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The Effects of Changing Margin Levels on Futures Market Activity, the Composition of Traders in the Market, and Price Performance*

The relationship between margins and the degree of excessive speculator participation in futures markets is analyzed. The paper extends previous analyses by assuming that margin costs (as opposed to margin levels) will vary for different types of speculative and hedge traders. For this reason and for others, margin changes will result in significant, albeit unpredictable, changes in the composition of traders in the market. Empirical evidence presented supports this hypothesis. It is concluded that margins are an inappropriate tool to control excessive speculation and should only be used to guarantee contract performance.

I. Introduction

In December 1984 the Board of Governors of the Federal Reserve System released "A Review and Evaluation of Federal Margin Regulation" (Federal Reserve Bank 1984). This study reexamined the purpose and the necessity of federal margin regulation in light of the changing structure of U.S. and foreign financial markets. Four major issues related to the effect and usefulness of security margin requirements were discussed, including (*a*) the diversion of credit from productive investment to purely speculative endeavors; (*b*) the protection of unsophisticated investors, who might overextend their private financial resources; (*c*) the protection of brokers from customer default; and (*d*) the use of credit limitations to forestall undue destabilizing price fluctuations.

Two issues related to the coordination of margin requirements on securities, options, and fu-

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tures were also discussed. These included (*a*) the necessity for a level playing field or for roughly equivalent margins for instruments that can serve as substitutes and (*b*) the delegation of administrative power for margin regulation.

The first three issues related to securities margins were dismissed as being of limited importance. In regards to the diversion of credit, the Federal Reserve analysts (Federal Reserve Bank 1984, p. 10) concluded that "securities credit might be said to affect the cost and availability of credit for other uses, but the direction of the effect is uncertain at an analytical level and the magnitude of the effect appears likely to be quite small." The Federal Reserve analysts (p. 12) concluded that margin requirements were an inappropriate tool to protect investors: "In general, margin requirements do not recognize the fungibility of credit and the importance of overall portfolio leverage, and they are uneven in impact in that the same margin ratio is required to acquire a stock whose price is highly volatile as one whose price is relatively stable. These considerations suggest that other types of regulating safeguards should be looked to first for the purpose of protecting investors."

Whether coordination of margin requirements for various related financial instruments is needed was left ambiguous. How the regulation of margin requirements would be administered, should they be deemed necessary, is also left unanswered. The important factors that should determine the outcome of this debate are related to the institutional differences between the industries. However, in all likelihood the resolution of these issues will emerge from a political debate among various self-interested participants. I have discussed these problems in greater detail in Hartzmark (1985).

This paper will deal directly with the fourth issue stated above, namely, destabilizing price fluctuations caused by excessive speculator participation. The major conclusion drawn is that varying margin levels to control speculator participation in the futures market is an inappropriate policy device. Increasing margin levels as a means to drive uninformed or naive speculators from the market during rapid price level escalation may actually backfire, resulting in a market dominated to a greater extent by unsophisticated traders. Should this group of traders be the cause of the aberrant price movements, the end result could be further and more dramatic price level changes. The Federal Reserve analysts (p. 15) are thus incorrect in concluding that "the evidence does not rule out the possibility that on occasion the markets will manifest tendencies toward "speculative" excesses that might be limited through the imposition of margin requirements at levels above those likely to prevail simply on the basis of self-protective actions of creditors and other private parties. If excesses can be avoided, margin requirements would be of value in minimizing the broader potential

instabilities that could afflict our highly interrelated financial system and economy."

Before one can consider whether altering margin levels is an appropriate and effective tool for reducing excessive speculation, one must understand the magnitude of the trading costs associated with margin requirements. It is often assumed that margin requirements impose no costs on traders and therefore that margin changes will have no effect on the behavior of traders. On the surface this assumption seems reasonable, given that margin levels are relatively low and that margin requirements can be posted in interest-bearing certificates. Under these assumptions margin requirements fulfill their role as a performance bond without affecting transactions costs and therefore are an ineffective tool for reducing speculator participation.

I disagree with this argument, as do various other authors (Telser 1981; Telser and Yamey 1965; Figlewski 1984; Tomek 1985). Their approach, as well as mine, is based on the assumption that margin requirements impose costs on traders. Therefore, changing margin levels will alter these costs as well as the risk-return opportunity set faced by individual investors. For the individual trader, the costs and risks are related to the probability that the trader will be caught short of liquid assets.

The analysis presented in this paper extends that of Telser (1981) by assuming that the effect of changes in margin requirements will vary across different trader groups (e.g., commercial, noncommercial, large, small, informed, or uninformed). Differences among traders emerge because of varied expected liquidity costs and risks. Therefore, explicit margin levels and implicit margin costs are quite different. Equal margin requirements do not necessarily imply equal margin costs across individual traders. A trader may have a lower than average specified margin requirement but a higher than average margin cost associated with his futures transactions.

The end result of an across-the-board margin change will not be evenhanded, as the liquidity costs and risks will vary across groups. Therefore, changes in margin requirements will undoubtedly change the composition of traders in the market (e.g., the relative proportions of speculative, hedge, naive, informed, large, and small traders). A priori assertions about the direction and magnitude of changes in the composition of traders in the market cannot be made unless the liquidity costs and risk preferences of the various trader groups are known. Additionally, one cannot determine to what degree the market price level and volatility will be affected by a margin level change. These changes will alter perceived profit opportunities and information sets, thus altering individual demands.

Because of these uncertainties, one cannot say unequivocally that an across-the-board margin increase will drive out relatively more unin-

formed, undercapitalized traders than informed, low-probability-of-default traders. With any margin change there will be two effects on the individual's demand for contracts—the "cost effect" and the "price effect." An increase in the margin requirement will lead to an increase in the cost of trading and thus, under normal circumstances, a reduction in the number of contracts demanded. If the informed traders have relatively higher margin costs and risks than the uninformed traders, the individual cost effects may then result in more informed traders leaving the market than uninformed traders. This cost effect could actually lead to an increase in the demand for futures when risk is an inferior good, as the income effect could overwhelm the substitution effect. As traders readjust their portfolios the aggregate set of information in the futures market will change, possibly altering the price level and volatility in the market. This price effect will then cause the individual to alter his or her demand for contracts.

An extreme example will clarify the importance of focusing on the differences between trader groups when making policy decisions. Three rather unbelievable assumptions about the information available to the exchanges or government regulators who might be determining the margin level are given: (*a*) these parties can precisely define and clearly observe which types of traders are in the market; (*b*) they can predict that prices that are currently on a rapidly escalating upward path are going to continue in that direction (they are not constrained by a random walk hypothesis); and (*c*) they know that the naive speculators are responsible for the price bubble that is now forming.

Under these assumptions, will an increase in the level of margin requirements to all traders necessarily drive out relatively more naive speculators than informed traders? Will an increase in margin requirements for speculators that is greater than the increase for hedgers necessarily drive out relatively more naive speculators than informed traders? The answer to both these questions is no. Overall, as we have discussed, it will be impossible to predict the extent to which different groups of traders will exit the market when faced with these changes. Even if margin requirements are raised for only the naive speculators, there is no guarantee that a greater proportion of these traders will exit the market than the informed traders. This result emerges because the naive traders may, under certain circumstances, increase their demands for contracts because of the cost effect (i.e., risk is inferior). Additionally, all traders will face and react to the price effect. Therefore, even under these extreme abstractions from reality, it would be unwise to use margin policy to reduce naive speculator participation. In the case in which it is impossible to identify the groups correctly and determine whether the rapidly escalating price will continue (the real world), margin policy will be even less effective to forestall excessive speculation and/or the price bubble.

To understand better the effect of margin changes on the composition of traders, market activity, and price performance, several empirical relationships will be analyzed. The empirical evidence indicates that changing margin levels on futures contracts result in predictable and negatively related effects on market activity (e.g., open interest and volume) and unpredictable, albeit statistically significant, effects on the composition of traders in the market. The evidence does not indicate that there is a statistically significant relationship between margin changes and price volatility.

From these results one can conclude that traders in futures markets are quite sensitive to even small changes in the margin level. However, exogenous shocks specific to the futures market, such as a margin change, may affect only the composition of traders in the market without having any significant price effects. The futures price represents the weighted average of participants' price predictions. These expectations reflect the available information on the underlying supply and demand conditions for the cash commodity. Even though the composition of traders in the market changes, the overall information aggregated into the market price may not change significantly. It may be, then, that only substantial margin changes, if even these, can result in observable effects on futures prices.

