EVIDENCE ON THE IMPACT OF FUTURES MARGIN SPECIFICATIONS ON THE PERFORMANCE OF FUTURES AND CASH MARKETS

James T. Moser

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by

James T. Moser

Research Department
Federal Reserve Bank of Chicago
230 S. LaSalle
Chicago, IL 60604-1413

Phone: (312) 322-5769
FAX: (312) 322-5231

Abstract

Changes in margin requirements for S&P and silver futures contracts are examined to determine their impacts on various measures of market performance. Margin changes are found to be unrelated to the subsequent volatility of futures prices after controlling for exchange interventions in the silver market. Speculative margin appears to be positively related to cash market volatility in both contracts. We find evidence of a positive relationship between margin changes and the volatility of open interest in the S&P contract. This suggests margin changes may increase the risk of realizing thin market conditions. No relationship is found between margin changes and other measures of market participation. A cost-of-carry model is introduced which relates compensation for nonperformance risk to margin changes. We find evidence favoring the hypothesized negative relation between margin changes and nonperformance.

Keywords: FUTURES MARGIN, NONPERFORMANCE, COST OF CARRY, BASIS

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I. Introduction

Recent volatility in stock and futures markets motivates further examination of margin and market performance. This paper investigates several paths through which linkages between futures margin changes and market performance may be expressed. Section II relates margin requirements to some traditional measures of performance. The first of these examines the role of margin in fulfulling the often-stated regulatory goal of controlling volatility. Second, we examine the impact of futures margin changes on volatility in the cash market. The third considers the role of margin in the determination of market participation. Our measures of market participation are the levels and volatilities of trading volume and open interest. For the futures markets, we examine levels and volatilities for both volume and open interest in each contract. Trading volume in the stock market is examined for evidence of a change in cash-market participation owing to margin changes in associated futures contracts.

This study of the correlation between margin changes and market performance suggests three conclusions. First, in itself, margin changes do not appear to affect the volatility of futures prices. A relation between margin changes and futures price volatility is supported only during periods when other forms of exchange intervention are used. Second, we find modest evidence that speculative margin changes in futures contracts produce higher volatility in associated cash markets. Maintenance margin changes which are generally concurrent with changes in speculative margin do not repeat this finding. Third, we reject linkages of margin changes with most of our market participation measures. The exception is a finding that margin changes appear to precede increases in the volatility of open interest for S&P contracts. This result may indicate increased risk of liquidity problems.

This correlative evidence motivates consideration of a model in section III for the impact of margin on the prices of cash and futures contracts. The cost-of-carry model is specialized to include compensation for nonperformance risk. This approach emphasizes the role of margin as a performance bond in the futures markets. Simply stated, if margin balances bond performance, then compensation for the risk of nonperformance should be negatively related to changes in margin. Section IV reports estimates of the parameters of our model, finding evidence favoring the hypothesized negative relation with margin changes. This suggests that exchanges seek to control nonperformance risk through the setting of margin. Section V summarizes the paper.

II. The Impact of Margin Changes on Market Performance

This section examines three possible impacts from changes in margin requirements: futures return volatility, cash return volatility, and futures market participation.[1] Schwert (1989a,1989b) suggests an iterative approach to examine the relationship between margin changes and price volatility. Variations on this approach are used to obtain inferences on the impact of margin on return volatilities for futures and underlying cash markets. The approach is also extended to examine margin implications for the volatility of volume and open interest.

A. Description of Data Set

Data used in these preliminary tests are from two contracts having a history of volatility and margin adjustments: the Chicago Merchantile Exchange (CME) stock index--S&P--contract and the Comex Silver contract. The data are daily observations of: futures prices, futures volume, open interest, and values of the underlying cash market index or price. The sample period for the S&P contract is June 30, 1982 through November 30, 1989. The sample period for the silver contract is September 27, 1974 through November 30, 1989. In both cases, series are

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[1] The literature on margin also addresses the issue of regulatory constraints on credit allocated to speculative purposes. See for example, Moore (1966) and Luckett (1982). This issue is not taken up here.

constructed for the nearest-to-expiration contract prior to its delivery month. As contracts enter the delivery month, the next-to-nearest delivery month is used. This sampling procedure avoids inferences regarding futures markets which are unique to delivery months.

Margin requirements are from the respective clearing organizations. Margin specifications are categorized according to type of position and time of requirement. Margins differ depending on whether the position is speculative or hedging with the former generally larger. Margin is required at the time either type of position is established--its initial margin--and as accounts are marked to market--its variation margin.[2]

Figures 1 and 2 graph required margin amounts for stock index futures on the their effective dates for each margin category. Figure 3 graphs required initial margin amounts for silver futures on their effective dates. Margin minimums are set by the clearinghouse after examining historical volatility in the cash and futures markets and, when available, ex ante volatilities implied by option prices. Margins for both contracts demonstrate a relation to market events. Peak margins in the S&P contract occur during the period beginning October 19, 1987 which coincides with the extreme stock price changes of

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[2] Only initial margin amounts for the silver contract are available.

that period. Peak margins in the silver contract appear during the period when the Hunt brothers attempted to corner the silver market. The focus of this section is to associate these margin changes with some plausible measures of market performance.

Figlewski (1984) points out that clearing members are at risk when maintenance margin levels are reached. Their risk derives from customer failure to comply with calls for margin made on reaching the maintenance level. Thus, an appropriate assessment of exchange risk considers the level of maintenance margin. He develops a model for the probability of margin violations over a given number of days. His model implies that maintenance margin levels of 10% or higher provide virtually sure protection against margin violations at reasonable mean and variance levels of the stock index.

Comparing Figures 1 and 2, changes in initial margin after October 1987 are more frequent than changes in maintenance margin. This suggests an incompleteness in the model of Figlewski. If adjustments to margin are made to control nonperformance risk, maintenance margin changes should occur at least as frequently as changes to initial margins. One explanation is that changes in initial margin serve additional purposes. The tendency of regulators to focus on initial margin suggests this purpose is to limit entry into the market. High initial margins may prevent unsophisticated investors from opening positions or reduce volatility due to speculation.

Gay, Hunter and Kolb (1986) find that margin setting appears to maintain a constant probability of exhausting margin balances. For example, assuming a normal distribution for price changes, setting margins at two standard deviations of price change maintains a 5% probability of exhausting margin. Warshawsky (1989) considers the sufficiency of exchange-imposed margin requirements to cover price changes. He finds that margins on index futures contracts provide sufficient coverage at the 99th percentile of absolute price changes.

These studies consider risk from the perspective of clearing members who face losses if margin calls are not met. Generally, this perspective provides an insight to the risk faced by the clearing association and the payments system, but not in the case of the CME. The CME uses a gross margining system. The difference is that all margin balances are held by the clearing association. Other clearing associations operate net margining systems, holding the net of margins collected from long and short positions. For example, clearing members with ten open contracts--six long and four short--at $1000 margin per contract must post margin with the association as follows: $10,000 under gross margining rules [10 x $1000], $2,000 under net rules [(6 - 4) x $ 1000].

The difference alters the potential liabilities of the clearing association. Under both methods, the clearing association guarantees the performance of each clearing member.

All else equal, gross margining rules increase resources available to the clearing association over that obtained from net margining systems. Thus, in terms of the nonperformance risk faced by the exchange, a given margin amount provides greater protection in a gross margining system than in a net margining system. In terms of the risk that customer margin calls will not be met, clearing members face identical risks.

B. The Relation Between Margin and Futures-Price Volatility

B.1 Tests of the Relation

Schwert (1989a,1989b) suggests a procedure to test the notion that margin changes influence volatility. He expresses the idea as a hypothesis of conditional heteroskedasticity. Estimation of the hypothesized variance function permits a simple test for the relevance of margin changes for changes in volatility. Using the procedure of Davidian and Carroll (1987), he begins with two specifications as follows:

$$R_t = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_i R_{t-j} + u_{1t} \qquad (1)$$

$$|u_{1t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j e_{t-j} + \mu_t \qquad (2)$$

where R_t is the time-t change in futures prices, D_{it} are indicator variables for the months of the year, and u_{1t} and μ_{1t} are the respective error terms. The procedure is a generalized least squares approach iterating on three steps. First, fit equation (1) to obtain the conditional mean and collect residual terms. Second, using the absolute values of these residuals, fit equation (2). This gives an estimate of the standard deviation of u_{1t} conditional on the month and past residuals. Third, these residuals become weights used in re-fitting equation (1) to produce GLS estimates used for the next round.[3]

The hypothesis that volatility is conditional on margin changes is tested by augmenting equation (2) with percentage margin changes for the period t-12 through t+12 giving:

$$|u_{1t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j e_{t-j} + \Sigma_{k=-12}^{12} \delta_{1k} dm_{t-k} + \mu_{1t}. \quad (3)$$

The coefficients δ_{1k} allow inferences on the relation between leads or lags of margin changes and volatility. Nonzero values for δ_{1k} imply that leads or lags of margin changes are related to volatility. For k in the interval {-1,-12}, a nonzero value implies that margin changes are in response to earlier volatility. For example, a positive $\delta_{1,-1}$ implies that volatility leads margin changes by one dane day: margins increase in response to past increases in volatility. Nonzero values of k in the interval {1,12} suggest a volatility response from margin changes. Thus, a negative $\delta_{1,+1}$ implies that

3 The monte carlo experiments of Davidian and Carroll (1987) suggest the procedure provides a fairly robust estimator for variance functions.

volatility lags margin changes: margin increases are correlated with subsequent volatility.

Table 1 reports sums of these coefficients estimated in the fifth iteration of the above procedure and tests for their significance. Inspecting the change in coefficients after each iteration, the fifth iteration produces unimportant differences in coefficients.[4] Test statistics are computed using White's (1980) adjustment for heteroskedasticity. Estimates are made separately for changes in speculative or hedging margin required either initially or as variation margin. For the S&P contract, coefficient sums are generally negative, but not significant at the usual levels and we can reject any relationship between futures-price volatility and margin changes. Silver contract results are uniformly negative, significantly so for lags of speculative margin changes. This suggests that the volatility of these futures prices declines following increases in initial margins. To illustrate the result, figure 4 plots the individual coefficient t statistics on the order of the lead/lag. The significantly negative coefficients at lags +4 and +7 weigh most heavily in this result. Interpreting this in a Granger-causal sense, increases in margin decrease volatility

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[4] The number of negative predicted values from the variance estimation equation is another indication of convergence. This number declines after each iteration. In each case this number was zero at the fifth iteration.

with the bulk of the impact on volatility coming on the fourth and seventh trading days following the margin increase.

