Futures Margins and Stock Price Volatility: Is There Any Link?

Paul H. Kupiec

INTRODUCTION

Recent episodes of heightened stock returns volatility have renewed academic and regulatory interest in the underlying determinants of equity price volatility. Studies by Schwert (1988a, 1988b) relate stock market returns volatility to real and financial macroeconomic factors. His results reinforce the findings of earlier studies that have found episodes of heightened stock price volatility that are not easily attributable to volatility in observable macroeconomic fundamentals.

The lack of a strong empirical relationship between stock price volatility and observable economic factors has been interpreted as evidence that stock prices exhibit "excess" volatility. Debate has focused on the equity-derivative product markets where it has been argued that low transactions costs, especially in stock-index futures, encourage destabilizing speculation. It is alleged that the low margin required on these instruments allow "fad" expectations held by a minority of traders to be magnified and reflected in market prices creating excess price volatility. A concise statement of this viewpoint, the so-called "excess volatility hypothesis," is found in the New York Stock Exchange's report on program trading,

> The trivial cost and tremendous leverage available make index futures and options an ideal instrument for speculation in short-term market movements. Speculation is in the index—the market itself—and the futures and options market reacts far more quickly to macroeconomic factors than does the underlying market, precisely because it is an index product. Thus activity on the futures and options market tends to predict, and hence influence, the prices of individual stocks on the exchange that, in theory, determine its value. To quite a substantial extent, the tail is wagging the dog.[1]

Although the view that derivative products "cause" cash market volatility is not uncommon among those who are skeptical of short-run market efficiency, this position

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[1]See Nicholas Katzenbach, *An Overview of Program Trading and its Impact on Current Market Practices*, The New York Stock Exchange, 1988.

Paul H. Kupiec is an Economist with the Board of Governors of the Federal Reserve System and Visiting Economist, Bank for International Settlements, Basel Switzerland.

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is not strongly supported by statistical evidence. Edwards (1988) studies the cash market return volatilities of the S&P 500 index, the Value Line index, spot T-bill and 90-day Eurodollar rates over periods before and after the introduction of a corresponding financial future derivative product. Except for 1987, volatility in the spot markets was smaller in years following the introduction of a derivative product. He finds evidence that the introduction of index-derivatives has increased volatility on expiration days, but this increase in volatility is transitory, with on average 80% of the expiration afternoon's price changes being reversed the following day.[2] Edwards attributes these movements to liquidity imbalances in the cash market interpreting the strong price reversals as evidence against the "futures speculation" excess volatility hypothesis.[3]

The literature investigating the effects of margin requirements on volatility is largely focused on the effects of the Federal Reserve Board's Regulation T margin requirement. Until recently, it was accepted that no relationship of any consequence, economic or statistical, exists between margin requirements and stock price volatility. A controversial article by Hardouvelis (1988) disputed this position and thereby rekindled academic interest in this area. Since the Hardouvelis study, Schwert (1988), Kupiec (1989), Salinger (1989), and Hsieh and Miller (1990) have empirically investigated the hypothesis that initial margin requirements and stock price volatility are inversely related. Without exception, they find no statistical support for a negative margin–volatility relationship. However, because the Federal Reserve Board has changed margin requirements so infrequently, the statistical power to detect a margin–volatility relationship may be low. In addition, since the introduction of equity-index futures in the early 1980s, a speculator's leverage constraint is no longer determined by regulation T margin requirements; that is, if a speculator wanted to take a maximally leveraged position in equity, he would use an index-futures contract. Because the effective margin rate on index-futures is small relative to those on stock purchases, studies that estimate margin–volatility relationships over the 1980s using regulation T margin rates incorrectly measure the binding margin rate. This mismeasurement may impart an upward bias into statistical estimates of the margin–volatility relationship because the 1980s was one of the more volatile decades of the century. Consequently, statistical evidence from futures margin data assumes added importance.

This article considers the issue of futures market leverage and its effects on cash market volatility. It investigates the statistical relationship between the initial margin requirements on the S&P 500 index-futures contract and the S&P 500 cash market volatility. The statistical results do not support the hypothesis that low initial futures margins are associated with increased volatility in the cash market. Rather, the results indicate that periods of higher cash market volatility are associated with higher initial margin rates in the index-futures market.

