Determining margin for futures contracts: the role of private interests and the relevance of excess volatility

James T. Moser

Margins should be made consistent to control speculation and financial leverage.

—Brady Report

On Monday, October 19, 1987, the Dow Jones Industrial Average declined 508 points. The marketplace on the following day is usually described as melting down. This analogy to a runaway nuclear reaction reflects the fear during the morning hours of October 20, 1987 that overheated trading activity had overwhelmed trading systems. Studies were commissioned to investigate the events of these two days and to propose remedies. One of these studies, the Brady Report, recommends raising margins on stock index futures contracts in order to reduce the chances of a future financial meltdown.[1]

Support for the higher margins proposed by the Brady Report stems from the view that low margins result in greater speculation which, in turn, leads to greater volatility. According to this view, volatility produced by speculative trading can be controlled by regulating margin. I call this view the Excess Volatility Argument. Another explanation of the link between volatility and margin levels is founded on the recognition that stock and futures exchanges face increased risk when stock market volatility increases. According to this view, stock and futures exchanges raise margin levels when volatility increases in order to compensate for the increased risk. I call this view the Prudential Exchange Hypothesis.

This article examines the relation between volatility and margin levels in order to assess the plausibility of the Excess Volatility Argument and the Prudential Exchange Hypothesis. The next section discusses the private interests involved in setting margin levels and their relevance to the justification of the Prudential Exchange Hypothesis. The Excess Volatility Argument is critiqued in the following section. Analysis of the theory underlying the Excess Volatility Argument, a review of existing evidence on the links between margin and volatility, and new tests of the theory all fail to support the proposition that raising margins leads to reductions in volatility. Evidence for the Prudential Exchange Hypothesis is mixed. Tests relating margin changes to previous levels of volatility fail to confirm the hypothesis. A cross-sectional approach to test this hypothesis is introduced and some preliminary results are reported. Conclusions concerning the Prudential Hypothesis and the Excess Volatility Argument are summarized in the last section of the article.

Private interests in determining margin requirements

According to the Prudential Exchange Hypothesis, stock and futures exchanges both have an interest in managing their exposure to

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risks from trades routed through their exchange. Margins are an important means to this end. However, the nature of the risk in stock and futures markets differs hence, margin requirements play different roles in stock and futures markets. The next two subsections develop this distinction.

The role of private interests in determining stock margin

In stock markets, brokerage firms sometimes lend money to investors for the purchase of stock (see Box 1 for an explanation of how margin lessens the risk of stock brokers). Lending benefits brokerage firms because it increases trading, thus increasing revenues from brokerage fees. The risk inherent in lending is controlled by collateralizing these loans with stock. Brokerage firms further reduce risk by requiring investors to pay a portion of the purchase price in cash. The amount of cash put up by the investor in a leveraged stock transaction is called margin. In particular, the amount of cash required when the position is initiated—the "down payment"—is referred to as the initial margin.[2]

Margin loans expose brokers to the risk that a stock price decline will produce losses in excess of the amount of posted margin. This risk increases both as the degree of leverage in the position increases and as the volatility of stock—the collateral—increases. Prudence motivates brokers to closely examine the ability of investors holding margined positions to cover their debt obligations. Increasing margin reduces the risk taken by the broker's extension of credit. Thus, it is in the broker's interests to require a prudential level of margin.

The interests of the broker also include fees from trades executed on behalf of his or her customers. Lending facilitates trading by increasing the size of positions which can be held given the investor's level of cash. Higher margins result in smaller loans, hence lower trading levels, other things equal. Thus, increasing margins lessens brokerage fee income. Stock brokers set margin by considering both risk and profit, choosing the level of margin which is expected to yield a competitive return for the level of risk.

Stock exchanges take the interests of brokers into account when setting limits on margin lending. Exchanges consistently acting against the interests of their brokers lose business as brokers find more favorable routes for trades. Thus, the Prudential Exchange Hypothesis predicts that a stock exchange sets margin levels which are consistent with the interests of stock brokers affiliated with the exchange. These interests, as previously identified, lead to levels of margin which balance revenues from trading activity with the risk of losses on credit extended to clients.

The role of private interests in determining futures margin

Determination of margin requirements for futures contracts raises concerns which are similar to those of the stock broker. Like stock brokers, futures exchanges, acting on behalf of their members, set futures margins to control their risks. However, the risks faced by the stock broker and the members of the futures exchange are not identical. In this section, I use a hypothetical futures contract on a stock index to develop the role of margin for futures positions.

Futures contracts trade on a variety of assets. Examples are contracts on wheat, frozen pork bellies, foreign exchange, Treasury bonds, and stock indexes. Contracts are distinguished by the price of the asset or commodity used to determine payments to the parties in the contract. As an example, consider the following hypothetical contract. Over the next three months, for every point the Standard and Poor (S&P) 500 rises from its present level, Mr. Short will pay Ms. Long $1,000. For every point it falls from this level, Ms. Long will pay Mr. Short $1,000.[3]

Mr. Short and Ms. Long are referred to as counterparties in the futures contract. The counterparties are further identified as holding the long or short side of the contract. In this contract, Ms. Long holds the long side, which commits her to make payments when the futures price falls and entitles her to receive payments when the price rises. Conversely, Mr. Short holds the short side, which entitles him to receive payments when the futures price falls and commits him to make payments when the price rises. Payments between the counterparties are determined by marking the contract to the current price of other futures contracts on the same underlying basket of commodities or assets. This mark-to-market procedure is conducted daily. Futures contracts feature terms serving two purposes. First, contract terms determine the usefulness of contracts. Second, contract terms enable the exchange to manage customer insolvency problems.

Futures are useful as low cost substitutes for transactions in the underlying asset. To see this, note that by carefully specifying a particular group of assets for determination of the final settlement price, the futures price will move closely with the price of the asset group. Thus, changes in the futures price for the S&P 500 are closely linked with changes in the prices of the 500 stocks used by Standard and Poor in constructing that index. The alignment of these prices is useful to individuals and firms seeking low cost means of altering the sensitivity of their portfolios to price changes.

To see the usefulness of futures contracts, suppose Mr. Short owns a portfolio of stocks, many of which are included in the 500 stocks comprising the S&P Index. This portfolio is called his cash position to distinguish it from the futures contract. When the prices of stocks

BOX 1

Leverage, risk, and the role of margin

The relation among leverage, risk, and the role of margin is most easily illustrated in the case of stocks. Borrowing to purchase stocks has leverage implications for both the borrowers (investors) and lenders (brokerage firms). This point can be illustrated with a simple T account.

Market value of shares purchased	$10,000	$6,000	Loan from broker
		$4,000	Equity placed by purchaser

In the example, the initial margin requirement is 40 percent.[1] Stock valued at $100 per share requires the purchaser of 100 shares to pay $4,000 of their purchase price. The broker lends the purchaser $6,000. This combination of funds produces $10,000 paid to the seller of the stock.

