably uninformed, when he faces an uninformed trader, in the long run, he can expect to break even. However, when he faces an informed trader, he can expect to make a loss. To stay in business, he must cover these losses. Thus, the bid ask spread must be increased to compensate for adverse selection costs associated with the dealer's trades with informed traders. These models have been investigated by Copeland and Galai (1983), Glosten and Milgrom (1985) and Easley and O'Hara (1987).

<u>Costs and Price Discovery</u>

Fleming, Ostdiek and Whaley (1996) find the trading costs affect the rate of price discovery in stock, options and futures markets. They assert that, in a perfectly frictionless and rational market, any new information must be incorporated

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simultaneously or arbitrage opportunities would arise. However, the existence of trading

costs inversely affects price discovery. They contrast this trading cost theory of price

discovery with the leverage hypothesis. The leverage hypothesis states that price

discovery will occur in markets that require lower capital outlays. However, the authors

note that the leverage hypothesis is inconsistent with empirical evidence. For example,

index futures prices in general lead the stock market in terms of price discovery. Futures

markets have both lower trading costs and more potential leverage. However, the stock

market leads the equity options market in price discovery. The equity options markets

have higher transactions costs, yet they have more leverage. Thus the authors conclude

that price discovery will generally occur in the least expensive market since information

traders will execute on the market that will generate the highest profit for them.

Fleming et al. argue that trading costs include at least (1) the market maker's bid

ask spread, (2) the broker's commission and (3) the market impact cost for large trades

which may signal an informed counterparty. Ates and Wang (2005) examined relative

price discovery in foreign exchange futures markets that trade the same underlying

currency on different trading platforms (floor versus screen trading). They conclude that

there is an operational cost differential that also affects price discovery. Thus, if margins

are a cost to the trader, price discovery can be affected as well.

Margins as Costs and Bid Ask Spreads

Two significant costs that traders face are bid ask spreads and, conceptually,

margins. Despite the inconsistent empirical literature as previously discussed, there are

strong theoretical reasons to suggest that margins are a cost to the trader and that it may,

in turn, affect bid ask spread. Figlewski (1984) and Telser (1981) have argued that

margins are a cost to the trader. Consistent with this hypothesis, Dutt and Wein (2003a)

have found exogenous margin increases negatively affect trading volume. Brennan

(1986) makes an intuitive argument why this is must be so. Margins are a performance

bond to guarantee the performance of a contract. Futures markets are marked-to-market

daily and thus require a smaller performance bond than similar forward contract of N

days (N>1). Many traders choose to engage in futures contracts rather than forward

contracts despite additional costs (costs associated with daily marking to the market,

basis risk, etc.). This implies that there is some additional benefit that traders receive

using futures over forward contracts. The primary difference in these two contracts is the

level of performance bond that must be offered to initiate the contract. Thus, it appears

that putting up performance bond funds are a cost to the trader. Telser (1981) argument

assumes traders have precautionary demand for holding liquid assets. Higher margin

requirements reduce a traders precautionary balances.[12] Therefore the trader is forced to

hold a smaller derivatives position to establish an appropriate level of precautionary

reserves.[13] For these reasons, margin requirements are considered a cost to the trader.

Mayhew, Sarin and Shastri (1995) find that changes in margin requirements in

options markets influence the bid ask spreads in both the underlying market and the

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[12] In lieu of cash , certain other assets such as treasury securities may be posted as margin
in futures markets. Since these are interest bearing, a common argument is that there is
therefore no opportunity cost of posting the margin. Telser's argument suggests that
treasury securities are part of precautionary balances and thus have the same effect as
posting cash.
[13] This is consistent with the way banks have been found to act. For example, see
Kashyap and Stein (2000).

options market as well. The market microstructure mechanism is theorized to work as follows. Market makers face adverse selection risk because of asymmetric information. They understand that, when they trade with an informed trader they can expect to lose money, while they expect a zero profit when they trade with an uninformed trader. Because of the presence of informed traders, they must increase their bid ask spread on all traders since they cannot identify informed versus uniformed traders. It follows that markets with relatively large numbers of informed traders will face large bid ask spreads.

Because informed traders expect a profit from their trade and uninformed traders do not, uniformed traders will be less willing pay to make a trade and therefore they are likely to be more sensitive to changes in costs such as the bid ask spread. The insight of Mayhew et al. was that margins are a cost to the traders and, as margins in the options markets became relatively larger, uninformed traders at the margin would be better off in the underlying market. As a consequence, market makers in the options market will increase their bid ask spreads while market makers in the underlying will decrease their bid ask spreads since the proportion of uninformed traders in the market has increased.

An implication of Subrahmanyam (1991) is that this process may be particularly strong for the S&P 500 index options contracts. Subrahmanyam suggests that index contracts should have a significant composition of uniformed investors. This is because uniformed investors that trade in underlying markets face significant adverse selection costs imbedded into the bid ask spread, as market makers attempt to protect themselves from trading with informed traders. Because index contracts face less potential exposure to informed traders with firm specific information, index contract will tend to attract

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uninformed investors. This implies the sensitivities of margin costs between index derivative markets may be quite high. Thus it is expected that the microstructure process described in Mayhew et al. may result in small changes in relative margin cost leading to large changes in market share.

The changing participation in markets due to changes in costs as Subrahmanyam and others have argued is consistent with the findings of Hartzmark (1986) and Chatrath et al. (2001) under the assumption that margin requirements are a cost. Hartzmark assumed that increases in margin requirements would impose a cost on traders and thus reduce trading volume. However, he concluded that using margins to reduce speculative volume would be a dangerous policy tool because it is unlikely to impact traders uniformly and may force classes of traders out of the market who are informed, possibly ultimately resulting in greater price volatility. Chatrath et al. (2001) also examined the types of traders that are affected by margin changes in COMEX gold and silver futures markets. They found that speculators and small traders were particularly sensitive to margin changes.

Substitutability of Futures and Options Markets

There is a question as to the degree to which futures and options on the same underlying are substitutable. Futures are often used for inter-temporal smoothing. Options are unique in that they are close to state claim assets and therefore can potentially help complete the market.

However, several arguments can be made as to why they may be substitutable. One argument is that futures and options with like underlyings directly compete since

traders can create synthetic futures through options. The argument is that a long (short) futures contract can be replicated through purchase of a long (short) at-the-money call and a short (long) at-the-money put.

However, there are other purposes for which futures and options may be substitutable. For example, a hedger could hedge an underlying using either futures or options contracts. If transaction costs were equal, the option would cost more to perform this function since the hedger would be required to pay a premium for this right whereas he can enter a futures contract at zero premium. However, one can envision a situation where the transaction cost of the futures is so high that the hedger would rather pay the option premium.

Similarly, a risk neutral trader who was informed would consider trading through either market as well. For similar reasons, he would also likely prefer the future given costs of transacting are equal. However, a similarly informed trader who is risk averse may trade the option instead, even if transaction costs are the same in both markets. The above examples assumed that transaction costs were the same. However, it clear that if transaction costs differed in futures and options markets substantially, it is possible the preferred venue of trading would change. Thus, it is envisioned that substitution of traders between markets should result from changes in margin costs and bid ask spreads.

3. Methodology and Data

The differences in SPI options and SPI futures margins may be illustrated as follows. Consider an upward trending market where the variance of price is constant through time but the means are moving by some constant drift factor. In theory, SPI futures margin committees that use a risk-based methodology will see no reason to change the margin requirements over time and therefore customer margin requirements for trading the future will be constant. On the other hand, as the price is increasing over time, the margin requirement of writing an uncovered SPI option increases since it is fundamentally based upon a percentage of price. If margins are, in fact, a cost to the trader and there is a significant degree of substitutability between the markets, the expectation is that the market share of futures would begin to increase as it becomes relatively cheaper to trade the SPI futures than SPI options.