The negative signs of the sums of leads and lags for both speculative and hedging positions suggest more is happening. Retaining the previous Granger-causal perspective, negative lead coefficients imply volatility falls prior to margin changes. This seems to obviate the need for changing margin. The margin change might instead be regarded as part of an overall policy intended to reduce volatility. This interpretation may be particularly apt given exchange intervention in the silver contract to reduce the impact of an apparent corner by the Hunt brothers. To investigate this possibility, the procedure was re-run for the post-corner period.[5] For this subsample, t statistics for speculative positions were: leads -.68, lags -1.51, leads and lags -1.55. For the hedging positions these were: leads -.12, lags -1.39, leads and lags -1.07. The general decline in t statistics for the post-corner period appears to weaken the relationship between margin changes and volatility suggesting other exchange interventions did play a role in the earlier period. The evidence suggests exchange intervention in the cornered silver contract of late-1979 and early 1980 did

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[5] Barnhill and Powell (1981) describe exchange interventions in the silver contract performance during this period. Following their description of exchange interventions, we begin the post-corner sample after May 31, 1980.

precede a decrease in futures-price volatility. This intervention included substantial margin increases. After this period, margin changes do not appear to play a role in the determination of futures price volatility.

B.2 Comparison to Previous Research

Much of the investigation of the relation between margin requirements and volatility concentrates on stock markets.[6] The impact of margin changes on futures prices generally finds no link between futures margins and futures volatility.

A 1967 report prepared for the Economic Research Service [hereinafter cited as ERS (1967)] of the Department of Agriculture studies the impact of speculative margin policy for grain contracts during the period 1948-1966. The impact from changes in initial margin requirements for speculative positions depends on the amount of change. The large margin changes during the earlier portion of the sample period are negatively related to daily price ranges, suggesting reductions in volatility. The effect of the smaller margin changes occuring

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6 Largay (1973), Largay and West (1973), Eckhardt and Rozoff (1976), Hardouvelis (1988,1989) examining U.S stock markets and Hardouvelis and Peristiani (1989) examining Japanese stock markets find a negative relationship between margin changes and stock price volatility. Grube, Joy and Panton (1979) find a d a positive relation. Other researchers find no relation. These are: Officer (1973), Ferris and Chance (1988), Kupiec (1989), Schwert (1989a,1989b), Hseih and Miller (1990), Salinger (1989) and Kumar, Ferris and Chance (1990).

after 1948 is less clear. Most of the effect (which is positive) appears to be limited to changes followed by important events subsequent to the margin change.

Hartzmark (1986) examines price volatility for twenty-five days before and after thirteen instances of changed margin in wheat, cattle, pork bellies and US bonds. Volatility is measured as the squared absolute value of price changes. Volatility comparisons are made with F statistics. He finds volatility increasing in eight of the thirteen cases, but not significantly at usual levels.[7] One significant decrease in volatility is found in the June 17, 1981 increase in margin for the wheat contract.

C. <u>The Relation Between Margin and Cash-Price Volatility</u>

C.1 Tests of the relation

These tests are similar to those of the previous subsection. We begin with the specifications:

[7] Indeed, using a simple sign test the number of volatility increases suggests a positive relation between margin and volatility. For the null of a negative relation between margin changes and volatility, no more than three positive cases is required for the five percent level of significance. The eight reported positives are better than two standard deviations above the number required for a negative relation.

$$r_t = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_i r_{t-j} + u_{2t} \qquad (4)$$

$$|u_{2t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j |u_{t-j}| + \Sigma_{k=-12}^{12} \delta_{2k} dm_{t-k} + \mu_{2t}. \qquad (5)$$

where r_t is the cash market rate of price change and u_{2t} is an error conditional on the calendar month and previous rates of return. Iterating as before, δ_{2k} measures the impact of changes in futures margin on cash market volatility.

Table 2 reports results from these regressions. For the stock-index samples, there is no evidence of a relationship at the five percent level of significance. At slightly lower levels of significance, the evidence favors a positive relation for lagged margin changes: increasing margin implies higher cash-market volatility. Figure 5 plots individual coefficient t statistics on the order of the lead/lag. Comparing volatilities before and after the period of the margin change indicates a persistent positive relationship with margin changes following the margin change.

Results for speculative silver margins differ from the pattern for futures volatility. At the 10% level of significance, the evidence favors an increase in cash-price volatility prior to changes in initial margin for speculative silver contracts; Table 1 reports a negative, but insignificant relationship between futures price volatility prior to a margin change. Margin changes appear to precede decreases in volatility for both the futures contract and its corresponding cash market. Increases in initial hedging margins appear to be unrelated to cash market volatility. To investigate the importance of the Hunt brother episode, a subsample for the post-corner period was constructed. The t statistics for summed regression coefficients of initial speculative margins are: leads .37, lags 1.75, leads and lags 1.50. For the hedge positions these are: leads -1.19, lags -.05, leads and lags -.87. For the subsample, the pattern is comparable to results from the S&P contract. Figure 6 plots individual coefficient t statistics. The pattern is similar to that for S&P cash volatility--margin increases are positively related to increased cash market volatility. Thus, omitting the results which include the Hunt episode, the evidence from both contracts appears to slightly favor an increase in cash price volatility following increases in speculative margins. The evidence does not support a relation between hedging margins and cash price volatility.

C.2 Comparison to previous research

Several researchers compare price volatility of cash assets preceding and following introduction of related futures contracts. Working (1960) finds a reduction in cash price volatility associated with the level of open interest in onion contracts. Gray (1964) cites evidence of a decline in potato price volatility after introduction of futures contracts in that commodity. Edwards (1988) finds lower volatility for the S&P 500, the Value Line index, the Tbill and 90-day Eurodollar contracts except during 1987 and on expiration days of the stock-index contracts. Harris (1988) finds increased volatility for individual stocks included in the computation of the S&P index.[8] Damodaran (1990) finds modest increases in cash market volatility following the introduction of S&P500 futures contracts. The increase appears to be in systematic risk. He also reports evidence of higher trading volume in stocks included in the index.

Kupiec (1990) conducts two tests for changes in stock index volatility from margin changes in the S&P contract. First, regressing index volatility on margin rates he finds a positive association between volatility and margin rates. Second, he regresses intraday volatility on lags of volatility and margin rates, finding a positive association for the one-day lag of the margin rate. The sum of the lag coefficients is not significant suggesting the effect on volatility is short-term. Further, specifications including lags of rates of price change produce insignificance for the margin rate coefficients. Kupiec interprets this as adjusting for the changes in return variance

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[8] This result corresponds to the higher volatility found in S&P stocks during the October 1987 market break. See Blume, Mackinlay and Terker (1989).

which have been found to accompany price declines. Thus, the positive relation between margin change and volatility appears to be spurious. Both results are consistent with prudential setting of futures margins.[9]

The results of our tests conform with those of Kupiec with the exception of those for hedging margin changes. Figures 2 and 3 suggests that hedging and speculative margin changes are generally coincident.[10] If the positive association is spurious for the reasons Kupiec suggests, hedging margin changes should also enter significantly with the same sign. Hedging margin changes are not significant and in two cases, S&P variation margin and silver initial margin, differ in sign from results for speculative positions. Thus, while the evidence is not particularly strong, it does suggest that speculative margin changes are positively related to subsequent cash market volatility.

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[9] Somewhat troubling is the reported lack of evidence of variance persistence. Both Chou (1987) and Kupiec (1989) find persistence in conditional variances.

[10] For the S&P contract, concurrent changes in initial margins for hedging and speculative positions occurred six times. There were 15 changes in speculative margin and 11 changes in hedging margin. S&P maintenance margins were concurrently changed 10 times. There were 10 changes in speculative margin and 11 changes in hedging margin. For the silver contract, initial margins changed concurrently 108 times. There were 116 changes in speculative margin and 108 changes in hedging margin.

D. Examination of Some Relations Between Margin and Volume

D.1 Tests of the relation

Additional measures of market performance are examined for relationships with margin changes. Two of these are the changes in the level of futures-market and cash-market volume. Volume levels are often used as measures of market participation. Clearly, inferences drawn from volume evidence rely on the indirect association between volume and participation. For example, reductions in the number of participants may be offset by increased trading activity of those who remain. Nevertheless, changes in volume associated with changes in futures margin might imply that the relative cost of trading has changed. For example, if maintaining margin balances is costly, an increase in futures margin might make the relative cost of trading in the cash market more favorable. Thus, increases in futures margin should be negatively associated with changes in futures market volume and positively associated with changes in cash market volume.

To examine these possibilities the following specifications are used:

$$dV_{ft} = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_j dV_{ft-j} + \Sigma_{k=-12}^{12} \delta_{3k} dm_{t-k} + v_{ft} \quad (6)$$

$$dV_{ct} = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_j dV_{ct-j} + \Sigma_{k=-12}^{12} \delta_{4k} dm_{t-k} + v_{ct}$$

(7)

where dV_{ft} and dV_{ct} are the changes in volume at t for, respectively, the futures market and the cash market. Our volume measure for the futures contracts are those reported by the exchange for the nearest-to-expiration contract.[11] Cash market volume for the stock market is total volume on the New York Stock Exchange. This volume figure encompasses trading in most of the stocks included in the Standard and Poor's index. The figure also includes trading in stocks listed on the NYSE but not included in the S&P 500. Our results may be biased if, for example, margin changes were to differentially impact trading in the S&P stocks. Volume figures for cash silver trades are not available. Tables 3 and 4 report these results. In no case, do we find evidence supporting a relation between margin changes and volume in the futures or cash markets.