To see the consequences of leverage for borrowers and lenders, we examine the effect of stock price changes. First, suppose the stock price rises to $110. After this price change, the T account looks as follows:

Market value of shares purchased	$11,000	$6,000	Loan from broker
		$4,000	Equity placed by purchaser
		$1,000	Gain on stock

Thus, the $4,000 invested has gained $1,000 for a 25 percent return on invested funds. Had the investor not purchased the stock on margin; and paid the full $10,000 for the stock, the rate of return would have been only 10 percent. The margined position earns 2.5 times the percentage change in stock prices (2.5 x 10 percent = 25 percent). These gains can be realized by selling the shares for $11,000, repaying the loan balance of $6,000 from the proceeds, leaving $5,000.

Examining the potential downside from a margined purchase explains why most stock purchases do not use margin. Suppose the stock price declines to $90. Now the T account looks like this:

Market value of shares purchased	$9,000	$6,000	Loan from broker
		$4,000	Equity placed by purchaser
		($1,000)	Loss on stock

The $4,000 invested results in a loss of $1,000 for a 25 percent loss. Had the purchase price been paid in cash, the percentage loss would have been only 10 percent. The alternative way of seeing this is to recognize that the ability to hold 2.5 times more shares implies that any losses will be magnified by 2.5. Further, as shown later, equity balances must be restored when these balances fall below a preset level. Compliance with this rule may require investors to sell other asset holdings to meet the call for additional equity.[2] Thus, from the investor's perspective, margined stock purchases lever up risk. The leverage factor is 1 + Loan/Equity. For the initial position, this is 1 + 6,000/4,000 = 2.5.

Now consider the above transaction from the lender's point of view. The lender will also have an interest in this leverage factor. Suppose the stock price declines to $60, so that the T account is:

in the portfolio decline, the value of Mr. Short's cash position declines. However, his short futures contract position entitles him to receive payments from Ms. Long when stock prices decline. These payments lessen the extent of losses realized from the cash position. Thus, futures contracting can reduce an investor's sensitivity to price changes. This use of futures contracts is called hedging.

Ms. Long finds the contract useful for a different reason. Generally, her cash position consists mostly of low risk bonds. At times she has concluded that stocks are undervalued. Taking the long side of a futures contract allows her to increase the sensitivity of her portfolio to changes in stock prices. In particular, when her assessment that stocks are undervalued proves true, she realizes gains from her futures position. This use of futures contracts is called speculation.

These uses of futures contracts are a cost effective means to the respective ends of Mr. Short and Ms. Long. Both results could be accomplished using transactions in the stocks themselves. Mr. Short could reduce his sensitivity to stock price changes by selling stocks and investing the proceeds in low risk assets such as Treasury bonds. Ms. Long could increase her sensitivity to stock price changes by selling some of her bonds and buying stocks. Each prefers to accomplish his or her respective end at the lowest possible cost. Futures contracts often provide the least costly route to adjusting portfolio sensitivity.

Market value of shares purchased	$6,000	$6,000	Loan from broker
		$4,000	Equity placed by purchaser
		($4,000)	Loss on stock

The broker faces a problem. Liquidating the position at its current market value insures that the outstanding balance of the loan is paid off. Not liquidating the position puts the broker at risk that the stock price will decline further and that the investor will not be able to make up the difference from other sources. If the latter case occurs, the broker suffers a loss. The extent of this loss depends on the additional decline in stock price and the amount the broker can recover from the other resources of the investor. Thus, once the investor has lost the equity in the position, the broker relies on estimates of the extent of these other sources. To avoid the risk inherent in these estimates, the broker establishes a maintenance margin requirement. When the level of equity falls below the maintenance margin requirement, a call for additional margin is made. Receipt of the called-for funds decreases the broker's reliance on estimates of other sources of wealth. Once funds are received, the broker's risk is reduced. An additional decline in stock price will, with certainty, be absorbed by the investor up to the new margin deposit.

[1]Currently initial margin requirements are 50 percent. The example uses 40 percent to clarify which portion is required from the investor (40 percent) and which is lent by the broker (60 percent).

[2]Bankruptcy law prevents access to certain assets to meet financial obligations.

However, contracts which are not dependable will not be useful. In the stock index futures contract described above, both Mr. Short and Ms. Long find the contract advantageous in the sense that it represents a low cost means of altering their sensitivities to changes in a broad measure of the stock market. However, Mr. Short might regard such a contract as worthless if he had reason to believe that, should prices fall, Ms. Long would be unable to make the required payment.[4] Similarly, Ms. Long's concerns about Mr. Short's ability to pay lower her assessment of the value of such a contract. Except for this insolvency issue, both find the contract useful. Thus, each party has an interest in resolving the insolvency problem at reasonable cost.

Resolution of the insolvency problem is the role of the exchange. Exchanges fulfill this role by requiring that all contracts clear through members of the clearing association affiliated with the respective exchange. In this process, the clearing association becomes counterparty to each side of all contracts traded on the exchange. Should either the long or short side fail to perform its obligations, the loss is realized by the clearing association rather than the original counterparty. Continuing the above example and introducing the role of the exchange, suppose the stock market rises ten points. Mr. Short owes Ms. Long $10,000. If he has become insolvent, the contract guarantee assures that Ms. Long is paid the $10,000.[5] This performance guarantee removes the respective credit risk concerns and focuses the attentions of the counterparties on contract price. Neither party finds it necessary to expend resources to evaluate the credit risk of the other party. This resolution of the insolvency problem increases the value of futures contracting for both parties. Performance guarantees provided to the counterparties are clearly costly. The exchange, acting to maintain the solvency of its clearing association, attempts to manage its potential for loss. This is accomplished by managing the exchange's exposure to the credit risk stemming from each participant in the contract. Management of the exchange's credit risk uses an overlapping system of solvency requirements, mark-to-market arrangements, and margin requirements. To see the role of the components of this system, I begin with an ideal characterization of the marketplace, then relax various assumptions in order to explain how each of these components is used to manage the credit risk of a futures exchange.

Evidence of solvency is the first level of protection. We can see the role of solvency requirements by imagining an ideal marketplace where monitoring of the wealth of each party is perfect and continuous. With the additional assumptions of immediate access to the wealth of these parties and unlimited liquidity in markets where assets can be immediately and costlessly sold off; no counterparty would be exposed to risk. Under these conditions, at the instant when a party is determined to be insolvent, that party's assets would be immediately attached, their futures positions closed out, and assets sold with the proceeds used to cover shortfalls arising from the futures position. Thus, with this characterization of the marketplace, the exchange avoids all risk of loss by relying on its legal authority to close out futures positions as counterparties become insolvent.

Relaxing the assumption of costless asset liquidation, the exchange incurs transactions costs in liquidating positions. This is readily resolved by applying "haircuts" to asset values when computing net worth for solvency purposes. That is, the value of each asset in the investor's portfolio is reduced—haircut—by the amount of transaction cost incurred on sale. Thus, solvency requirements are sufficient for the exchange to manage its exposure with this characterization of the marketplace.

If the assumption that assets can be liquidated immediately is dropped, exchanges prefer asset holdings which can be used to settle payment obligations. On determining that a counterparty has become insolvent, the exchange seeks to avoid risk by closing positions and disbursing payments quickly. Delays encountered in the liquidation of assets increase the exchange's risk of realizing further losses. Since futures contracts require that positions realizing gains be paid in cash, exchanges have a strong preference for asset holdings in cash or readily convertible to cash. This enables the exchange to attach assets which can be immediately applied to fulfill its required payments of gains. Thus, margin requirements amend the solvency requirement by stipulating that futures positions be supported by liquid asset holdings. The requirement that margin balances be deposited with the exchange further enhances this liquidity requirement: funds are immediately available to the exchange.