In general, the objective is to construct the analysis to understand the impact of the changes in relative margin requirements on substitution between these markets. Substitution in these markets will most likely take place between the nearby (closest expiring) futures contract and the at-the-money options contract. The most liquid contract in futures markets is generally the nearby. Traders wishing trade beyond the three month term of the futures contract will generally trade into the next furthest out contract approximately eight days into the expiring month. In options markets, it is

generally the case that at-the-money options are the most actively traded. Contracts become successively more illiquid as they become further in-the-money or out-of-the-money. Further, if a trader was motivated to substitute between futures for options, at-the-money options and futures start from close to the same baseline price. For these reasons, this analysis concerns itself with nearby futures and at-the-money options (both puts and calls).

The first step in this process is to define the SPI futures and options market trading volume. Let O_t^P and δ_t^P be the SPI put options trading volume and its delta on day t for the at-the-money series (i.e., option that has a common strike and expiration). Likewise, let O_t^C and δ_t^C be the SPI call options trading volume and its delta on day t for the at-the-money series. Similarly, let F_t be the SPI futures trading volume on day t for the nearby expiration. The SPI futures equivalent trading volume is then defined as:

$$F_t^E = F_t + 0.4(\delta_t^P O_t^P + \delta_t^C O_t^C) = F_t + O_t$$

The underlying notion of this analysis is that there is some substitutability between SPI futures and options contracts in that one may be relatively cheaper to hold the same leveraged position. This calculation necessitates two adjustments on the option trading volume. Generally, these options will have a delta that is less than one. That is, when the underlying moves by $1, the option premium will change by less than $1. On the other hand, the delta on the future will be essentially $1. Consequently, some number of options contracts greater than one will be worth one futures contract, even if they were the same notional value. However, the notional values of SPI options and futures contracts are not equal and therefore requires a second adjustment. SPI Futures contracts

settle at 250 times the index value while the SPI options contracts settle for 100 times the

index. Thus, options contracts are calculated as forty percent of futures volume to

account for the smaller notional values of options contracts.

Accounting for such differences, a measure of the degree to which the SPI options

margins exceed futures margins is constructed as:

$$\Gamma_t^O = \frac{1}{0.4}\left(\left(\frac{O_t^P}{O_t^C + O_t^P}\right)\left(\frac{M_t^P}{\delta_t^P}\right) + \left(\frac{O_t^C}{O_t^C + O_t^P}\right)\left(\frac{M_t^C}{\delta_t^C}\right)\right) - M_t^F$$

where M_t^F is the futures margin requirement and day t, M_t^P is the margin requirement

for the at-the-money put series on day t and M_t^C is the margin requirement for the at-the-

money call series on day t. Alternatively, the SPI excess options margins can be

expressed as a proportion:

$$\tilde{\Gamma}_t^O = \frac{\Gamma_t^O}{M_t^F}$$

Econometric Methods

Background: Questions to be Addressed

The econometrics of this study is designed to answer four questions:

(1) Is there an economic link between SPI options and futures trading volume?

(2) Do excess SPI options margins impact trading volume in SPI options markets?

(3) Does excess SPI options margins increase SPI futures trading volume?

(4) Does excess SPI options margins change relative market bid ask spreads?

The first question simply asks whether there is a basic statistical relationship

between related derivatives markets. The hypothesis is that trading volumes of futures

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and options may respond to the same market forces. For example, increases in volatility (uncertainty) should increase the trading volume of both futures and options markets (e.g., Cornell, 1981).

The second question relates the impact of costs on a trading volume. It is accepted that the bid ask spread is a cost to the trader. As such, it is expected to empirically impact trading volume. This is important to establish a baseline of how costs affect trading volume. In this model, the excess margin variable is incorporated to determine if it has any impact as a cost on trading volume. Even if excess options margins reduce trading volume, it is not clear that some of the loss in options trading volume will move to futures markets. If this were the case, it would imply a larger deadweight loss from excess options margins if there exist no better substitutes.

The third question examines whether there is an indication that excess margin costs in options markets increases future trading volume. If so, this supports the contention that derivatives markets with the same underlying are substitutes. However, it is plausible that there is no relationship or perhaps even a complementary relationship.

The fourth question addresses a theory of market microstructure which suggests that if margins are costs, increases in excess options margins should increase options bid ask spreads relative to those in the futures markets. The proportion of uninformed traders is likely to be relatively high in index contracts. Further, uninformed traders have been found to be more sensitive to costs than informed traders. Thus, if there is substitution between markets, it is expected that uninformed traders to move from option to futures markets when costs in options markets become relatively high. With a higher proportion

of uninformed traders now in futures markets, the bid ask spreads should narrow as adverse selection costs faced by the market makers fall. Likewise, with a larger probability of market makers in options markets now facing an informed trader, options bid ask spreads should widen.

Background: Time Series

In financial time series, it is not unusual for a variable of interest, for example a price, to be non-stationary. The consequence of this non-stationarity is that regressions may produce spurious results. Because it is likely with financial time series that a variable will follow a stochastic trend and will be integrated to order one, it is important to test for its existence and use a first difference will make the variable stationary, if appropriate.

The method chosen to examine if times series variables are stationary is the Augmented Dickey Fuller (ADF) test. Briefly, the ADF test checks for whether there is a unit root in the series. If there is, then variable does not possess a constant mean, variance and autocovariances for each lag.

The ADF test is specified as follows:

$$[1] \; \Delta y_t = \psi y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + u_t$$

The inclusion of Δy_{t-i} {for i=1 to p} presumes that the error term would be autocorrelated without these variables. It is an attempt to model the autocorrelation so the error term is, in fact, white noise. Given the error term, u_t, is white noise under this specification, the parameter ψ is examined.

The null hypothesis is $\psi=0$, that is, the series y_t has a unit root. The alternative

hypothesis is that $\psi<0$. If $\psi<0$ and it is statistically significant according to Dickey-

Fuller critical values, then it can reasonably be concluded that the series does not have a

unit root. In other words, the effect of any shock to the system will die off and the series

y_t is stationary. Therefore, statistical methods can be validly applied to y_t. If the null

hypothesis cannot be rejected, then the series Δy_t must be tested:

$$[2] \ \Delta^2 y_t = \psi \Delta y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta^2 y_{t-i} + u_t$$

In other words, a test must be performed to determine if the null hypothesis that

Δy_t has a unit root can be reasonably rejected. This process is repeated until the null

hypothesis can reasonably be rejected. However, it is reasonable to expect that a

financial time series variable y_t is likely to be integrated to order one (I(1)) and thus it is

expected that [1] will be not be able to be rejected [2] will be rejected.

There are two complications to this test. The first involves the critical values

since they are not appropriately characterized by the student's t distribution as a

consequence of non-stationarity. The appropriate critical values for rejection are Dickey-

Fuller critical values and their estimated values are defined in Fuller (1976). The second

complication involves defining the appropriate p lags in the model. This is done through

an information criterion.

Increasing p increases the number of explanatory variables and therefore tends to

increases the explanatory power. However, there is a loss in the degrees of freedom by

adding additional variables. The information criterion seeks to choose a number p such

that the value of the information criterion is minimized. While there are several different measures of information criterion, Akaike's (1974) Information Criterion (AIC) is used in this analysis. This is represented as:

$$AIC = \ln(\hat{\sigma}^2) + \frac{2k}{T}$$

where T is the sample size and $k = p + q + 1$. Here q is the number of previous lags of the disturbance term that affects the univariate time series y_t ($y_t = \mu + \sum_{i=1}^{q} \theta_i u_{t-i} + u_t$).