Although this study finds a positive statistical relationship between margins and volatility, the implications of this association are unclear. A negative statistical relationship would unambiguously support the excess volatility hypothesis. A positive statistical relationship, although counter to the predictions of the hypothesis, is not sufficient to

[2]Stoll and Whaley's (1987) findings are consistent with those reported by Edwards.

[3]Blume, MacKinlay, and Terker (1989) document the existence of short-term price reversals in S&P 500 stocks during the October 1987 market break. They find these price reversals are related to a measure of selling pressure. These empirical findings are consistent with the existence of liquidity imbalances during periods of heavy futures-driven cash market volume.

formally reject it. The complication is that futures margins are set endogenously according to the unobserved expectations of the margin committee. As a result, margins may be a proxy for expected volatility. As the margin committee's expected volatility estimate cannot be separately identified, it is impossible to separate the expectational effect from a true independent margin–volatility relationship. Although the historical behavior of the margin committee suggests that the expected volatility effect is likely to be of little practical importance, the possibility remains that low margins are destabilizing. The results do not, however, provide any evidence to support the excess volatility hypothesis. Rather, the results are consistent with both the prudential behavior of the futures exchange's margin committee and with the hypothesis that high margins reduce market liquidity and thereby increase price volatility.

MARGIN, LEVERAGE, AND PRICE VOLATILITY

In the margin–volatility debate, the central issue is the claim that the amount of leverage available to investors has an influence on the volatility of financial asset prices. Those advocating such a relationship argue that significant ability to leverage positions enables speculators to bid up asset prices in excess of their fundamental equilibrium values; and, conversely, high leverage causes asset prices to fall more precipitously during market declines as leveraged investors are required to sell their stock to meet margin calls.

Kupiec and Sharpe (1990) investigate the effects of leverage and margin requirements on stock price volatility in the context of a theoretical model of asset price determination. In their model, stock returns exhibit volatility in excess of that attributable to dividends owing to the influences of both "noise traders" and time-varying tastes for risk bearing. Their results indicate that margin requirements can indeed lower volatility by restricting the demands of "bullish" noise-traders when equity prices are rising, but they may equally well increase equity price volatility by restricting the demands of risk-tolerant investors when prices are falling. In their model, higher margin requirements need not reduce, and may in fact increase, stock price volatility.

Goldberg (1985) focuses on different aspects of the equilibrium effects of imposing or altering margin requirements. Using a Miller debt-and-taxes model, he argues that higher initial margins will lead to higher equity price volatility because firms will increase their use of leverage to offset the loss of leverage available to investors.

Hartzmark (1986) develops a model of futures markets which includes heterogeneous trading groups each of which experiences unique liquidity costs associated with a given level of required initial margin. Altering margin requirements affects equilibrium prices, volatility, and open interest by changing the composition of the trading groups transacting in the market. In his model, changes in margin requirements have ambiguous effects on equilibrium prices and volatility because the new equilibrium will depend on which trading groups enter and leave the market. Empirically, Hartzmark finds a negative relationship between the level of margins and open interest, and no strong relationships between the level of margins and price volatility, or trading volume.

Fishe, Goldberg, Gosnell, and Senha (1990) study the effects of margin changes on the volatility of the futures prices of ten real commodities. They find no strong evidence of a negative margin–volatility relationship. Instead, margin–volatility effects are mixed across time and contract—sometimes positive, sometimes negative. The results do not suggest any stable pattern that might be exploited by regulators to control volatility.

INITIAL MARGIN IN THE FUTURES MARKETS

In contrast to stock market margins which were legislated with the intent of curbing "speculative" trading, the purpose of initial margins in futures transactions is prudential.[4] Initial margin in the futures markets takes the form of a security deposit or performance bond. Initial margin is a fixed dollar amount per contract that, at the customer level, may be satisfied by depositing cash, treasury securities, securities listed on the AMEX or NYSE valued at 70% of their market value, or an acceptable bank letter of credit with the Futures Commission Merchant.[5] The dollar amount of the margin depends on the underlying contract, the type of trader posting margin and the economic conditions prevailing at the time.[6] Initial margins are set by the exchange's margin committee with the intent of insuring the performance of a futures position. The margin committee sets initial margin deposits at levels that, with a high degree of confidence, exceed a large single-day's price change of a contract, but not so large as to limit market participation.