Mark-to-market arrangements augment the arsenal of exchange protections against credit risk by substituting for perfect monitoring of wealth. Frequent marking to market creates a flow of information to the exchange on the solvency of counterparties. To see this, recall that mark-to-market rules require positions incurring losses to cover these losses with cash payments. Cash paid by customers to brokers is forwarded to the clearing member and then to the clearing association. Brokers observing the payments made by their customers can infer their ability to continue to cover losses. Likewise, by observing delays in payments made by clearing members, the clearinghouse can infer their members' abilities to continue to cover losses. Delays in making mark-to-market payments reveal liquidity problems which may develop into solvency problems. The cost of obtaining this information is decidedly less than the cost of direct monitoring systems which might be regarded as nearly ideal.

As the frequency of marking contracts to market increases, the exchange approximates the ideal case of continuous monitoring of counterparty wealth. However, this approach is costly. Reducing the mark-to-market frequency places the exchange at risk that the counterparty has become insolvent since the position was previously marked to market. Thus, futures margin balances are used to collateralize the completion of the obligation to make mark-to-market payments. Margin balances bond the performance of contract holders to make the cash payments required when contracts are marked to market.[6] Failure to complete this obligation creates an exercisable claim on the margin account. By exercising this claim while simultaneously closing out the futures contract, the maximum loss of the exchange is the loss on closing out the futures position netted against the margin balances for the account.[7]

Thus, futures exchanges rely on solvency, mark-to-market arrangements, and margin to control the credit risk inherent in futures contracting. Margin provides the clearinghouse with liquid assets which lowers the cost of making payments to contract holders. Mark-to-market arrangements provide a signal of the level of liquidity available. The combination of mark-to-market arrangements and margin limits the credit risk exposure of the exchange. This combination of lower credit risk, lower costs of transacting, and the presence of an information generating process for customer liquidity lowers the cost of providing guarantees against counterparty risk. This increases the usefulness of futures contracting by increasing its dependability.

Distinctions in margin assessments provide additional support for the idea that futures exchanges rely on multiple avenues to manage their exposure to credit risk. For example, qualified hedgers have long or short cash positions in the asset underlying the futures contract. Because losses and gains on futures positions are offset by changes in the value of the underlying asset, hedgers expose the exchange to less credit risk exposure than do speculative positions. Recognizing their exposure is less, futures exchanges specify lower margin requirements for qualified hedgers than for more speculative positions.[8] Clearing members of the exchange are another category of participants having reduced margin requirements. Clearing associations closely monitor the risk of clearing member insolvency. Having incurred the cost of this additional monitoring activity, the clearing association increases its reliance on these solvency assessments and, consequently, reduces the level of margin required for clearing member positions.

Private interests and the Prudential Exchange Hypothesis

The above discussion shows that private interests motivate both the stock broker and the futures exchange to require margin. Use of margin facilitates trading of stocks and futures contracts, thereby increasing revenues from fees paid to stock brokerage firms and to members of futures exchanges. However, inadequate margin levels for stock positions increase the riskiness of loans made by brokerage firms. Inadequate margin levels for futures contracts increase the cost of contract-performance guarantees. In both cases, the risk of loss encourages the affected parties to reduce these risks by increasing margin levels. Both stock and futures exchanges have incentives to keep margins at an optimal level at which fees from increased trading provide an adequate return for the risks they bear.

Clearly, an increase in stock price volatility increases the potential losses of investors and hence increases the risk of insolvency. Thus, it would make sense for exchanges to respond to increased volatility by increasing margin requirements. This might reduce revenues from trading activity, but will clearly decrease the risk of losses from insolvency. Conversely, a decrease in volatility lessens the threat of insolvency. So, it would make sense for exchanges to respond to decreased volatility by lowering margin requirements in order to increase revenues from trading activity. The Prudential Exchange Hypothesis is the hypothesis that exchanges do indeed act in the way just described, raising margins in response to increased volatility and lowering margins in response to decreased volatility. A positive association between observed changes in volatility and subsequent changes in margin levels would be evidence in favor of the Prudential Exchange Hypothesis. Below I describe the results of research investigating the relation between changes in volatility and changes in margin levels and discuss the implications for the Prudential Exchange Hypothesis.

Margin determination and the Excess Volatility Argument

While the Prudential Exchange Hypothesis suggests that increases in volatility should lead to increases in margin, the Excess Volatility Argument suggests that increases in margin should lead to decreases in volatility. The

Excess Volatility Argument originated as an argument to justify the regulation of margin on stocks.[9] The argument is frequently extended to margins for futures contracts. This section explains the Excess Volatility Argument as it is applied to stocks. I then demonstrate problems with the argument.

Federal regulation of margin requirements on stocks began with the Glass-Steagall Act of 1934. The act empowered the Federal Reserve to specify margin requirements for stock.[10] This portion of the act was motivated by concern that margins prior to the 1929 stock market crash had been too low. Following the 1929 crash, proponents of the Excess Volatility Argument felt that low stock margin requirements encouraged speculation which exacerbated price swings. The claim that there is a direct relationship between speculation and volatility is based on the view that trends in market prices can be identified as they occur and that speculators respond to these trends by taking positions which profit from near term anticipated price changes. This combination produces a bandwagon effect or speculative bubble. For example, according to this view, if speculators perceive markets as rising, they think that easy profits can be had by buying into the market quickly to take advantage of the next round of price increases. The added pressure of these orders to buy elevates prices further. Each round of profits increases interest in "jumping on the bandwagon."[11]

Proponents of the Excess Volatility Argument believe that private brokerage firms cannot be relied on to limit speculation by requiring high margins on stocks because high margins would decrease trading volume and the profits from brokerage fees. The solution to the problem of excessive volatility, according to the Excess Volatility Argument, is to move control of margin from the securities industry to government. By raising the cost of speculative positions, episodes of excessive speculation could be managed by officials who do not benefit from increased trading activity. Further, these officials are answerable to the public for their decisions, making them sensitive to the concerns of the public.

Problems with the Excess Volatility Argument

The Excess Volatility Argument as applied to stocks depends on a number of implicit assumptions. First, investors are assumed to ignore the risk of participating in speculative excesses. Second, brokerage firms are assumed to ignore their risks in facilitating the trades of these investors. Third, investors are assumed to lack opportunities to avoid margin requirements. If any of these implicit assumptions are not plausible, then the argument is less credible.

First, consider the assumption that most investors ignore the risk involved in speculation. According to the above scenario, investors buy in response to price increases produced in previous rounds of buying. They ignore fundamentals, such as the ability of the firm to make expected dividend payments, which determine the fundamental value of stocks. For the scenario to work, investors must ignore the fact that as stock prices rise they become further removed from fundamental values.[12] Investment motivated by this reliance is risky. The larger the distance from the stock price to its fundamental value, the greater the necessary correction. Buy orders which increase upward pressure face the risk of increasingly large losses. Thus, investors placing these orders are ignoring the risk that the price correction will produce a loss. As risk averse investors raise their assessments of risk, they require higher returns. However, in this case, expected returns must decline as the size of the necessary correction increases. It is not plausible to claim that in general, investors ignore the risks of speculation in this way.