Likewise, p is the number of previous lags of the time series y_t itself that affects the current series y_t ($y_t = \mu + \sum_{i=1}^{p} \phi_{ii} y_{t-i} + u_t$).

Model for Question 1: Is there an economic link between SPI options and futures trading volumes?

This models presented here provide evidence of whether options and futures trading volume variables are bound together by some long run relationship consistent with substitution between these markets. If futures and options volumes are not stationary, this question if examined by testing whether the volume series are cointegrated with each other. If the volume series are stationary, their relationship is examined by a vector autoregressive model.

The cointegration model is first considered. As previously stated, it is common for financial time series variables to be integrated of order 1, (I(1)). Given this assumption that futures volume F_t and futures equivalent options volume O_t are each I(1), a linear combination of these variables is expected to be I(1) as well in general. An

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exception to this rule occurs when the two variables are cointegrated. In such a case, the linear combination of I(1) variables is expected to be of I(0), i.e., follow a stationary process. The economic implication of cointegrated variables is that there exists some force that binds together the component variables to a long run relationship. It is the hypothesis in this analysis that substitution between related derivatives markets will generate this long run equilibrium relationship and thus F_t and O_t will be cointegrated.

While, in general, a structural relationship between stationary differenced variables exhibits no long run relationship, if the variables are cointegrated, the relationship can be described by an error correction model.

The Johansen method is employed to directly test the cointegrating relationship between options and futures trading volume. Consider the vector z_t:

$$z_t = \begin{bmatrix} F_t \\ O_t \end{bmatrix}$$

The following vector autoregressive system (VAR) can be specified:

$$z_t = \beta_0 + \beta_1 z_{t-1} + \beta_2 z_{t-2} + \cdots + \beta_k z_{t-k} + u_t$$

β_0 is a 2 by 1 constant vector, $\beta_1 - \beta_k$ are 2 by 2 coefficient matrices and u_t is a 2 by 1 error vector. Akaike's Information Criterion is used to determine k. Letting

$$\Pi = \left[\sum_{i=1}^{k} \beta_i \right] - I_2 \text{ and } \Gamma_i = \left[\sum_{j-1}^{i} \beta_j \right] - I_2, \text{ the VAR system can be transformed into the}$$

vector error correction model (VECM):

$$\Delta z_t = \Pi z_{t-k} + \Gamma_1 \Delta z_{t-1} + \Gamma_2 \Delta z_{t-2} + \cdots + \Gamma_{k-1} \Delta z_{t-(k-1)} + u_t$$

In the long run, the expectation is that $\Delta z_{t-1} - \Delta z_{t-(k-1)}, u_t$ will all equal zero. Consequently, the Johansen test examines Π to test for cointegration among the z_t variables.[14]

If the volume series are stationary a vector autogression model is an appropriate tool t examine the temporal relationship between among the pair. The AIC criterion is under to establish the appropriate lag level.

Model for Question 2: Do excess SPI options margins impact trading volume in SPI options markets?

Options trading volume and the market's bid ask spread are theoretically simultaneously determined. Following other empirical work such as George and Longstaff (1993) on this relationship, the following two equation simultaneous system is postulated:

$$\ln(O_t) = \phi_0 + \phi_1 \ln(BA_t^O) + \phi_2 \ln(\sigma_t) + \phi_3 \ln(r_t) + \phi_4 \ln(\Gamma_t^O) + \phi_5 \ln(I_{t-1}^O) + \phi_6 \ln(O_{t-1}) + \phi_7 \ln(P) + \varepsilon_t^O$$

$$\ln(BA_t^O) = \delta_0 + \delta_1 \ln(I_{t-1}^O) + \delta_2 \ln(O_t) + \delta_3(\sigma_t) + \delta_4 \ln(\Gamma_t^O) + \delta_5 \ln(P) + \delta_6 \ln(BA_{t-1}^O) + e_t^{BA^o}$$

where P is the average price on day t, BA_t^O is the options realized bid-ask spread in the options markets, σ_t is the *intraday* volatility, I_t^O is the lagged options open interest, r_t is a risk free interest rate, and Γ_t^O is the excess margin over performance bond requirement in level terms. This equation system will be estimated using two-stage least squares.

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[14] Brooks (2002) provides a detailed description of the Johansen cointegration test.

Model for Question 3 and 4: Do excess SPI options margins increase SPI futures trading volume? Do excess SPI options margins change relative market bid ask spreads?

These questions are addressed utilizing a simultaneous equation system since bid ask spreads and trading volumes are theoretically jointly determined:

$$\ln(\frac{O_t}{F_t}) = \beta_0 + \beta_1 \ln(\frac{BA_t^o}{BA_t^F}) + \beta_2 \ln(\sigma_t) + \beta_3 \ln(r_t) + \beta_4 \ln(\widetilde{\Gamma}_t^O) + \beta_5 \ln(\frac{I_{t-1}^o}{I_{t-1}^F}) + \beta_6 \ln(\frac{O_{t-1}}{F_{t-1}}) + \beta_7 \ln(P) + \varepsilon_t$$

$$\ln(\frac{BA_t^o}{BA_t^F}) = \alpha_0 + \alpha_1 \ln(\frac{O_{t-1}}{F_{t-1}}) + \alpha_2 \ln(\frac{O_t}{F_t}) + \alpha_3 \ln(\sigma_t) + \alpha_4 \ln(\widetilde{\Gamma}_t^O) + \alpha_5 \ln(\frac{BA_{t-1}^o}{BA_{t-1}^F}) + \alpha_6(P) + e_t$$

BA_t^F is the realized futures bid ask spread, I_t^F is the futures open interest, and $\widetilde{\Gamma}_t^O$ is the

proportion of options margin to futures margin at time t. The central parameters of

interest are those of the excess options margin variables, β_4 and α_4. If increases in

excess option margin requirements cause options trading volume to fall relative to futures

trading volume as hypothesized in this study, the expectation is that parameter β_4 will be

significantly negative if substitution is occurring. Further, if excess options margins

increase and uninformed traders migrate to the futures markets, the bid ask spread of

options relative to futures should increase. Consequently, α_4 should be positive and

significant.

<u>Estimation of Cost of Market Maker Services</u>

This section discusses the estimation of the bid ask spread in the futures and

equity options markets in general and the SPI derivatives in particular. The most

significant cost of transacting in organized financial markets is bid ask spread (Fleming et

al., 1996). Options markets have quoted bid ask spreads. However, the dealer quote is the maximum favorable price that the dealer can transact (of a defined size) by rule. Thus, quotes in the equity options markets are referred to as firm quotes. However, this is not necessarily the real cost of transacting to the customer. It is common for dealers to quote spreads wider than those at which they would actually be willing to transact. When a trade is made, frequently the transacted price is superior to the quoted price from the customer's perspective. This is called price improvement. This represents the real cost of the market making services, i.e., effective bid ask spreads. Futures markets, on the other hand, do not have quoted spreads. The cost of market making services is imbedded into the futures transaction price. However, examination of the price behavior throughout the day can be used to estimate the average cost of market making services in futures markets. This is referred to as the realized bid ask spread.

Bid Ask Spread in Futures Markets

The daily estimates of realized bid ask spreads in the SPI futures market is constructed following Wang et al. (1994). The methodology is referred to as the absolute price reversal methodology. Data available to estimate the bid ask spread provide transaction prices and their time stamps as they occurred throughout a trading day if the price changed from the previous value. This dataset does not contain information on trades. The price reversal methodology consists of analyzing the data to provide one estimate of liquidity per day that is called the mean absolute price reversal.