The initial margin requirement needed to maintain an open position in an S&P 500 index-futures contract differs by type of trading account. Clearing member and hedger accounts are subject to identical initial margin requirements. This level of required margin, the "hedge margin," is also equal to the maintenance margin requirement on speculative trading accounts.[7] The initial margin requirement on speculative trading accounts is higher than the hedge margin. The statistical analysis of this paper focuses on the hedge margin not only because it is the lowest margin requirement for maintaining an open position in an S&P 500 contract, but also because the largest volume of futures trading occurs through hedging accounts.[8] For the S&P 500 stock index-futures contract, the hedge initial margin requirement has varied between roughly 2% and 13.5% of a contract's value (Table 1). For the most part, it appears that hedge margins have been adequate for their prudential functions.[9] Although they may have been prudentially adequate, hedge margin requirements have historically been set far below the prevailing 50% margin requirement on common stocks.

The prudential management of margins will induce a relationship between the contract's price volatility and the required level of margin. Fenn and Kupiec (1993) consider prudential margin policy in a futures-style settlement system. Using the principle of efficient contract design from Brennen (1986), they derive alternative optimal margin policy rules that minimize the costs of maintaining contract integrity. In these models, optimal margin policies imply the existence of a positive relationship between a contract's return volatility and its futures margin rate. Under an optimal prudential margining rule that allows for only routine daily settlements, the contract's margin should be proportional to the contract's predicted price volatility. The constant of proportionality is related to the cost of posting margin, the transactions cost of settling, and the costs associated

[4]For a discussion of the legislative intent behind the Federal regulation of initial margin requirements, see Moore (1966). For a discussion of the functions of futures margins see Figlewski (1984), or Fenn and Kupiec (1993).

[5]Futures clearinghouses do not accept securities for margin from clearing members. For a discussion see Sofianos (1988).

[6]For a more complete discussion of initial and maintenance margins in the futures markets see Sofianos (1988), or Warshawsky (1989).

[7]The initial and maintenance margin requirements are identical for clearing member and hedger accounts.

[8]In its periodic report, "Commitments of Traders," Commodity Futures Trading Commission (CFTC), Washington, DC, CFTC staff estimate that reportable speculative open interest is, on average, roughly 7% of reportable open interest. (A trade larger than 300 contracts is reportable.) An additional reason for focusing on the hedging margin is the high degree of colinearity in the hedging and speculative margin rates over this time period.

[9]For an analysis of futures margins from a prudential adequacy perspective, see Fenn and Kupiec (1993).

TABLE I

S&P 500 Margin History (CME)			S&P 500 Futures Hedging Margin Rate Distribution Characteristics 21 April 1982 to 30 June 1989	
Date	S&P 500 Futures Hedging Margin	Hedge Margin rate		
05.04.82	2500	4.36%		
26.10.82	3000	4.50%		
02.02.87	5000	3.65%	Mean	3.97%
20.10.87	7500	6.67%	Standard deviation	1.88
23.10.87	10,000	8.06%	Minimum value	2.16
29.10.87	12,500	10.72%	Maximum value	13.42
30.10.87	15,000	12.26%		
21.12.87	10,000	8.03%		
22.09.88	4000	2.96%		

TABLE II
HEDGE MARGIN LEVELS AND S&P 500 RETURN VOLATILITY

Margin	S&P 500 Return Standard Deviation %	Minimum Return %	Maximum Return %
2500	1.14	−4.05	4.65
3000	0.89	−4.93	3.84
4000	0.83	−6.31	2.72
5000	1.11	−5.29	2.84
6000	0.84	−2.62	1.87
10,000	1.19	−7.01	3.52
15,000	1.99	−4.27	2.88

with contract default. Empirically, Fenn and Kupiec find that futures exchanges increase stock-index futures margins when contract volatility increases, but they do not "fine-tune" margin to anywhere near the degree implied by the optimal prudential margin-setting rule.

STOCK PRICE VOLATILITY AND FUTURES MARGINS

Since the introduction of the S&P 500 futures contract, regulation T initial margin requirements for the purchase of common stock have been set at 50%. In contrast, the initial margin required to purchase an S&P 500 futures contract has changed many times. Table I gives the history of initial margin requirements of the S&P 500 futures contract and reports some sample statistics describing the distribution of the contract's hedge margin rate; that is, the hedger margin measured as a percent of contract's value.[10]

Table II reports estimates of the sample statistics for S&P 500 returns sorted by the level of futures hedge margin. The 7500 and 12,500 margin levels are not represented in the table because the corresponding samples of daily returns are too small to produce reliable estimates. These estimates suggest no obvious margin–volatility relationship.