The Excess Volatility Argument also neglects the incentive of brokerage firms to set margins prudentially. As previously demonstrated, individual brokerage firms face the risk that margin loans will not be repaid if customer losses exceed available funds. To control this risk, brokerage firms have incentives to raise margin levels. These incentives mitigate the higher revenues from increased trading activity.

The exchanges recognize that brokerage firms near bankruptcy may compete for brokerage fees by lowering margins. These firms will be more willing to require lower margin because lower margin increases the number of orders placed through these firms and increases revenues from brokerage fees. This additional business prevents bankruptcy provided the realized losses from insolvent customers are small relative to the additional revenue from fees. The incentive to take this chance is greatest for firms which have the least to lose; that is, brokerage firms which are nearly bankrupt.

However, this form of competition harms viable brokerage houses in three ways. First, competition for business reduces the immediate revenues from brokerage fees for viable firms. Second, bankruptcy of a brokerage firm lessens industry good will.[13] This intangible asset is the capitalized value of trading activity which stems from confidence that brokers properly represent customer interests. Evidence that brokerage firms are aggressively pursuing their own interests damages this confidence, reducing the value of their good will. Third, brokers must be confident that commitments made with other brokers will be honored. Insufficient margining by individual brokerage firms lessens confidence in the completion of these commitments. This leads to increased costs as brokers replace the surety afforded by adequate margin balances with increased monitoring of the financial well being of the other brokers. To reduce these costs, exchanges, acting in the interests of the industry, set minimum margin requirements. These minimums prevent nearly bankrupt firms from increasing their risks to attract additional brokerage fees at the expense of the remainder of the industry.

Third, for margin regulation to work as proponents of the Excess Volatility Argument suggest, investors must lack alternative sources of funds. Margin requirements specify the amount of collateral which must be deposited for loans which are collateralized by stocks purchased with the funds provided. These requirements can be understood as restrictions on leverage which can be avoided. For example, individuals can avoid margin restrictions by seeking loans on their other sources of wealth, such as funds from a second mortgage or borrowing against the cash value of insurance contracts. These sources can be used to create "homemade" leverage at higher levels than those allowed using credit collateralized with stock holdings. In addition, Fishe and Goldberg (1986) point out that if leverage preferences exceed those available under margin regulations, firms can increase their debt to provide any desired level of leverage. The ability to avoid restrictive margin requirements suggests that the regulation will be relatively ineffective.[14]

The above objections show that the Excess Volatility Argument as applied to stock markets has a number of weaknesses. Consequently, it does not present a strong case for the claim that controlling margin will influence the volatility of stock prices. Proponents extend the Excess Volatility Argument to futures markets.[15] This extension ignores the differing roles of margin in the respective markets. The objections described above also hold for the Excess Volatility Argument as it applies to futures markets. Furthermore, there may be additional difficulties for the case of futures markets since margin plays a different role in futures contracts than in stock transactions. Analysis of the terms of futures contracts reveals no compelling reason to expect margins to control volatility in futures markets.

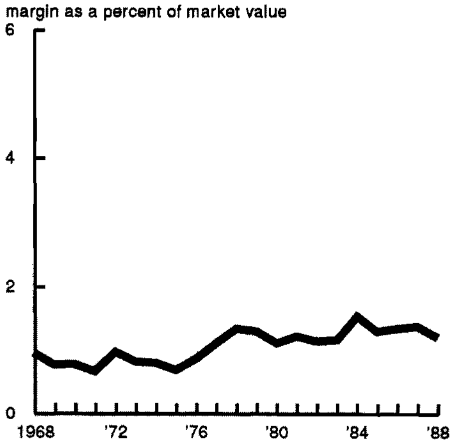
In this section, I have described some of the conceptual difficulties for the Excess Volatility Argument. In the next section, I consider the empirical evidence concerning the effects of margin changes on the volatility of prices.

Evidence of the effects of margin changes on volatility

A number of empirical findings do not support the claim that margin levels affect volatility. First, in order to have an effect on stock price volatility, equity positions funded by margin loans would have to constitute a sizable portion of investments in the stock market. Figure 1 graphs the dollar value of securities margin loans on equities as a percentage of the market value of corporate equity over the period 1968 to 1988. The dollar value of margined securities positions are a small portion of total stock holdings. Thus, attempt-

FIGURE 1

Extent of margin positions: NYSE



ing to decrease the number of margined securities positions by raising the cost of holding these positions would influence stock prices only if speculative activity affecting a small portion of stock holdings could have a significant impact on prices for both margined and unmargined stocks. With such a large percentage of equity holdings unaffected by the level of required margin, policies influencing the level of margin required to purchase equities are unlikely to significantly affect volatility.[16]

Considerable empirical research examines the links between margins on securities and the volatility of security prices. This literature is extensive and is not reviewed here.[17] A repeated finding is that changes in equity margins are not related to subsequent changes in stock price volatility.[18]

Similar research for a wide array of futures contracts shows that margins on futures contracts are an ineffective tool for reducing volatility. Previous work by Furbush (1988) compares S&P 500 volatility before and after margin changes on the S&P 500 futures contract, and finds no significant change in volatility. On the other hand, Kupiec (1990) finds a *positive* association between daily volatility estimates for the S&P 500 index and previous initial margin rates (the amount of margin divided by contract value) for that contract. Both results contradict the negative association predicted by the Excess Volatility Argument.

In this section, I present additional evidence that raising futures margins does not lower the volatility of the futures contract price. As with any literature testing for a nonzero effect, econometric difficulties can bias the test toward finding no effect. Recognition of this problem encourages careful researchers to try alternative approaches and repeated testing of a nonzero effect. My evidence improves on the existing literature in several ways. First, I use a new econometric technique to obtain volatility estimates. The procedure uses a method which improves the measurement of volatility and isolates changes in margin from changes in the level of futures price. Second, I test both the Prudential Exchange Hypothesis and the Excess Volatility Argument.

My procedure consists of testing the hypothesis that margin changes are associated with the volatility of two financial futures contracts (see Box 2 for details of this procedure). Using leads and lags of the margin change variables allows a determination of the time ordering of the relationship between margin changes and volatility. That is, using Equation 2 (see Box 2), we can determine whether changes in volatility come before or after changes in margin. The approach utilizes the persistence of volatility to associate margin changes occurring around a volatility shock.[19]

The test employs rates of margin changes which occur before the date of observed volatility (margin change "lags") and rates of margin changes which occur after the date of observed volatility (margin change "leads") in a regression having volatility as the dependent variable. The coefficients on these before and after margin changes are relevant to two quite different hypotheses about the relationship between margin changes and volatility. According to the Prudential Exchange Hypothesis, futures exchanges respond prudentially to higher volatility by increasing margin requirements. If this hypothesis is correct, then margin changes should occur after shocks to volatility. For example, if volatility of a futures price rises due to an oil crisis, margins on affected contracts should rise in response. Thus, there should be positive coefficients on margin changes occurring after observed volatility. That is, positive coefficients on margin changes occurring after observed volatility indicate that futures exchanges, acting to protect their interests, raise margin when exchange officials observe increases in volatility. Thus, positive coefficients on margin changes occurring after observed volatility can be taken as evidence affirming the Prudential Exchange Hypothesis.