The concept can be explained as follows. Market makers in the SPI futures markets do not post quotes, rather they buy at a slightly lower price than the true value

and sell at a slightly higher price. However, the only information that is available is the prices at which transactions occur. If no information entered throughout the day and the true value remained constant, high prices would denote dealer sales and low prices would denote dealer buys, in general. That is, relatively low and high transaction prices will be indicative of what is termed the bid ask bounce. The problem is that information enters the market throughout the day which masks the bid ask bounce. The absolute price reversal methodology attempts to estimate the bid ask bounce and throw out changes in price due to information flow. It does this by asserting that when prices continue to increase, or prices continue to decrease, it is indicative of information entering the market. The bid ask spreads resulting around information trades are not therefore taken into account. The remaining trades convey the bid ask bounce. These trades can be examined to estimate an average liquidity measure.

According to Ates and Wang (2005) the procedure to estimate realized bid ask spreads is as follows:

(1) create an empirical joint distribution of the SPI futures price change ΔP_t and its lag ΔP_{t-1}

(2) discard the subset of price changes that exhibit price continuity through time. This attempts to eliminates trades that move prices based upon changes in fundamental information.

(3) Calculate the absolute value the price changes, i.e., $\left| \Delta P_t \right|$ for the non-continuity subset.

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(4) Calculate the average of $|\Delta P_t|$ for the day to get an estimate of the round trip

  cost of transacting for that day.

Bid Ask Spread in Options Markets

In equity options markets such as the SPI options market, market makers post

quoted bid ask prices. In practice, trades occur at more favorable prices than the posted

bid ask spreads suggest. Price improvement occurs as a matter of competition.

Consequently, the real cost of trading is reflective in the effective spreads, that is, the

spread that the customer actually pays.

Ideally if it is known that a transaction is a buy or a sell and the transaction price

is known, then one –half of the bid ask spread can be determined by subtracting the

transaction price from the true value of the underlying asset. However, the true value is

not known but can be estimated from the quoted prices. For example, say the bid was $9

and the ask was $11. At the time the quote is active a buy transaction takes place at

$10.50. The quoted spread is $11-$9=$2. But this is not reflective of the effective

spread. To see this,

  (1) assume the true value of the asset is at the midpoint of the quote. In this case, it

    would be ($11+9)/2=$10.

  (2) for buy transactions, subtract the estimated true value from the transaction price.

    In this example, it would be $10.50-$10.00 equals $0.50 for a one-half trip.

    Multiplying this by 2 results in the true cost of market making services of $1.00,

    not $2.00 as the quoted spread indicated. Bid ask spreads for sale transactions are

    computed similarly.

There are, of course a number of complications in calculating effective bid ask spreads. First, in equity options markets, each exchange posts their bid ask prices. By rule, the transaction price must occur within the most favorable bid and the most favorable ask that any of the exchanges offer. Thus, effectively, there is a best bid and ask at any instant of time. While these quotes are active, transaction prices must occur within the bound.   Once the best bid and offer is established the above procedure can be implemented. In the case of S&P 500 options specifically, only the CBOE submits quotes since the specific index is proprietary to CBOE. This, their bid and ask quotes are the national best quotes.

To construct a daily measure of the effective bid ask spreads in the options markets, the mean intraday effective bid ask spread estimates are trade weighted to provide a liquidity measure that is indicative of that day's trading cost of market making services.

Data

This study relied on data sources from various entities. These data required to carry out this study was voluminous which constrained the length of the period of study. The study period was chosen to be January 3, 2005 to November 16, 2005. The main limiting factor in this analysis is the requirement for the use of intraday data from the Options Price Reporting Authority (OPRA) to construct options realized bid ask spreads. These data are available to the SEC and contains all quotes and trades during each day. From the OPRA dataset, SPI options data was extracted for this analysis. Time and Sales was provided by the CFTC for the SPI futures. These data provide intraday data of every price changes along with its time stamp. These data was used to compute realized futures

bid ask spreads through the absolute mean reversal methodology. The CFTC also

provided daily closing data on the SPI futures contract. The CME provided data on the

initial and maintenance margin requirement on the SPI futures contract. Finally, the

CBOE provided daily data on the SPI options contract including the end of day delta.

4. Empirical Results

Across all futures expirations there were about 600,000 observations of price updates for the SPI futures contract. The vast majority of these price updates are in the nearby contract where most of the trading activity takes place. Generally speaking, the closest expiring contract is the most active contract. However, in the expiring month where the contract expires approximately three weeks into the month, the next furthest out expiring contract (i.e., the next deferred) becomes the most active from the 6-10 days into the month.[15] Calculating the average absolute mean reversals on a contract that is not the most actively traded contract will dramatically increase the bid ask spread estimates by two to three times. Therefore the most actively traded contract is first identified to be the future on a given day with the greatest number of price changes. This is presumed to be an indication of trading activity. This procedure resulted in well behaved estimates. Henceforth, I will refer to these most actively traded contract as the "nearby."

Summary statistics calculated for the daily liquidity estimates for SPI futures are reported in Table II. These estimates are reported in dollars per futures contract. Over the period, the minimum daily bid ask spread estimate was $32.02, while the maximum was $42.81. The maximum occurred in October 26, 2005 and was surrounded by other relatively high bid ask spread estimates. Therefore, the relatively high bid ask spread

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[15] Specifically, the contract expires the Thursday prior to the third Friday of the expiring month. This is also true with SPI options.

estimate appears unrelated to any expiration effect. Finally, on a monthly basis, note that the median and mean estimates were similar, also indicating that influential outliers are unlikely to be driving the estimates.

TABLE II
Summary Statistics for S&P 500 Futures Daily Bid Ask Spread
in Dollars per Contract
By Month in 2005

Month	Days	Mean	Median	Std. Dev.	Max	Min
1	20	35.71	35.69	1.28	39.68	33.39
2	19	33.47	33.31	0.94	35.35	32.07
3	22	34.59	34.51	1.37	37.35	32.26
4	21	36.61	36.37	1.84	39.40	33.89
5	21	35.96	35.37	1.93	39.94	32.73
6	22	35.09	34.94	1.75	39.28	32.02
7	20	35.41	35.31	1.76	40.15	33.38
8	23	34.60	34.41	1.38	38.30	32.88
9	21	35.44	35.01	1.94	40.10	32.47
10	21	39.43	39.34	1.83	42.81	36.42
11	12	35.61	35.41	2.04	40.61	33.22

Effective Options Bid Ask Spreads

If traders view S&P 500 futures and options as substitutes for their purposes, they are most likely to substitute between nearby futures and at-the-money options. At-the-money options' strike prices are definitionally very close to their underlying prices which provides one aspect of close substitution. Further, at-the-money options are generally among the most actively trades and liquid of options. Options whose strikes are significantly in-the-money and out-of-the-money tend to be illiquid. Thus, this analysis only examines at-the-money put and call options.

III illustrates the summary statistics for at-the-money effective options spreads by month. The figures are reported on a round trip contract basis. Roughly speaking, the bid-ask cost of a round trip transaction in an S&P 500 options contract over the period was about $50.00. The variation in the options bid ask spreads are seen to be large vis-à-vis futures bid ask spread cost estimates.