To carry out these empirical analyses, various statistical tests on prices, volume, open interest, and composition are performed. The results of these tests are reported in Section VIII. The following two sections explain why there are margin requirements and the costs they impose. In Sections IV–VI, a simple model of trader behavior will be introduced to determine the effects of margin changes on trader demand, the amount of trading in the market, and the price performance of the market.

II. The Rationale for Margin Requirements

A margin on a futures contract represents a performance bond or earnest money. This deposit serves two purposes—it helps protect the integrity and reputation of the futures exchange, and it protects the middleman, known as the futures commission merchant (FCM), from customer default. Telser (1981, p. 225) describes why FCMs demand performance margins from their customers: "These margins serve to protect the brokers from losses that may result from adverse price changes affecting the customer's net balance. Although the customers are liable to the brokers for these losses, it is less costly for the brokers to have funds on hand in the form of their customers' margins they can use to settle the amounts owed them by their customers than to rely on legal proceedings to recover what is due them." The clearinghouse requirement of margin deposits from its clearing members is based on a

similar rationale.[1] In this paper, however, I shall focus only on the minimum margin that customers deposit with a member FCM, for this level is determined by the each exchange's margin committee.[2]

The level of initial margin required by an FCM of its customer is some dollar amount, usually only 2%–10% of the value of the contract. The initial margin can be satisfied with either cash or interest-bearing U.S. obligations.[3] The maintenance margin or the level that must be maintained under all circumstances is usually set at 60%–80% of the initial margin. When the value of the account falls below the maintenance level, cash must be deposited with the FCM to bring the account back to the specified level. The initial and maintenance margin requirements will usually be set at different levels for speculators and for hedgers.

The exchanges set the minimum level of margin that a member FCM must demand from its customers. However, the FCM does have the option to require a greater margin. It does so if it perceives the risk of trading in the particular market as greater than the risk as perceived by the exchange. The FCM may also raise the required level for a particular customer if that customer is viewed as an above-average risk. Therefore, there is a second tier of support in the event that the exchange fails to set the margin at a high enough level to satisfy the FCM. The FCM is free to act on its own accord, depending on the perceived level of risk associated with the trading of a particular customer.

Margin deposits were not always required of futures market participants. The early Chicago Board of Trade rules stated only that "margins may be demanded" (Taylor 1917). In 1872 this was changed to enable traders "the right to require margins" (Taylor 1917). It was not until the Board of Trade Clearing Corporation was established in 1925 that the modern margin rules became institutionalized (Brinkman 1981). This became necessary because customers with losses would sometimes fail to meet their obligations (i.e., walk away from the trade). Since 1925, however, no clearing member has defaulted on a Chicago Board of Trade contract (Brinkman 1981).[4]

1. Margins are put up by clearing members with the clearing corporation. Margins are also put up by customers with their FCMs. There are separate guidelines for each type of margin.

2. The margin committee is made up of exchange members or representatives from member FCMs. An attempt is made to select people from a variety of interest groups.

3. Regulation 431.02 of the Board of Trade of the City of Chicago deals with clearinghouse margin requirements for clearing members. It is interesting to note that negotiable stocks and bonds that are free from liens can be posted but are valued at only 75% of their market value. U.S. Treasury notes and bonds having a maturity of greater than 3 years can also be posted but are valued, at most, at 80% of their market value.

4. Customers of FCMs have defaulted. There are no records of the level of customer defaults, but it is believed to be quite low (Federal Reserve Bank 1984, p. 8). Additionally, even after default an FCM may seek recourse in the courts.

III. Do Margin Requirements Increase the Cost of Trading?

There are various opinions on just what the opportunity cost associated with a futures transaction is. The views range from Black (1976), who believes that the opportunity cost is zero, to Dusak (1973), who calculates the opportunity cost as the full value of the contract to be bought or sold in the future.

Dusak assumes that the opportunity cost of taking a futures position is the full value of the contract. She states (1973, p. 1393), "The essential point is that buying a futures contract is like buying a capital asset on credit where the capital asset in this case happens to be the spot commodity." Investors then look at the full value of a contract (e.g., $25,000) as their liability and not at the margin (e.g., $2,000).

To justify his view, Black (1976) relies on the institutional feature of daily marking to the market. Because the clearinghouse debits and credits accounts daily, Black concludes that the value of the contract goes to zero because it is rewritten each day. This assumption is based on the notion that the margin account must remain at a certain level or the position is offset. It fails, however, to explain the costs associated with the initial margin. Other economists, including Anderson (1981), have dealt with this problem by pointing out that the initial margin can be satisfied by using interest-bearing Treasury bills. Therefore, the opportunity cost of posting the margin is zero since the customer receives the interest payments from his margin account. If either the Black view modified by Anderson or the Dusak view is correct, then altering the level of margin requirements will not affect the behavior of traders. This makes the regulation of margin requirements in order to reduce "excessive" speculation an irrelevant issue since margin levels are not a factor determining the individual demands for futures.

Telser (1981) and Telser and Yamey (1965) have approached the issue of the opportunity cost of investing in futures in a different way. This approach relates the opportunity cost to the level of margin demanded by the FCM. Even if the margin account is earning interest, the customer will react to the changes in the level of the margin requirement by altering his portfolio. Telser (1981, p. 235) states: "Treasury Bills are highly liquid assets that stand ready for use by the holder in case of emergency or to take advantage of profitable opportunities that may suddenly present themselves. They are part of the holder's precautionary balance. If he commits them for use as margin, they are unavailable for other uses. They are no longer part of his precautionary balance. Hence, the margin requirement surely imposes a cost on the investor."

This argument holds for firms as well as for individuals and is pertinent for both large and small traders. It says that investors can expect

to incur a cost if they are caught in an illiquid position. This expected cost and the risk associated with it must then be included as part of the investment opportunity set faced by a trader. When the margin level is changed, the risk-return trade-offs that are given to investors will change as well. The costs associated with the margin requirements need not be substantial to have important effects on trader behavior.

Implicit in Telser's argument is that Treasury bills that are free of liens are not the same as Treasury bills posted in a margin account. The lien-free Treasury bills serve many purposes and can easily be converted to cash if the trader is faced with an emergency or a profitable opportunity. On the other hand, there is some positive probability that an investor will not be able to convert quickly the Treasury bills in a margin account into cash. For example, should there be a series of price limit moves, the trader might not be able to exit the futures market and withdraw the Treasury bills from the margin account. In fact, if the price-limit moves have an adverse effect on the value of his position, the trader may be forced to post additional funds in cash.

To achieve greater insight into the concepts of expected liquidity cost and risk, the following example is offered. Assume that an individual trader holds $1 million of Treasury bills. He has satisfied his initial futures margin requirement by posting $500,000 in Treasury bills. For this example, let us assume that the investor can instantaneously convert his Treasury bills to cash so that he need hold no cash. Further, let us assume that there are 10 possible states of the world that may arise (e.g., medical emergency, house fire, auto accident, great investment opportunity, etc.). Each state will have its own associated probability. In five of these states of the world the trader can continue to hold his futures positions and use his lien-free Treasury bills to take care of his debts. However, in the five other states the trader will have to borrow if he desires to continue to hold his futures position. There will obviously be a cost associated with this borrowing in each state. There will be an expected cost of being caught short of funds equal to the cost associated with borrowing in each state times the probability that a given state appears.

If initial margin levels are increased by 50%, the trader will have to post $750,000 to continue to hold his futures positions. The amount of lien-free Treasury bills that he holds is now reduced, even though the trader's overall portfolio seems unchanged (i.e., $1 million in Treasury bills and some future positions). The allocation has changed, however. The number of states of the world in which the trader will have to borrow may increase (say from five to eight). This will, ceteris paribus, increase the expected costs and risks of being caught in an illiquid position. Therefore, we can see how changes in margin requirements will alter the trader's expected costs and risks.

In addition to the expected costs mentioned above, there are actual

transactions costs associated with posting margin and recomposing a portfolio. There are transactions costs associated with bid-ask spreads and transfer fees, as well as time costs. And, finally, there will most likely be a cost associated with an investor's desire to liquidate a futures position quickly. The investor will be forced to take the high end of the bid-ask range when going long or the low end when going short instead of waiting for a favorable price.[5] Further, if the trader's position is large enough and the maturity month or contract he is trading in is thinly traded, he may face an "execution cost" (Working 1960) associated with his ability to affect the market price. For example, if he must quickly sell a large position short to offset the long position he holds, he will probably have to reduce his ask price greatly and sell at a lower price than he might have been able to get had he more time to liquidate his position slowly.