Margins and Average Daily Volatility

Figure 1 plots the time series of average daily S&P 500 cash market volatility estimates and the average daily hedging margin on the nearest S&P 500 index-futures contract for the sample period April 21, 1982, to June 30, 1989. Volatility is estimated from the monthly standard deviations of the excess return on the S&P 500 index corrected for the effects of nonsynchronous trading following the procedures of French, Schwert, and Stambaugh (1987).[11] The average daily hedging margin rate for month j is the average, for all days in month j, of the hedge margin divided by the nearest-expiration futures contract's settlement value (500 times the settlement price).

An examination of the plots in Figure 1 does not suggest a negative relationship between cash market volatility and futures margins. The 1982 fourth-quarter peak in average daily volatility is preceded by a relatively rapid 1% decline in the futures margin rate. Over the period 1982 to mid-1986, average hedge-margin rates trended downward

[10]The margin rate on a day is defined as the required hedge margin at market open divided by 500 times the prior day's closing price of the nearest to maturity S&P 500 index-future.

[11]The excess return is defined as the daily differences of the natural logarithms of the S&P 500 index less the overnight repurchase agreement rate of interest. This volatility measure assumes a zero mean return. For daily data, correcting for a nonzero mean makes little difference in the estimated value [see French, Schwert, and Stambaugh (1987)].

inducing no apparent trend in volatility. During 1986, futures margin rates fell as the S&P 500 posted substantial gains, but again, volatility appeared unaffected by the margin rate trend. In early 1987, the margin rate increased sharply along with temporary increases in cash market volatility. During the October 1987 market crash and the months that followed, average margin rates increased substantially in response to both increases in the hedge margin and losses in the value of the S&P 500 index.

Table III reports the results of regressions of estimated volatility on lagged volatility and the average hedge margin rate.[12] The results indicate that there is a positive relationship between the level of the hedge margin rate on the futures contract and the volatility of the S&P 500 index. Higher margins in the futures market are correlated with higher volatility in the cash market.

Margins and Intraday Volatility

If the level of the S&P 500 index follows a log-normal diffusion process, the intraday variance of the diffusion process, s^2, can be estimated from the range of the processes over an interval of time [Parkinson (1980)],

$$s^2 = 0.360738\ (\text{range})^2$$

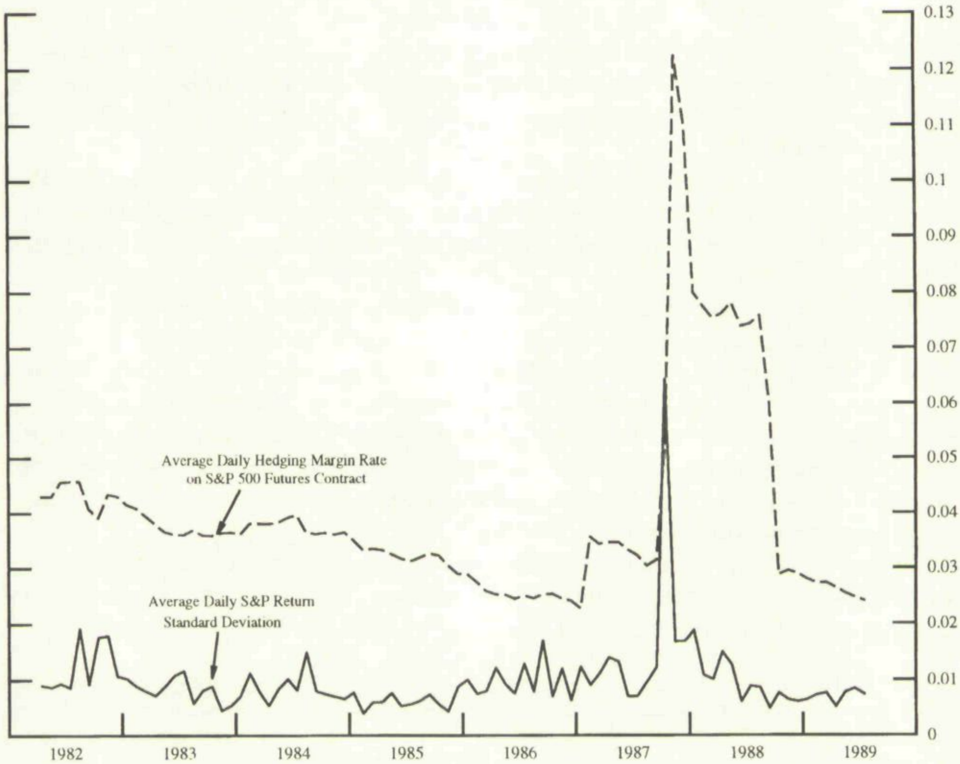

Figure 1
Average daily volatility estimates and average S&P 500 futures hedging margin rates (by month).