TABLE III
Summary Statistics for S&P 500 Options Effective Spreads
In Dollars per Contract
By Month in 2005

Month	Days	Mean	Median	Std. Dev	Max	Min
1	20	67.23	72.54	31.80	116.03	10.18
2	19	39.43	38.12	9.04	59.96	25.68
3	22	44.11	38.54	19.81	93.27	18.82
4	21	67.72	69.29	26.01	110.77	15.19
5	21	41.48	38.63	18.31	76.21	14.92
6	22	40.64	33.68	24.27	120.61	8.78
7	20	55.03	54.84	26.68	108.38	13.07
8	23	54.16	50.79	21.40	101.33	16.32
9	21	45.23	39.35	20.45	85.15	17.85
10	21	51.63	50.08	27.64	115.45	15.77
11	12	49.67	49.88	18.17	81.45	11.63

*round trip cost

As previously noted however, the S&P 500 options contract has a lower notional value and generally has a lower delta than the futures counterpart. Thus a position in a number of options contracts would have to be held to have the same leverage as one futures contract. Making these adjustments leads to options effective bid ask spreads for futures equivalent positions that are much larger. Table IV reports these results. While a futures contract's round trip cost is roughly $36.00, the round trip bid ask spread cost of

an equivalent options position generally more than 6 times of that. This suggests that trading in futures is dramatically cheaper than trading in options.

TABLE IV
Futures Equivalent S&P 500 Options Effective Spreads
Adjusted for Contract Size and Option Delta
In Dollars per Contract
By Month in 2005

Month	Days	Mean	Median	Std. Dev.	Max	Min
1	19	318.15	313.63	151.31	591.96	54.16
2	19	188.76	190.60	46.73	288.25	78.90
3	21	220.82	198.81	93.36	431.81	90.49
4	21	319.05	326.83	126.61	532.52	88.33
5	20	202.88	194.13	91.72	381.03	71.75
6	22	192.50	156.18	120.27	579.88	46.71
7	19	256.73	249.36	132.10	511.22	54.46
8	22	265.29	255.43	98.05	469.10	83.24
9	20	208.17	191.81	89.67	394.22	81.15
10	20	250.68	236.74	128.81	524.77	89.62
11	12	238.91	235.30	84.98	384.21	55.91

SPI Futures and Options Volume Link

To examine the relation between futures and options volume, the stationarity of each volume series must first be determined. This is done through the Augmented Dickey Fuller test. To determine that number of lags that should appropriately be specified for each series' ADF test, the AIC criterion is used.

Table V reveals that AR(4) minimizes the AIC criterion for futures trading volume. Under this specification, the null hypothesis that futures trading volume has a unit root is rejected. Thus, futures trading volume is stationary.

TABLE V
Futures Trading Volume
Augmented Dickey-Fuller Tests for Stationarity
Lag Specification by Akaike's Information Criterion

P	E'e	Orig. T	Missing values	Avail. T	AIC	Root	t(Root)
0	42822975406	222	1	221	19.09123	-0.18038	-4.65
1	41845691065	222	2	220	19.08181	-0.15302	-3.79
2	41532575804	222	3	219	19.08807	-0.16552	-3.96
3	41424949508	222	4	218	19.09935	-0.17141	-3.94
4	**39863234721**	**222**	**5**	**217**	**19.07491**	**-0.20497**	**-4.61**
5	39343249906	222	6	216	19.07587	-0.22769	-4.89
6	39169341642	222	7	215	19.08564	-0.21342	-4.32
7	39092897965	222	8	214	19.09800	-0.21746	-4.19
8	38861872016	222	9	213	19.10649	-0.21396	-3.94
9	38401067177	222	10	212	19.10910	-0.19626	-3.48
10	37406307337	222	11	211	19.09751	-0.22235	-3.86
11	37272732889	222	12	210	19.10871	-0.23297	-3.88
12	37242118260	222	13	209	19.12277	-0.22629	-3.61

* No trend term and a constant term is assumed.
** At the 5 percent level of significance, the Dickey-Fuller critical value is -2.86.
*** Akaike's Information Criterion is specified as $AIC = \ln\left[\frac{e'e}{T}\right] + \frac{2(p+1)}{T}$ where e'e is the residual sum of

squares, T is the sample size and the MA term, q, is assumed to be zero.
**** model is $\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon$ where y_t is futures trading volume and β is the root.

Table VI reveals the results of the unit roots test for adjusted options trading volume.

Minimization of the AIC criterion leads to the specification of the AR(1) model. Like the

test on futures trading volume, the null hypothesis that adjusted options volume has a unit

root is strongly rejected.

Given both volume series are stationary, the temporal relationship between these

variables is examined through a vector autoregressive model. Table VII shows that an

AR(1) is the appropriate order of the VAR under the AIC criterion.

TABLE VI
Adjusted Options Trading Volume
Augmented Dickey-Fuller Tests for Stationarity
Lag Specification by Akaike's Information Criterion

P	E'e	Orig. T	Missing Values	Avail. T	AIC	Root	t(root)
0	**248443886**	**222**	**1**	**221**	**13.94161**	**-0.80425**	**-12.11**
1	247819725	222	2	220	13.95277	-0.83326	-9.66
2	244860932	222	3	219	13.95453	-0.75298	-7.29
3	244755624	222	4	218	13.96797	-0.75789	-6.52
4	243666267	222	5	217	13.97750	-0.73373	-5.72
5	242425490	222	6	216	13.98648	-0.78552	-5.66
6	242004663	222	7	215	13.99895	-0.78846	-5.23
7	241482502	222	8	214	14.01110	-0.81891	-5.07
8	240551988	222	9	213	14.02166	-0.81440	-4.72
9	239908089	222	10	212	14.03352	-0.79690	-4.35
10	239596605	222	11	211	14.04687	-0.82641	-4.28
11	238198822	222	12	210	14.05579	-0.89375	-4.39
12	235337999	222	13	209	14.05860	-0.85319	-3.98

* No trend term and a constant term is assumed.

** At the 5 percent level of significance, the Dickey-Fuller critical value is -2.86.

*** Akaike's Information Criterion is specified as $AIC = \ln\left[\frac{e'e}{T}\right] + \frac{2(p+1)}{T}$ where e'e is the residual sum of squares, T is the sample size and the MA term, q, is assumed to be zero.

**** model is $\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon$ where y_t is adjusted options trading volume and β is the root.

TABLE VII
Futures-Options Trading Volume VAR
AR Order Determination
by Akaike's Information Criterion

P	AIC
1	**33.05846**
2	33.06967
3	33.09076
4	33.12645
5	33.11946
6	33.12355
7	33.17077
8	33.20156
9	33.22750
10	33.24567
11	33.25852
12	33.27179

In short, there is no evidence that futures and options volumes are temporally related to each other. Table VIII reports this from two perspectives. First, from the VAR perspective, past options volume significantly affect current options volume at a high level of confidence, say 95 percent. However, past options volumes do not significantly affect current futures volume. Likewise, past future volumes do affect current futures volumes, but do not significantly affect current options volumes. This can

TABLE VIII
Evidence of Temporal Volume Relationships
Between Futures and Adjusted Options Trading Volumes
January 3, 2005 – November 16, 2005

a. VAR Options-Futures Regression Parameters			
Dependent Variable	**Constant**	**O(t-1)**	**F(t-1)**
Options Volume	761.780	0.193	0.003
t-stat	4.550	2.910	0.920
Futures Volume	7335.280	86653.000	0.818
t-stat	3.440	0.990	21.070

b. Granger Causality Tests - OLS Regressions			
	Restricted R-Squared	**Unrestricted R-Squared**	**F-stat***
O(t-1) G-Cause F(t)	0.038	0.042	0.838
F(t-1) G-Cause O(t)	0.671	0.672	0.993

*   Based on one restriction, 220 sample size and k unrestricted equation regressors
** At a 5 percent level of significance, the critical value is 3.84.
*** The restricted equation is in the general form $y_t = \alpha + \beta_1 y_{t-1} + \varepsilon_1$ and the unrestricted equation is $y_t = \alpha + \beta_1 y_{t-1} + \beta_2 x_{t-1} + \varepsilon_1$
**** The null hypothesis that $\beta_2 = 0$ can not be rejected in either case.

also be seen in a simple Granger-Causality framework. Specifically, the null hypotheses that past options volumes do not granger-cause current futures volumes and past futures volumes do not granger cause current options volumes can not be rejected with a sufficiently high degree of confidence.

