Margin Requirements and Futures Activity: Evidence from the Soybean and Corn Markets

BAHRAM ADRANGI
ARJUN CHATRATH*

This article investigates the impact of margin requirements on the trading activity and volatility in futures markets. We extend Hartzmark's (1986) model for futures demand to allow for the costs imposed by margins to change across the maturity of the contract. The model is tested employing data from the soybean and corn markets. We find that trading activity becomes more sensitive to margin changes as one gets closer to contract maturity, inconsistent with the notion that margins impose important opportunity costs on futures traders. Margins are found to have a negative impact on the trading activities of all types of traders, though there is some evidence that margin alterations bring about changes in the makeup of the market. The data also indicate that margins are likely to be hiked during periods of increased volatility, and reduced during periods of relative

*The authors have benefited from the comments of Gikas Hardouvelis and an anonymous referee. The authors are solely responsible for any remaining errors. The article was funded by the Dr. Robert B. Pamplin Jr. Research Grant at the University of Portland.
Corresponding author, School of Business Administration, University of Portland, 5000 North Willamette Boulevard, Portland, OR 97203.

- *Bahram Adrangi is a professor of Business Economics in the School of Business Administration at the University of Portland in Portland, Oregon.*
- *Arjun Chatrath is an Assistant Professor of Finance in the School of Business Administration at the University of Portland in Portland, Oregon.*

The Journal of Futures Markets, Vol. 19, No. 4, 433–455 (1999)

CCC 0270-7314/99/040433-23

stability, thus suggesting that margin alterations serve primarily as insurance to futures exchanges. Jrl Fut Mark 19: 433–455, 1999

INTRODUCTION

Margins on futures contracts represent performance bonds or good-faith deposits that protect the futures commission merchants against investor default—and ultimately protect the reputation of the futures exchange. The optimal design of futures contracts in preventing contract default is extensively examined in the literature, and the consensus is that margins have performed fairly well in this respect (for example, Telser, 1981; Figlewski, 1986; Gay, Hunter, & Kolb, 1986; Edwards & Neftci, 1988; Hardouvelis, 1990; Moser; 1991; Fenn & Kupiec, 1993; Gemmill, 1994; Hardouvelis & Kim, 1995).[1] Several of these studies demonstrate that changes in futures margins follow or coincide with changes in underlying volatility, consistent with the notion that exchange members set margins in the interest of reducing their exposure.

However, the effect of margin requirements on market efficiency and price volatility remains a far more controversial issue, one that has been problematic to resolve. The research problems arise from at least two sources. First, the nature of margin management in futures markets makes it difficult to assess directly the impact of margin changes on price behavior. Futures exchanges are widely thought to change margin requirements in anticipation of changes in market volatility. Therefore, even if margins have a negative impact on volatility, this development would be hard to uncover, because a correctly forecasted trend in volatility by the margin authorities may swamp the true relationship (for example, Hardouvelis & Kim, 1995). Second, the proposed link flowing from margin changes to volatility is an indirect one. It relies on the notion that margins impose varying burdens or costs across trader groups. This disparity in burden is thought to change the makeup of traders in the marketplace and, ultimately, to alter price behavior. There is only some evidence that supports the link between margins and the makeup of traders (for example, Hartzmark, 1986). There is even less evidence on the link between certain trader-groups and volatility (for example, Chatrath & Song, 1998).

To further complicate the issue, there are vastly disparate opinions on the nature and extent of the costs associated with futures margins.

[1]Gay, Hunter, and Kolb (1986) also discuss the hierarchy of legal obligations in futures contracts.

Black (1976) suggests that there are no opportunity costs associated with futures margins, because the daily marking-to-market feature of these markets forces the value of contracts to zero. Black's view is based on the assumption that the contract is offset each day or that the margin account remains constant. Black (1976) and Anderson (1981), among others, note that the initial margin requirement can be satisfied by holding interest-earning treasury bills in the margin account, so that the opportunity cost may be zero.[2] Given that futures margin levels are usually quite low (between 2% and 10%), and, given that financial instruments may be employed to post futures margins, the proposition that there are no costs associated with margins appears reasonable on the surface.

On the other hand, Telser (1981), Figlewski (1984), Hartzmark (1986), and Hardouvelis (1990), among others, are of the view that margins and margin changes do impose considerable costs to traders. In Telser's (1981) view, even though margin accounts may earn interest, investors will react to changes in the level of margin requirements by reallocating their financial resources. Holders of treasury bills can otherwise sell them to take advantage of opportunities that may suddenly present themselves. Once committed to a margin account, these securities are no longer part of the investor's "precautionary" balance. Hartzmark (1986) notes that certain types of traders may be faced with relatively high opportunity and transaction costs. Small traders are generally cash deficient, and these traders would find themselves especially constrained when faced with an unexpected margin hike. Transaction costs would arise from posting margins and recomposing portfolios.[3] In a similar argument, Hardouvelis (1990) suggests that speculators, holding more risky assets and less cash in their portfolos, may be relatively sensitive to margins.

The general evidence is in favor of those who suggest that futures margins do impose a cost on traders, and several studies have documented that increased margins discourages trading activity (for example, Fishe & Goldberg, 1986; Fishe et al., 1990; Ma, Kao, & Frohlich, 1993). However, there has been little indication as to the nature of the cost imposed by margin changes.

In this study, we extend Hartzmark's (1986) model of demand for futures contracts to allow for liquidity costs imposed by margins to change

[2]Some futures commission merchants will accept stocks in lieu of cash or treasuries for fulfilling margin requirements—though at about 50% of their market value.

[3]Hartzmark (1986) compares the level of speculation and size of traders before and after margin changes in the wheat, feeder cattle, pork bellies, and treasury bond futures markets. He finds evidence that trader composition is altered as a result of margin changes, but is unable to find support for the hypothesis that small trader positions are more sensitive to margin changes.

across the maturity of contracts. Liquidity costs are categorized into either transaction-costs relating to margin changes or opportunity costs of margins. We argue that tracking the impact of margins on trader behavior across contract maturity will reveal the type of cost imposed by margins. If margins impose a significant opportunity cost, traders will be more sensitive to increased margins farther away from maturity. If only the transaction-cost component of margins is material, the demand for futures contracts will become more sensitive to margin changes as we approach expiration. Thus contract maturity could serve to either magnify or dampen the impact of margin changes on trading activity.

Our article examines the impact of margin requirements on the trading activity in the soybean and corn futures markets over a ten-year interval. Over the period of study, these two markets have witnessed a large number of margin alterations relative to other commodity markets. This article makes three important contributions to the literature. Foremost, this study documents the role of contract maturity in the relationship between margin changes and contract demand. Such evidence would have very important regulatory implications. For instance, if margins impose greater costs on traders farther away from maturity, margin changes would be relatively ineffective in manipulating the trading activity in the nearby contract. Second, this study details the impact of margins on the positions of four groups of traders—and on the overall makeup of the market. Whereas most studies on the impact of margins on trading activity are conducted in the context of aggregate -volume or open interest, the present study also employs disaggregated open interest data.[4] Third, this article also provides evidence regarding the causal relationship between margins, futures trading, and market volatility.

The results indicate that trading activity becomes more sensitive to margin changes as one gets closer to contract maturity. This suggests that margins impose important transaction-costs (rather than opportunity costs) on futures traders. Moreover, although there is some evidence to suggest that margin changes will bring about changes in the makeup of the traders in the market, there is no evidence that speculators or small traders cause or exacerbate market volatility. Thus margins may be an inappropriate device to reduce volatility in futures markets. Finally, the results are consistent with the hypothesis that margins are deployed as an insurance mechanism: this study documents a strong positive relationship between *lagged* price volatility and changes in initial- and maintenance-margin requirements.