Proponents of the Excess Volatility Argument expect margin increases to reduce volatility. Evidence that volatility is persistent implies that volatility will not change unless a subsequent shock produces a change. Proponents of the Excess Volatility Argument argue that margin changes shock volatility by raising the cost of holding speculative positions. Thus, increases in margin lower volatility and decreases in margin raise it, according to proponents of the Excess Volatility Argument. A finding of negative coefficients on margin changes occurring before observed volatility is consistent with this expectation.

A related question concerns the length of time separating futures margin and volatility changes. The low cost of futures trading suggests that responses to a change in margin are likely to be quickly observed. This suggests the time between margin changes and observed volatility need not be long. Alternatively, if margin changes produce purely transitory effects, they would not be a particularly useful policy tool.[20] This motivates examining a longer interval. In order to test the Excess Volatility Argument, I looked at margin changes that occurred up to twelve trading days before observed volatility. Twelve trading days are more than one-half month, so it seems reasonable to expect that any effects from a margin change would be observed during this interval. Also, if margin changes produce effects which persist

BOX 2

Procedure to test association of margin changes and volatility

Davidian and Carroll (1987) introduce a method later extended by Schwert (1989) to calculate daily volatility estimates. Schwert and Seguin (1990) show that, assuming normality, this procedure gives unbiased estimates of daily return standard deviations. The procedure iterates between a specification for mean returns and a separate specification for volatility. Equation 1 gives the specification for the mean return from a futures contract as follows:

$$(1)\quad r_t = X_t^{\prime} \beta + \varepsilon_t ;$$

where r_t is the continuously compounded return for a futures contract at time t. This return is conditional on information available at t such as the month of the year and previous returns. This information set is represented by X_t. The residual, ε_t, captures the effects on returns from unanticipated events occurring at time t. The parameter β summarizes the contribution of information items in the determination of returns. The variance of ε_t summarizes the volatility due to unanticipated events over the sample period. Under certain conditions ε_t is an efficient estimator of the true volatility.[1] One of these conditions is that volatility is unchanging or homoskedastic.

If the error terms are heteroskedastic, then we need to identify the source of heteroskedasticity in order to correct for it in Equation 1. That is, we need a theory which can be tested about the determinants of volatility in futures returns. The Excess Volatility Argument is a testable theory that margin affects volatility. Equation 2 expresses the relevant theory as follows:

$$(2)\quad |\varepsilon_t| = Y_t^{\prime} \alpha + \sum_{\substack{i=-k, \\ i \neq 0}}^{k} \gamma_i \, dm_{t+i} + \mu_t ;$$

where $|\varepsilon_t|$ is the absolute value of the residual from Equation 1, Y_t are information-set variables which might affect the volatility of returns, and dm_t are percentage changes in margin requirements at time t. The parameters α and γ_i summarize the impact of these variables on volatility. Nonzero values for these parameters imply that volatility is affected by the associated variable. Of primary interest here are the γ_i which summarize the effect of margin changes. A negative coefficient implies that margin increases are related to lower volatility, a positive coefficient implies that margin increases are related to higher volatility.

Variables included in the information set, X_t for Equation 1 and Y_t in Equation 2, require additional explanation. Lags of futures contract returns are included in Equation 1 to capture short term shifts in expected returns. Inclusion of indicator variables for the months of the year incorporates effects on returns from seasonal or contract life-cycle effects. Finally, since returns at time t are dependent on risk assessments, after the first iteration twelve lags of the volatility estimate from Equation 2 are included as a measure of risk. The Y_t variables in Equation 2 include the indicator variables for months of the year and twelve lags of volatility from Equation 1. The motivations for these inclusions differ from those in Equation 1. Including the months of the year is motivated by Samuelson's (1965) theory which implies that the volatility of futures prices changes over the life of the contract. Lags of volatility are included to accommodate the persistence of volatility shocks. French, Schwert, and Stambaugh (1987), Poterba and Summers (1986), and Jain and Joh (1988) provide evidence for this persistence in asset returns.

Finally, it is necessary to iterate the procedure. Iteration is necessary because the hypothesized heteroskedasticity in Equation 1 implies the ε_t are inefficient. The problem can be corrected by using predicted values from Equation 2 as weights in a weighted least squares re-estimation of Equation 1. Each iteration improves the efficiency of the ε_t estimates. Davidian and Carroll (1987), using Monte Carlo experiments, find that two iterations are sufficient to resolve efficiency problems. I found that the earlier iterations often produce some negative predictions. To ensure positive weights are used, I iterate five times to avoid this problem.

[1]Efficient in the sense that the information set is being used to the fullest extent possible.

for less than one-half month, they would be relatively useless policy tools. For similar reasons, I looked at margin changes during the 12 days following observed volatility in order to test the Prudential Exchange Hypothesis. It is reasonable to reject the Prudential Exchange Hypothesis if exchange responses to increased volatility occur more than twelve business days after a substantial increase in volatility.

The data consist of daily prices for two financial futures contracts traded at the Chicago Mercantile Exchange: the deutschemark and the S&P 500 futures contract. Sample periods are from June 30, 1974, to December 31, 1989, for the deutschemark contract and from June 30, 1982, to December 31, 1989, for the S&P 500 contract. This sampling interval gives 3,811 observations for the deutschemark contract and 1,842 observations for the S&P 500 contract. On any sample date, futures contracts for several delivery months trade simultaneously. This implies that the prices of any of these contracts might be used to compute returns. Following industry norm, I use prices for contracts which are nearest to delivery. The nearest-to-delivery contract is generally the heaviest traded and, hence, regarded as most representative of that day's trading.[21] As contracts approach expiration, this procedure requires that expiring contracts be replaced by the subsequent contract. Thus, on the last day of the month prior to a delivery month, I roll out of the nearby contract and into the next delivery month. This procedure avoids making inferences which are unique to the delivery month.

Continuously compounded rates of returns from these price series are matched to the effective dates of changes in initial margin requirements for speculative and hedge positions.[22] Over the respective sample periods, there were seventeen changes in initial margin for the deutschemark and nineteen changes of initial margin for the S&P 500. These margin changes are expressed as continuously compounded rates of margin change. This approach produces zeroes where no margin change has occurred and small positive or negative values elsewhere.[23] These data are from the CME clearing association.