[12]Monthly dummy variables are included to allow for seasonality but, aside from October which is likely sample specific, there is no statistical evidence of monthly variation in volatility. Consequently only the constrained model estimates are reported.

TABLE III
MONTHLY VOLATILITY REGRESSION ESTIMATES
SAMPLE PERIOD 21 APRIL 1982 TO 30 JUNE 1989

Variable	Estimate	t-Statistic
Intercept	0.006	3.18[a]
Lagged volatility	0.048	0.37
Average margin rate	0.096	1.95[b]
R^2	0.080	

Monthly volatility is measured by the average daily S&P 500 return standard deviation in a month corrected for the effects of nonsynchronous trading. Lagged volatility is the monthly standard deviation lagged one month. The average margin rate is the average daily futures margin rate for the nearest expiration S&P 500 contract.

[a]Indication statistical significance at the 5% level.

[b]Indicates statistical significance at the 10% level.

where the range is the difference of the natural logarithms of the high and low price for the day. Although this estimator assumes zero drift in the diffusion process, the bias imparted by ignoring the drift is negligible for daily data.[13]

The intraday volatility estimates for the S&P 500 index are calculated for the period July, 1987, through July, 1989. A plot of the sample volatility estimates and the daily S&P 500 futures hedge-margin rate appear in Figure 2. The time series plot of intraday volatility estimates exhibit at least two notable characteristics: extreme intraday volatility associated with the October, 1987 crash; and relative stability of intraday volatility since the beginning of 1988.

Table IV reports the ten highest and ten lowest volatility days in the sample. The table shows that the lowest volatility days occur when both the level of margin and margin rates are low. Conversely, high volatility days are predominately associated with high margin settings.

Table V presents the estimates of the "best fitting" ARMA model of the natural logarithm of intraday volatility series. The log transformation reduces the (right) skewness of the intraday volatility distribution. Using the Schwartz criterion and Box–Ljung statistics as a basis for model selection, an AR(5) model appears to adequately characterize the intra-day volatility series.[14] The coefficient's estimated t-statistics, calculated using the heteroskedasticity and autocorrelation robust standard error estimates suggested by Newey and West (1987), indicate that the intraday volatility series is stationary with statistically significant AR coefficients up to lag 5.

The model reported in Table V includes estimates of the effects of "double witching" (witch2) and "triple witching" (witch3) day expirations.[15] The parameter estimates show no statistically significant increase in this intraday volatility measure on these days.[16]

[13]Garman and Klass (1980) discuss biases that may be imparted by the effects of nonsynchronous trading, discrete price increments and the existence of bid–ask spreads. These biases are negligible for the S&P 500 index. In addition, to the extent that the range estimator is biased, so long as the bias is constant over time it will not materially affect inference from the estimates that are the focus of the analysis.

[14]When individual daily intercepts are included in the regression, the F-test statistic for testing the equality of the daily intercepts is 0.388 which is not significant at any conventional level of the test (p-value of 0.8172).

[15]A "double witching" day is a day on which index options and individual stock options expire. A "triple witching" day is a double witching day on which a stock-index futures contract also expires.

[16]The lack of statistical significance is counter to results of Day and Lewis (1988) who find evidence of increased volatility on both expirations when they measure volatility using implied volatility estimates from index options using the Black and Scholes (1973) pricing model and data over the sample period June 1983