[4]An exception is Kim (1993), who examines the role of margins in the positions of hedgers, speculators, and small traders in metal futures markets.

DEMAND FOR FUTURES CONTRACTS WITH TIME VARYING LIQUIDITY COSTS

Hartzmark (1986) develops a two-period model of futures demand, based on the assumption that traders hold T-bills that can be used in the futures margin account. The author derives the following demand functions for long and short contracts respectively

$$f_i^* = \frac{1}{A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)}[(p_{il}^f - p_o^f) - A_i y_i^* \sigma_{sfi} - M_i LC_i], \text{ if } f_i^* > 0, \quad (1)$$

$$f_i^* = \frac{1}{A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)}[(p_{il}^f - p_o^f) - A_i y_i^* \sigma_{sfi} + M_i LC_i], \text{ if } f_i^* < 0, \quad (2)$$

where f_i^* is the i_{th} trader's demand for futures contracts, with $f_i^* > 0$ implying a long position, and $f_i^* < 0$ a short position; A_i is the risk parameter of individual i, with $A_i > 0$ implying risk aversion; σ_{fi}^2 is individual i's estimation of the distribution of futures prices; M_i is the required margin for individual i; σ_i^2 is the variance of trader i's liquidity cost, LC_i; p_{i1}^f is individual i's expectation of the futures price in period 1; p_0^f is the price in period 0; y_i^* is the quantity of optimal cash commitment of individual i; and σ_{sfi} is the covariance of the prediction error of spot and futures price. Hartzmark alludes to period 1 as the settlement period. Without loss of generality, period 1 can also apply to periods prior to expiration, when the trader decides either to settle the contract, or stay with the position, putting up further margins if required.[5]

Eqs. (1) and (2) represent linear relationships between the number of contracts demanded (f_i^*) and the market price (p_0^f), and have a margin-cost component. The margin cost component is a function of the required margin (M_i) and the expected liquidity cost (LC_i). Interestingly, margins will reduce the absolute quantity of contracts demanded, even if the expected liquidity costs (LC_i) are zero, because $M_i^2\sigma_i^2$ appears in the denominator of each of the demand functions.

As suggested earlier, time to maturity may also play an important role in the above demand functions. If margins impose significant opportunity cost, traders will be more sensitive to margin changes farther away from maturity. An increase in margins at time 0 (say, for instance, with a hundred days to maturity) would mean that more of the traders' funds, albeit

[5]Typically, futures commission merchants will request traders to meet their margin calls by the end of the next trading day. Settling the contract will preclude the need to address the margin call.

interest-bearing, will be tied up for this period. A trader who values liquidity highly may find the higher margin to be a strong disincentive to enter the market at this time.

On the other hand, if traders perceive no significant opportunity costs in futures margins (for example, Black, 1976, and Anderson, 1981), and there are only transaction costs (commissions and reallocation expenses) associated with updating a margin account, one can make a case that traders will be especially sensitive to margin changes closer to maturity. Assuming traders already anticipate the transaction costs associated with the normal settlement of contracts, a margin call close to maturity will provide them with an incentive to close out their positions early.[6]

To build on Hartzmark's (1986) framework, denote the loss of earnings power associated with a margined account as oi and all reallocation costs as τ_i so that $LC_i = o_i + \tau_i$. Both o_i and τ_i are nonnegative, and, as discussed above, $o_i' > 0$ and $\tau_i' < 0$ where $'$ denotes the partial w.r.t time to maturity (TTM).[7] Substituting for LC_i in eqs. (1) and (2) and taking first derivative, we obtain for the long and short positions, respectively:

$$\frac{\partial f_i^*}{\partial M_i} = -(2A_iM_i\sigma_i^2)[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-2}$$

$$[(p_{il}^f - p_0^f) - A_iY_i^*\sigma_{sft} - M_i(o_i + \tau_i)] - (o_i + \tau_i)$$

$$[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-1} < 0,\ if\ f_i^* > 0. \tag{3}$$

$$\frac{\partial f_i^*}{\partial M_i} = -(2A_iM_i\sigma_i^2)[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-2}$$

$$[(p_{il}^f - p_0^f) - A_iY_i^*\ \sigma_{sfi} + M_i(o_i + \tau_i)] + (o_i + \tau_i)$$

$$[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-1} > 0,\ if\ f_i^* < 0. \tag{4}$$

To examine the effect of TTM on the sensitivity of demand to margin changes, we differentiate eqs. (3) and (4) w.r.t to TTM, obtaining:

[6]To put it differently, we can write the expectations on transaction costs associated with the futures position as a function of P(M,ΔM,S), where P(M) is the expectation on the margin at 1, P(ΔM) is the probability that margin levels will he changed, and P(S) is the probability that the trader will settle at period 1. But $P(S) \rightarrow 1$ as one approaches maturity. Hence expectations on the level of transaction costs must increase as the time to maturity diminishes.

[7]The opportunity-cost component is, by definition, a linear function of TTM. With little generalization, the transaction cost component may also be thought of as a linear function of TTM, so that $\tau_i = \alpha + \beta \cdot \text{TTM}$, $\alpha > 0$, $\beta < 0$.

$$\frac{\partial^2 f_i^*}{\partial M_i \partial TTM_i} = (2A_i M_i^2 \sigma_i^2)[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-2}\ (o_i' + \tau_i') - (o_i' + \tau_i')[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-1} > 0,\ if\ o_i' > |\tau_i'|. \quad (5)$$

$$\frac{\partial^2 f_i^*}{\partial M_i \partial TTM_i} = -(2A_i M_i^2 \sigma_i^2)[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-2}\ (o_i' + \tau_i') + (o_i' + \tau_i')[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)]^{-1} < 0,\ if\ o_i' > |\tau_i'|. \quad (6)$$

If the opportunity cost of putting up the increased margin is greater than the transaction-cost component of the margin hike, TTM will serve to magnify the impact of margins on trading activity.[8] The opposite is true if the transaction cost component of margin changes are greater than the opportunity costs.

To further illustrate the role of TTM in the demand functions, we can rewrite eqs. (1) and (2) as a linear demand function obtaining

$$p_0^f = (p_{il}^f - A_i y_i^* \sigma_{sfi} \mp M_i(o_i + \tau_i)) - f_i^*[A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)] \quad (7)$$

The term in the first parentheses represents the constant term, and that in the second is the slope term. This function, almost identical to that developed in Hartzmark (1986, eq. 5c), has a kink of the size $M_i(o_i + \tau_i)$. The kink can be thought of a price-range within which there is no incentive to take on either a long or a short position in the contract. It is evident that as the margins rise, the kink widens, and the slope becomes steeper. Moreover, if $o_i' > \tau_i'$, TTM will enhance the kinked area. In other words, TTM will serve to magnify the impact of margins on demand if there are significant opportunity costs, and will dampen the impact of margins if transaction costs are the only material costs.[9]

EVIDENCE FROM THE SOYBEAN AND CORN MARKETS

Data

We employ daily price, volume (for nearby and next-to-nearby contracts), open interest (for nearby and next-to-nearby contracts), margins data, and

[8]The signs in eqs. (5) and (6) are definite when the estimation of the distribution of futures prices, $\sigma_{fi}^2 < M_i^2\sigma_i^2$ and indefinite otherwise. The signing becomes more intractable when σ_{fi}^2 is itself considered a function of TTM. In the interest of brevity we assume σ_{fi}^2 to be time invariant and less than $M_i^2\sigma_i^2$.