TABLE 1

Summary of tests for the Excess Volatility Argument

	Coefficient t statistics			
	Deutschemark contract		S&P 500 contract	
Trading days after a margin change	Speculative positions	Hedge positions	Speculative positions	Hedge positions
1	−1.78	−1.08	−2.59	−1.53
2	−0.41	0.68	−1.71	0.59
3	0.82	0.98	1.85	0.49
4	2.02	0.60	0.51	−1.20
5	0.59	−0.17	−0.80	−0.78
6	−0.63	−0.05	1.05	0.11
7	−0.08	−0.40	2.37	0.57
8	1.14	1.33	1.13	−0.16
9	0.42	0.85	0.13	−0.12
10	0.16	−0.44	−0.91	2.44
11	−0.49	−1.75	0.46	−2.74
12	−0.36	−0.33	0.32	−1.22
Coefficient sums	0.0001	0.0001	0.0003	−0.0008
F statistic (hypothesis that coefficient sum equals zero)	0.16	0.06	1.62	1.12
(p value)	(0.69)	(0.80)	(0.20)	(0.29)

Table 1 reports coefficients of margin changes before observed volatility used to test the Excess Volatility Argument. Recall that the Excess Volatility Argument predicts that there should be a negative association between volatility and previous changes in margin. Individual coefficient t statistics for speculative and hedge positions in both contracts do not support the Excess Volatility Argument. For the deutschemark, one speculative margin change coefficient (lag 4) differs reliably from zero at the conventional 5 percent level, but has the wrong sign. Two individual coefficients for the S&P are significant for both speculative positions (lags 1 and 7) and hedge positions (lags 10 and 11), but these are of opposite sign. Coefficient sums are examined because the effect of a margin change may be spread across several days, producing a cumulative effect not evident on any one day. Three of the four coefficient sums are positive, indicating that volatility rises following a margin increase. To determine the significance of these coefficient sums, they are tested against 0 with an F test. Asymptotic critical values for this test are: 3.84, at the 5 percent confidence level and 6.63, at the 1 percent confidence level. In each case, the coefficient sums do not differ reliably from 0. Thus, the results do not indicate a negative association between margin changes and volatility realized after these changes, as implied by the Excess Volatility Argument.

An alternative to associating margin changes with the size of price changes is to examine the frequency distribution of price changes. Figure 2 charts the frequency of S&P 500 futures price changes for each level of margin over the sample period. Price changes are categorized as more than 1 percent, more than 2 percent, etc. Thus, horizontal bars in the chart depict the percentage of price changes larger than a given size which were observed for the indicated level of margin. If high volatility is more likely when margin levels are low, then a greater percentage of large price changes should be observed in the low margin regions. Examining each price change row, it appears that large price changes are equally likely to occur at each level of margin observed. Thus, the evidence of this test does not show that low margin levels lead to high volatility.[24]

Table 2 summarizes coefficients on margin changes after observed volatility used to test the Prudential Exchange Hypothesis. Recall that the Prudential Exchange Hypothesis predicts a positive association between volatility and subsequent margin changes. Signs of individual coefficients are mixed and their magnitudes are generally insignificant. No important differences appear to exist between speculative positions and hedge positions, indicating that exchange responses to volatility do not differ between these two classifications. Coefficient sums for the deutschemark contract are positive. This is indicative of a positive association between past volatility and margin changes as predicted by the Prudential Exchange Hypothesis. However, F test results indicate these coefficient sums do not reliably differ from 0. Coefficient sums for the S&P 500 contract are

FIGURE 2

Frequency distribution of price changes and S&P 500 margin levels

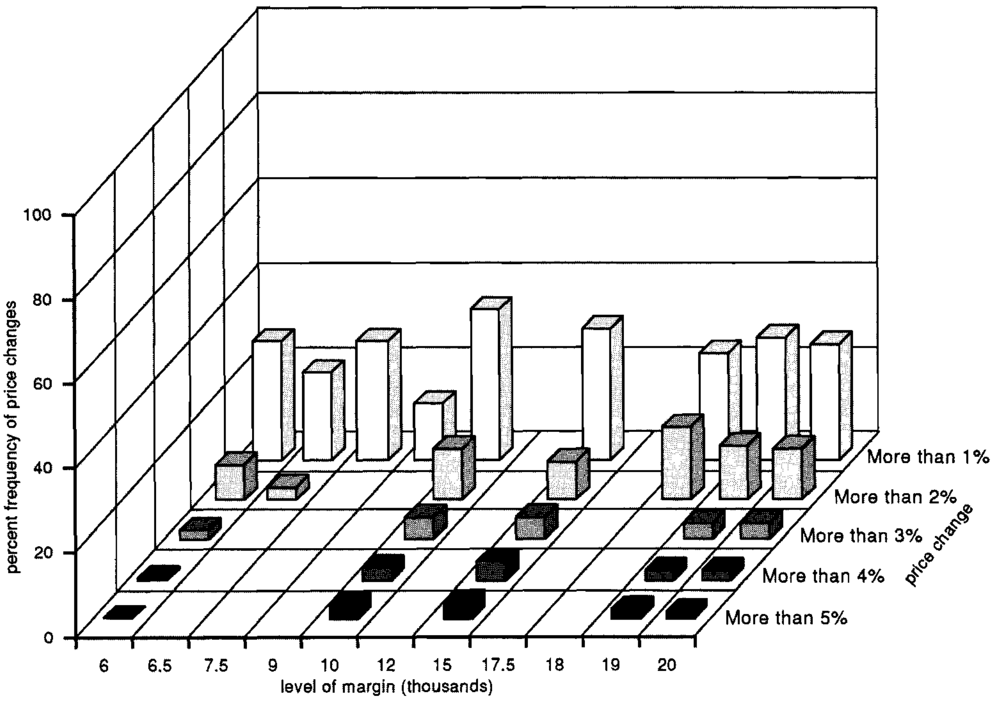


TABLE 2

Summary of tests for the Prudential Exchange Hypothesis

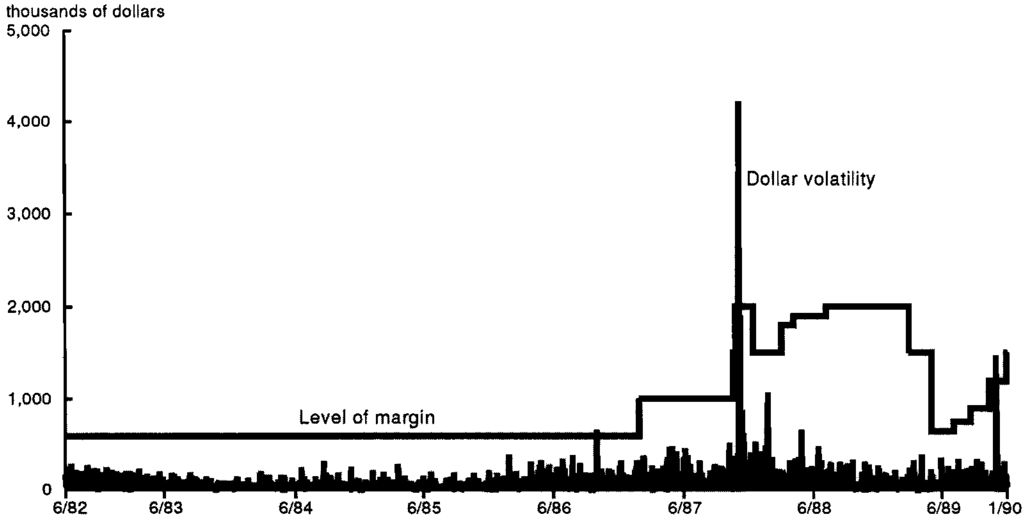
Trading days prior to a margin change	Coefficient t statistics: Deutschemark contract, Speculative positions	Deutschemark contract, Hedge positions	S&P 500 contract, Speculative positions	S&P 500 contract, Hedge positions
1	0.62	1.22	0.35	−2.35
2	0.76	0.20	−1.37	−2.44
3	0.38	−1.41	−0.66	2.05
4	2.38	0.63	−0.37	1.10
5	−2.10	−0.47	0.77	0.03
6	−0.33	0.44	−0.26	−1.40
7	−0.24	0.01	0.37	0.58
8	1.34	0.83	0.44	2.43
9	0.39	1.57	−0.96	−0.06
10	−0.07	−0.33	−1.32	−2.67
11	1.24	1.10	0.22	−1.21
12	−0.44	−0.47	−0.67	−0.16
Coefficient sums	0.0004	0.0003	−0.0001	−0.0009
F statistic (hypothesis that coefficient sum equals zero)	1.24	0.89	0.99	1.65
(p value)	(0.27)	(0.34)	(0.32)	(0.20)