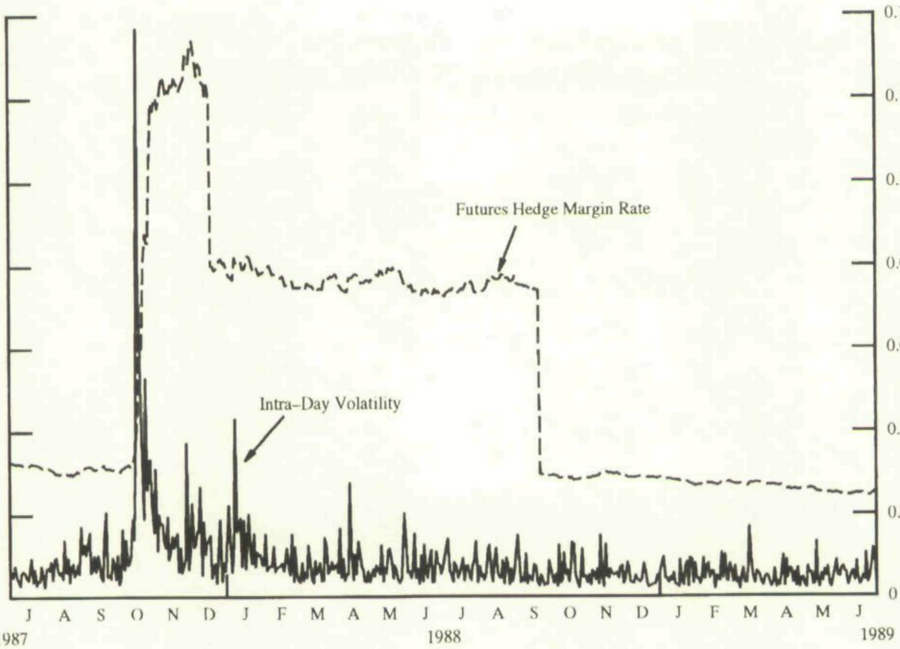

Figure 2
S&P 500 Intraday volatility estimates.

The AR(5) model estimates are a useful baseline characterization of intraday volatility univariate dynamics.

If a margin committee follows an optimal prudential margin setting rule with a predetermined number of daily settlements, under the assumption that intraday volatility is independent of the margin setting, the optimal margin is a function of forecasted volatility. If $\hat{v}_t$ represents the optimal forecast of intraday volatility before market open on day t, the optimal margin rate setting, MR_t, is given by

$$MR_t = a\hat{v}_t, \qquad a > 0$$

where "a" is a parameter determined by the interest cost of posting margin, the marginal cost of settlement, and the expected loss rate on a nonperforming contract.[17] If exchanges follow an optimal margin policy and efficiently forecast intra-day volatility, the margin rate can be introduced directly into the AR(5) model of Table V, because under these assumptions the margin rate will be uncorrelated with the innovation in the volatility generating process.[18] Although the margin rate variable can be introduced into the baseline AR(5) model, under the assumption that margins have no independent effect on volatility, they should not add any explanatory power to the equation.

through December 1986. Since June 1987, the expiration of both the S&P 500 and the NYSE composite futures contracts coincide with the Friday opening prices. The apparent attenuation of the "triple witching" effect may be a direct result of this change in the expiration procedure from Friday closing to opening. The absence of monthly expiration or "double witching" effects cannot be related to any expiration change as these contracts expiration procedures are unchanged.

[17]See Fenn and Kupiec (1993).

[18]This implicitly assumes that the five lags contain all the relevant information necessary to forecast volatility. The importance of this assumption and supporting evidence are discussed subsequently in the text.

TABLE IV
TEN HIGHEST AND LOWEST VOLATILITY DAYS JULY 1987 TO 8 AUGUST 1989

Date	Intraday Standard Deviation	Hedge Margin	Margin Rate
	Ten lowest volatility days		
19.07.89	0.068%	4000	2.4%
09.03.89	0.17	4000	2.7
16.02.89	0.19	4000	2.7
06.07.89	0.21	4000	2.5
25.10.88	0.21	4000	2.8
04.05.89	0.21	4000	2.6
10.04.89	0.22	4000	2.7
16.05.89	0.22	4000	2.5
25.05.89	0.22	4000	2.5
22.12.89	0.22	4000	2.9
	Ten highest voltaility days		
19.10.87	13.7%	7500	7.4%
20.10.87	7.6	7500	6.9
21.10.87	5.4	7500	5.8
26.10.87	5.3	10,000	9.1
08.01.88	4.3	10,000	8.3
30.11.87	3.7	15,000	12.9
22.10.87	3.7	10,000	8.2
16.10.87	3.6	5000	3.5
29.10.87	3.4	15,000	12.2
03.11.87	3.1	15,000	11.9

Table VI reports the estimation results from models that incorporate the market-open and four previous days' future's margin rates into the AR(5) specification. The margin rate enters the model significantly, increasing the explanatory power of the model without degrading the importance of the baseline model's lagged volatility terms. Test statistics, calculated using consistent covariance estimates, indicate that the impact-multiplier margin rate coefficient is positive and statistically significant, and the long-run effects (the sum of the margin rate coefficients) are also positive and significant. These results are not consistent with the view that low futures margins are associated with high cash market volatility. Although correlations do not imply causality, there appears to be a positive correlation between the futures margin rate and the magnitude of S&P 500 cash market volatility—higher margins are associated with higher volatility.