[9]That transaction costs create kinks (or jumps) in the demand functions is not new to the literature (see, for example, Cohen, Maier, Schwartz, & Whitcomb, 1981). However, the TTM dimension alluded to above is probably unique to markets in which trader positions have a definite life.

the bimonthly commitment of traders (COT) data for the soybean and corn contracts (Chicago Board of Trade) over the interval from January 1986 through March 1995.[10]

As is common practice, the nearby series (daily price, volume, and open interest) are constructed by following a contract up to the last day of the preexpiration month, at which point the series switches to the next nearby contract. The next-to-nearby contract series are constructed employing the identical rollover dates, but with data from the less mature contract. The choice of the rollover days were more than arbitrary or based merely on prior practice. To illustrate, Figure 1 plots the trends in average volume and open interest in corn. It is clear that the nearby volume drops off sharply at the end of the preexpiration month—apparently when traders switch to the next-to-nearby contract. This pattern is also discernable, though not as strongly, for the open interest series. Thus the selection of the linking methodology serves to create a relatively smooth set of trading activity (and, presumably, price) series. The volume and open interest series for the nearby and next-to-nearby contracts are averaged over two-week (bimonthly) intervals to match the COT data exactly.[11]

The COT data reflects the contractual commitments, for all maturities, of four trader-groups: commercial traders, noncommercial traders, small traders, and spreaders. Commercial traders are defined by the CFTC-guidelines as large hedgers, or traders who hold positions representing a substitute for transactions to be made at a later time in the cash market, and whose positions exceed the reporting levels established for that contract.[12] Noncommercial traders are large speculators whose holdings exceed the CFTC reporting levels. Small traders are traders whose positions do not exceed the reporting levels, and no distinction is made regarding their motives (that is, hedging or speculation). Finally, spreaders hold opposite positions on futures contracts over different maturities. The COT data includes the number of traders in the commercial and noncommercial categories.[13]

[10]The daily settlement prices, futures volume, and open interest are obtained from the Futures Industry Institute (Washington, DC). The margins data and the COT data, compiled by the Commodity Futures Trading Commission (CFTC), is obtained from the Pinnacle Data Corporation (Webster, NY). The COT data is available twice monthly only since January 1986, and monthly since January 1983.

[11]It is likely that analyzing averaged volume and open interest data should further reduce the risk of distortion-related biases that arise from splicing the futures series.

[12]Reporting levels are 750,000 bushels for the corn market and 500,000 bushels for the soybeans market.

[13]Others who have employed COT data, mainly in studies on risk premia in futures markets, include Carter, Rausser, and Schmitz (1983), Chang (1985), Bessembinder (1992), Kim (1993), and Chatrath, Liang & Song (1997).

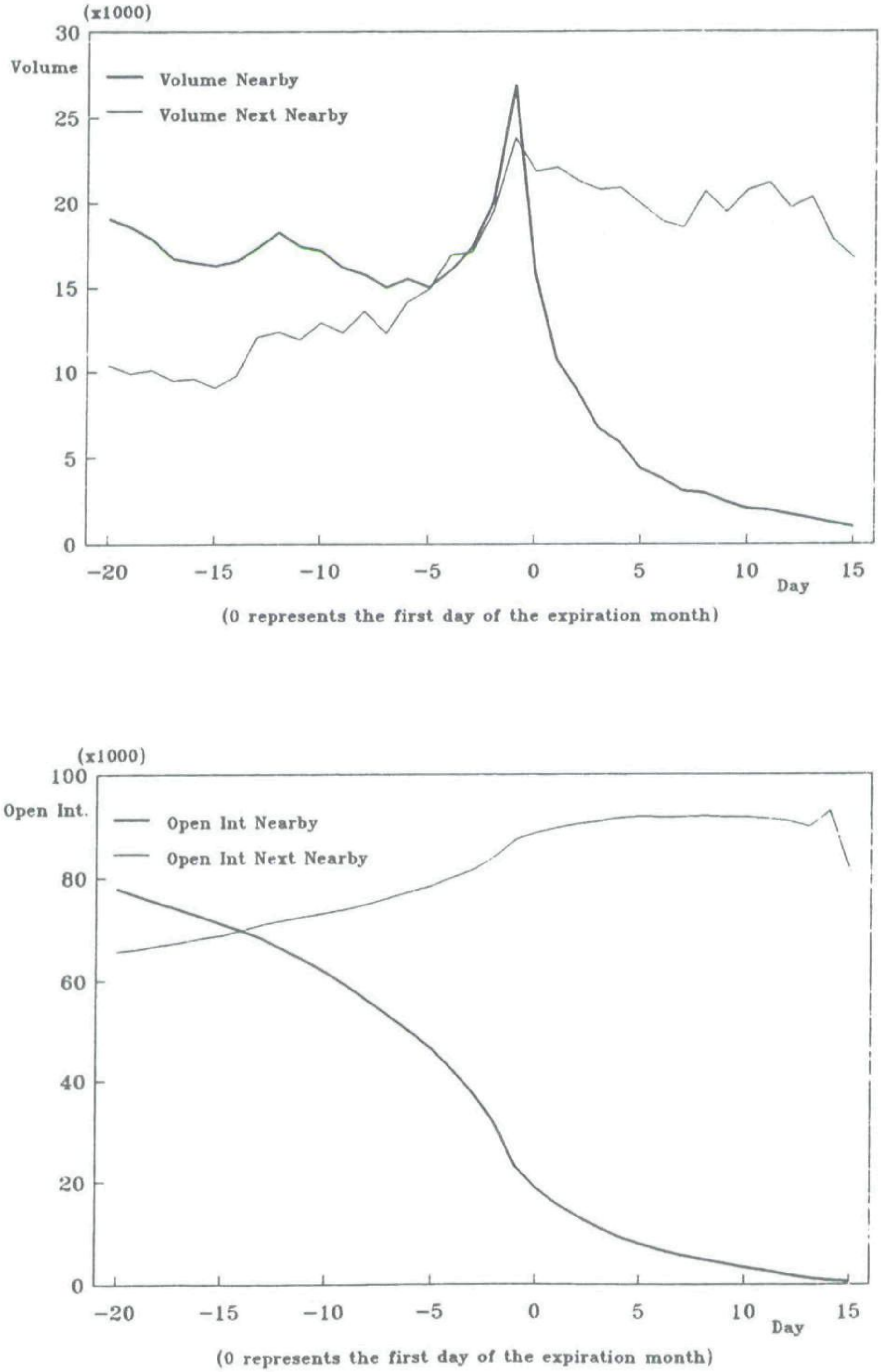


FIGURE 1

Trends in volume and open interest around contract expiration: average figures for corn (January 1986–March 1995).

TABLE I

A Description of Margins Requirements
for Soybean and Corn (January 1986–March 1995)

A: Frequency of Margin Changes

	Soybean			*Corn*		
	Specul. Initial	*Specul. Maintain*	*Hedger*	*Specul. Initial*	*Specul. Maintain*	*Hedger*
Increased	20	19	19	15	17	17
Decreased	24	22	22	17	15	15
Total	42	41	41	32	31	31

B: Margins and Margin/Contract-Value Ratios

	Soybean				*Corn*			
	Margins		*Margins/Value*		*Margins*		*Margins/Value*	
	Specul. Initial	*Hedger*	*Specul. Initial*	*Hedger*	*Specul. Initial*	*Hedger*	*Specul. Initial*	*Hedger*
Mean	1271.90	962.03	2.216	2.126	502.94	354.71	2.266	2.134
SD	484.56	407.35	0.081	0.080	169.40	138.52	0.096	0.088
ADF	−3.13	−3.19	−4.25[a]	−4.40[a]	−4.19[a]	−4.29[a]	−4.84[a]	−4.96[a]
ADF(Δ)	−7.74[a]	−7.25[a]	—	—	—	—	—	—

Notes: The statistics are for margins and margins as a percentage of contract value. Maintenance margins for speculators are identical to the initial and maintenance margins imposed on hedgers. ADF and ADF(Δ) represent Augmented Dickey-Fuller test statistics for the level and differenced series, respectively.
[a]represents significant at .01.