Volume, Bid Ask Spread and Excess Margins in Options Markets

Tables IX and X report the simultaneous estimation of adjusted options volume and

options bid ask spread by two stage least squares. Table IX is primarily concerned with

examining whether excess options margins affect options trading volume. The

expectation is that, if there is substitution between markets, higher excess options

margins would cause uninformed traders to leave the market. Market makers should then

raise the bid ask spread and this should conceptually reduce trading volume. The results

showed that the parameter ϕ_4 is positive and insignificantly different than zero. Thus,

excess options margins do not appear to affect options trading volume. Further, the

estimate of the parameter of excess margins on the bid ask spread (δ_4) in Table X, while

is carries that theoretically correct sign, is insignificant as well. Thus there is little

evidence that excess options markets affect either options volume or options bid ask

spread. This is not consistent with substitution occurring as posited in this study.

TABLE IX
Dependent Variable: Adjusted Options Volume
Estimated Simultaneously with Options Bid Ask Spread
by Two-Stage Least Squares (all natural logs)

	Coefficient	Parameter	t-stat
ϕ_0	Constant	26.00815	1.03
ϕ_1	Options Effective Spread	-0.84387	-1.77
ϕ_2	Intraday Volatility	-0.18772	-1.13
ϕ_3	Three Month Treasury Rate	0.479831	1.09
ϕ_4	Level Dollar Excess Options Margins	0.264008	0.58
ϕ_5	Options Open Interest (t-1)	-0.00409	-0.04
ϕ_6	Adjusted Options Volume (t-1)	0.242076	2.51
ϕ_7	Underlying Price	-3.38534	-0.95
	R and Adjusted R Squared	0.08386	0.05273

It is important to note that the relationship between options bid ask spread and contemporaneous volume have the correct signed effect (negative) in Tables IX and X, as expected a priori. Options effective spreads are negatively related to adjusted options volume and is significant at the 8 percent level. However, while the impact of adjusted options trading volume is estimated to be negative on options bid ask spread, the parameter value is insignificantly different than zero at a high degree of confidence.

TABLE X
Dependent Variable: Options Effective Bid Ask Spread
Estimated Simultaneously with Adjusted Options Volume
by Two-Stage Least Squares
(all variables on natural logarithms)

	Coefficient	Parameter	t-stat
δ_0	Constant	19.89423	1.29
δ_1	Adjusted Options Volume (t-1)	0.054828	0.22
δ_2	Adjusted Options Volume (t)	-0.30087	-0.33
δ_3	Intraday Volatility	-0.15078	-1.46
δ_4	Level Dollar Excess Options Margins	-0.21182	-0.36
δ_5	Underlying Price	-2.25760	-1.05
δ_6	Options Bid Ask Spread (t-1)	0.171847	0.95
	R and Adjusted R Squared	0.08045	0.05380

Excess Options Margins on Relative Volumes and Bid Ask Spreads

Table XI and XII address fundamental questions of this study. First, if excess options margins increase, are the relative market volumes affected? In other words, do increases in excess margins alter the market share between the S&P 500 futures and options markets? The critical parameter, β_4 is insignificant. This provides evidence against substitution occurring. This indication is further supported when the simultaneously

estimated relative bid ask spread equation regression reported in Table XII. Excess

margins do not significantly affect relative bid ask spreads at a high level of confidence.

However, this result is with caveat.[16]   Further, changes in relative bid ask spreads do not

appear to impact relative trading volumes (Table XI).

TABLE XI
Dependent Variable: Adjusted Options Volume Relative to Futures Volume
Estimated Simultaneously with Options Bid Ask Spread Relative to Futures Bid Ask
Spread
by Two-Stage Least Squares
(all variables on natural logarithms)

	Coefficient	Parameter	t-stat
β_0	Constant	34.63276	1.23
β_1	Options Effective Spread Relative to Futures Bid Ask Spread	-0.47507	-0.75
β_2	Intraday Volatility	-0.49159	-2.23
β_3	Three Month Treasury Rate	0.689147	1.58
β_4	Excess Options Margins Relative to Futures Margins	0.357572	0.83
β_5	Options Open Int. (t-1) Relative to Futures Open Int. (t-1)	-0.15981	-1.59
β_6	Adj. Options Volume (t-1) Relative to Futures Volume (t-1)	0.365604	3.60
β_7	Underlying Price	-5.17558	-1.32
	R and Adjusted R Squared	0.11602	0.08598

Taken together, there is little evidence that substitution is occurring between the S&P 500

futures and options markets. More precisely, there is little evidence that changes in option

margin requirement affect relative market share.

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[16] While the parameter estimate of -0.514 is insignificant at the 5 or 10 percent level, it
would be significant at the 15 percent level. Thus, some would argue that this is a grey
area.

TABLE XII

Dependent Variable: Relative Options to Futures Bid Ask Spread
Estimated Simultaneously with Adj. Options Volume Relative to Futures Volume
by Two-Stage Least Squares
(all variables on natural logarithms)

	Coefficient	Parameter	t-stat
α_0	Constant	121.15846	0.72
α_1	Adj. Options Volume (t-1) Relative to Futures Volume (t-1)	-0.10266	-0.88
α_2	Adjusted Options Volume (t) Relative to Futures Volume	0.532468	1.53
α_3	Intraday Volatility	-0.00961	-0.06
α_4	Excess Options Margins Relative to Futures Margins	-0.51385	-1.46
α_5	Options Bid Ask Spread (t-1) Relative to Futures Bid Ask Spread (t-1)	0.22930	2.66
α_6	Underlying Price	-1.29127	-0.54
	R and Adjusted R Squared	0.06834	0.04133

5. Discussion and Conclusion

A summary of the general microstructure theory that is asserted in this study is as follows. Broadly, traders can be categorized into informed and uninformed traders. Informed traders may be of the type where they know firm specific information or they may know economy-wide information. They will trade in a venue such that they can most efficiently profit from the information. Uninformed traders and market makers expect to lose when trading with informed traders. In the case of this study involving index contract, informed traders would likely have economy-wide information. However, in general, market makers and uninformed traders cannot identify informed traders. Market makers overcome the expected loss by imbedding a premium to all traders (adverse selection cost) in general and increase the bid ask spread when the expectation that the counterparty is informed increases (e.g., when a trader makes an unusually large trade (Kyle (1984)). Uninformed traders are very sensitive to costs and seek to avoid them (Subrahmanyam (1991)).

The general theory posited in this study is that there are two markets, the futures and the options market that are close substitutes. Informed traders can profit in either market. However, an increase (decrease) in the presence of the uninformed traders cause market makers to increase (decrease) their bid ask spread to cover consequent changes in

expected adverse selection costs. Uninformed traders react by these cost changes by exiting (entering) the market causing volume to decrease (increase).

This study posits that an increase (decrease) in margins increases (decreases) cost to traders. This, in turn, propagates the above mechanism. That is, an increase (decrease) in margin costs cause uniformed traders to exit (enter) the market. This increases (decreases) the bid ask spread in the market and decreases (increases) the bid ask spread in the competitive market as market makers in both markets adjust their quotes for expected changes in adverse selection costs. This causes corresponding changes in composition of trading volume between the markets.

Because futures margins on the S&P 500 futures contract is fundamentally based upon underlying risk while options margins are fundamentally based on price, from day to day, the ratio of futures margins to options margins will vary. Since margins are costs to the trader, this microstructure mechanism is expected to come into play.