The method used previously to examine futures and cash return volatility was also used to examine the relation between the volatility of volume and margin changes. The volatility of futures volume can be used as a measure of the risk of market thinness. Increases in the volatility of volume suggest a greater risk that investors will encounter a thin market. A relationship between past margin changes and volume volatility

[11] As before, contracts entering their expiration months are replaced by the next-to-nearest expiration month.

would then imply changes in this risk. Table 5 reports results from these tests. The evidence does not support a relationship.

This series of tests can be summarized as finding no support for a volume impact. Thus, results from these indirect measures of participation would imply no changes in futures or cash market participation can be attributed to changes in margin.

D.2 Comparison to previous research

ERS (1967) find that margin changes are negatively related to volume. Fishe and Goldberg (1986) and Hartzmark (1986) find reductions in open interest for nearby contracts following margin increases. Presumably, at some level, reduced open interest would impact trading volume, Hartzmark (1986) is unable to confirm an impact on volume. Fishe and Goldberg (1986) report ambiguous results linking margin and volume. They find significant changes in three-day average volume following margin changes, but no significance for five-day average volume.

E. Examination of Some Relations Between Margin and Open Interest

E.1 Tests of the Relation

Open interest figures state the number of contracts outstanding at the close of trading. The measure provides an alternative measure of market participation. We examine the effect of margin changes on open interest as another route to obtain insight on the role of margin in the determination of market participation. Following the previous method we define:

$$dO_{ft} = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_j dO_{ft-j} + \Sigma_{k=-12}^{12} \delta_k dm_{t-k} + w_{ft} \quad (8)$$

where dO_{ft} are changes in open interest at time t. Open interest is for the nearest-to-expiration contract save for contracts entering their expiration months. Table 6 reports the results. We find no evidence of linkage between margin changes and the level of open interest for any of the samples.

As before, volatility of open interest might indicate the risk of market thinness. To examine the impact of margin changes on the volatility of open interest we again use the method of Schwert. Table 7 reports the results. For the S&P contract, we find evidence of an increase in open interest volatility following changes in margin. Figure 7 plots the coefficient t statistics. The pattern suggests the bulk of the response occurs within two periods of the margin change. This result is not corraborated in the silver contract.

E.2 Comparison to previous research

Fishe and Goldberg (1986) and Hartzmark (1986) find reductions in open interest for nearby contracts following margin increases. This result is consistent with a higher cost of trading.

F. Some Anecdotal Evidence and Summary

Evidence can also be obtained from specific instances of margin increases. Figlewski (1984) reports that in 1965 the Johnson Administration requested margin increases in the Comex copper contract. After a series of margin increases amounting to more than a 300% increase in margin, volume on the contract declined from 832 contracts in November to 260 in January. The final days of trading in the Mexican Peso contract at the CME illustrate an alternate link between margin and volume. After the depreciation of the peso in 1985, the CME raised margins to 100% of contract value. Trading in the contract persisted. The explanation for this continued trading is that maintaining margin balances provided a way to circumvent Mexican restrictions on currency exports.[12]

This anecdotal evidence urges a cautious interpretation of the correlation evidence reported in the previous subsections. The common feature of these anecdotes is the extreme changes made in margin requirements. Since extreme changes are unusual, sample sizes limit our ability to draw inferences from these cases. In the realm of usefully sized samples, our evidence supports three conclusions. First, in the silver contract we find a negative relation between futures margin and futures

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[12] I am indebted to John Davidson of the CME Clearing House Division for this story.

volatility in samples which include exchange intervention through margin rules as well as other forms. This evidence is not corraborated by the results from the S&P contract, nor in the silver contract when margin is the principal mechanism for exchange intervention.

Second, we find modest evidence that cash market volatility increases with speculative margin changes. This phenomena does not appear to be explained along the lines offered by Kupiec (1989). Third, we find no evidence of a volume effect from margin changes in either the mean or volatility. The examination of open interest suggests an increase in the volatility of open interest following margin changes, but no relation between the level of open interest and margin changes.

III. A Cost-of-Carry Specification Incorporating Nonperformance Premiums

A. Forces Affecting Compensation for the Risk of Nonperformance

This section examines the relationship between margin rules for futures contracts and the cash-futures basis. The cost-of-carry model implies that prices for futures contracts eliminate any arbitrage profits from simultaneously held futures and cash positions. Observed differences in these prices are, therefore, interpreted as market-determined compensation for the marginal costs of holding these positions. These costs include the riskless rate used to finance the position, the net of any convenience yields obtained from holding the good and its storage costs, and, lastly, compensation for nonperformance on the futures contract.

The nonperformance premium is featured in this section. Kane (1980) emphasizes the role of nonperformance in the determination of futures prices. Futures contracts are executory contracts; that is, contracts specifying terms which must be executed by parties to the contract. Failure to live up to these specifications is termed nonperformance. Since nonperformance imposes costs on the counterparties to open contracts, the risk of nonperformance should be compensated. Brennan's (1986) Theory of Efficient Contract Design argues that competition between exchanges results in contracts which minimize these costs.

Exchanges minimize nonperformance costs through two jointly determined routes. First, exchange guarantees of contract performance involve the exchange clearing members in each futures contract as third-party guarantors. Edwards (1982) describes the form of these guarantees. Clearing members guarantee the performance of their matched long and short positions. Exchange clearinghouses guarantee the performance of the net positions of each clearing member. Since all trades must be conducted through clearing members, all contracts traded on the exchange involve a third-party guarantor.

As a second route to minimizing nonperformance costs, exchange rules committees alter contract specifications.

Contract nonperformance is rational only when losses from futures positions exceed the wealth of the contractholder. Margin requirements play a key role in controlling nonperformance risk. Margin reduces exposure to nonperformance risk in two ways. First, these balances reduce nonperformance risk by assuring the availability of a minimum level of wealth. Second, delays in posting margin signal clearing members of the potential liquidity problems of its clients. Combining these separate roles, margin balances provide a mechanism to assess and manage exchange exposure to nonperformance. Increasing margin requirements decreases the potential liability of the exchange to cover losses.

B. A Cost-of-Carry Model for Nonperformance Premiums

The cost-of-carry model developvelops the futures price from the cost of holding the underlying asset to delivery of the futures contract. Absent arbitrage opportunities, the futures price at t for a contract delivering the underlying good or asset at T is:

$$f(T,t) = P(t)\exp\{E_t(r+s-c+\Pi)\tau + \epsilon_{t,T}\} \qquad (8)$$

where $f(T,t)$ is the futures price at t delivering the underlying good or asset at T, P(t) is the cash market price at t, $E_t()$ is the expectations operator conditional on information available at t, $\epsilon_{t,T}$ is the time-t error which is fully realized at time T, and at continuously compounded annual rates:

r = the riskless rate of interest

s = the cost of storing the good

c = the convenience yield obtained by holding the good

Π = the nonperformance premium.

Finally, τ is the number of years until contract expiration; that is, (T-t)/365.

Equation (4) is useful for its insight into the determination of futures prices. For example, the variables r, s, and Π are regarded as relevant costs to agents doing business in the underlying good or asset. The variable c would be regarded as a revenue source.[13]

From the discussion in the previous subsection, Π is related to the level of margin denoted as M and nonperformance risk denoted σ. Thus, $\Pi=\Pi(M,\sigma)$ with $\delta\Pi/\delta M<0$ and $\delta\Pi/\delta\sigma>0$. Thus, increasing margin decreases market-determined compensation required for nonperformance risks while increases in nonperformance risk increase required compensation for this risk. Fishe and Goldberg (1986) use an options framework to express a similar point. They note that nonperformance of a futures contract can be regarded as putting the contract to the

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[13] Interestingly, a positive convenience yield implies the marginal price setter is not a pure speculator. Since convenience yields decrease the cost of holding the position, agents having a business purpose for inventories of the good will have lower carrying costs.

exchange. Clearinghouse guarantees require the clearing members of the exchange to make good on the contract. Bailey and Ng (1989) further develop this insight to examine changes in nonperformance premiums for exchanges experiencing substantial increases in nonperformance risk. We use this insight to motivate an investigation into the relation between margin and cost of carry.

One period later, the cost of carry relation will be

$$f(T,t+1) = P(t+1)\exp\{E_{t+1}(r+s-c+\Pi)\tau(-1) + \epsilon_{t+1,T}\} \qquad (9)$$

where $\tau(-1)$ is the number of years under contract expiration after one period. Taking logs, subtracting equation (8) from equation (9), and re-arranging gives

$$\begin{aligned} \log\left(\frac{f(T,t+1)}{P(t+1)}\right) &= \log\left(\frac{f(T,t)}{P(t)}\right) \\ &+ \{E_{t+1}(r+s-c+\Pi) - E_t(r+s-c+\Pi)\}\tau \\ &- E_{t+1}(r+s-c+\Pi)\tau \qquad (10) \\ &+ \epsilon_{t+1,T} - \epsilon_{t,T} \end{aligned}$$

The LHS and first term on the RHS are the continuously compounded bases at, respectively, time T+1 and t. The second term on the RHS is the difference in expected cost of carrying the position over the period t to t+1. The third term on the RHS is the negative of the time t+1 cost of carrying the position. The last two terms are the errors.

Defining B(T,t) as the log basis at time t for a contract expiring at time T, we estimate equation (10) as follows:

$$B(T,t+1) = \beta_0 + \beta_1 B(T,t) + \beta_2 rh_t + \beta_3 dm_t + \beta_4 h_t + e_{t+1} \quad (11)$$

where h_t is the holding period in years from t to t+1. From the model β_1 gives the relationship of the basis at t+1 to the prior period basis. β_2 is an estimate of the relation between riskfree rates of interest and the basis. With riskless borrowing opportunities, β_2=1. β_3 relates the basis to changes in margin. Increases in margin should lower any nonperformance premiums incorporated into the market's determination of basis. Thus, margin changes should be negatively related to changes in basis. β_4 is our estimate for s-c under the assumption that the net of storage costs and convenience yields is constant.

The error term, e_{t+1}, includes the remaining terms of equation (10). This includes the difference in expected costs of carry and the difference in realized errors. Changes in expectations cannot persist over long periods, thus the mean of changed expectations are zero. Nevertheless, expected costs of carry might well vary systematically over the lives of futures contracts. For example, convenience yields might have seasonal components. Such seasonality would suggest autocorrelation at lags of e_{t+1}.