The soybean and corn contracts investigated here make particularly good candidates for our study. The sample interval witnessed a fair amount of variation in the initial- and maintenance-margin requirements in these two commodities. Panel A of Table I reports the frequency of margin changes. Initial margin levels were altered forty-two times for the soybean contract and thirty-two times for the corn contract. Almost without exception (and as is common practice), changes in the initial margins were accompanied by proportional changes in the maintenance margins.[14]

We also consider a "relative-cost" approach to the measurement of margin requirements by constructing the ratio of margins to contract value.[15] If one assumes that margin requirements impose opportunity

[14]It should be noted that maintenance margins and margins for hedgers were identical in each of the two contracts. Thus, whereas initial margins on speculators are higher than on hedgers, there is a very high correlation between margin changes for the two trader groups.

[15]Relative (percentage) initial margin requirements for either contract are given by $M_t/(P_t{}^*Q)^*100$,

costs, the variable represents the proportion of funds relative to the contract value on which a futures trader loses earnings-potential. Panel B of Table I provides summary statistics for the margin levels and the ratio of margins to price. It is evident that hedging margin requirements are substantially lower than the initial margins for speculators (by approximately 25% and 30%), as is common practice in U.S. futures markets.

Our study considers two measures of market volatility. The first measure of volatility employed in this study is designed to highlight the abnormally large changes in the prices of the commodities. The method involves constructing a band based on a robust measure of dispersion of prices in each sample (for example, Hoaglin, Iglewicz, & Tukey, 1986; Hoaglin & Iglewicz, 1987). Jumps are identified as the frequency of daily changes in returns that are less than $(R_L - 1.5R_Q)$, or greater than $(R_U + 1.5R_Q)$, where returns are given by $\log(F_t/F_{t-1})^*100$, R_L and R_U represent the 25th and 75th percentile of returns, and $R_Q = (R_L - R_U)$ is the interquartile range.[16] Such a measure of extreme price changes may be especially relevant in the context of the kinked demand curve—as discussed earlier. Moreover, margin changes are themselves episodic and may be instigated by (expectations of) extreme price changes (for example, Telser, 1981, and Edwards & Neftci, 1988).

The second measure of volatility is the conditional variance obtained from Bollerslev's (1986) GARCH (1,1) model. This measure may be thought of as the "normal" measure of volatility, as we find that daily price changes in both the commodity futures prices contain an ARCH process.[17] The margin data and the frequency of price jumps and conditional variance measures are aggregated over bimonthly periods to match the frequency of the COT data exactly.

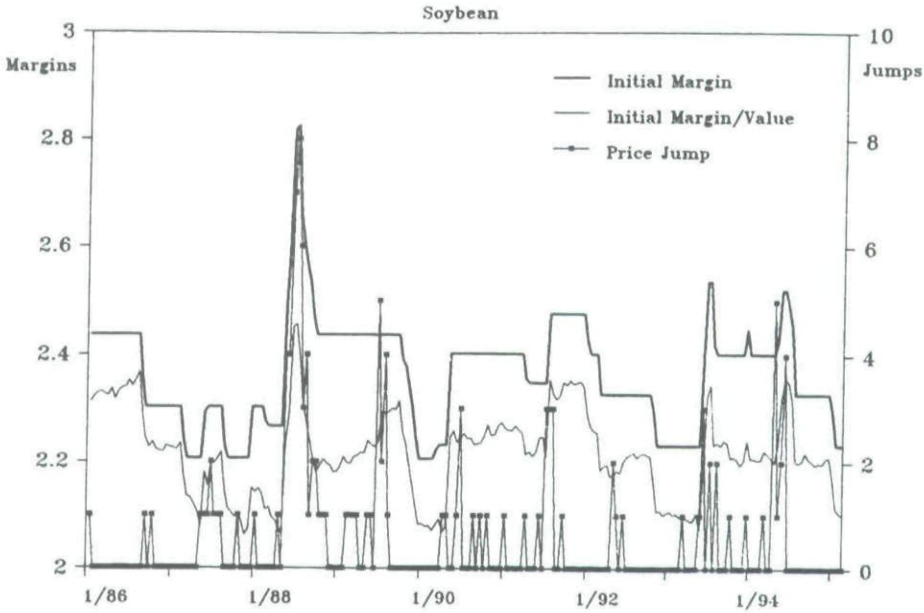
Volatility, Margins, and Trading Activity

As noted earlier in this article, several empirical studies demonstrate that changes in futures margins follow or coincide with changes in underlying

where M_t represents the margin requirement per contract, P_t is the quoted futures price per bushel, and Q is the quantity of bushels in a contract. Futures prices for the two commodities are quoted in cents per bushel, with 5,000 bushels making a contract.

[16]Among others, Becketti and Sellon (1989) have also employed this measure of volatility.

[17]We find considerable nonlinear dependence in the return data. Ljung-Box statistics were significant for the squared daily returns, and Engle's (1982) ARCH test statistics is highly significant for both commodities. On the other hand, standardized residuals from the GARCH model showed no signs of such dependence using the same tests, indicating that the GARCH model provides a good fit to the data. Moreover, the measure $(R_t\text{-}\mu)/h_t$, where R_t and μ are the returns and average of returns, and h_t is the conditional variance, is found to have near-zero mean and a standard deviation very close to 1 for both commodities—which indicates that ht is a reasonable measure of "normal" volatility (see Hsieh & Miller, 1990). These diagnostics are available from the authors.



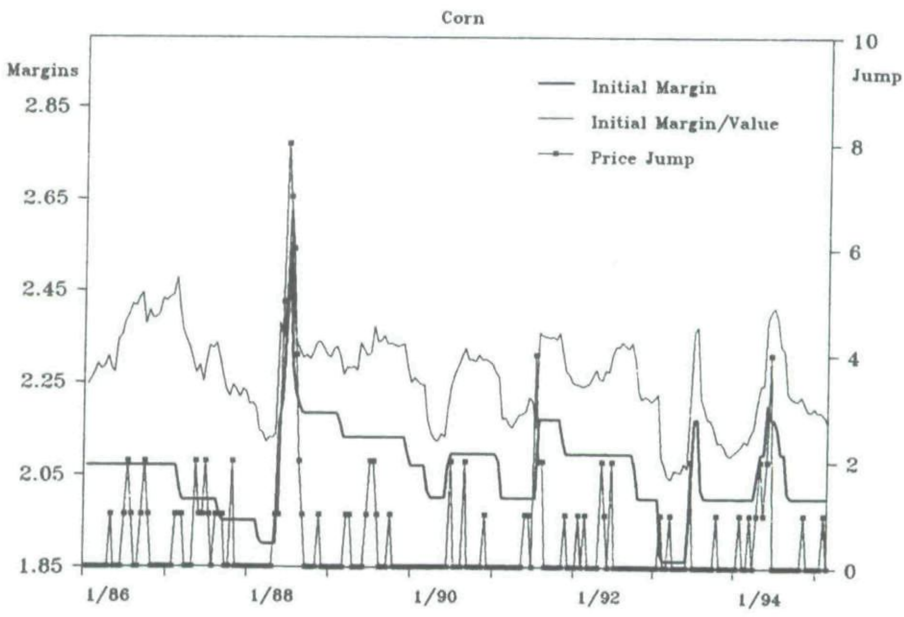


FIGURE 2
Margin levels and price jumps (January 1986–March 1995).