Margins, Volatility, and Return-Dependent Heteroskedasticity

The positive volatility–margin statistical relationship may be induced by return-dependent heteroskedasticity in stock index returns. French, Schwert, and Stambaugh (1987); Schwert (1988); and Turner, Startz, and Nelson (1989) find that cash market volatility tends to be larger around periods of negative market returns. Large losses in the index's value increase the futures margin rate independent of margin committee action. The heteroskedastic return generating process interacting with the "automatic" margin rate response may account for the positive estimated relationship.

TABLE V
ARMA MODEL ESTIMATES FOR INTRADAY VOLATILITY SERIES INCLUDING ESTIMATES OF FUTURES AND OPTION EXPIRATION-DAY EFFECTS 1 JULY 1987 TO 8 AUGUST 1989

Coefficient	Estimate	*t*-Statistic	Estimate	*t*-Statistic
intercept	−5.07	(51.03)[a]	−1.07	(4.23)[a]
std(t-1)	0.156	(3.64)[a]	0.156	(3.63)[a]
std(t-2)	0.121	(2.83)[a]	0.120	(2.78)[a]
std(t-3)	0.135	(3.15)[a]	0.136	(3.18)[a]
std(t-4)	0.187	(4.38)[a]	0.188	(4.35)[a]
std(t-5)	0.190	(4.41)[a]	0.189	(4.36)[a]
witch2			0.036	(0.28)
witch3			0.128	(0.58)

Box–Ljung Statistics for AR(5) Model

Lag	Chi-Square	p-Value
12	8.03	0.24
18	10.49	0.57
24	16.41	0.56
30	18.50	0.78

Std(t-j) is the natural logarithm of the intra-day standard deviation on day t-j.

Witch2 is a variable that takes the value of one double witching day; 0 otherwise. Witch3 is analogously defined for triple witching expiration days.

[a]Indicates statistical significance at the 1% level of the test.

To control for return-dependent (conditional) heteroskedasticity, five lagged daily geometric returns are introduced into the margin–volatility specification, and Table VII reports the estimation results.[19] Consistent with earlier findings, the lagged return coefficients are negative and statistically significant indicating that volatility increases when the market falls. After controlling for heteroskedasticity, intraday volatility remains positively related to futures margin rates, and futures margin rates continue to add to the explanatory power of the intraday volatility model.

Despite the positive statistical relationship, it is possible that low margins could be destabilizing. The estimated margin–volatility relationship is the result of two potentially offsetting effects. The first effect is a possible independent margin–volatility relationship—a relationship that may be consistent with the excess volatility hypothesis. The second effect is an expected volatility effect. If the margin committee optimally adjusts the margin rate and, in doing so, forecasts future volatility with some alternative model that is a more efficient predictor than the AR(5) model estimated herein, the margin rate they set would be positively correlated with future volatility. This positive correlation could completely offset a negative independent margin–volatility relationship in the sample estimates. This separate channel of correlation cannot be identified because

[19]When a 30-day geometric return is introduced into the regression, it is insignificant and does not otherwise alter the inferences implied by the model estimates.

TABLE VI
INTRADAY VOLATILITY FUTURES MARGIN ESTIMATES

Variable	Margin Rate in Logs		Margin Rate in Levels	
	Estimate	*t*-Statistic	Estimate	*t*-Statistic
intercept	−1.540	5.56[a]	−2.10	5.39[a]
std(*t*-1)	0.102	2.31[a]	0.11	2.41[a]
std(*t*-2)	0.071	1.61	0.08	1.70
std(*t*-3)	0.103	2.35[a]	0.10	2.37[a]
std(*t*-4)	0.162	3.70[a]	0.16	3.55[a]
std(*t*-5)	0.175	4.01[a]	0.17	3.85[a]
margin(*t*)	1.138	2.95[a]	18.04	2.89[a]
margin(*t*-1)	−0.077	0.15	−2.22	0.26
margin(*t*-2)	−0.077	0.15	−0.73	0.09
margin(*t*-3)	−0.603	1.16	−7.36	0.88
margin(*t*-4)	−0.247	0.64	−5.15	0.83
	Estimate	***t*-Statistic**	**Estimate**	***t*-Statistic**
Sum of margin coefficients	0.134	6.77[a]	2.59	6.92[a]

Std(*t-j*) is the natural logarithm of the standard deviation measure to intraday volatility on day *t-j*. Margin(*t*) is the margin rate at market open on date *t*.