The difference in the error terms of equation (10) implies an MA(1). Combining these inferences for the error term suggests that estimation of equation (11) must use an ARMA(p,1) model for the process where p is determined from the data.

IV. Estimates of the Cost-of-Carry Model

A. Description of the Data Set

The previously described data set is augmented with daily cash market prices used to compute the basis. Riskfree rates of interest are from the Federal Reserve Bank of New York. This series is described as a three-month Treasury Bill series. Since three-month maturity bills are not issued daily, actual maturities depend on the day of the week. Monday bills are "same-day" quotes obtained from dealers for bills issued the previous Thursday, maturities are 86 days. Tuesday and Wednesday bills are Thursday "when-issued" bills auctioned on Monday, maturities for both are 91 days. Thursday and Friday bills are "next-day" quotes obtained from dealers for 91-day maturities issued on Thursday, maturities are, respectively, 90 and 89 days. Bill rates used in our specifications are converted to continuously compounded annual rates calculated as follows:

$$r_t = \log\left(\frac{1}{1 - q_t \frac{dtm}{36000}}\right)\left(\frac{365}{dtm}\right)$$

where q_t is the quoted discount rate and dtm is the days to maturity as determined by the day of the week for each quote.

B. Regression Results

Equation (11) was estimated for an MA(1) with a variety of autoregressive lags included. Model selection was determined by examining residual autocorrelations from each. Including lags 2 and 8 for the S&P contract and lags 2, 7 and 8 for the Silver contract seems appropriate. Box-Ljung Q(k) statistics were calculated to detect autoregressive problems through the twelfth lag. At the twelfth lag the critical value for the five percent level is 21.03. None of the Q(12) statistics exceed this critical value.

Table 8 reports results from the cost of carry model for the S&P and silver contract for the available margin categories. Results are consistent across the margin categories.

Panel A reports the results for the S&P contract. The model implies the intercept is zero, β_0 is well within two standard errors of zero. β_1 is less than one and the difference is significant. β_2 is greater than one and the difference is sign ificant. The model implies the β_2 coefficient equals one if positions can be financed at riskless rates of interest. β_3 is negative and differs reliably from zero for all but the initial speculative margin category where it does not differ significantly from zero. The evidence suggests that nonperformance premiums are negatively related to changes in margins.

β_4 estimates the average net of convenience yield and cost of carry. These estimates do not differ reliably from zero. Convenience yields for financial assets are the return to holding the asset. This yield should equal its cost of carry, else an arbitrage opportunity exists. Hence, for a financial asset a zero value for β_4 is consistent with zero arbitrage opportunities.

Estimates of the cost-of-carry model for silver contracts are reported in Panel B. Again using the intercept as a specification check, estimates of β_0 are more than four standard errors from zero. This result implies a persistent return in excess of the costs included in the specification from holding a hedged position in silver. The post-corner subsample dating from May 31, 1980 yields similar results. The evidence from the intercept estimates is inconsistent with zero arbitrage opportunities.

β_1 is less than unity, falling much below the estimates obtained from the S&P contract. β_2 exceeds unity and is much larger than coefficients from the S&P contract. β_3 is negative for both hedging and speculative positions; significantly so, for speculative positions. The negative relation between margin and compensation for nonperformance risk repeats results from the S&P contract. β_4 is significantly negative for both speculative and hedging positions suggesting the net of convenience yield and storage costs is negative.

C. Comparison to Previous Research

Fama and French (1987) investigate cost of carry models for a variety of commodity futures contracts using monthly observations on twenty-one contracts. Their specification includes 12 dummy variables which control for monthly seasonals and an interest rate variable. They obtain coefficients on interest rates ranging from -4.32 to 2.71. None of the reported coefficients, however, differ significantly from one. Averaging coefficients across the contracts they study gives an average interest-rate coefficient of 1.06.

Bailey and Ng (1989) use a cost of carry model to interpret changes in nonperformance premiums. They use an event-study approach to investigate innovations in the excess of the basis over the riskfree rate for contracts trading on distressed exchanges. They find increases in these excess returns which coincide with announcements indicating increased likelihood of exchange failure.

Hirshleiffer (1988) links transactions costs to residual risk premiums. His model predicts that increased transactions costs reduce market participation by speculators. Hedgers respond by compensating speculators for portions of their residual risk.

Margin balances are frequently argued to represent a cost of transacting futures. Thus, the percentage changes in margin included in our cost of carry specification might be interpreted as capturing this residual risk premium. However, one would expect to see some evidence of a change in market participation. Our previous investigations on the effect of margin changes on market participation suggest no change in the level of participation. Further, one would expect to find this premium only in specifications which include changes in speculative margin. This suggests that we are more likely to be capturing changes in nonperformance premiums.

V. **Summary**

Linkages between market performance and margin specifications for futures contracts on the S&P index and silver are investigated. Our series of causality tests finds three results. First, in the silver contract we find a negative relation between futures margin and futures volatility in samples which include exchange intervention beyond setting margin. This evidence is not corraborated by results from the S&P contract nor in the silver market when exchange intervention principally involves margin setting. Second, we find modest evidence that cash market volatility increases with speculative margin changes. Third, we examine several measures of market participation. In this series of tests, we find evidence that margin changes precede volatility in open interest for the S&P contract. This result is not corraborated by the silver contract. This might suggest an increased risk that traders will encounter a thin market. Such a risk would suggest increases in bid-offer spreads for futures contracts as opportunities to unwind contract positions become less certain. Other market participation measures are examined, these are: volume of futures trading, volume of cash market trading, volatility of futures volume, and levels of open interest. Examination of margin links to these other market participation measures leads us to reject any link.

A model is developed linking the cost of carrying the cash asset with the risk of nonperformance. We argue that nonperformance risk should diminish when margin increases. This implies that compensation for nonperformance risk should be negatively related to the level of margin. Estimates of the model are generally consistent with the model--margin changes are negatively related to basis when other costs of carry are included.

The results have implications for policy makers. Links between margin changes and the volatility of futures prices are absent. Margin appears to be an ineffective tool for controlling futures market volatility. Our results imply that changes in futures market margin are positively related to cash market volatility. Indeed, the effect of changing margin may be perverse. Our evidence suggests that margin changes are positively related to volatility in the cash market.

On the other hand, our results suggest that the margin specifications of futures exchanges do impact nonperformance risk. Thus, potential losses from clearinghouse guarantees of performance serve to motivate exchanges to control nonperformance risk. The margin-setting behavior of the exchange obtains a positive externality--residual nonperformance risk borne by holders of futures contracts is reduced.

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Table 1
Relation of Futures Price-Change Volatility with Margin Requirements

$$|u_{1t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j e_{t-j} + \Sigma_{k=-12}^{12} \delta_{1k} dm_{t-k} + \mu_{1t}$$

Futures Position	Initial Margin $\Sigma\delta_{1k}$	Initial Margin T-statistic	Variation Margin $\Sigma\delta_{1k}$	Variation Margin T-statistic
Speculative S&P				
leads (k=-1..-12)	-.0000	-.03	-.0002	-.50
lags (k=1..12)	-.0004	-1.06	-.0001	-.16
leads & lags (k=-1..12;1..12)	-.0004	-.77	-.0003	-.46
Hedging S&P				
leads (k=-1..-12)	.0001	.16	-.0004	-1.20
lags (k=1..12)	-.0003	-.67	.0003	.74
leads & lags (k=-1..12;1..12)	-.0002	-.37	-.0002	-.31
Speculative Silver				
leads (k=-1..-12)	-.0001	-1.21		
lags (k=1..12)	-.0002	-2.26*		
leads & lags (k=-1..12;1..12)	-.0004	-2.45*		
Hedging Silver				
leads (k=-1..-12)	-.0003	-1.42		
lags (k=1..12)	-.0001	-.67		
leads & lags (k=-1..12;1..12)	-.0004	-1.56		

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 2
Relation of Cash Price-Change Volatility with Margin Requirements

$$|u_{2t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j |u_{t-j}| + \Sigma_{k=-12}^{12} \delta_{2k} dm_{t-k} + \mu_{2t}$$

Futures Position	Initial Margin		Variation Margin	
	$\Sigma\delta_{2k}$	T-statistic	$\Sigma\delta_{2k}$	T-statistic
Speculative S&P				
leads (k=-1..-12)	-.0002	-.59	.0001	.29
lags (k=1..12)	.0004	1.69	.0004	1.62
leads & lags (k=-1..12;1..12)	.0003	.78	.0004	1.36
Hedging S&P				
leads (k=-1..-12)	.0000	.16	-.0002	-.74
lags (k=1..12)	.0004	1.34	.0001	.52
leads & lags (k=-1..12;1..12)	.0004	1.08	-.0000	-.15
Speculative Silver				
leads (k=-1..-12)	.0002	1.66		
lags (k=1..12)	-.0006	-4.09*		
leads & lags (k=-1..12;1..12)	-.0004	-1.73		
Hedging Silver				
leads (k=-1..-12)	-.0000	-.18		
lags (k=1..12)	.0004	.65		
leads & lags (k=-1..12;1..12)	.0004	.56		

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 3
Relation of Futures Volume Levels with Margin Requirements

$$dV_{ft} = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_j dV_{ft-j} + \Sigma_{k=-12}^{12} \delta_{3k} dm_{t-k} + v_{ft}$$

Futures Position	Initial Margin $\Sigma\delta_{3k}$	Initial Margin T-statistic	Variation Margin $\Sigma\delta_{3k}$	Variation Margin T-statistic
Speculative S&P				
leads (k=-1..-12)	-.4550	-.18	.4693	.22
lags (k=1..12)	-.6572	-.27	-.3065	-.15
leads & lags (k=-1..12;1..12)	-1.1122	-.32	.1628	.06
Hedging S&P				
leads (k=-1..-12)	.6638	.27	.4928	.26
lags (k=1..12)	-.3553	-.15	-.2672	-.14
leads & lags (k=-1..12;1..12)	.3084	.09	.2256	.08
Speculative Silver				
leads (k=-1..-12)	-11.1213	-.49		
lags (k=1..12)	10.9652	.48		
leads & lags (k=-1..12;1..12)	-.1562	-.01		
Hedging Silver				
leads (k=-1..-12)	-20.0140	-.68		
lags (k=1..12)	15.2325	.52		
leads & lags (k=-1..12;1..12)	-4.7815	-.12		