TABLE II

Tests for Endogeniety: Hausman Specification Tests

Variable	*Soybean*	*Corn*
ΔIM	55.87[a]	58.65[a]
RIM	40.12[a]	44.79[a]
Jump	3.56[c]	2.45
Conditional volatility	10.21[a]	18.02[a]

Notes: The test statistic is generated using the method illustrated in Griffiths, Hill, and Judge (1993, p. 465)). ΔIM and RIM represent changes in margins and margins as a percentage of contract value. To compute the chi-square statistics for ΔIM (RIM), the change in total open-interest series was regressed on ΔIM (RIM), alternately employing OLS and 2SLS. In the 2SLS estimation, jump and lagged jump are employed as instrument variables. Similarly, to test the endogeneity of the jump (conditional volatility) measures, change in open-interest series was regressed on jump (conditional volatility) employing OLS and 2SLS, where ΔIM, lagged ΔIM, and time to maturity are employed as instrument variables. The statistics are distributed chi-square with 1 degree of freedom.
[a,b,c]represent significance at 0.01, 0.05, and 0.10, respectively.

volatility. The coincidence of volatility and margin changes is brought out clearly in Figure 2, which plots the initial margins (standardized for illustration) and relative margins, alongside the measure of jump volatility. The coefficients of correlation between the initial margin and price jumps is .65 for the soybean market, and 0.56 for the corn market.[18]

However, such evidence does not indicate the direction of influence between margin levels and volatility. To further assess this relationship and to specify properly our models to examine the impact of margins on trading activity, we conduct tests for endogeneity of the margin and volatility variables. For this purpose we conduct the Hausman (1978) specification test in an errors-in-variables model by specifying changes in open interest as a function of, alternately, margins and volatility.[19] Table II reports the Hausman test statistics. The hypothesis of nonendogeniety is strongly rejected for the change in margins (ΔIM), initial margins as a percentage of contract value (RIM), and the conditional volatility—but rejected only weakly for jump volatility.

[18]High correlation coefficients were also noted when employing the alternate measures of volatility and margins. For instance, the coefficients for the relative margin–conditional variance pairings are 0.33 and 0.39 for soybean and corn, respectively.

[19]The test statistic is constructed employing the differences in coefficients and covariance matrices from OLS and 2SLS solutions (see Griffiths, Hill, & Judge, 1993, p. 465). To compute the statistics for ΔIM (RIM), the change in open-interest series was regressed on ΔIM (RIM) employing OLS and 2SLS. In the 2SLS estimation, jump and lagged jump are employed as instrument variables. Similarly, to test the endogeneity of the volatility measures, change in open-interest series was regressed on a volatility measure employing OLS and 2SLS, where ΔIM, lagged ΔIM, and time to maturity are employed as instrument variables.

Following the evidence on endogeneity, the relationship between volatility, margins, and trading activity is first examined via the trivariate near-vector autoregressive (VAR) model

$$\Delta IM_t = \alpha_M + \sum_{i=1}^{2} \beta_{M,i}\Delta IM_{t-i} + \sum_{j=1}^{2} \gamma_{M,j} J_{t-j} + \sum_{k=1}^{2} \eta_{M,k}\Delta TV_{t-k} + \tau_M TTM_t + \varepsilon_{M,t}, \quad (8a)$$

$$\Delta TV_t = \alpha_S + \sum_{i=1}^{2} \beta_{S,i}\Delta IM_{t-i} + \sum_{j=1}^{2} \gamma_{S,j} J_{t-j} + \sum_{k=1}^{2} \eta_{S,k}\Delta TV_{t-k} + \tau_S TTM_t + \varepsilon_{S,t}, \quad (8b)$$

$$J_t = \alpha_J + \sum_{i=1}^{2} \beta_{J,i}\Delta IM_{t-i} + \sum_{j=1}^{2} \gamma_{J,j} J_{t-j} + \sum_{k=1}^{2} \eta_{J,k}\Delta TV_{t-k} + \tau_J TTM_t + \varepsilon_{J,t}, \quad (8c)$$

where J_t represents the frequency of price jumps, ΔTV_t is the changes in average *total* volume (that is, volume across nearby and next-to-nearby contracts), and TTM_t represents the time to maturity (in days).[20] The time to maturity variable is intended to control for any maturity effects in either of the three endogenous variables.[21] We arrived at very similar results when we alternately employ RIM in place of ΔIM; conditional volatility in place of jump volatility; and *total* open interest of speculators, small-traders, and spreaders in place of volume.[22]

The results in Table III lend strong support for the hypothesis that exchange members set margins in the interest of reducing their exposure: the lagged volatility coefficients are positive and highly significant in the ΔIM equations for both commodities. The evidence is also consistent

[20]The lag length of two produced regression residuals that are serially unrelated as indicated by Durbin-h statistics.

[21]The inclusion of the TTM variable in the volatility equation is motivated by the possibility that volatility patterns change as one approaches contract maturity (Samuelson, 1965). Further, market corners and squeezes occur closer to maturity, and give rise to episodic price jumps (for instance, see Cooper & Donaldson, 1998). Therefore, exchanges may be more susceptible to increase margins closer to maturity. Finally, volume is generally strongest for the nearby contract until close to maturity, when it drops off sharply as traders switch to farther away contracts. Because we are examining total volume (that is, volume across contracts), the role of time to maturity is not (a priori) as clear on this variable.

[22]Margin levels across speculators and hedgers are highly correlated, so that employing volume (which includes hedging volume) should not be considered inappropriate.

TABLE III

	Soybean			Corn		
	ΔIM	*ΔTV*	*Jump*	*ΔIM*	*ΔTV*	*Jump*
Constant	5.943^{a}	$0.65e^{4}$	0.035	4.855^{a}	$0.98e^{4}$	0.046
	(27.72)	(0.70)	(0.39)	(25.50)	(1.46)	(0.63)
ΔIM_{t-1}	0.208^{a}	$-0.22e^{4b}$	−0.005	0.252^{a}	$-0.99e^{3c}$	0.026
	(3.90)	(−1.99)	(−0.36)	(5.61)	(−1.89)	(1.48)
ΔIM_{t-2}	-0.057^{c}	$-0.13e^{3}$	0.003	−0.049	$-0.94e^{3}$	−0.017
	(−1.82)	(−0.67)	(0.16)	(−1.43)	(−1.55)	(−1.26)
ΔTV_{t-1}	$-0.48e^{-6}$	-0.563^{a}	$0.19e^{-6}$	$-0.13e^{-5}$	-0.295^{a}	$-0.94e^{-6}$
	(−0.34)	(−10.82)	(0.34)	(−0.82)	(−4.40)	(−1.53)
ΔTV_{t-2}	$-0.43e^{-6}$	-0.511^{a}	$-0.85e^{-6c}$	$-0.18e^{-5}$	-0.199^{a}	$-0.67e^{-6}$
	(−0.39)	(−10.82)	(−1.73)	(−1.17)	(−2.87)	(−1.06)
$Jump_{t-1}$	0.760^{a}	$0.81e^{4}$	0.417^{a}	0.806^{a}	$-0.82e^{4}$	0.635^{a}
	(4.61)	(1.13)	(6.16)	(4.50)	(−1.08)	(9.13)
$Jump_{t-2}$	0.633^{a}	$0.22e^{4}$	0.286^{a}	0.241	$0.13e^{5c}$	0.030
	(3.89)	(0.31)	(4.28)	(1.34)	(1.68)	(0.44)
TTM	$-0.38e^{-3}$	-0.620^{3a}	$0.27e^{-3}$	-0.91^{-3}	−4.169	$0.28e^{-3}$
	(−0.24)	(−9.12)	(0.52)	(−0.94)	(−1.47)	(0.74)
F(ΔIM)	25.23^{a}	5.28^{b}	0.02	43.22^{a}	4.79^{b}	0.60
F(TV)	0.20	150.45^{a}	0.63	1.63	21.73^{a}	2.76
F(JUMP)	80.53^{a}	2.31	121.61^{a}	47.22^{a}	0.51	126.67^{a}

Notes: The results are from a trivariate system with dependent variables: change in margins (ΔIM), price jumps, and changes in total volume across nearby and next-to-nearby contracts (ΔTV), and exogenous variable, TTM, representing the time to maturity (in days). Figures in () are t-statistics. F(·) represents the F-value for the sum of the lagged coefficients of the variable.