Whether or not a trader holds a balance of cash- and/or lien-free Treasury bills in excess of his required margin, he faces liquidity risk and an expected liquidity cost. We can specify the ith individual's uncertain margin cost associated with his futures transactions as

$$|f_i|M_i \cdot L\tilde{C}_i,$$

where $f_i > 0$ means that the trader is net long f_i contracts; $f_i < 0$ means that the trader is net short; M_i is the fixed margin requirement per contract in dollars; and $L\tilde{C}_i$ is the uncertain liquidity cost in percentage terms should he be faced with unforeseen events and forced to borrow or liquidate his futures position.[6]

The individual trader will have an estimate of the expected liquidity cost and the distribution of possible outcomes. The expected cost includes both the actual transactions costs associated with margin accounts and the expected costs of being caught in an illiquid position. We can specify the expected value and the variance of $L\tilde{C}_i$ as

$$E(L\tilde{C}_i) = LC_i \geq 0$$

and

$$V(L\tilde{C}_i) = \sigma_i^2 > 0.$$

One would expect that, the higher the margin requirement, the higher is the LC_i; or, in the other words, as the proportion of Treasury bills in the margin account to Treasury bills free of liens grows, LC_i will grow. As this ratio approaches infinity (i.e., the trader holds no Treasury bills in excess of the margin requirement), then LC_i will approach $r_{Bi} - r_L$, where r_{Bi} is the individual's expected borrowing rate and r_L is

5. If he does not have an opportunity or time to search for the "best" price among all possible options, he will have to unload his position and reduce his expected return. This is a variant of Stigler (1961).

6. Throughout this paper, - denotes a random variable.

the risk-free Treasury bill lending rate.[7] In the case in which this ratio is infinite the trader would have to go to the credit market and borrow to replenish his Treasury bill account. To simplify the model that follows, a constant marginal expected liquidity cost shall be assumed. The addition of an increasing expected marginal liquidity cost adds little insight into the complicated effects that margin changes have on trader behavior.[8]

IV. The Demand for Contracts

To develop a model of trader behavior that includes the transactions costs associated with margins, an elementary model of expected utility maximization is used in which the utility function is exponential in total wealth. I assume that (*a*) traders are risk averse; (*b*) traders possess different information sets; (*c*) traders possess different abilities to filter or interpret information; (*d*) information possessed by individuals is not fully revealed in the market price for contracts when the trader trades; (*e*) traders possess different borrowing costs; (*f*) there are two periods and all decisions are made in the initial period at time zero; and (*g*) trader wealth is held in Treasury bills used to purchase the cash commodity or used to purchase futures positions. With these assumptions we can specify the *i*th individual's expected utility function as

$$E(\tilde{U}_i) = E(\tilde{W}_{i1}) - \left(\frac{1}{2}\right)A_i\, V(\tilde{W}_{i1}), \tag{1}$$

where A_i is the risk parameter of individual *i*; $A_i > 0$ implies a risk-averse individual; $E(\tilde{W}_{i1})$ is the expected period-1 wealth of individual *i*; and $V(\tilde{W}_{i1})$ is the variance of expected period-1 wealth of individual *i*. Uncertain terminal wealth for the *i*th trader can be specified as

$$\begin{aligned}\tilde{W}_{i1} = {} & \tilde{p}^s_1 y_{i0} - C(y_{i0}) + f_{i0}(\tilde{p}^f_1 - p^f_0) + |f_{i0}|M_i(1 + r_L - L\tilde{C}_i) \\ & + (W_{i0} - |f_{i0}|M_i)(1 + r_L),\end{aligned} \tag{2}$$

7. One can argue that, if we are in a world where the credit market is perfectly competitive, where transactions, monitoring, and bankruptcy costs are zero, and where banks are earning economic profits equal to zero, then the perceived borrowing rates of demanders of credit will be less than the actual borrowing rates that banks charge. In equilibrium, this perceived borrowing rate must be equal to the risk-free lending rate, or individuals and banks will be earning positive economic profits. The perceived borrowing rate is less than the actual rate because individuals realize that, if they are unable to pay back their loans, they can costlessly declare themselves insolvent. Obviously, the banks realize this and thus charge borrowing rates above lending rates. However, this zero transactions cost world is not the correct setting for my problem. Therefore, I posit that $r_{Bi} > r_L$ for all *i*.

8. Additionally, in a world with credit rationing the supply of credit would become inelastic at some point and $r_{Bi} - r_L$ grow larger. Whether $r_{Bi} - r_L$ becomes constant or goes toward infinity is an empirical issue and is not addressed in this paper.

where

W_{i0} = wealth set aside in period 0 to be invested at the risk-free lending rate, r_L;

y_{i0} = the amount of the commodity that the individual commits in period 0 to be purchased ($y_{i0} < 0$) or sold ($y_{i0} > 0$) in period 1 (note that there is no output uncertainty in this model);

$C(y_{i0})$ = net revenue or cost function;[9] $C_y > 0$ and $C_{yy} \geq 0$;

$\tilde{p}^f_1$ = the price in period 1 of a maturing futures contract purchased in period 0 (this is a random variable in period 0);

$\tilde{p}^s_1$ = the price in period 1 of the commodity purchased in the spot market (this is a random variable in period 0);

p^f_0 = the price in period 0 of a futures contract maturing in period 1; and

f_{i0} = number of futures contracts purchased ($f_{i0} > 0$) or sold ($f_{i0} < 0$) in period 0 by individual i.

This specification of terminal wealth allows for great flexibility in characterizing what type of trader the ith individual is (Anderson and Danthine 1981, pp. 1185–86).[10] The ith individual chooses y_{i0} and f_{i0} so as to maximize expected utililty. The first-order conditions are

$$p^s_{i1} - c_y - A_i(y_{i0}\sigma^2_{si} + f_{i0}\sigma_{sfi}) = 0 \tag{3}$$

if $f_{i0} > 0$:

$$p^f_{i1} - p^f_0 + M_i(1 + r_L - LC_i) - M_i(1 + r_L) - A_i(f_{i0}\sigma^2_{fi} + y_{i0}\sigma_{sfi} + M_i^2 f_{i0}\sigma^2_i) = 0 \tag{4a}$$

if $f_{i0} < 0$:

$$p^f_{i1} - p^f_0 - M_i(1 + r_L - LC_i) + M_i(1 + r_L) - A_i(f_{i0}\sigma^2_{fi} + y_{i0}\sigma_{sfi} + M_i^2 f_{i0}\sigma^2_i) = 0, \tag{4b}$$

where

$p^s_{i1} = E(\tilde{p}^s_{i1})$ = individual i's expectation of the period-1 spot price;

$p^f_{i1} = E(\tilde{p}^f_{i1})$ = individual i's expectation of the period-1 futures price;

$\sigma^2_{si} = V(\tilde{p}^s_{i1})$ = the variance of individual i's prediction error on the spot price or individual i's estimation of the distribution of the spot prices;

$\sigma^2_{fi} = V(\tilde{p}^f_{i1})$ = the variance of individual i's prediction error on the futures price or individual i's estima-

9. Note that this includes purchase costs ($C[y] > 0$) incurred in period 0 or revenues from merchandising agreements committed to in period 0 ($C[y] < 0$).

10. Further, the model allows for basis risk or $\tilde{p}^f_1 \neq \tilde{p}^s_1$.

tion of the distribution of the futures prices; and

$\sigma_{sfi} = \text{COV}(\tilde{p}^s_{i1}, \tilde{p}^f_{i1}) =$ the covariance of individual i's prediction errors on the spot and futures price or individual i's estimation of the covariation between spot and futures prices.

Since y_{i0} and f_{i0} are solved simultaneously, we can solve for $y_i^* = y_{i0}$ by substituting f_{i0} from equation (4a) or (4b) into equation (3) and setting expected marginal revenue equal to expected marginal cost (Hartzmark 1984).[11]

After solving for the ith individual's optimal cash position, y_i^*, we can substitute y_i^* into equations (4a) and (4b). With a little manipulation we can write the demand for futures contracts as

$$f_i^* = \frac{1}{A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)} [(p^f_{i1} - p^f_0) - A_i\, y_i^*\, \sigma_{sfi} - M_i LC_i] \quad (5a)$$

if $f_i^* > 0$ and as

$$f_i^* = \frac{1}{A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)} [(p^f_{i1} - p^f_0) - A_i\, y_i^*\, \sigma_{sfi} + M_i LC_i] \quad (5b)$$

if $f_i^* < 0$.

Combined, equations (5a) and (5b) result in a kinked demand curve for futures contracts. Actually, they represent two linear relationships between the contracts demanded (f_i^*) and the market price (p^f_0), with equation (5a) relevant for long positions and with equation (5b) relevant for short positions.