[a]Indicates statistical significance at the 5% level.

the margin committee's expected volatility estimate is unobservable.[20] Although this theoretical explanation is possible, it is not very compelling. Fenn and Kupiec (1993) show that margin committees do not appear to "fine tune" margins in the manner that would be required to make the margin rate an optimal predictor of volatility. Consequently, it is doubtful that the margin rate is a proxy for an optimal predictor of future volatility.

A second explanation still admits the possibility that margins have an independent negative effect on volatility. If the best one-step-ahead predictor of intraday volatility is a nonlinear model, including the margin rate may improve the baseline model's explanatory power owing to the linear misspecification. Here again, margins could have an independent negative effect on volatility and yet, this effect could be hidden by the model's misspecification. A study by Hsieh (1991), however, discredits this explanation. Hsieh considers different models for predicting daily volatility and his findings generally support linear autoregressive models for daily stock-index volatility series. He fits AR models to S&P 500 daily volatility estimates and tests residuals for general forms of nonlinearity using the BDS test. He finds an AR(5) model to be the preferred specification, and finds no evidence of significant omitted nonlinearities.

A third interpretation of the positive margin–volatility relationship is that high margins reduce market liquidity and thereby increase price volatility. In this instance it is still the case that, although they may not strictly follow an optimal prudential margin rule,

[20]Discussions with clearinghouse officials suggest that the primary inputs into the margin committee's expected volatility estimate are data on historical price movements and intuitive judgment. As such, it is doubtful that their expected volatility estimate can be separately identified.

TABLE VII
INTRADAY VOLATILITY FUTURES MARGIN ESTIMATES

Variable	Margin Rate in Levels	
	Estimate	t-Statistic
intercept	−2.23	5.73[a]
std(t-1)	0.074	1.67
std(t-2)	0.057	1.30
std(t-3)	0.108	2.49[a]
std(t-4)	0.166	3.79[a]
std(t-5)	0.179	4.07[a]
margin(t)	2.800	2.87[a]
R(t-1)	−5.481	4.29[a]
R(t-2)	−3.888	2.99[a]
R(t-3)	−4.09	3.09[a]
R(t-4)	−1.113	0.86
R(t-5)	−2.568	2.00[a]
Sum of margin coefficients	2.80	2.87[a]

Std(t-j) is the natural logarithm of the standard deviation measure of intra-day volatility on day t-j. $R(t$-$j)$ is the geometric close to close return from day t-j-1 to day t-j. Margin(t) is the margin rate at market open on date t.
[a]Indicates statistical significance at the 5% level.

margin committees tend to raise margins when volatility significantly increases. Both effects, liquidity and prudential margin management, will induce a positive margin rate coefficient estimate, but estimates of the independent effects are not recoverable.

SUMMARY AND CONCLUSIONS

The evidence presented in this article suggests that, if there exists a statistical relationship between the initial margin rate on stock-index futures products and the volatility in the cash market, the relationship is positive. High margin rates in the futures markets tend to be associated with periods of above-average volatility in the cash markets.

Although the estimated margin–volatility relationship is positive, this study cannot formally reject the excess volatility hypothesis. There are two reasons why the excess volatility hypothesis may be true and yet futures margins may be positively correlated with future cash market volatility. One possible explanation is the prudential behavior of the futures margin committee. Margin committees tend to raise required margin when volatility increases. An active margin committee "reaction function" could induce a positive correlation large enough to overwhelm an independent negative margin–volatility relationship. An alternative possibility is the inherent nonlinearity of volatility time series. If the true volatility process is nonlinear, a positive margin–volatility correlation may be induced by linear misspecification. Although both of these explanations are possible, neither of them appear compelling. Rather, the more compelling interpretation is the negative liquidity effects of high margins. High margins may reduce liquidity in the futures market and thereby increase price volatility. Distinguishing between these alternative explanations of the positive margin–volatility relationship is an important area for future research.

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