[a,b,c]represent significant at 0.01, 0.05, and 0.10, respectively.

with the notion that margins impose liquidity costs on traders: The lagged coefficients for the margin variables are significant in the trading volume equation. Finally, there is no evidence to indicate that extreme volatility is impacted by either futures trading activity or margins.

To address the concern that the VAR solutions fail to capture near-contemporaneous causal relationships, we conduct a battery of regressions that control for the endogeneity of the trading activity and margin variables. A further examination of the impact of margins on trading activity is conducted by estimating the two-stage least squares (2SLS) model,

$$Activity_t = \alpha_0 + \alpha_1 \Delta I\hat{M}_t + \alpha_2 \hat{J}_t + \tau TTM_t + \varepsilon_t, \tag{9}$$

where change initial margins and jumps are modelled as potentially endogenous variables.[23]

[23]The instrument variables in the model are TTM, lagged initial margin changes, and lagged jumps.

TABLE IV

Two-Stage Estimates of the Impact of Margins on Trading Activity

Panel A: Soybean

	ΔSPEC	*ΔHEDGE*	*ΔSMALL*	*ΔSPREAD*	*ΔNSPEC*	*ΔNHEDGE*
Constant	50.023[a]	54.108[a]	58.349[a]	46.331[a]	0.20e^{3}[a]	0.22e^{3}[a]
	(4.12)	(4.19)	(4.79)	(4.12)	(3.48)	(4.45)
ΔIM	−7.198[a]	−8.134[a]	−8.389[a]	−6.649[a]	−29.428[a]	−33.346[a]
	(−4.12)	(−4.20)	(−4.13)	(−3.14)	(−3.53)	(−4.69)
Jump	16.876[a]	21.097[a]	19.646[a]	15.256[a]	27.807[b]	52.266[a]
	(3.69)	(3.80)	(3.15)	(2.95)	(2.00)	(4.02)
TTM	−0.010	−0.009	−0.008	−0.002	−0.209[b]	−0.077
	(−0.77)	(−0.65)	(−0.41)	(−0.18)	(−2.33)	(−0.94)
r^2	0.17	0.17	0.20	0.14	0.22	0.20

	MAKEUP1	*MAKEUP2*	*MAKEUP3*	*ΔTVOL*	*ΔTOI*
Constant	0.908[a]	1.906[a]	1.273[a]	46.793[a]	52.470[a]
	(22.91)	(41.66)	(4.26)	(4.08)	(4.03)
ΔIM	−0.002	−0.88e^{-3}	−0.071	−6.739[a]	−7.540[a]
	(−0.30)	(−0.14)	(−1.09)	(−4.09)	(−3.85)
Jump	0.038[a]	0.045[a]	0.403[a]	15.686[a]	17.663[a]
	(2.67)	(2.80)	(3.82)	(3.62)	(3.60)
TTM	−0.30e^{-3}	−0.12e^{-3}	−0.001	−0.012	−0.006
	(−1.62)	(−0.86)	(−1.52)	(−0.98)	(−0.40)
r^2	0.05	0.05	0.07	0.13	0.19

Panel B: Corn

	ΔSPEC	*ΔHEDGE*	*ΔSMALL*	*ΔSPREAD*	*ΔNSPEC*	*ΔNHEDGE*
Constant	39.223[a]	42.408[a]	46.530[a]	36.590[a]	0.19e^{3}[a]	0.38e^{3}[a]
	(4.80)	(5.17)	(4.26)	(3.19)	(3.49)	(4.80)
ΔIM	−6.448[a]	−7.422[a]	−7.645[a]	−6.005[a]	−30.611[a]	−67.360[a]
	(−4.83)	(−4.97)	(−4.82)	(−4.80)	(−3.61)	(−4.88)
Jump	11.260[a]	14.442[a]	13.581[a]	10.733[a]	25.445[c]	0.10e^{3}[a]
	(3.67)	(3.89)	(3.73)	(3.74)	(1.94)	(4.51)
TTM	−0.006	−0.007	−0.004	−0.002	−0.107	−0.284[b]
	(−0.73)	(−0.77)	(−0.46)	(−0.23)	(−1.63)	(−2.49)
r^2	0.19	0.20	0.18	0.10	0.23	0.27

	MAKEUP1	*MAKEUP2*	*MAKEUP3*	*ΔTVOL*	*ΔTOI*
Constant	1.139[a]	2.249[a]	0.903[a]	30.582[a]	37.798[a]
	(12.81)	(21.98)	(3.62)	(5.39)	(5.31)
ΔIM	−0.116[a]	−0.170[a]	−0.220[b]	−13.630[a]	−16.88e^{4}[a]
	(−2.92)	(−3.72)	(−1.98)	(−5.37)	(−5.30)
Jump	0.015	0.018	0.213[b]	6.596[a]	8.622[a]
	(0.50)	(0.54)	(2.53)	(3.43)	(3.57)
TTM	0.86^{-5}	0.49e^{-4}	0.64e^{-3}[b]	−0.001	−0.004
	(0.09)	(0.44)	(2.40)	(−0.16)	(−0.48)
r^2	0.21	0.27	0.17	0.28	0.25

Notes: The results are from the 2SLS estimation of

$$Activity_t = \alpha_0 + \alpha_1 \Delta \hat{IM}_t + \alpha_2 \hat{J}_t + \tau TTM_t + \varepsilon_t$$

where Activity is, alternately, trader-makeup, and the change in the number of contracts held by each trader group, number of traders, volume, and open interest; J is price jumps; MAKEUP1 is defined as (speculator commitments/hedging commitments); MAKEUP2 is (total nonhedger commitments)/commitment of hedgers); MAKEUP3 is (speculator numbers/hedger numbers); TTM_t, is the time to maturity; figures in () are t-statistics; r^2 is the squared coefficient of correlation between observed and predicted dependent variable.

[a,b,c]represent significant at 0.01, 0.05, and 0.10, respectively.

Table IV reports the results for a variety of trading activity measures, including number of speculators (NSPEC) and number of hedgers (NHEDGE), along with three measures representing the makeup (MAKEUP$_i$) of the market. The results clearly suggest that margin changes are negatively related to the number of contracts held by the four groups of traders, as well as to the number of speculators and hedgers for both soybean (Panel A) and corn (Panel B). The coefficient for the predicted value of ΔIM is negative and significant at the 0.01 level for the four trader groups, the two variables representing trader numbers, as well as for ΔTVOL (volume of nearby and next-to-nearby contracts) and ΔTOI (open interest of nearby and next-to-nearby contracts).