The demand equations can be decomposed into three components. The speculative component is related to the degree to which the trader's price expectation (p^f_{i1}) is greater or less than the market price (p^f_0). The hedge component is related to the quantity of the optimal cash commitment (y_i^*), the degree of risk aversion (A_i), and the estimation of the degree of covariation between the spot and futures prices (σ_{sfi}). Finally, the margin cost component is a function of the level of the required margin (M_i) as well as of the expected liquidity cost (LC_i). It is important to note that the absolute quantity of contracts demanded is reduced because of the uncertainty associated with the liquidity cost even if the expected liquidity costs are zero (i.e., $LC_i = 0$). This is made apparent with $M_i^2\sigma_i^2$ appearing in the denominator of the two demand equations. In summary, the equations show that margin requirements reduce the demand for futures contracts because of the expected cost as well as the additional risk.

11. Note that I have assumed that the covariances of LC_i with $\tilde{p}^f_{i1}$ and p^s_{i1} are zero; therefore, these terms do not appear in the first-order conditions.

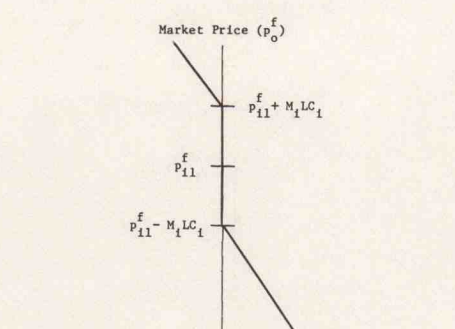

FIG. 1.—The demand for contracts by the *i*th individual

We can rewrite equations (5a) and (5b) as linear demand curves:

$$p^f_0 = \underbrace{(p^f_{i1} - A_i y^*_i \sigma_{sfi} \mp M_i LC_i)}_{\text{(intercept term)}} - \underbrace{f^*_i [A_i(\sigma^2_{fi} + M^2_i \sigma^2_i)]}_{\text{(slope term)}}. \quad (5c)$$

In figure 1, the relationship between the market price (p^f_0) and the quantity of contracts demanded (f^*_i) is shown graphically. In figure 1, it is assumed that $y^*_i = 0$, so that the trader is a pure speculator. In this case, there is a kink in the demand curve, or a region where the demand for contracts is zero, between ($p^f_{i1} - M_iLC_i$) and ($p^f_{i1} + M_iLC_i$). If the market price, p^f_0, is less than $p^f_{i1} - M_iLC_i$, the trader will take a long position, expecting that the contract price will rise over time. It is obvious that, the greater the level of the margin requirement or the greater the expected liquidity cost, the longer is the kink or price interval where the trader will remain out of the market. If $y^*_i \neq 0$, then the curves will shift up or down, depending on whether the trader is a long or short hedger.

There will be two cost effects when the margin level is changed. First, the expected cost is altered, and the length of the kink is changed. Second, the risks associated with being short of liquid funds is changed, and the slope of the demand curve changes. As shown in figure 2, if, ceteris paribus, margins are doubled, then the kink doubles in length. In addition, the slope increases in absolute magnitude by four times. This shows that people who are holding small positions feel the

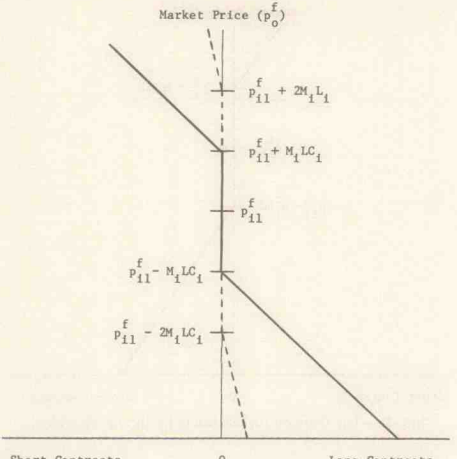

FIG. 2.—The shift in the demand for contracts by the ith individual when the margin level is doubled.

absolute effects of margin increases via the increase in the expected cost, while those who are holding large positions feel greater effects from the decreased liquidity and, thus, the increased liquidity risk. With an increase in the required margin, the trader will reduce his holdings and maybe even exit the market, even if his price expectations have not changed.

V. The Market (Excess) Demand for Contracts and the Market Clearing Price

In this section the excess demand curve for futures contracts is derived. We need only add the assumption that the futures market clears. In other words, the net position of all traders combined is zero. We shall assume that there are z different groups of traders. Within any one group there are n_i ($i = 1, 2, \ldots, z$) identical traders all with the same attributes (σ_{fi}^2, σ_{si}^2, σ_{sfi}, M_i, LC_i, and σ_i). Since all long positions have a corresponding short position, the market clearing equation can then be written as:

$$0 = \sum_{j=1}^{n_1} f_{1j} + \sum_{k=1}^{n_2} f_{2k} + \sum_{m=1}^{n_3} f_{3m} + \ldots + \sum_{v=1}^{n_z} f_{zv} \qquad (6a)$$

$$0 = n_1 f_1 + n_2 f_2 + n_3 f_3 + \ldots + n_z f_z. \tag{6b}$$

$$0 = \sum_{j=1}^{z} \frac{n_i}{A_i(\sigma_{fi}^2 + M_i^2\sigma_i^2)} [(p_{i1}^f - p_0^f) - A_i y_i^* \sigma_{sfi} \mp M_i LC_i]. \tag{7}$$

The market clearing price, p_0^f, can be solved from equation (7):

$$p_0^f = \sum_{i=1}^{z} \lambda_i [p_{i1}^f - A_i y_i^* \sigma_{sfi} \mp M_i LC_i], \tag{8}$$

where

$$\lambda_i = \frac{n_i}{A_i(\sigma_{fi}^2 + M_i\sigma_i^2)} \Big/ \sum_{i=1}^{z} \frac{n_i}{A_i(\sigma_{fi}^2 + M_i\sigma_i^2)}.$$

Equation (8) shows that the market price is a weighted average of each group's estimate of the period-1 futures price as well as a weighted average of the hedge ratios and margin costs. The weights take into account the group attributes, such as risk aversion, prediction ability, and size. It is interesting to note that the level of margin can directly affect the equilibrium futures price. Even if M_i and LC_i are the same for all i, the overall effect of including margin costs on the equilibrium futures price will not necessarily be zero. It will depend on the relative magnitude of $\Sigma\lambda_i$ for those with long positions as compared to $\Sigma\lambda_j$ for those traders with short positions. The overall effect will be equal to

$$[(M_i LC_i)] \left(\sum_{i=1}^{n} \lambda_i - \sum_{j=n+1}^{z} \lambda_j \right) \gtrless 0,$$

where there are $i = 1, \ldots, n$ traders with short positions and $j = n + 1, \ldots, z$ traders with long positions. If any or all of the cost components (i.e., M_i or LC_i) differ between groups, then the inclusion of margin costs will have a more complicated effect on the equilibrium futures price.

The results presented above are much easier to see and understand when viewed graphically. In figure 3, demand curves for two traders with different price expectations, p_{11}^f and p_{21}^f, are shown, along with a market (excess) demand curve. The two individual demand curves are aggregated to determine the market (excess) demand curve. The market clears and the market price is determined where excess demand is zero. If person 1 faces margin costs of M_1^1 (= $M_1 LC_1$) and person 2 faces margin costs of M_2^1 (= $M_2 LC_2$), then the market clears at price p_3 with person 1 holding f_3 long positions and person 2 holding f_3 short positions. If the margin level faced by person 1 is exogenously increased, the margin costs to that trader will rise to M_1^2, and certain portions of the market (excess) demand curve will shift. This results from the change in person 1's demand curve. In this case the price falls to p_4 and the number of open contracts falls to f_4. If margin levels are

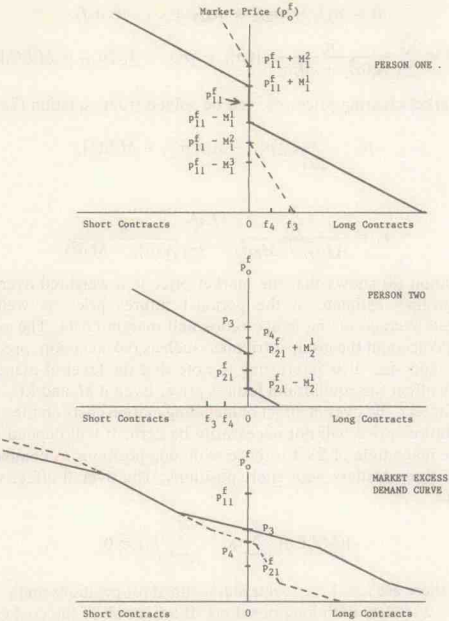

FIG. 3.—The derivation of the market (excess) demand curve

increased for both traders, there may be no change in the equilibrium price for contracts (this depends on a whole number of variables). There would, however, be an unambiguous decrease in the equilibrium number of open contracts.