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 4
Relation of Cash Market Volume Levels with Margin Requirements

$$dV_{ct} = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_j dV_{ct-j} + \Sigma_{k=-12}^{12} \delta_{4k} dm_{t-k} + v_{ct}$$

Futures Position	Initial Margin		Variation Margin	
	$\Sigma\delta_{4k}$	T-statistic	$\Sigma\delta_{4k}$	T-statistic
Speculative S&P				
leads (k=-1..-12)	.3950	.68	.2032	.41
lags (k=1..12)	-.3051	-.53	-.3423	-.70
leads & lags (k=-1..12;1..12)	.0898	.11	-.1391	-.20
Hedging S&P				
leads (k=-1..-12)	.3154	.55	.5616	1.26
lags (k=1..12)	-.5334	-.93	-.4024	-.91
leads & lags (k=-1..12;1..12)	-.2180	-.27	.1592	.25

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 5
Relation of Futures-Volume Volatilities with Margin Requirements

$$|u_{5t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j e_{t-j} + \Sigma_{k=-12}^{12} \delta_{5k} dm_{t-k} + \mu_{5t}$$

Futures Position	Initial Margin		Variation Margin	
	$\Sigma\delta_{5k}$	T-statistic	$\Sigma\delta_{5k}$	T-statistic
Speculative S&P				
leads (k=-1..-12)	-.0101	-.16	.0545	.79
lags (k=1..12)	-.0033	-.05	-.0156	-.23
leads & lags (k=-1..12;1..12)	-.0134	-.15	.0388	.40
Hedging S&P				
leads (k=-1..-12)	.0361	.47	-.0061	-.12
lags (k=1..12)	-.0990	-1.32	.0249	.51
leads & lags (k=-1..12;1..12)	-.0630	-.59	.0188	.27
Speculative Silver				
leads (k=-1..-12)	.0714	.67		
lags (k=1..12)	-.0982	-.92		
leads & lags (k=-1..12;1..12)	-.0268	-.18		
Hedging Silver				
leads (k=-1..-12)	.1365	1.25		
lags (k=1..12)	-.0372	-.34		
leads & lags (k=-1..12;1..12)	.0993	.64		

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 6
Relation of Open Interest with Margin Requirements

$$dO_{ft} = \Sigma_{i=1}^{12} a_i D_{it} + \Sigma_{j=1}^{K} b_j dO_{ft-j} + \Sigma_{k=-12}^{12} \delta_{6k} dm_{t-k} + w_{ft}$$

Futures Position	Initial Margin		Variation Margin	
Enter Table Data	$\Sigma\delta_{6k}$	T-statistic	$\Sigma\delta_{6k}$	T-statistic
Speculative S&P				
leads (k=-1..-12)	.3658	.39	-.0241	-.03
lags (k=1..12)	.1516	.17	-.0628	-.08
leads & lags (k=-1..12;1..12)	.5175	.40	-.0869	-.08
Hedging S&P				
leads (k=-1..-12)	-.0204	-.02	-.0452	-.06
lags (k=1..12)	-.0199	-.02	-.1306	-.19
leads & lags (k=-1..12;1..12)	-.0404	-.03	-.1759	-.18
Speculative Silver				
leads (k=-1..-12)	-1.8365	-.06		
lags (k=1..12)	-1.4257	-.04		
leads & lags (k=-1..12;1..12)	-3.2622	-.07		
Hedging Silver				
leads (k=-1..-12)	-15.7859	-.38		
lags (k=1..12)	.3577	.01		
leads & lags (k=-1..12;1..12)	-15.4283	-.26		

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 7
Relation of Open Interest Volatility with Margin Requirements

$$|u_{7t}| = \Sigma_{i=1}^{12} \alpha_i D_{it} + \Sigma_{j=1}^{L} \beta_j |e_{t-j}| + \Sigma_{k=-12}^{12} \delta_{7k} dm_{t-k} + \mu_{7t}$$

Futures Position	Initial Margin		Variation Margin	
	$\Sigma\delta_{7k}$	T-statistic	$\Sigma\delta_{7k}$	T-statistic
Speculative S&P				
leads (k=-1..-12)	-.0030	-.27	.0172	1.51
lags (k=1..12)	.0148	1.42	.0298	2.66*
leads & lags (k=-1..12;1..12)	.0118	.78	.0470	2.94*
Hedging S&P				
leads (k=-1..-12)	.0007	.06	.0065	.69
lags (k=1..12)	.0291	2.64*	.0300	3.24*
leads & lags (k=-1..12;1..12)	.0298	1.89	.0365	2.77*
Speculative Silver				
leads (k=-1..-12)	.0067	.15		
lags (k=1..12)	-.0191	-.42		
leads & lags (k=-1..12;1..12)	-.0124	-.19		
Hedging Silver				
leads (k=-1..-12)	-.0232	-.67		
lags (k=1..12)	-.0007	-.02		
leads & lags (k=-1..12;1..12)	-.0239	-.48		

* significantly differs from zero at the 5% level.

Note: T-statistics use White's (1980) correction for heteroskedasticity.

Table 8
Estimates for Cost-of-Carry Model

$$B(T,t+1) = \beta_0 + \beta_1 B(T,t) + \beta_2 rh_t + \beta_3 dm_t + \beta_4 h_t + e_{t+1}$$

Panel A: S&P Contract

	Initial		Variation	
	Hedging	Speculative	Hedging	Speculative
β_0	-.0003 (.0002)	-.0004 (.0002)	-.0004 (.0002)	-.0003 (.0002)
β_1	.8529 (.0147)	.8934 (.0132)	.8695 (.0140)	.8637 (.0143)
β_2	4.6625 (1.231)	3.3750 (1.122)	4.0565 (1.186)	4.2231 (1.203)
β_3	-.0255 (.0035)	.0018 (.0035)	-.0153 (.0027)	-.0187 (.0030)
β_4	-.1328 (.1129)	-.0430 (.1067)	-.0852 (.1104)	-.1034 (.1113)
MA(1)	.33	.39	.36	.35
AR parameters included	2,8	2,8	2,8	2,8
Q(12)	18.61	11.93	14.66	15.80

(Standard errors in parentheses.)

Table 8--continued
Estimates for Cost-of-Carry Model

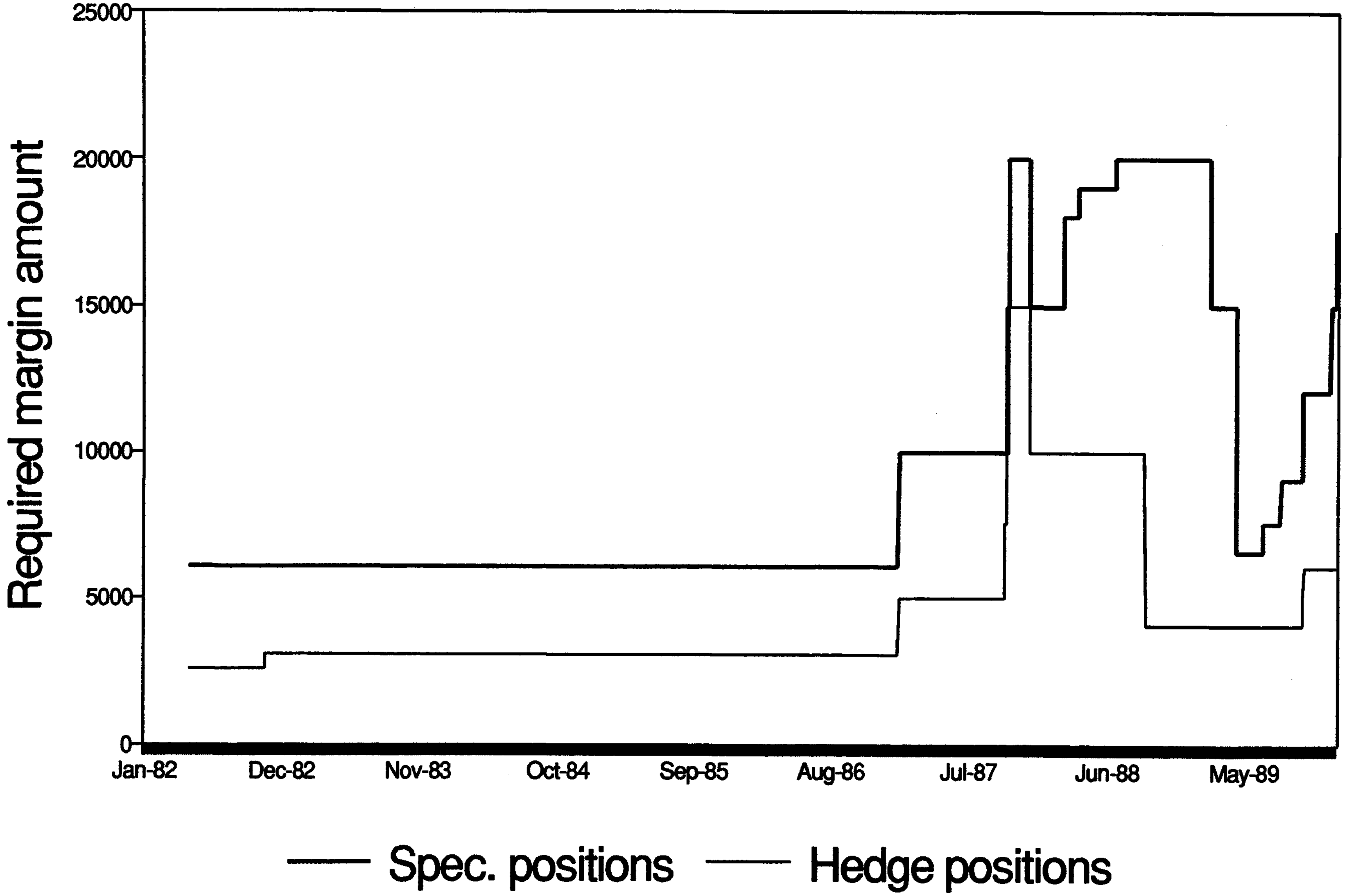
$$B(T,t+1) = \beta_0 + \beta_1 B(T,t) + \beta_2 rh_t + \beta_3 dm_t + \beta_4 h_t + e_{t+1}$$