There are indications that margins changes have altered the makeup of traders in the corn contract, but not in the soybean contract. The ΔIM coefficient in Panel B is significantly negative in the equation for MAKEUP1, which is defined as speculative commitments divided by hedging commitments, and in the equation for MAKEUP2, defined as the commitments of speculators, small traders, and spreaders divided by the commitment of hedgers. Thus higher margins have resulted in lower levels of speculation and small trader activity relative to hedging activity in the corn contract. A similar pattern for the corn contract is found for MAKEUP3, defined as the number of speculators divided by number of hedgers.[24]

The Role of Maturity in the Margins–Activity Relation

The first two sections of this article discussed the potential role of time to maturity in the relationship between margin changes and trading activity. The premise has been that, if margins impose an opportunity cost on traders, the impact of margins should be more severe farther away from maturity. On the other hand, if margins impose only transaction costs, traders will be more sensitive to margins closer to maturity. To examine the nature of the costs imposed by futures margins, we evaluate

The ratio of margins to price (RIM) and conditional volatility (h) were alternately employed (in place of ΔIM and Jump, respectively) with very similar results.

[24]We also undertook two-stage regressions where volatility (price jumps) are modeled as dependent on changes in commitments, prior volatility levels, and time to maturity. In the interest of brevity, we do not report the results here. However, it is notable that we find no evidence that either large speculators or small traders are responsible for the price jumps in either corn or soybean futures. In fact, we find some evidence to indicate that the participation of speculators and small traders may be actually dampening volatility. Such evidence is consistent with, among others, Osler (1995), Osler and Carlson (1996), and Chatrath and Song (1998), who suggest that speculative activity helps smooth exogenous shocks to the market.

the impact of margin changes on trading activity for the nearby and next-to-nearby contracts.

We first undertake 2SLS regressions of changes in log volume (open interest) on changes in initial margins, volatility, and time to maturity across the nearby and next-to-nearby contracts.[25] The results in Table V clearly favor the transaction-cost hypothesis: The ΔIM coefficient is consistently negative for the nearby contract alone. That is, margin changes are found to have a larger (negative) impact on volume and open interest for the nearby contract. These patterns are consistent across both the soybean and corn contracts.[26]

There may be some concern that the effect captured in Table V (of next-to-nearby contract being less sensitive to margins) may simply be the reflection of the prevalence of hedgers in the further-away contracts, and not of margins imposing important transaction costs. If hedgers are less sensitive to margin changes, then the effect we may be capturing in Table V could be related to trader behavior rather than transaction costs. Kim's (1993) study suggests that margins do impact trader groups in disparate ways, as we have shown in this article (Table IV).[27]

To address the above concern, and to assess the role of contract-maturity in the trading activity-margins relationship more directly, we run OLS regressions of the form

$$\Delta\ln(Activity_t) = \alpha_0 + (\alpha_1 + \alpha_2 TTM_t)\Delta IM_t + \alpha_3 TTM_t + \varepsilon_t$$

where $\Delta\ln(Activity)$ is, alternately, the change in log of volume and change in open interest. The model allows for the sensitivity parameter of trading volume to margins, $(\alpha_1 + \alpha_2 TTM_t)$, to be a nonlinear function of time-to-maturity. The α_2 coefficient will indicate the nature and significance of the role of contract-maturity in the activity-margins relationship. If the coefficient $\alpha_2 < 0$, one can make the case that the (negative) impact of margins is heightened as we get closer to expiration. Following our arguments in the first two sections, this would suggest that margins do impose important transaction costs (rather than opportunity costs).

The results in Table VI support the hypothesis that time-to-maturity plays a role in the margins-futures activity relationship and support the contention that margins impose important transaction costs. The

[25]Taking logs of changes in volume and open interest normalizes the activity measures across nearby and next-to-nearby contracts, thus making the impact coefficient (ΔIM) more comparable across regressions.

[26]Very similar patterns are found from 2SLS regressions of changes in volume (open interest) on relative margins (RIM), volatility, and time to maturity.

[27]For further evidence on the margin sensitivities of various trader groups, see Kim (1993, Table 6.1, 6.2).

TABLE V

Margin-Sensitivity of Nearby and Next-to-Nearby Contracts:
Changes in Initial Margins

	Δln(Volume)		*Δln(Open-Interest)*	
	Nearby	*Next-to-Nearby*	*Nearby*	*Next-to-to-Nearby*
Panel A: Soybean				
Constant	−0.462[a]	0.064	−0.709[a]	0.488[a]
	(−3.44)	(0.53)	(−5.81)	(3.55)
ΔIM	−0.575[b]	−0.184	−2.027[b]	−0.282
	(−2.45)	(−0.78)	(−2.17)	(−0.96)
Jump	0.519[c]	0.498	0.836	−0.798
	(1.78)	(0.67)	(1.13)	(−0.94)
TTM	−0.032[a]	0.002	−0.045[a]	0.025[a]
	(−6.31)	(0.44)	(−8.08)	(4.00)
r^2	0.15	0.03	0.20	0.07
Panel B: Corn				
Constant	−0.076[c]	0.267[a]	−0.487[a]	0.368[a]
	(−1.83)	(2.86)	(−4.12)	(3.03)
ΔIM	−1.115[b]	−0.076	−1.163[b]	−0.114
	(−2.41)	(−0.22)	(−2.13)	(−0.05)
Jump	0.267	0.315	0.699	0.615[c]
	(1.19)	(0.86)	(0.70)	(1.67)
TTM	−0.009[a]	0.010[a]	−0.022[a]	0.016[a]
	(−3.04)	(3.25)	(−5.75)	(3.69)
r^2	0.08	0.06	0.17	0.12

Notes: The results are from the 2SLS estimation of

$$\Delta\ln(Activity_t) = \alpha_0 + \alpha_1 \Delta \hat{IM}_t + \alpha_2 = \hat{J}_t + \tau TTM_t + \varepsilon_t$$

where Δln(Activity) is, alternately, the change in log of volume and open interest (Δln(volume) and Δln(Open-Interest), respectively; TTM_t represents the time to maturity; ΔIM represents changes in initial margins; figures in () are t-statistics; r^2 is the squared coefficient of correlation between observed and predicted dependent variable.
[a,b,c]represent significant at 0.01, 0.05, and 0.10, respectively.

TTM·ΔIM coefficient is negative for all regressions (nearby and next-to-nearby), though especially significant only for the nearby contracts. In other words, the closer one is to contract maturity (in either the nearby or next-to-nearby contracts), the greater is the impact of margin changes on trading activity.

SUMMARY AND CONCLUSIONS

Prior literature indicates that margin requirements on futures contracts serve the purpose of insuring members of the futures exchange, or serve the purpose of controlling underlying volatility by keeping certain traders from the market, or both. Evidence pertaining to the impact of margin

TABLE VI

Margin-Sensitivity and Contract Maturity: Nonlinear Estimates

	Δlog(Volume)		*Δlog(Open-Interest)*	
	Nearby	*Next-to-Nearby*	*Nearby*	*Next-to-Nearby*
Panel A: Soybean				
Constant	−0.429[a]	0.097	−0.654[a]	0.415[a]
	(−6.23)	(1.08)	(−7.71)	(4.06)
ΔIM	−0.57e−3[a]	−0.42e−3	−0.67e−3[a]	−0.37e−3[c]
	(−2.94)	(−1.61)	(−2.79)	(−1.68)
TTM · ΔIM	−0.16e−3[a]	−0.33e−4[b]	−0.16e−3	−0.19e−4[a]
	(−12.06)	(−2.19)	(−10.32)	(−2.85)
TTM	−0.028[a]	0.005	−0.042[a]	0.025[a]
	(−7.89)	(1.13)	(−9.74)	(4.88)
R^2	0.52	0.22	0.50	0.29
Panel B: Corn				
Constant	−0.109	0.272[a]	−0.477[a]	0.394[a]
	(−1.38)	(3.23)	(−4.70)	(3.57)
ΔIM	−0.001[c]	−0.65e−3	−0.002[c]	−0.001
	(−1.72)	(−0.62)	(−1.81)	(−0.92)
TTM · ΔIM	−0.12e−3[a]	−0.52e−4[c]	−0.15e−3[a]	−0.71e−4[c]
	(−3.20)	(−1.79)	(−3.97)	(−1.88)
TTM	−0.007[b]	0.010[a]	−0.023[a]	0.015[a]
	(−2.31)	(3.37)	(−6.33)	(3.86)
R^2	0.11	0.08	0.22	0.09