In the case in which the vertical sections of each of the individuals' demand curves intersect, all trading ceases. For example, if person 1's margin is raised again to M^3_1, there will be no trading. In this case the market will clear at $p^f_{11} - M^3_1 = p^f_{21} + M^1_2$. At this price, neither trader desires to hold any long or short positions. Therefore, the figure shows how heavy margin costs may choke off trading. This is especially important in markets in which price expectations converge. Further, the higher the level of liquidity costs or the risk associated with having illiquid portfolios, the lower the margin levels must be to ensure that trading takes place.

Two important points should be made here. First, the traders with price expectations (p^f_{i1}) closest to the currently quoted market price (p^f_0) will, ceteris paribus, be the first to exit with any increase in margin requirements. This leaves only those traders with price expectations that diverge most from the market price remaining in the market. A market composed of only those traders with extreme price expectations might be less stable (Figlewski 1984). Second, those traders who have the highest margin costs will, ceteris paribus, feel the greatest effect of the margin increase. Which group of traders this might be is impossible to predict.

VI. Price Volatility

The volatility of the market price for contracts will be related to the variances of the prediction errors or abilities to estimate the futures price of the various groups of traders. Additionally, the volatility will be a function of margin costs. Assuming that there are no dependencies among the group errors, one can write the volatility of the market place (p^f_0) as

$$V_f = \lambda_1\sigma^2_{f1} + \lambda_2\sigma^2_{f2} + \lambda_3\sigma^2_{f3} + \ldots + \lambda_z\sigma^2_{fz}, \tag{9}$$

so that

$$V_f = g(n_1, \ldots, n_z;\ A_1, \ldots, A_z;\ \sigma^2_{f1}, \ldots, \sigma^2_{fz};\ M_1, \ldots, M_z;\ \sigma^2_1, \ldots, \sigma^2_z).$$

Therefore, the volatility is a weighted average of the variances of the individual prediction errors. If any of the n_i's change, it is likely that the price volatility will change as well.

Does this mean that if the most naive or uninformed traders with the highest variance are driven out of the market the price volatility will be reduced? Not necessarily. It is difficult to show mathematically but relatively easy to understand intuitively. If the withdrawal of the highest variance traders results in a change in p^f_0, some low-variance traders may leave as profit opportunities may be reduced for them. The realignment of the market and the changing numbers of traders within each group may result in more price volatility even though the highest variance traders have been driven out. By driving out certain traders the market price and the volatility of that price will change. However, because of the nature of trading in these markets, one cannot say a priori exactly what the direction of the effects will be. In fact, the effects might be offsetting, and there could be little or no change in price volatility.

In the example above, naive traders were simply forced out of the market. Determining the effects of changes in margin policy on exit and

entry of traders is even more complicated. If the margin is raised by the same amount for all traders, the effect will be felt differently across groups, depending on LC_i and f_i^*. Initially, the high cost traders will exit. However, this will have a feedback effect on the price level and the price volatility and may result in the departure of certain other groups of traders, depending on their price expectations, risk preferences, and costs. In the end we can predict that the weights, λ_i, will change; however, predicting the direction of the change will be impossible.

There will also be differing effects across groups because of differences in risk aversion. When the margin level is changed, individuals will respond by altering their investment portfolios. Whether the traders will substitute toward assets with less risk than futures contracts is difficult to predict. For example, if the margin level is raised, one would expect a substitution away from risky futures positions. However, if the trader's income elasticity with respect to risk is negative, this substitution effect may be overwhelmed by the income effect. The trader will sell off his risk-free assets to allow for the purchase or the continued holding of futures contracts. In this way the overall portfolio will include a greater proportion of risky assets.

Using a simple model of trader behavior, the effects of changing margin levels on contract demand, the price level, and price volatility have been shown. Because the market price and price volatility are a function of the relative magnitudes of the attributes of the different trader groups–and it is difficult to determine which groups will enter or exit the market when there is a margin change—it is impossible to determine the full effect of a margin change.

VII. Description of the Sample Used for Empirical Tests

In Section VIII, 13 unrelated margin level changes will be examined to determine the effect of these changes on the market activity, the composition of traders in market, and the price performance. These margin changes took place in four markets between July 1, 1977, and December 31, 1981. The markets analyzed include: (*a*) the Chicago Board of Trade (CBT) wheat market; (*b*) the CBT U.S. Treasury bond market; (*c*) the Chicago Mercantile Exchange (CME) pork bellies market; and (*d*) the CME feeder cattle market.

There are several reasons why this group of markets was chosen. First, data on the composition of traders was limited. Second, over the period for the market to be chosen there had to be a reasonable number of changes in margin requirements. And third, a variety of unrelated markets was desired.

Information on the individual episodes when margin requirements were changed is presented in table 1. Initial and maintenance margin

TABLE 1 Information on Margin Changes, July 1977–December 1981

Market and Effective Date	New Margin Level (in $)				Percent Change in Level				51-Trading-Day Interval	31-Trading-Day Interval
	Speculative		Hedge		Speculative		Hedge			
	Initial	Maintenance	Initial	Maintenance	Initial	Maintenance	Initial	Maintenance		
CBT wheat:										
October 20, 1977	1,000	600	600	600	−20	−20	−20	−20	September 15–November 25, 1977	September 29–November 10, 1977
June 21, 1979	1,250	750	750	750	25	25	25	25	May 16–July 27, 1979	May 31–July 13, 1979
January 11, 1980*	1,250	1,000	1,000	1,000	0	33	33	33	December 5, 1979–February 15, 1980	December 18, 1979–February 1, 1980
June 17, 1981	1,000	750	750	750	−20	−25	−25	−25	May 12–July 23, 1981	May 27–July 9, 1981
Feeder cattle:										
March 27, 1978	1,200	900	1,000	700	50	50	67	75	February 16–May 1, 1978	March 3–April 17, 1978
March 26, 1979	1,500	1,200	1,500	1,200	25	33	50	71	February 16–May 1, 1979	March 5–April 17, 1979
July 6, 1981	900	600	700	600	−40	−50	−53	−50	May 29–August 10, 1981	June 12–July 27, 1981
Pork bellies:										
March 27, 1978	1,500	1,000	1,200	900	25	11	0	0	February 16–May 1, 1978	March 3–April 17, 1978
August 23, 1978	1,500	1,000	1,500	1,000	0	0	25	11	July 19–September 28, 1978	August 2–September 14, 1978
June 25, 1979†	1,200	900	1,200	900	−20	−10	−20	−10	May 18–July 31, 1979	June 4–July 17, 1979
U.S. Treasury bonds:										
May 25, 1979‡	1,000	800	800	800	−20	−20	−20	−20	April 20–July 2, 1979	May 4–June 18, 1979
October 11, 1979§	1,500	1,250	1,250	1,250	50	56	56	56	September 6–December 3, 1979	September 20–November 16, 1979
October 16, 1979‖	1,000	800	800	800	−33	−36	−36	−36	. . .	. . .
October 23, 1979#	3,000	2,500	2,500	2,500	200	213	213	213	. . .	. . .
October 26, 1979**	2,000	1,600	1,600	1,600	−20	−20	−20	−20	. . .	. . .
February 26, 1980††	2,500	2,000	2,000	2,000	25	25	25	25	January 21–April 1, 1980	February 4–March 18, 1980
June 3, 1980	2,000	1,500	1,500	1,500	−20	−25	−25	−25	April 28–July 9, 1980	May 12–June 24, 1980

SOURCE.—Photocopied sheets given to me by CBT and CME economists.

* This margin change resulted from the grain embargo imposed on the Russians. The CBT wheat market was closed on January 7–8 and reopened on January 9, the date the market opened and closed down by the limit.

† These margins are for contracts trading in the new crop-year contracts. The old crop-year margins were increased to $1,000 and $700, respectively.

‡ Margins for the current delivery month were left at $1,250 and $1,000, respectively.

§ Variable margins are in effect that are equal to 150% of the original level. Because the period from October 11–October 26, 1979 was one of constant change, the 31- and 51-trading-day intervals are longer and are stated as if the 15-day period were one episode.