Panel B: Silver Contract

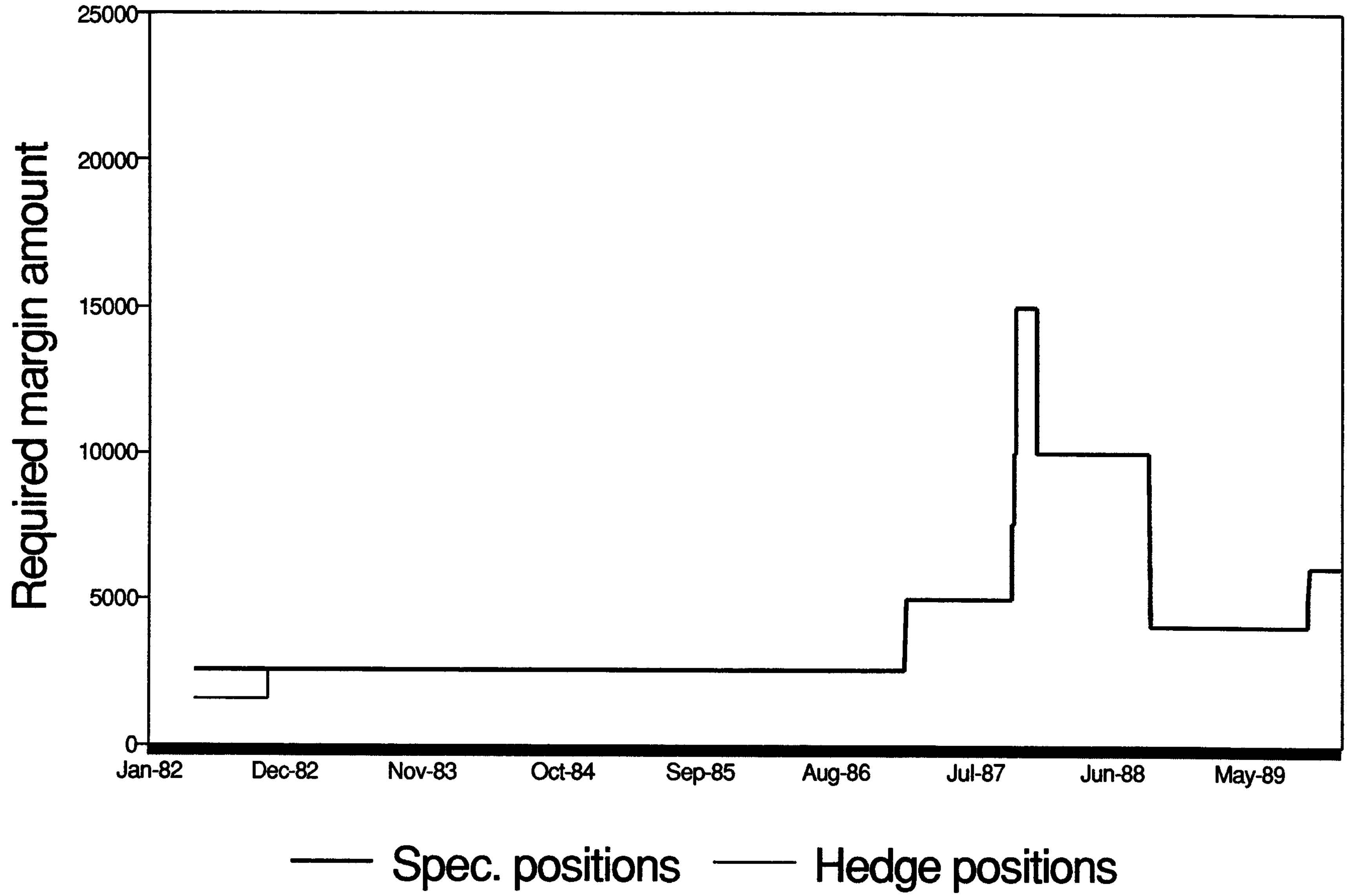
	Initial	
	Hedging	Speculative
β_0	.0037 (.0008)	.0037 (.0008)
β_1	.6450 (.0236)	.6449 (.0234)
β_2	14.0775 (3.410)	14.3542 (3.397)
β_3	-.0064 (.0056)	-.0149 (.0044)
β_4	-1.3161 (.3235)	-1.3365 (.3224)
MA(1)	.12	.12
AR parameters included	2,7,8	2,7,8
Q(12)	17.22	18.48

(Standard errors in parentheses.)

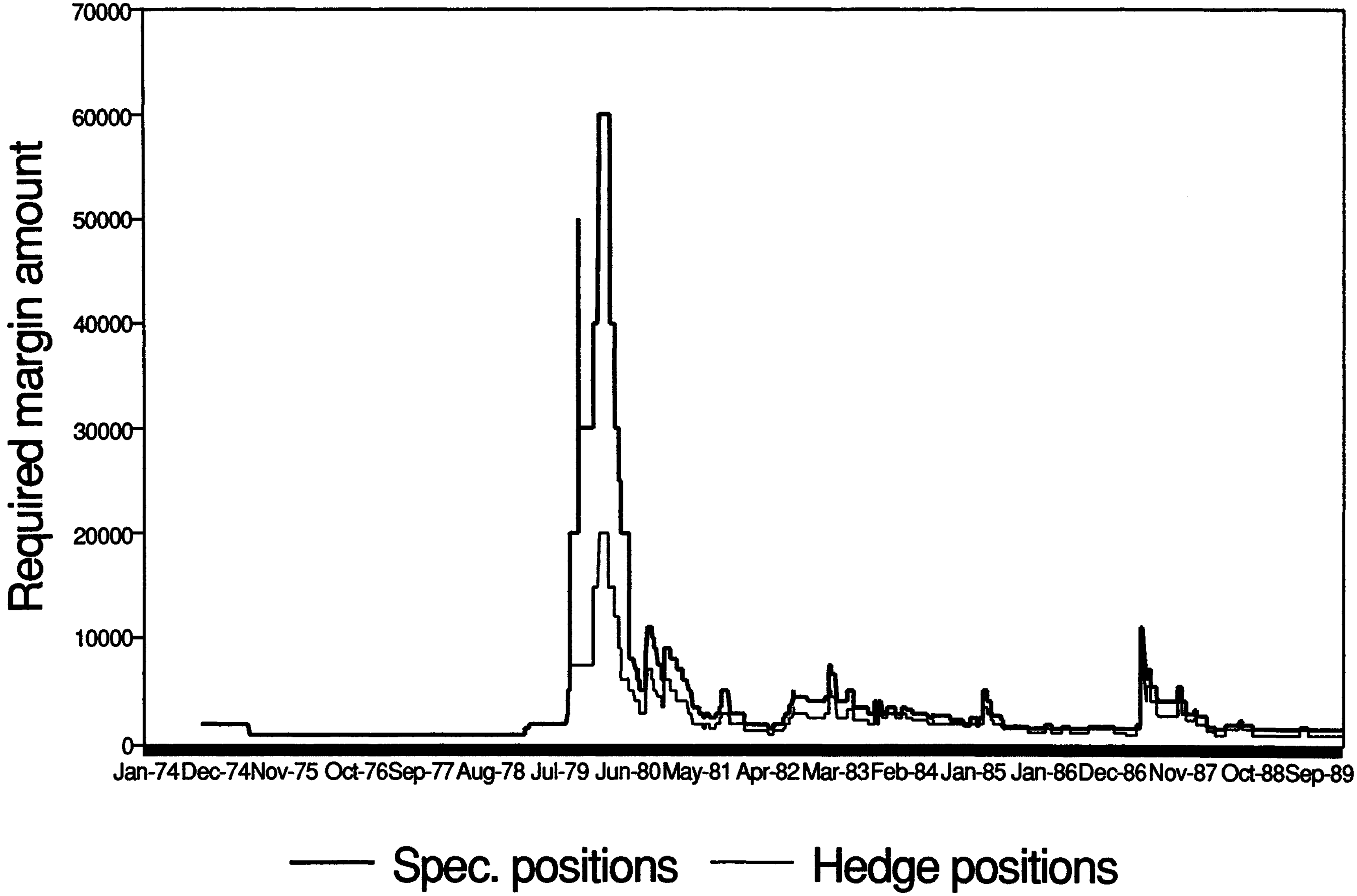
1. S&P initial margin requirements for speculative and hedge positions