negative, but F test results indicate they do not significantly differ from 0. F test results fail to support the Prudential Exchange Hypothesis.

The negative signs for the S&P are opposite those expected. This motivates further examination of volatility and S&P margin levels. Volatilities obtained from the above iterative procedure are restated to obtain the dollar volatility per day of the S&P contract. These volatilities and the level of speculative margin are graphed in Figure 3. The graph shows that the level of required margin has remained high while volatility for most of the period after 1987 fell to 1986 levels. Dividing margin requirements by dollar volatility gives the level of coverage obtained by the exchange. Comparing the pre-1987 period with the post-1987 period, margin levels since October 1987 provide the exchange with 51 percent greater coverage than previously. This greater coverage lessens the need of the ex-

FIGURE 3

Speculative margins and volatility: S&P 500 futures



change to raise margin in response to volatility increases. In other words, the exchange does not need to raise margins in response to higher volatility because margin requirements are already high enough to cover its increased risk. This may explain the lack of evidence for the Prudential Hypothesis.

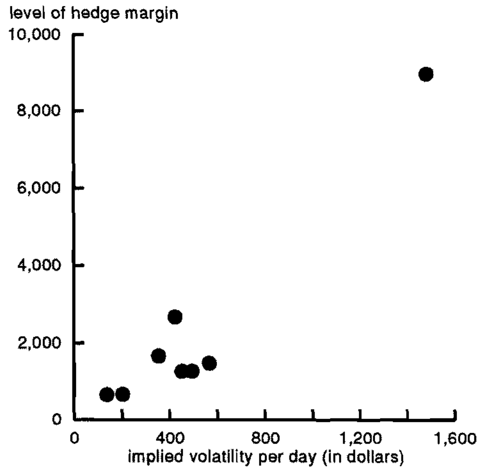
Another way to test the Prudential Exchange Hypothesis is as follows. Prudential exchanges can be expected to set margin levels for contracts according to the risk of losses from insolvency. Since high price volatility places the exchange at greater risk, levels of margin required for contracts should rise with the anticipated price volatility of these contracts. One way to observe anticipated volatility is to use the volatility implied by observed prices on futures options. Thus, I hypothesize that margin levels will be positively associated with implied volatilities.

To demonstrate this approach, implied volatilities were computed for closing prices on futures options traded on September 9, 1991. The contracts used were: soybean, corn, and Treasury bonds from the Chicago Board of Trade; and S&P 500, live cattle, Swiss franc, deutschemark, and Japanese yen from the Chicago Mercantile Exchange. Volatilities are stated on a per day, dollar basis.[25] This gives, in dollars, the largest up-or-down change which can be expected in a single day with probability .33. Thus, setting margin levels at three times this volatility provides these exchanges with 99 percent confidence that margin balances will be sufficient to cover losses realized in one day by either long or short positions. Figure 4 graphs margin required for these contracts on our volatility estimates. The predicted positive association is demonstrated by the graph. The simple correlation between margin levels and volatility is .92 which does provide some evidence for the claim that margin levels are positively associated with the level of exchange risk. The evidence from a single sample date presented in this article is not sufficient for a test of the Prudential Exchange Hypothesis, however, the positive result suggests that further testing may provide stronger evidence.

Summarizing the evidence, my tests for the link between futures margin and volatility do not support the Prudential Exchange Hypothesis. However, this result may be due to the relatively higher margin requirements after

FIGURE 4

Margin levels and implied volatility
Cross-section of contracts: 9/9/91



1987. My tests do produce further evidence against the Excess Volatility Argument.

Conclusions

The Excess Volatility Argument implies that higher margin can be used to control speculation resulting from excessive volatility. This article presents several arguments suggesting that this argument is flawed, as well as new evidence indicating that the volatility of futures prices is not reduced by raising futures margin.

The evidence that changes in futures margin do not lead to changes in volatility is quite compelling, consequently, the Excess Volatility Argument should not be a consideration in the government regulation of margins. It is clear that private interests in setting margins do exist. I have described the prudential interests of the futures exchanges. These interests provide some support for the view that exchanges are motivated to set margins at prudential levels.

Effective public oversight of margin setting for futures contracts requires policymakers to identify the interests which are best served by changing margins. Otherwise, financial markets risk being encumbered by unnecessary regulation. Margin regulation is unlikely to reduce the volatility of futures prices. However, other roles for margin, including the public's interest in the safety of futures clearing houses and the payments system, warrant additional research.

FOOTNOTES

[1]The Brady Report is the name generally given to a report prepared by the January 1988 Presidential Task Force on Market Mechanisms headed by Nicholas Brady, Secretary of the Treasurer.

[2]Since 1934, the Federal Reserve Board of Governors has set margins for stock by specifying the initial margin required for stock purchases. Margin regulation is motivated by the Excess Volatility Argument which is explained later. At this point, it is important for the reader to realize that, in addition to this regulatory activity, private interests are also at work in determining margin.

[3]To avoid a technical problem, I oversimplify by assuming the cost of carry for the cash asset is zero. Costs of carry are the financing costs net of returns from holding the cash asset. They determine the difference between futures prices and current prices for the cash asset. For the purposes of this example, they can be ignored.

[4]Further, resources would be expended to make this determination. Thus, the ability of counterparties to avoid this cost will weigh in their assessment of the worth of futures contracting.

[5]This description is somewhat oversimplified. Edwards (1982) goes into more detail. Essentially, the clearing association guarantees payments between the clearing members of the exchange. Were the hypothetical contract made through a single clearing member, Ms. Long would face the risk that the clearing member would be unable to make good on the payment should Mr. Short be insolvent. The clearing association is not obligated to fulfill commitments between a clearing member and any other party.

[6]Fenn and Kupiec (1991) point out that increasing the frequency of marking contracts to market serves as a substitute for raising the level of margin.

[7]This loss may be further reduced by proceeds from the sale of assets going to the exchange.

[8]The Chicago Mercantile Exchange presently determines margin requirements of positions using its Standard Portfolio Analysis of Risk (referred to as "SPAN"). The system evaluates the risk of the individual after netting out positions in several markets and determines the level of margin required for the net position.

[9]See Kindleberger (1989) and Chance (1990).