‖ Margins returned to their original level.

Margin levels were changed to $2,000 and $1,600, respectively. However, variable margins of $3,000 and $2,500 were immediately imposed. Current delivery month margins were set at $2,500 ($3,000) and $2,000 ($2,500) with the variable margin levels in parentheses.

** Margins returned to their original levels.

†† There were no longer any distinctions made for the current delivery month.

requirements for both speculators and hedgers are given in dollar amounts per contract. These amounts represent the minimum levels that FCMs must charge their customers. They are determined by the exchanges' margin committees. Percentage changes in the initial and the maintenance margin levels are given as well. These represent the dollar change in the margin requirement divided by the dollar amount of the margin prior to the change. For example, in the CBT wheat market the initial margin requirement for speculators was increased from $1,000 to $1,250 effective June 21, 1979. This represents a 25% increase in the initial margin requirement. In most cases the initial and the maintenance margin requirements changed by the same percentage.

Also given in table 1 are the inclusive dates for the 31- and 51-trading-day periods surrounding the effective date of change in the margin level.[12] For the statistical tests that will be presented, variables were constructed using one of these two time intervals. For example, the mean open interest was calculated 15 trading days prior to the margin change on October 20, 1977 (or from September 29, 1977, to October 19, 1977) and 15 trading days after this date (or from October 21, 1977, to November 10, 1977). For certain other calculations the 51-trading-day interval was used.

One should be aware that the effective date as presented in table 1 may not have been the actual date that traders were faced with higher margin requirements. Because FCMs can force customers to post sums that are greater than the exchange-determined margin requirements, traders may have been posting higher than minimally required levels before the effective date. The FCM officials with whom I spoke indicated that they often increased the margin levels they required of their customers in advance of the exchanges. Unfortunately, the only available historical information on margin changes comes from the exchanges.

After examining the *Wall Street Journal* during the days preceding the margin changes, it was concluded that most of the margin increases lagged the introduction of major new information. Additionally, very few margin increases were the result of a single event and were usually the culmination of a long period of uncertainty resulting in high price volatility. Margin decreases seemed exogenously determined. When margins were decreased, they came long after the event or events that led to the preceding margin increase. Further, margin decreases usually came in packages with margin changes for a number of unrelated commodities (i.e., the decrease in the margin for pork bellies was once announced at the same time as margin decreases for gold, deutsche marks, Swiss francs, and live cattle futures contracts). Exchange econ-

12. These intervals exclude weekends and holidays.

omists have indicated that this reduction in margin levels across the board is usually an attempt to gain customers or to increase volume by offering lower cost opportunities to trading. Therefore, one could conclude that these competitive reductions probably came from periodically scheduled margin committee meetings rather than from the special meetings arranged to deal with a crisis.

Except for the January 11, 1980, episode in the CBT wheat market and the October 1979 episode in the U.S. Treasury bond market, there were no other major events that could be associated with margin increases. The Soviet grain embargo was the event that led to the January 11, 1980, increase in margin requirements in the CBT wheat market. The October 1979 episode in the Treasury bond market was omitted because the various margin changes were interrelated and spanned such a long period that it would have been impossible to pinpoint the relevant event date to carry out a before-and-after comparison.

The increases in the requirements in the feeder cattle and the pork bellies markets that took place on March 27, 1978, may have resulted from the announcement of corrected slaughter estimates related to the two markets. However, the changes in these two markets were made along with a number of changes in other markets (i.e., gold, live cattle, live hogs, and skinned hams). This would suggest a more general, economywide event as the causal factor. The August 23, 1978, margin increase in the pork bellies market may have resulted from the announcement of studies linking nitrites to cancer. The March 26, 1979, margin increase in the feeder cattle market may have been due to unusual market conditions (i.e., high concentration of long positions). The June 21, 1979, margin increase in the CBT wheat market may have been due to the announcement of Soviet crop shortfalls. Other than these events, no other endogenous factors that would have led to margin changes were detected.

VIII. Effects of Margin Changes on the Market

A. Introduction

Using open interest, volume of trade, composition of traders, and price data we shall examine the effects of changes in margin requirements on the market. The theoretical model presented in this paper suggests that margin levels are directly related to market activity, the price level, and price volatility. The results, although not conclusive because of the small sample consisting of only 13 observations, indicate that margin changes do have a significant effect on the composition of and the activity in the market. In addition, there is little evidence supporting the assertion that margin changes have an effect on price performance.

The fact that there are significant changes in the composition of traders in the market without effects on prices would follow from a model in which the futures price is almost exclusively a function of the spot price as well as other exogenously determined variables (e.g., interest rates, cost of carry, and so on). In this case, participants in the futures market might be very sensitive to the margin level, while the price would be unrelated to the margin. Additionally, as the theoretical model suggested, insignificant price effects might be observed because of the offsetting effects of trader entry and exit when margin levels are changed.

One must not, however, assume that the insignificant effects on the price, observed from the relatively small margin changes examined, can be generalized to the large changes that might be imposed by an outside authority. In addition, the strong effects on composition and market activity would most likely be even more significant if margins rose from 5% to, say, 50%.

There is a problem that one must be aware of when viewing the empirical results. One can presume that the alterations in margin requirements resulted from changes in many internal factors in the market. This is especially true for margin increases. Because of this endogeneity issue, many of the variables presented in equations (5a) and (5b) may have changed concurrently with the margin level, M_i. For example, the announcement of a Soviet grain embargo could have changed price expectations as well as the estimates of the price variances and covariances. Therefore, volume, open interest, composition, and price volatility may have been affected independently of the change in the margin level. Even so, as was discussed above, most changes were not related to any major event.

B. Effects of Margin Changes on Market Activity

In table 2 market activity measures before and after the margin changes are presented. Because the theory does not distinguish between contracts about to expire and those with more time to maturity, open interest and volume across all maturity months were aggregated to get market totals. Additionally, this method of aggregation avoids problems with the normal life cycle patterns of any one contract where increases in open interest and volume are subsequently followed by decreases in market activity. Examining the graphs of open interest and volume (which do not appear in this paper), it does not appear as though seasonal influences affected any of the empirical results.

Also included in table 2 are the percentages of open contracts that were held by reporting commercial and noncommercial traders in long, short, and spread positions. Traders were defined as commercial if their line of business was directly related to the underlying commodity. A more detailed description of how these categories were derived is given in Hartzmark (1984, p. 117).

TABLE 2 Market Activity Measures Averaged for 15 Trading Days before and after Margin Changes

Market and Episode	Open Interest ($\times 10^3$)			Volume ($\times 10^3$)			Commercial Percent						Noncommercial Percent					
							Gross Long		Gross Short		Spread		Gross Long		Gross Short		Spread	
	Before	After	t-stat	Before	After	t-stat	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
CBT wheat:																		
October 20, 1977*	247.98	250.56	−1.33	33.60	39.10	−1.41	.51	.48	.59	.58	.15	.15	.22	.23	.22	.22	.13	.15
June 21, 1979	204.20	251.21	−4.65	79.06	96.75	−1.91	.35	.42	.50	.52	.17	.16	.28	.22	.20	.17	.13	.12
January 11, 1980	277.21	253.69	3.24	96.18	104.34	−1.00	.24	.35	.43	.47	.11	.11	.22	.21	.19	.15	.14	.11
June 17, 1981*	260.76	279.88	−3.98	81.19	132.12	−4.11	.49	.46	.27	.30	.16	.17	.10	.12	.22	.24	.08	.10
Feeder cattle:																		
March 27, 1978	16.55	16.76	−1.04	2.45	1.87	2.24	.22	.23	.25	.20	.04	.03	.39	.37	.05	.06	.03	.03
March 26, 1979	26.03	23.48	4.65	5.31	5.17	.29	.28	.28	.17	.19	.06	.07	.39	.33	.18	.17	.14	.11
July 6, 1981*	9.29	10.70	−4.65	2.00	2.57	−2.03	.29	.36	.16	.19	.04	.05	.11	.11	.24	.26	.07	.06
Pork bellies:																		
March 27, 1978	9.69	10.16	−1.45	6.74	7.04	.00	.05	.06	.11	.19	.05	.06	.31	.27	.22	.26	.09	.10
August 23, 1978	7.42	7.88	−2.36	3.82	4.11	−.79	.02	.02	.15	.12	.01	.01	.30	.29	.34	.33	.14	.09
June 25, 1979*	17.85	23.94	−4.65	7.24	7.57	−.71	.02	.03	.17	.12	.02	.03	.18	.19	.37	.40	.08	.09
U.S. Treasury bonds:																		
May 25, 1979*	48.30	55.46	−4.65	7.68	8.22	−.75	.30	.28	.32	.37	.23	.23	.49	.44	.44	.38	.39	.34
February 26, 1980	68.80	61.13	4.48	17.06	15.56	1.04	.14	.14	.18	.20	.11	.11	.51	.50	.49	.45	.40	.38
June 3, 1980*	82.96	83.08	.00	22.89	26.91	−2.20	.16	.19	.27	.26	.14	.15	.42	.42	.38	.38	.34	.33

NOTE.—Asterisks denote margin decrease; otherwise, margin was increased.