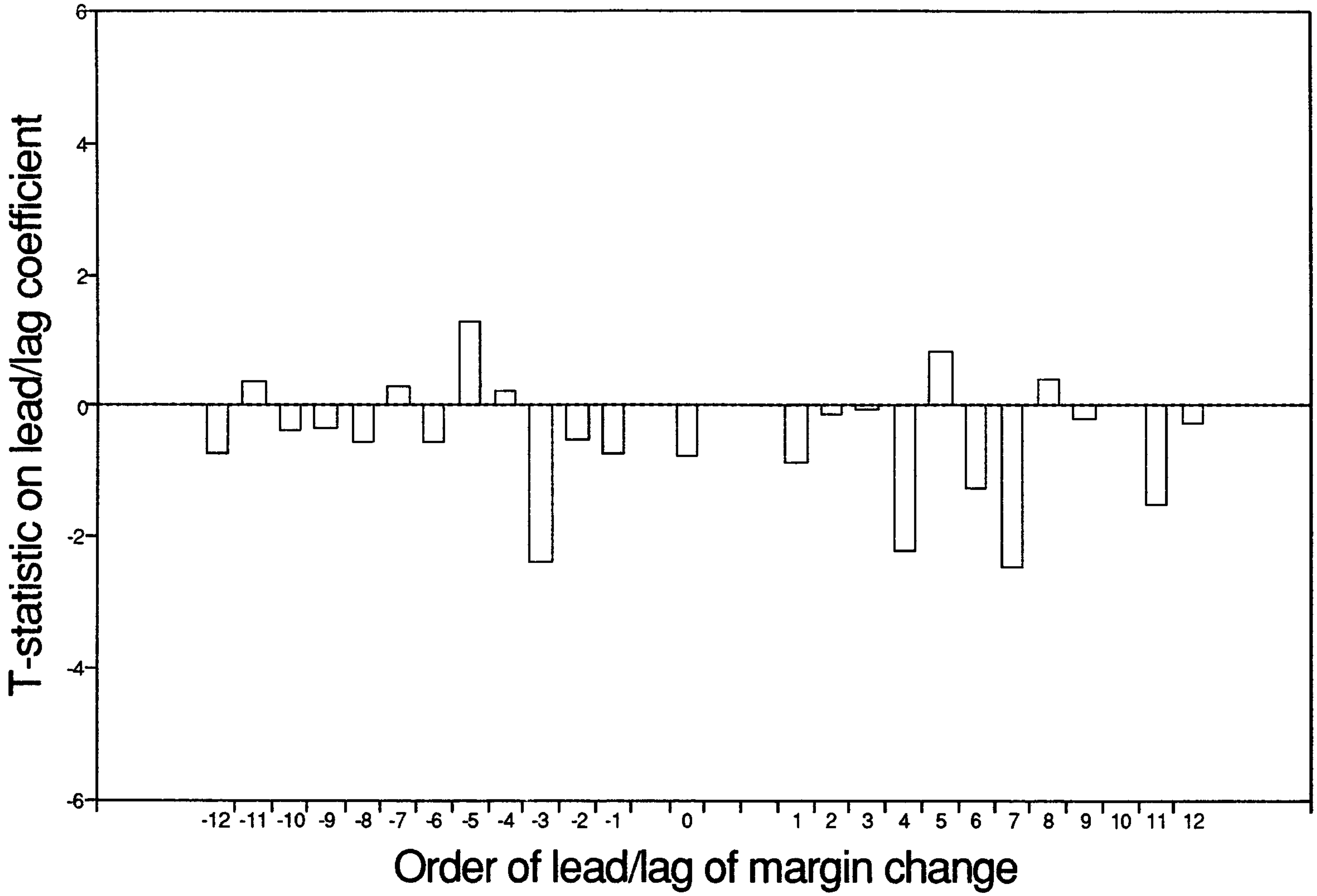
2. S&P maintenance margin requirements for speculative and hedge positions



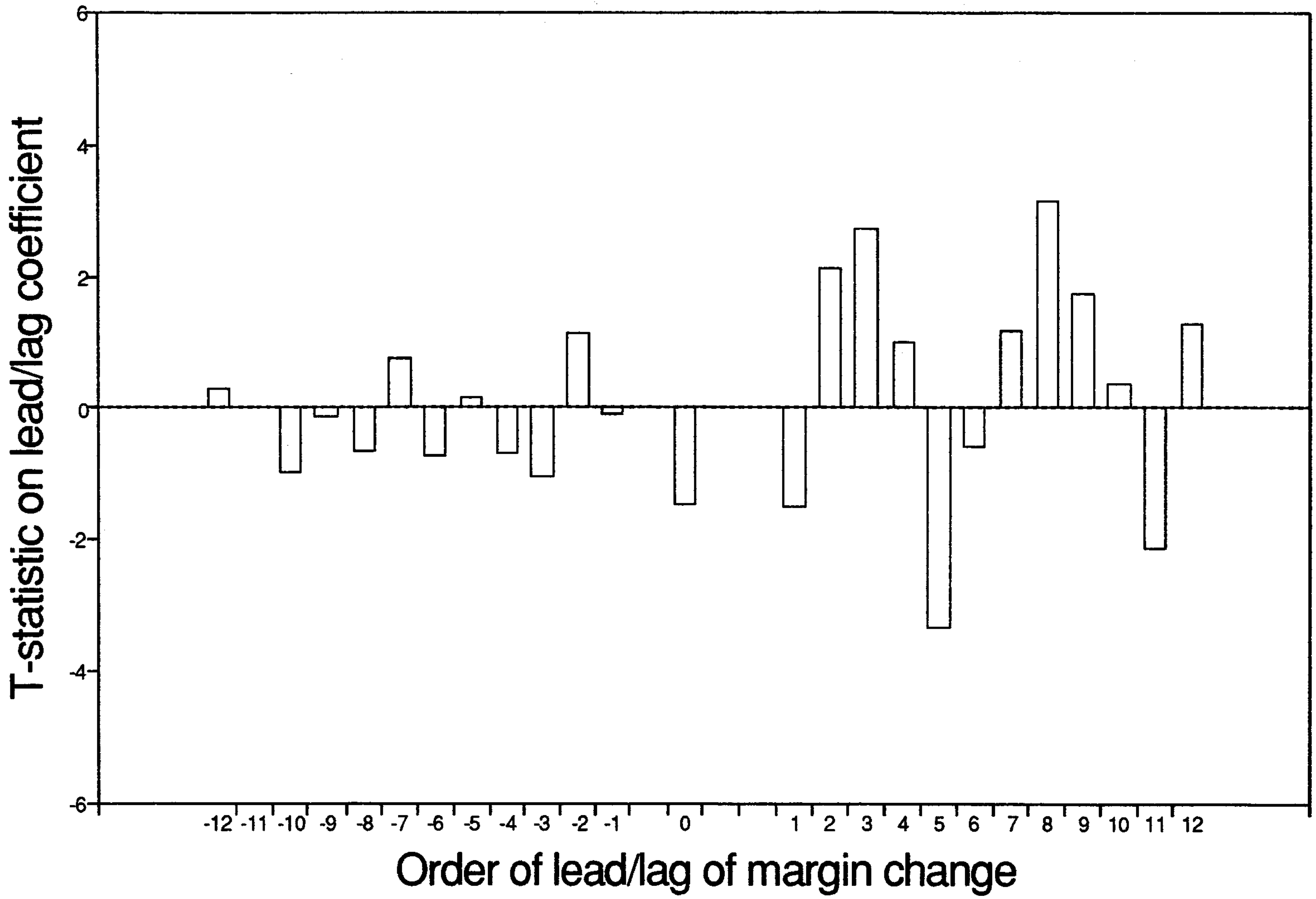
3. Silver initial margin requirements for speculative and hedge positions



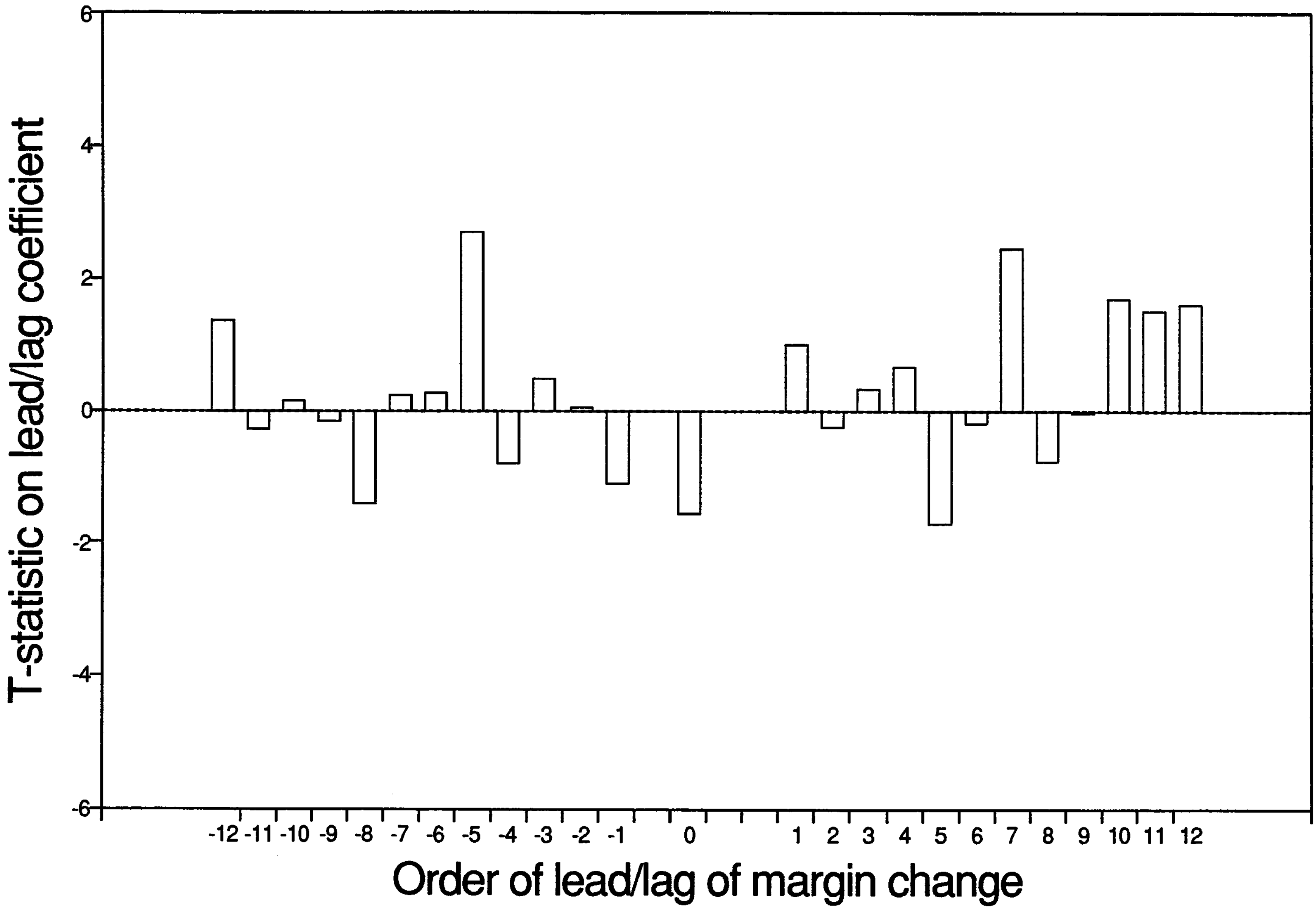
4. Silver futures price volatility
Initial margin on speculative positions