The direct question that this study addresses is whether changes in margin requirements affect market share. The above theory suggests a mechanism how this can occur. It is in this context the results are interpreted.

This study arrives at one unambiguous conclusion: The assertion that changes in options margins leads to changes in market share between S&P 500 futures and options is unsupported by the evidence. On the face of it, therefore, the analysis appears to not support the basic theoretical microstructure mechanism presented here. Specifically, Subrahmanyam (1991) suggested that uninformed traders sensitivity would lead to bid ask spread and volume changes. Mayhew et al. study that found evidence that margin

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changes on options affected relative bid ask spread. However, the evidence of this effect found in this study was weak: (1) there was no evidence that these two contract volumes were temporally related (Table VIII); (2) excess margins in options markets did not affect options trading volume (Table XI); (3) excess margins did not affect options bid ask spread (Table X); (4) relative excess margins did not affect relative trading volumes (Table XI) and; (5) there was only weak evidence that relative excess margins inversely affected relative bid ask spreads (-0.514 with a t-stat of -1.46; Table XII);

While it is possible to interpret this evidence as a rejection on this microstructure process, a more plausible explanation exists. First, it must be recognized that the analysis did find evidence of trader's sensitivity to costs. For example, Table IX shows that options traders are sensitive to increases in options bid ask spreads. Specifically, a one percent increase in options effective spreads is estimated to lead to a 0.843 percent reduction in options trading volume (at the 8 percent or higher level of significance). This is consistent with the relationship other authors have found (e.g., Wang and Yau (2000) in futures markets, George and Longstaff (1993) in options markets). The question then becomes, if traders are sensitive to costs and margins are costs as Telser (1981), Figlewski (1984) and Brennan (1986) have argued, why do changes in excess options margins not affect trading volumes in one or both markets?
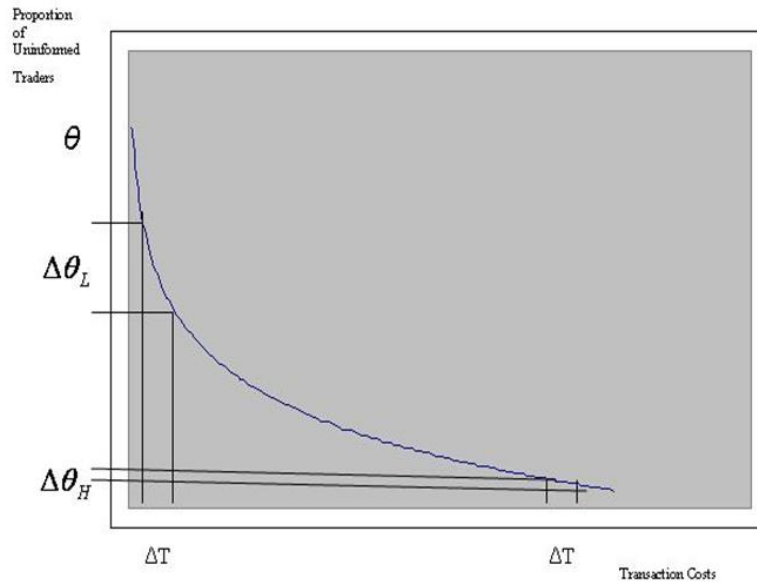
Recall that the bid ask transaction costs for a round trip S&P 500 futures contract is roughly $36.00. The round trip transactions cost for a comparable options position is generally greater than six times that of the futures bid ask spread. This large transaction cost introduces a wedge in arbitrage between the markets. That is, the changes in excess

margins must overcome this transaction cost in order to persuade traders to substitute. It is quite likely that the transaction cost causes most uninformed traders to trade in the futures markets rather than the options markets. Consequently, changes in excess margins have very little effect on the proportion of uninformed traders at this point and consequently bid-ask spreads and volumes.

Figure 3 illustrate this argument. Let ϑ be the proportion of uninformed traders in a market that has a close substitute with arbitrary transaction cost T equal to zero. As the transaction cost T grows, the proportion of uninformed traders that remain in the market falls. Given the hypothesized functional form below, an incremental change in transaction costs ΔT will have a different effect on uninformed traders depending upon whether transactions costs are relatively high in the market. If transaction costs are low, an increase of ΔT will cause a large decrease in the proportion of uninformed traders by $\Delta \vartheta_L$. By contrast, if the transactions costs are already high, the same incremental increase in transaction costs ΔT will have a negligible effect ($\Delta \vartheta_H$) on the proportion of uninformed traders in the market. As an example, assume that the actual proportion of uninformed traders follows the model: $\hat{\theta} = \theta + \Psi \ln(T)$ or specifically, $\hat{\theta} = 0.5 - .010 \ln(T)$. An incremental change of 1 from T=1 to 2 will cause the proportion of uninformed traders to fall by 4 percent. In contract, an incremental change from T=101 to T=102 will cause the proportion of uninformed traders to fall by only 0.1 percent.

Further, since informed traders wish to trade with uninformed traders, they too will trade in the futures markets. This argument is consistent with the fact that S&P 500

Let ϑ be the proportion of uninformed traders in a market that has a close substitute with arbitrary transaction cost T equal to zero. As the transaction cost T grows, the proportion of uninformed traders that remain in the market falls. Given the hypothesized functional form below, an incremental change in transaction costs ΔT will have a different effect on uninformed traders depending upon whether transactions costs are relatively high in the market. If transaction costs are low, an increase of ΔT will cause a large decrease in the proportion of uninformed traders by $\Delta \vartheta_L$. By contrast, if the transactions costs are already high, the same incremental increase in transaction costs ΔT will have a negligible effect ($\Delta \vartheta_H$) on the proportion of uninformed traders in the market. As an example, assume that the actual proportion of uninformed traders follows the model: $\hat{\theta} = \theta + \Psi \ln(T)$ or specifically $\hat{\theta} = 0.5 - .010 \ln(T)$. An incremental change of 1 from T=1 to 2 will cause the proportion of uninformed traders to fall by 4 percent. In contract, an incremental change from T=101 to T=102 will cause the proportion of uninformed traders to fall by only 0.1 percent.

FIGURE 3
A hypothesized Relationship
Between the Proportion of Uninformed Traders and Transactions Costs in a Market with
Close Substitutes

futures volume far outstrips that of S&P500 options. Further, it is consistent with

Fleming et al.(1996) finding that price discovery occurs in the lowest cost market.

Specifically, they found that price discovery occurred first in the futures markets,

followed by the options markets, followed by the options markets**.**

The fact that adjusted bid ask spreads in options markets are so much higher than

in futures markets has potentially masked the ability of this analysis to examine the

relationship between excess margin costs and bid ask spread. However, conceptually,

there can be such a relationship which ultimately drives bid ask spreads. Methods of

estimate this relationship would be valuable.

BIBLIOGRAPHY

BIBLIOGRAPHY

Ates, A., & Wang, G.H.K. (2005). Liquidity and price discovery on floor versus screen-based trading systems: An analysis of foreign exchanges futures markets (working paper). New Orleans, LA: October 6-9 Annual Meetings of Financial Management Association.

Bates, D., & Crain, R. (1999). Valuing the futures market clearinghouse's default exposure during the 1987 crash. Journal of Money, Credit, and Banking, 31, 248-272.

Bernanke, B. (1990). Clearing and settlement during the crash. Review of Financial Studies, 3, 133-151.

Black, F. (1976). The pricing of commodity contracts. Journal of Financial Economics, 3, 167-179.

Brennan, M.J. (1986). A theory of price limits in futures markets. Journal of Financial Economics, 16, 213-233.