In the theoretical model presented in the previous sections it was shown that when margin levels are raised (lowered) the number of open contracts falls (rises). The relationship between margin changes and volume changes was not discussed in the theoretical model. Margins are paid on positions held, not on those traded. Therefore, if most of the volume in a market is the result of scalping or of day trading, one would not expect to see a large change in volume before and after the event. However, at the "margin," volume and open interest in any one market are related in the longer term so that one would expect that an increase (decrease) in the margin level would lead to a reduction (increase) in the volume of trade. In the short term, however, margin changes in any direction should be positively related to volume. This is because volume and changes in open interest should be directly related.

In table 2 the average total volume and open interest for 15 trading days before the effective date and for 15 trading days after are presented. A nonparametric test called the Wilcoxon rank-sum test was used to determine whether there was a significant difference between the averages in each of the two periods.[13] The Wilcoxon test is appropriate when the underlying distribution of the variable is unknown, as it is for most of the variables used here. The *t*-statistic presented in table 2 represents a level of statistical significance and is comparable to the *t*-statistic presented when the underlying distribution is assumed to be normal.

Open interest. The results for open interest indicate that, in those seven of nine cases where the *t*-statistics are significant at the 1% level, the predicted inverse relationship between open interest and margin changes exists. Leaving aside the statistical significance, one observes that in nine of 13 cases the average open interest moves in the correctly predicted inverse direction. The probability of such an event appearing randomly is 13.3%.[14]

Another way to analyze this relationship is to examine margin decreases only. These would seem to hold everything else constant since these changes appear to be unrelated to any endogenous event in the particular market. Additionally, remember that FCMs are allowed to set margin requirements above the exchange-determined levels but not below. When exchanges increase margin requirements, there may be little effect (at the effective date) since FCMs may have preempted the

13. For a description of exactly how this test is performed, see Conover (1980, pp. 280–92).

14. We can look at this like flipping a coin. There is a probability of .133 of getting nine heads (correct predictions) in 13 tosses. For 13 of 13 the probability is .0001, for 12 of 13 (.002), for 11 of 13 (.011), for 10 of 13 (.046), for nine of 13 (.133), and for eight of 13 (.290).

exchange requirement. This will not be the case for margin decreases, as the FCMs cannot reduce levels below those specified by the exchanges. For each of the six times that margins were decreased, average open interest increased. In four of these cases the average open interest, after the margin reduction, was significantly greater than before.

Tomek (1985) uses a different technique on a much larger sample to examine the relationship between margin changes and open interest. In his sample he had 111 margin increases. He found that of the 51 increases that had accompanied significant changes in open interest, 30 were correctly predicted and 21 incorrectly predicted. In only 51% of the 111 increases did Tomek observe the correctly predicted change in open interest.

Observing margin decreases, Tomek observed more favorable results. Of the 47 cases when a change in open interest was significantly related to the margin change, 30 were correctly predicted and 17 incorrectly predicted. In 62% of the 101 decreases Tomek observed the correctly predicted change in open interest. Even though the sample size is larger than the one used in this paper, the results offer less support for the theory.

Volume. For the volume measure, in nine of 13 cases there is no significant change between the before and after periods. However, in all four cases when the *t*-statistics are significant at the 5% level, the sign is correctly predicted. In addition, when examining movements of the averages (leaving aside the significance measures) one finds that in nine of 13 cases the correct prediction is made (i.e., volume and margin levels are inversely related). For the six margin decreases, volume increased all six times (significantly three times). This supports the longer term hypothesis that margin changes and volume will be inversely related. Tomek's (1985) results relating volume and margin changes show, for the most part, only a weak relationship.

Group shares. Commercial and noncommercial shares of total open interest are also presented in table 2. The theory would suggest that, under normal circumstances, the cost effect would lead to a relative reduction (increase) in the positions held by higher cost traders when margin requirements for all traders are increased (decreased). One might assume that the commercial traders have relatively lower margin costs than their noncommercial counterparts. Since commercial traders face lower margin levels and may also face lower expected liquidity costs (since they may be partially or completely hedged), this assumption certainly seems plausible.

For the noncommercial traders (in this case assumed to be the relatively high cost traders) in the 11 cases in which there is some notice-

able change in the long (short) share, the share moves in the inversely predicted direction 10 (eight) times. For the commercial (assumed to be lower cost) traders, margin increases (decreases) result in increased (decreased) shares in seven of ten cases for the long share and in eight of 13 for the short share.

Overall, the open interest, volume, and share results indicate that changing margins does alter market activity. In addition, some of the most significant changes come when margins are reduced. Combined, this is strong evidence that margins do impose costs on traders and thus that changing margin levels will affect trader behavior and the likelihood of trader participation in the market.

C. *Effects of Margin Changes on the Composition of Traders*

The model presented in the earlier sections indicated that changes in margin levels would effect different types of traders to varying degrees. The normal cost effect led to the exit of higher cost traders when margin requirements were increased. It is commonly asserted that the small, uninformed speculator will be the first to exit the market when margin levels are raised. Implicit in this assertion is that this group of traders has the highest costs and risks of transacting. This assumption is behind the policy recommendation that increased margin requirements should be used to reduce the excessive speculation that leads to destabilizing price fluctuations. In this section, we seek to determine empirically which traders are high cost and which are low cost or whether costs vary at all.

In table 3, three measures of relative trader participation are used to demonstrate whether there is a statistically significant relationship between changes in margin requirements and trader participation. These include the NONCOMMERCIAL index, the SUCCESS index, and the SIZE index. These composition indices are averaged 15 trading days before and 15 trading days after the margin changes. The *t*-statistics are used to determine whether the two means differ and are derived from the Wilcoxon rank-sum test. A standard deviation for each index is also presented. In general, these indicate that all the composition indices were quite stable over each 15-trading-day period.

The NONCOMMERCIAL index is a variation on the speculative index developed by Working (1960). Working's index was developed to measure the degree of excess speculative (noncommercial) activity. "Excessive" was defined as the amount above that which was needed to offset net hedger (commercial) positions.

The SUCCESS index was derived by taking the total long and short contracts (net of spreading) held by large traders who earned positive dollar profits over the full 4½-year period and dividing this sum by the total long and short contracts (net of spreading) held by those large traders who, at the end of the 4½ years, were in the red on their futures

TABLE 3 **Composition Indices Averaged for 15 Trading Days before and after Margin Changes**

Market and Episode	NONCOMMERCIAL Index			SUCCESS Index			SIZE Index		
	Before	After	*t*-stat	Before	After	*t*-stat	Before	After	*t*-stat
CBT wheat:									
October 20, 1977*	1.45	1.49	−1.87	1.25	1.43	−4.27	.77	.75	3.73
	(.02)	(.05)		(.10)	(.04)		(.01)	(.01)	
June 21, 1979	2.05	1.77	3.94	1.57	2.55	−4.65	.66	.66	−.29
	(.09)	(.13)		(.11)	(.30)		(.01)	(.01)	
January 11, 1980	2.35	1.93	4.32	2.37	1.60	4.37	.54	.59	−4.27
	(.11)	(.08)		(.23)	(.08)		(.01)	(.01)	
June 17, 1981*	2.45	2.49	−1.53	2.62	1.45	4.56	.54	.55	−1.53
	(.09)	(.21)		(.15)	(.53)		(.02)	(.32)	
Feeder cattle:									
March 27, 1978	2.97	3.08	−1.24	2.11	2.42	−4.56	.46	.43	2.36
	(.21)	(.07)		(.10)	(.14)		(.03)	(.00)	
March 26, 1979	3.09	3.07	.21	1.68	1.24	4.65	.51	.48	3.73
	(.05)	(.10)		(.22)	(.08)		(.02)	(.01)	
July 6, 1981*	3.09	2.60	4.23	1.21	1.13	2.53	.40	.46	−4.56
	(.18)	(.07)		(.11)	(.08)		(.02)	(.01)	
Pork bellies:									
March 27, 1978	18.38	7.22	4.60	1.35	1.86	−3.73	.35	.39	−4.31
	(8.74)	(1.11)		(.15)	(.34)		(.01)	(.02)	
August 23, 1978	6.87	9.19	−4.36	2.79	1.91	4.02	.40	.38	2.74
	(1.06)	(.67)		(.58)	(.19)		(.02)	(.01)	
June 25, 1979*	7.16	10.86	−4.65	3.55	2.96	3.65	.37	.37	.00
	(1.41)	(.52)		(.40)	(.12)		(.01)	(.01)	
U.S. Treasury bonds:									
May 25, 1979*	2.83	2.94	2.08	1.22	1.62	−4.31	.77	.73	4.65
	(.18)	(.12)		(.13)	(.20)		(.01)	(.02)	
February 26, 1980	5.94	5.38	2.99	.95	.72	4.60	.66	.64	2.45
	(.55)	(.49)		(.08)	(.06)		(.01)	(.01)	
June 3, 1980*	4.33	4.18	1.41	1.37	1.23	3.11	.61	.62	−3.69
	(.27)	(.26)		(.09)	(.11)		(.01)	(.01)	