[10]Federal Reserve Regulations T, U, X, and G state current margin requirements.

[11]Kindleberger's (1989) history provides an excellent description of the events preceding and following the 1929 crash from an Excess Volatility perspective. Similar arguments have also been made regarding the role of margins on stock index futures in the 1987 crash. For an example, see the Brady Report.

[12]Alternatively, it might be argued that these investors all believe they can exit the market prior to the necessary correction. Note that this is an assumption that exit can be perfectly timed. Relaxing the perfect-timing assumption introduces the risk of being late and incurring losses during the correction. Risk averse investors will take on this risk only if it is compensated. Since the risk is costlessly avoided by not participating in the bubble, it is not compensated. Thus, if investors are risk averse, bubbles are not possible.

[13]The presence of performance guarantees offered by the exchange makes these costs more explicit. The membership is contractually obligated to make good on defaults of its nonperforming members.

[14]The effectiveness of regulating margin becomes dependent on the relative costs of leverage obtained through margin loans and leverage obtained from other sources; that is, homemade leverage. If homemade leverage is relatively costly, then raising margin requirements increases the cost of obtaining leverage and may decrease speculative activity.

[15]A clear case of extending the Excess Volatility Argument to futures markets can be found in the Brady Report.

[16]Salinger (1989,Table 1) also makes this point.

[17]Chance (1990) and France (1990) review the literature of the relationship between volatility and stock and futures margin.

[18]Hardouvelis (1988) is a notable exception. Hsieh and Miller (1990) point out that the Hardouvelis procedure is susceptible to problems with persistent variance. Kupiec (1988, Table 5) replicates the Hardouvelis procedure. He finds that much of the effect traces to the last half of the 1930s.

[19]That is, it is assumed that changes in volatility due to shocks are permanent, not temporary. For example, if the volatility of futures prices increases due to an oil crisis, the assumption is that volatility will remain at the new level until another shock occurs. This assumption is important for determining the cause of observed changes in volatility. For example, if volatility responses to shocks were temporary rather than permanent, then an observed change in volatility might be the result of volatility returning to its previous level after a temporary response, rather than a response to a new shock. This assumption is supported by the evidence from Schwert (1989). Additionally, the results from the specifications used in this paper support volatility persistence.

[20]For transitory effects from margin changes to be useful, regulators must be willing to change margin requirements frequently.

[21]France and Monroe (1991) investigate the effects of futures margin on the less heavily traded contracts expiring on later delivery months. This approach investigates the importance of liquidity on the margin-volatility association.

[22]Continuously compounded rates of change are computed as the difference in the log of prices. I am indebted to

Bjorn Flesaker who suggested this approach to obtain symmetry between rates of increase and decrease.

[23]Signed dummy variables were also tried in place of percentage changes of margin. The results were similar to those reported here, however, the level of significance was lower. This suggests that the amount of margin change provides information in addition to the information that margin changed and the direction of that change.

[24]Using margin as a percentage of contract value in place of margin levels does not change this conclusion.

[25]Volatilities were implied using the Black-Scholes option model for options on futures nearest to expiration and at the money. This procedure obtains an annualized volatility for rates of change. Annualized volatilities were restated to dollars per day by dividing them by the square root of 365 and multiplying by the dollar value of the contract.

REFERENCES

Chance, Don M., "The effects of margin on volatility of stocks and derivative markets: a review of the evidence," manuscript, Virginia Polytechnic and State University, 1990.

Davidian, Marie, and Raymond J. Carroll, "Variance function estimation," *Journal of the American Statistical Association* 82, 1987, pp. 1079-1091.

Edwards, Franklin, "The clearing association in futures markets: guarantor and regulator," Conference paper presented at the Industrial Organization of Futures Markets: Structure and Conduct, Columbia University, New York City, November 4-5, 1982.

Fenn, George, and Paul Kupiec, "Prudential margin policy in a futures-style settlement system," Finance and Economics Discussion Series Paper No. 164, Federal Reserve Board, Washington, D.C., 1991.

Fishe, Raymond P. H., and Lawrence G. Goldberg, "The effects of margins on trading in futures markets," *Journal of Futures Markets* 6, 1986, pp. 261-271.

France, Virginia Grace, "The regulation of margin requirements: a survey," University of Illinois at Urbana-Champaign Working Paper No. 90-1670, 1990.

France, Virginia Grace, and Margaret A. Monroe, "The effects of margin requirements on futures trading," mimeograph, University of Illinois at Champaign-Urbana, 1991.

French, K.R., G. W. Schwert, and R. F. Stambaugh, "Expected stock return and volatility," *Journal of Financial Economics* 19, 1987, pp. 3-29.

Furbush, Dean, "The regulation of margin levels in stock index futures markets," working paper, Office of Economic Analysis, United States Securities and Exchange Commission, 1988.

Hardouvelis, Gikas, "Margin requirements and stock market volatility," Federal Reserve Bank of New York, *Quarterly Review*, 1988, pp. 80-89.

Hseih, David, and Merton Miller, "Margin regulation and stock market volatility," *Journal of Finance* 45, 1990, pp. 3-29.

Jain, P., and G. Joh, "The dependence between hourly prices and trading volume," *Journal of Financial and Quantitative Analysis* 23, 1988, pp. 269- 283.

Kindleberger, Charles P., *Mania, panics, and crashes: a history of financial crises*, Basic Books, Inc., 1989.

Kupiec, Paul, "Initial margin requirements and stock return volatility: another look," *Journal of Financial Services Research* 3, 1988, pp. 287-301.

__________, "Futures margins and stock price volatility: is there any link?," Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System, 1990.

Moser, James T., "Evidence on the impact of futures margin specifications on the performance of futures and cash markets," Federal Reserve Bank of Chicago Working Paper No. WP-90-20, 1990.

__________, "The implications of futures margin changes for futures contracts: an investigation of their impacts on price volatility, market participation and cash-futures covariances," *Review of Futures Markets*, forthcoming.

Poterba, J. M., and L. H. Summers, "The persistence of volatility and stock market fluctuations," *American Economic Review* 76, 1986, pp. 1142-1151.

Presidential Task Force on Market Mechanisms, "Report of the presidential task force on market mechanisms: January 1988," excerpt reprinted in Robert J. Barro, Robert W. Kamphius, Jr., Roger C. Kormendi, and J. W. Henry Watson, eds., *Black Monday and the Future of Financial Markets*, Homewood, IL, Irwin, 1989, pp. 127-203.

Salinger, Michael A., "Stock market margin requirements and volatility: implications for regulation of stock index futures," *Journal of Financial Services Research* 3, 1989, pp. 121-138.

Samuelson, Paul A., "Proof that properly anticipated prices fluctuate randomly," *Industrial Management Review* 6, 1965, pp. 41-49.

Schwert, G. William, "Business cycles, financial crises and stock volatility," *Carnegie-Rochester Conference Series on Public Policy* 31, 1989, pp. 83-126.

Schwert, G. William, and Paul Seguin, "Heteroskedasticity in stock returns," *Journal of Finance* 45, 1990, pp. 1129-1150.

Telser, Lester G., "Margins and futures contracts," *Journal of Futures Markets* 2, 1981, pp. 225-253.