Brooks, C. (2002). Introductory econometrics for finance. Cambridge, UK: Cambridge University Press.

Bystrom, H. (2006). Back to the future: Futures margins in a future credit default swap index futures market. Journal of Futures Markets, *forthcoming*.

CFTC (2001). Review of standard portfolio analysis of risk (SPAN) margin system as implemented by the Chicago Mercantile Exchange, Board of Trade Clearing Corporation and the Chicago Board of Trade. Washington, DC.

Chatrath, A., & Adrangi, B. (1999). Margin requirements and futures activity: Evidence from the soybean and corn markets. Journal of Futures Markets, 19, 433-455.

Chatrath, A., Adrangi, B., & Alleder, M. (2001). The impact of margins in futures markets: Evidence from the gold and silver markets. The Quarterly Review of Economics and Finance, 41, 279-294.

Cohen, K., Maier, S., Schwartz, R., & Whitcomb, D. (1981). Transaction costs, order placement strategy and existence of the bid ask spread. Journal of Political Economy, 89, 287-305.

Copeland, T., & Galai, D. (1983). Information effects and the bid ask spread. Journal of Finance, 38, 1457-1469.

Cornell, B. (1981). The relationship between volume and price variability in futures markets. Journal of Futures Markets, 20, 5-18.

Cotter, J. (2001) Margin exceedences for european stock index futures using extreme value theory, Journal of Banking and Finance, 25, 1475-1502

Demstez, H. (1968). The cost of transacting. Quarterly Journal of Economics, 82, 33-53.

Dutt, H.R., Fenton J., Smith J.D., & Wang, G.H.K. (1997). Crop year influences and variability of the agricultural futures spreads. Journal of Futures Markets. 17, 341-367.

Dutt, H.R., & Wein, I.L., (2003a). Revisiting the empirical estimation of the impact of margins changes on futures trading volume. Journal of Futures Markets, 23, 561-576.

Dutt, H.R., & Wein, I.L. (2003b) On the adequacy of single-stock futures margining requirements. Journal of Futures Markets, 23, 989-1002.

Dutt, H.R., & Harris, L.E. (2005). Prudent position limits for cash settled derivative contracts. Journal of Futures Markets, 25, 945-965.

Easley, D. & O'Hara, M., (1987). Price, trade size, and information in securities markets. Journal of Financial Economics, 19, 69-90.

Edwards, F.R., (1983). The clearinghouse association in futures markets: Grantor and regulator. Journal of Futures Markets, 3, 369-392.

Figlewski, S. (1984). Margins and market integrity: Margin setting for stock index futures and options. Journal of Futures Markets, 4, 385-416.

Fishe, R. P. H., & Goldberg, L.G. (1986). The effects of margins on trading in futures markets. Journal of Futures Markets, 6, 261-271.

Fishe, R.P.H., Goldberg, L.G., Gosnell, T.F., & Sinha, S. (1990). Margin requirement in futures markets: Their relationship to price volatility. Journal of Futures Markets, 10, 541-554.

Fleming J., Ostdiek, B., & Whaley, R.E. (1996). Trading costs and the relative rate of price discovery in stock, futures and options markets. Journal of Futures Markets, 16, 353-387.

Fuller W.A. (1976). Introduction to statistical time series. New York, NY: Wiley.

GAO (2000). CFTC and SEC: Issues related to the Shad Johnson Accord. Washington, DC: GAO/GGD-00-89.

Garman, M. (1976). Market microstructure. Journal of Financial Economics, 3, 257-275.

Gay, G.D., Hunter, W.C., & Kolb, R.W. (1986). A comparative analysis of futures contract margins. Journal of Futures Markets, 6, 307-324.

George, T. J., & Longstaff, F.A. (1993). Bid ask spreads and trading activity in the S&P 100 options market. Journal of Financial and Quantitative Analysis, 28, 381-97.

Glosten, L. & Milgrom, P. (1985). Bid ask and transaction price in a specialist market with heterogeneously informed traders. Journal of Financial Economics, 13, 71-100.

Gray, R.W. (1967). Price effects of a lack of speculation. Food Research Institute Studies, Supplements to Volume 7.

Gray, R.W. (1979). The emergence of short speculation. International Futures Trading Proceedings, Volume 6.

Hardouvelis, G.A. (1988). Margin requirements and stock market volatility. FRBNY Quarterly Review. Summer.

Hardouvelis, G.A. (1990). Margin requirements, volatility, and transitory component of stock prices. American Economic Review, 80, 736-762.

Hartzmark, M.L. (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, 147-180.

Ho, T. & Stoll, H. (1981). Optimal dealer pricing under transactions and return uncertainty. Journal of Financial Economics, 9, 47-73.

Hsieh, D. & Miller, M. (1990). Margin regulation and stock market volatility. Journal of Finance, 45, 3-30.

Kashyap A. & Stein J. (2000). What do a million banks have to say about the transmission of monetary policy. American Economic Review, 90, 407-428.

Kuhn, B.A., (1980). Margins: A review of the literature (working paper). Chicago, Illinois: Board of Trade Research and Speculation, Seminar Report, 85-92.

Kupiec, P.H., (1989). Initial margin requirements and stock market volatility: Another look. Journal of Financial Services Research, 3, 287-301.

Kupiec, P.H. (1997). Margin requirements, volatility and market integrity: What have we learned since the crash? (working paper). Washington, DC: Federal Reserve Board.

Kyle, A.S. (1984). A theory of futures market manipulations, in R.W. Anderson (Ed.), Industrial organization of futures markets, Lexington, MA: DC Heath.
Mayhew, S., Sarin, A., & Shastri, K. (1995). The allocation of informed trading across related markets: An analysis of the impact of changes in equity option margin requirements. Journal of Finance, 5, 1635-1653.

Nathan, R. & Associates, Inc. (1967). Margins, speculation and prices in grain futures markets. Washington, DC: US Department of Agriculture, December 1967.

O'Hara, M. (1995). Market microstructure theory. MA, USA: Blackwell Inc.

Rutledge, D.J.S. (1979). Trading volume and price variability: New evidence on the price effects of speculation. International Futures Trading Proceedings, 5.

Schwert, G.W. (1988). Business cycles, financial crisis, and stock volatility (working paper). Rochester, NY: The Bradley Policy Research Center Working Paper 88-06.

Subrahmanyam, A. (1991). A theory of trading in stock index futures. Review of Financial Studies, 4, 17-51.

Tan, K (2005). Next: Ease margin rules. Barron's. New York, NY: August 22, 2005. Vol 85, Iss. 34; pg. M11.

Telser, L. G. (1981). Margins and futures contracts. Journal of Futures Markets, 1, 225-253.

Wang, G.H.K., Michalski, R.J., Jordan, J.V., & Moriarity, E.J. (1994). An intra-day analysis of bid ask spreads and price volatility in the S&P 500 index futures market. Journal of Futures Markets, 14, 837-859.

Wang, G.H.K. & Yau J. (2000). Trading volume, bid-ask spread, and price volatility in futures markets. Journal of Futures Markets, 20, 943-970.

Working, H. (1948). Theory of the inverse carrying charge in futures markets. Journal of Farm Economics, 30, 1-28.

CURRICULUM VITAE

Hans R. Dutt was born on December 30, 1965, in Queens, New York. He graduated from Huntington High School in 1984. He earned an AAS degree in accounting from Alfred State College in 1986, a BA degree in economics from the University of Buffalo in 1988, and an MA degree in economics in 1990. He has worked as a financial economist at the Commodity Futures Trading Commission and is currently a financial economist with the Securities and Exchange Commission. He has published several scholarly academic articles in the *Journal of Futures Markets* (1997, 2003, 2003, 2005).