Notes: The results are from the OLS estimation of

$$\Delta\ln(Activity_t) = \alpha_0 + (\alpha_1 + \alpha_2 TTM_t)\Delta IM_t + \alpha_3 TTM_t + \varepsilon_t$$

where Δln(Activity) is, alternately, the change in log of volume and change in open interest; TTM_t represents the time to maturity; ΔIM represents changes in initial margins; figures in () are t-statistics; r^2 is the squared coefficient of correlation between observed and predicted dependent variable.

[a,b,c]represent significant at 0.01, 0.05 and 0.10, respectively.

changes on volatility, however, has been inconclusive. The proposed link flowing from margin changes to volatility is an indirect one. It relies on the notion that margin changes impose varying costs across trader groups. This disparity in burden is thought to change the makeup of traders in the marketplace, and ultimately alter price behavior. Prior literature provides no evidence as to the nature of the costs associated with margins and whether such costs change the makeup of traders. There is also little evidence on the link between certain trader-groups and volatility.

In this article, we examine the impact of margin requirements on the positions of four groups of traders and test for the nature of liquidity costs in the soybean and corn markets. We argue that if margins impose significant opportunity costs, trading activity will be more affected by margin changes relatively far from maturity. On the other hand, if margins impose no opportunity costs, and only transaction costs, then trading activity will be more sensitive to margin changes relatively close to maturity. We find open interest and trading volume to be relatively insensitive to margin changes further away from maturity. We suggest that this evidence is inconsistent with the opportunity-cost hypothesis.

One may argue that the testing procedures are biased in favor of such a finding, because traders who take positions far from maturity are primarily hedgers—who may be more committed to staying the course until settlement. However, we find hedgers are also significantly (negatively) affected by margin changes; and, for the soybean contract, hedgers are found to be as sensitive to margin alterations as other trader groups. Furthermore, we also perform tests that are not dependent on comparing the impact of margins on nearby and next-to-nearby contracts, and find further support for our findings.

The results also suggest that margins may be an inappropriate device to reduce volatility in futures markets. Although we find some evidence that margins can change the makeup of the market, we find no evidence that speculators or small traders (who suffer the highest margin requirements) cause or exacerbate price volatility. Finally, our results are consistent with the hypothesis that margins are managed as an insurance mechanism: This study documents a strong positive relationship between *lagged* price volatility and changes in initial- and maintenance-margin requirements.

BIBLIOGRAPHY

Anderson, R. (1981). Comments on "Margins and futures contracts." The Journal of Futures Markets, 1, 259–264.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 31, 307–327.

Becketti, S., & Sellon Jr., G. H. (1989). Has market volatility increased? Federal Reserve Bank of Kansas City, Economic Review, 74, 17–30.

Becketti, S., & Roberts, D. J. (1990). Will increased regulation of stock index futures reduce stock market volatility? Federal Reserve Bank of Kansas City, Economic Review, 75, 33–46.

Bessembinder, H. (1992). Systematic risk, hedging pressure, and risk premiums in futures markets. Review of Financial Studies, 5, 637–668.

Black, F. (1976). The pricing of commodity contracts. Journal of Financial Economics, 3, 167–679.

Carter, C. A., Rausser, G. C., & Schmitz A. (1983). Efficient asset portfolios and the theory of normal backwardation. Journal of Political Economy, 91, 319–331.

Chatrath, A., & Song, F. (1998). Futures commitments and commodity price jumps. Financial Review, forthcoming.

Chatrath, A., Liang, Y., & Song, F. (1997). Commitment of traders, basis behavior, and the issue of risk premia in futures markets. The Journal of Futures Markets, 17, 707–731.

Chang, E. C. (1985). Return to speculators and the theory of normal backwardation. Journal of Finance, 40, 193–208.

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

Cooper, D. J., & Donaldson, R. G. (1998). A strategic analysis of corners and squeezes. Journal of Financial and Quantitative Analysis, 33, 117–138.

Edwards, F. R., & Neftci, S. N. (1988). Extreme movements in futures prices: Implications of setting margins. The Journal of Futures Markets, 8, 639–656.

Engle, R. F. (1982). Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. Econometrica, 50, 987–1007.

Fenn, G. W., & Kupiec, P. (1993). Prudential margin policy in futures-style settlement system. The Journal of Futures Markets, 13, 389–409.

Figlewski, S. (1984). Margins and market integrity: Margin setting for stock index futures and options. The Journal of Futures Markets, 6, 385–416.

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

Fishe, R. P. H., Goldberg, L. G., Cosnell, T. F., & Sinha, J. (1990). Margin requirements in futures markets: Their relationship to price volatility. The Journal of Futures Markets, 10, 541–554.

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

Gemmill, G. (1994). Margins and the safety of clearing houses. Journal of Banking and Finance, 18, 979–997.

Griffiths, W. E., Hill, R. C., & Judge, G. G. (1993). Learning and practicing econometrics, New York: John Wiley & Sons.

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

Hardouvelis, G. A., & Kim, D. (1995). Margin requirements, price fluctuations, and market participation in metal futures. Journal of Money, Credit, and Banking, 27, 659–671.

Hartzmark, M. L. (1986). The effects of changing margin levels on futures market activity, the composition of traders in the market, and price performance. Journal of Business, 59, S147–S180.

Hausman J. A. (1978). Specification tests in econometrics. Econometrica, 46, 1251–1271.

Hoaglin, D. C., Iglewicz, B., & Tukey, J. W. (1986). Performance of some resistant rules for outlier labelling. Journal of the American Statistical Association, 81, 991–999.

Hoaglin, D. C., & Iglewicz, B. (1987). Fine-tuning some resistant rules for outlier labeling. Journal of the American Statistical Association, 82, 1147–1149.

Hsieh, D. A., & Miller, M. H. (1990). Margin requirements and stock market volatility. Journal of Finance, 45, 3–29.

Kim, E.-S. (1993). Margin requirements and the behavior of hedgers and speculators in metal futures markets. Unpublished dissertation, Rutgers, State University of New Jersey.

Ma, C. K., Kao, G. W., & Frohlich, C. J. (1993). Margin requirements and the behavior of silver futures prices. Journal of Business Finance and Accounting, 20, 41–60.

Moser, J. T. (1991). Determining margins for futures contracts: The role of private interests and the relevance of excess volatility. Federal Reserve Bank of Chicago, Economic Perspectives, 3–18.

Osler, C. L., & Carlson, J. A. (1996). Rational speculation and exchange rate volatility. Federal Reserve Bank of New York Staff Reports, 13, 1–30.

Osler, C. L. (1995). Short-term speculators and the origins of near random-walk exchange rate behavior. Federal Reserve Bank of New York Staff Reports, 3, 1–66.

Samuelson, P. A. (1965). Proof that properly anticipated prices fluctuate randomly. Industrial Management Review, 6, 41–63.

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