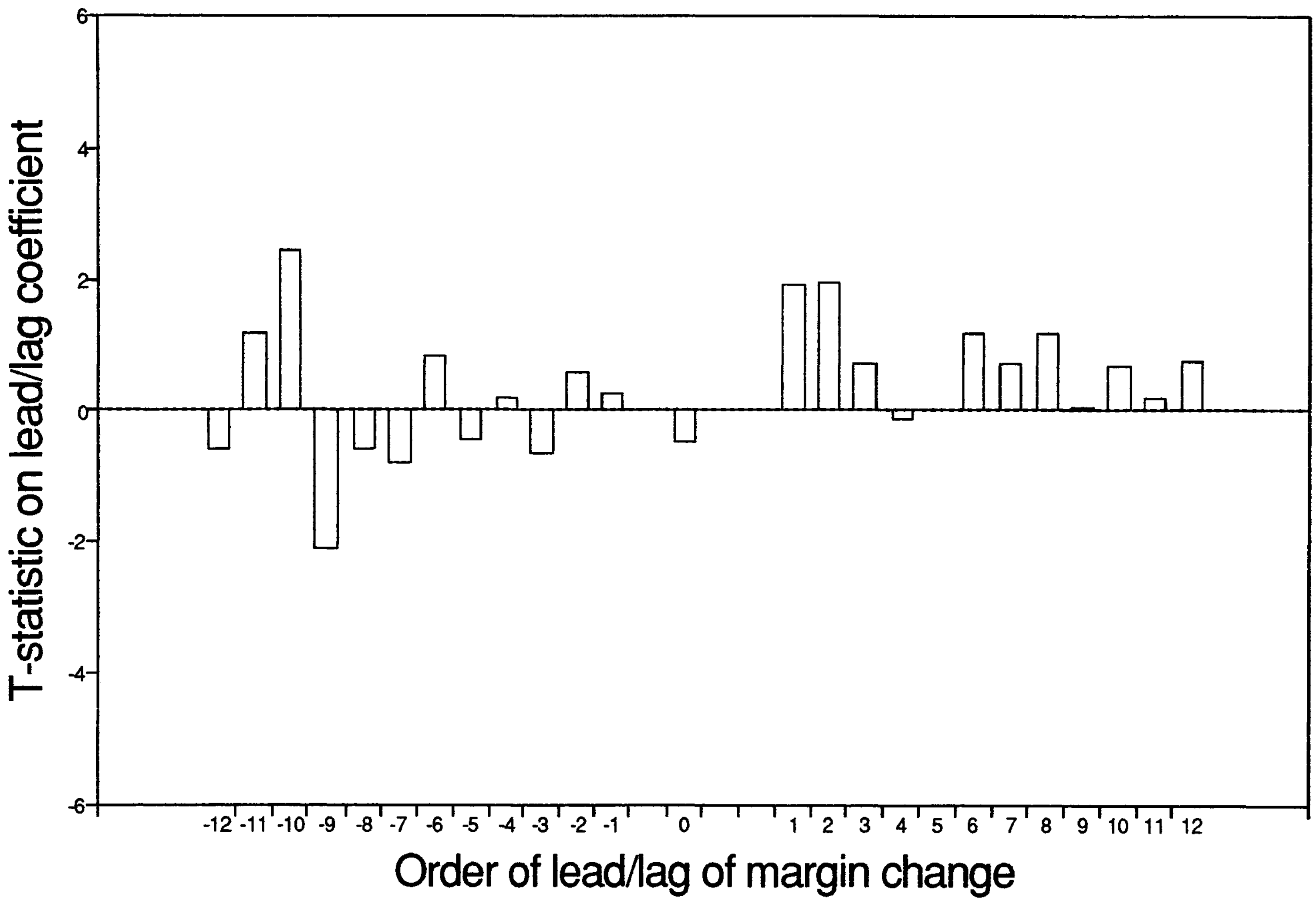
5. S&P cash price volatility
Initial margin on speculative positions



6. Silver cash price volatility
Initial margin on hedge positions



7. S&P open interest volatility
Initial margin on hedge positions



Working Papers and Staff Memoranda

The following lists papers developed in recent years by the Bank's research staff. Copies of those materials that are currently available can be obtained by contacting the Public Information Center (312) 322-5111.

Working Paper Series

A series of research studies on regional economic issues relating to the Seventh Federal Reserve District, and on financial and economic topics.

REGIONAL ECONOMIC ISSUES

Taxation of Public Utilities Sales: State Practices and the Illinois Experience *Diane F. Siegel and William A. Testa*	**WP-86-1**
Measuring Regional High Tech Activity with Occupational Data *Alenka S. Giese and William A. Testa*	**WP-87-1**
Alternative Approaches to Analysis of Total Factor Productivity at the Plant Level *Robert H. Schnorbus and Philip R. Israilevich*	**WP-87-2**
Industrial R&D An Analysis of the Chicago Area *Alenka S. Giese and William A. Testa*	**WP-87-3**
Metro Area Growth from 1976 to 1985: Theory and Evidence *William A. Testa*	**WP-89-1**
Unemployment Insurance: A State Economic Development Perspective *William A. Testa and Natalie A. Davila*	**WP-89-2**
A Window of Opportunity Opens for Regional Economic Analysis: BEA Release Gross State Product Data *Alenka S. Giese*	**WP-89-3**
Determining Manufacturing Output for States and Regions *Philip R. Israilevich and William A. Testa*	**WP-89-4**
The Opening of Midwest Manufacturing to Foreign Companies: The Influx of Foreign Direct Investment *Alenka S.Giese*	**WP-89-5**

A New Approach to Regional Capital Stock Estimation: Measurement and Performance *Alenka S. Giese and Robert H. Schnorbus*	**WP-89-6**
Why has Illinois Manufacturing Fallen Behind the Region? *William A. Testa*	**WP-89-7**
Regional Specialization and Technology in Manufacturing *Alenka S. Giese and William A. Testa*	**WP-89-8**
Theory and Evidence of Two Competitive Price Mechanisms for Steel *Christopher Erceg, Philip R. Israilevich and Robert H. Schnorbus*	**WP-89-9**
Regional Energy Costs and Business Siting Decisions: An Illinois Perspective *David R. Allardice and William A. Testa*	**WP-89-10**
Manufacturing's Changeover to Services in the Great Lakes Economy *William A. Testa*	**WP-89-12**
Construction of Input-Output Coefficients with Flexible Functional Forms *Philip R. Israilevich*	**WP-90-1**
Regional Regulatory Effects on Bank Efficiency *Douglas D. Evanoff and Philip R. Israilevich*	**WP-90-4**
Regional Growth and Development Theory: Summary and Evaluation *Geoffrey J.D. Hewings*	**WP-90-5**
Institutional Rigidities as Barriers to Regional Growth: A Midwest Perspective *Michael Kendix*	**WP-90-6**

ISSUES IN FINANCIAL REGULATION

Technical Change, Regulation, and Economies of Scale for Large Commercial Banks: An Application of a Modified Version of Shepard's Lemma *Douglas D. Evanoff, Philip R. Israilevich and Randall C. Merris*	**WP-89-11**

Reserve Account Management Behavior: Impact of the Reserve Accounting Scheme and Carry Forward Provision **WP-89-12**
Douglas D. Evanoff

Are Some Banks too Large to Fail? Myth and Reality **WP-89-14**
George G. Kaufman

Variability and Stationarity of Term Premia **WP-89-16**
Ramon P. De Gennaro and James T. Moser

A Model of Borrowing and Lending with Fixed and Variable Interest Rates **WP-89-17**
Thomas Mondschean

Do "Vulnerable" Economies Need Deposit Insurance?: Lessons from the U.S. Agricultural Boom and Bust of the 1920s **WP-89-18**
Charles W. Calomiris

The Savings and Loan Rescue of 1989: Causes and Perspective **WP-89-23**
George G. Kaufman

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Elijah Brewer III

Payments System Risk Issues on a Global Economy **WP-90-12**
Herbert L. Baer and Douglas D. Evanoff

Deregulation, Cost Economies and Allocative Efficiency of Large Commercial Banks **WP-90-19**
Douglas D. Evanoff and Philip R. Israilevich

Evidence on the Impact of Futures Margin Specifications on the Performance of Futures and Cash Markets **WP-90-20**
James T. Moser

MACRO ECONOMIC ISSUES

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David A. Aschauer

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Stock Market Dispersion and Real Economic Activity: Evidence from Quarterly Data *Prakash Loungani, Mark Rush and William Tave*	**WP-90-15**
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Another Look at the Evidence on Money-Income Causality *Benjamin M. Friedman and Kenneth N. Kuttner*	**WP-90-17**
Investment Smoothing with Working Capital: New Evidence on the Impact of Financial Constraints *Steven Fazzari and Bruce Petersen*	**WP-90-18**

Staff Memoranda

A series of research papers in draft form prepared by members of the Research Department and distributed to the academic community for review and comment. (Series discontinued in December, 1988. Later works appear in working paper series).

Risks and Failures in Banking: Overview, History, and Evaluation *George J. Benston and George G. Kaufman*	**SM-86-1**
The Equilibrium Approach to Fiscal Policy *David Alan Aschauer*	**SM-86-2**
Banking Risk in Historical Perspective *George G. Kaufman*	**SM-86-3**
The Impact of Market, Industry, and Interest Rate Risks on Bank Stock Returns *Elijah Brewer, III and Cheng Few Lee*	**SM-86-4**
Wage Growth and Sectoral Shifts: New Evidence on the Stability of the Phillips Curve *Ellen R. Rissman*	**SM-87-1**
Testing Stock-Adjustment Specifications and Other Restrictions on Money Demand Equations *Randall C. Merris*	**SM-87-2**
The Truth About Bank Runs *George G. Kaufman*	**SM-87-3**
On The Relationship Between Standby Letters of Credit and Bank Capital *Gary D. Koppenhaver and Roger Stover*	**SM-87-4**
Alternative Instruments for Hedging Inflation Risk in the Banking Industry *Gary D. Koppenhaver and Cheng F. Lee*	**SM-87-5**
The Effects of Regulation on Bank Participation in the Market *Gary D. Koppenhaver*	**SM-87-6**
Bank Stock Valuation: Does Maturity Gap Matter? *Vefa Tarhan*	**SM-87-7**