NOTE.—Asterisks denote margin decrease; otherwise, margin was raised. Standard deviations are in parentheses.

transactions.[15] One can think of this ratio in one of two ways—either as the ratio of informed (successful) traders to those who were uninformed (failures) or as the ratio of lucky (winning) to unlucky (losing) traders.

The SIZE index is derived by adding together the gross long and short positions of all commercial and noncommercial reporting (large) traders and dividing the sum by twice the open interest. This index measures the degree of concentration of large traders. The residual of the denominator minus the numerator is equal to the total long and short positions held by nonreporting traders.

The NONCOMMERCIAL index is defined as

$$= 1 + \frac{NC_L}{C_L + C_S}, \quad \text{if } C_S > C_L,$$

$$= 1 + \frac{NC_S}{C_L + C_S}, \quad \text{if } C_L \geq C_S,$$

where NC_L is the long contracts held by reporting noncommercial traders and all nonreporting traders; NC_S is the short contracts held by noncommercial traders and all nonreporting traders; C_L is the long contracts held by commercial traders; and C_S is the short contracts held by commercial traders (note that spread positions are subtracted from the gross long and short positions).

An example of how this index is calculated will show its range from 1 to ∞. Assume that there are 100 open contracts. If commercial traders hold 100 long and 100 short positions, then the index equals one (since $C_L = 100$, $C_S = 100$, and $NC_L = NC_S = 0$). If commercial traders hold all 100 short positions and no long positions, then the index equals two. If the commercial traders hold 50 short positions and no long positions, then the index equals three. If there are no commercial traders in the market, the index equals infinity.

If speculators are the high cost traders, then one might expect that when margins are increased (decreased) the NONCOMMERCIAL index would fall (rise). Examining the movements of this index before and after the event (leaving aside statistical significance), one finds that this hypothesis is supported in only eight of 13 cases. In the eight cases in which the t-statistics are significant at a 5% level, there are only five cases that are correctly predicted. Three of these are for margin decreases. Needless to say, this is not strong support of the assertion that speculators are necessarily the high cost traders. In addition, since only eight of 13 events had significant changes before and after the margin change, the hypothesis that margin changes alter the composition of the market is not strongly supported.

15. These profits were calculated using daily reports on the positions of large traders. See Hartzmark 1984.

One interesting comparison of the movement of the NONCOMMERCIAL index, when only one of the two trader groups faces increased margin costs, can be observed by examining the March 25, 1978, and August 23, 1978, margin increases in the pork bellies market. On the first date, only the margin level for speculators (noncommercial traders) was increased. On the latter date, only the margin level for hedgers (commercial traders) was increased. The NONCOMMERCIAL index fell sharply after the first margin change and rose sharply after the second margin change. In both these cases the groups that faced the increased margin requirements reduced their relative positions. This is partial support for raising margin requirements to a target group should it be desirable to drive them out. Remember, however, that there is no guarantee that the target group will exit. Additionally, it is difficult correctly to identify the target group.

The results for the SUCCESS index indicate that for both margin increases and margin decreases there are significant changes (at the 2.5% level) from the period before the event to the period after. All 13 changes significantly differ from zero. In addition, all but one are significant at less than the 1% level. However, there is no systematic movement of the SUCCESS index that can be related to the direction of the margin change. What these results indicate is that margin changes influence the composition of the market; however, the full effects are impossible to predict a priori.

Examining the SIZE index, one observes significant changes (at the 2.5% level) before and after the event in 10 of 13 cases. Assuming that the large (small) traders are the relatively low (high) cost traders, the theory suggests that high (low) cost traders are more sensitive to margin increases (decreases). Unfortunately, either the assumption or the theory is faulty, as the empirical support is weak. The theory is supported in six of the 10 significant cases but in only six of the 13 cases in which statistical significance is disregarded. Again this indicates that there are significant effects on the composition of traders in the market when altering the margin levels; however, the ability to predict these effects is limited. Further, there is little evidence supporting the contention that margin increases will drive out the small speculators relative to all other traders.

D. Effects of Margin Changes on Price Volatility

In this section the relationship between changes in price volatility and changes in margin requirements is examined. In the theoretical model it was shown that price volatility was related to the weighted average of the variances of the traders' prediction errors. Therefore, as different traders enter and exit the market the price volatility should change. The theory suggests that, since we cannot determine which trader groups will exit (enter) when margin requirements are increased (de-

creased), the effect on the volatility of prices is indeterminate. Assuming that increased speculative activity leads to less stable prices and that speculators are the first to exit when margin requirements are increased, then one would expect that changes in margin requirements and price volatility are inversely related. Alternatively, if one expects that raising margin requirements will cause traders to exit, leading to a reduction in volume and a less liquid market, then greater price volatility will be observed when margin requirements are raised. Finally, even though traders are sensitive to changes in margin requirements, it may be the case that the connection between the futures price and the cash price is so tight that relatively small changes in margin requirements have undetectable effects on price volatility. In what follows, I shall attempt to determine if any of these statements are correct.

Because prices in general were trending up or down prior to the change in the margin requirement, price volatility and not the price level was examined.[16] Price volatility is calculated in two ways in table 4. First, volatility is measured as the 25-trading-day average of the square of the day-to-day change in the log of the closing price:[17]

$$\text{VOLATILITY} = \sum_{i=1}^{24} [\log(P_t) - \log(P_{t-1})]^2$$

Included as well is the open, high, low, and close (OHLC) volatility index, which utilizes information on opening, high, low, and closing prices. This index was derived by Garman and Klass (1980, p. 74) to serve as a more efficient measure of volatility by including more of the available information on prices than the close-to-close estimate. Its greater efficiency means that fewer days are needed to obtain a good estimate of the volatility. The OHLC volatility index is calculated using the following formula:

$$\text{OHLC} = 0.511\,(u - d)^2 - 0.019[c(u + d) - 2ud] - 0.383c^2,$$

where

$$u = \log(\text{HIGH}) - \log(\text{OPEN}),$$
$$d = \log(\text{LOW}) - \log(\text{OPEN}),$$
$$c = \log(\text{CLOSE}) - \log(\text{OPEN}).$$

This measure has an obvious defect for, if the market opens and closes up or down the limit (with the high and low prices equal to the opening price), OHLC equals zero. Fortunately, this was not a prob-

16. I used the prices for the contract closest to delivery unless part of the interval fell in the maturity month. If this were the case, I used the prices for the contract next closest to maturity.

17. I also performed the test for 15-trading-day intervals before and after the margin change. The results were almost identical.

TABLE 4 **Nearby Price Volatility Measures Averaged for 25 Trading Days before and after Margin Changes ($\times 10^{-4}$)**

	Absolute Price Changed Squared			OHLC Volatility Index		
Market and Episode	Before	After	*F*-stat	Before	After	*t*-stat
CBT wheat:						
October 20, 1977*	1.29	1.24	1.04	.81	.88	−.76
June 21, 1979	5.10	5.40	1.06	2.82	3.81	−1.55
January 11, 1980	1.86	2.20	1.18	1.10	2.31	−2.33
June 17, 1981*	.95	2.06	2.17	.72	1.35	−2.77
Feeder cattle:						
March 27, 1978	2.17	1.60	1.36	1.08	.95	.17
March 26, 1979	1.26	1.33	1.05	.71	.93	−1.16
July 6, 1981*	1.05	1.39	1.32	.68	.81	.19
Pork bellies:						
March 27, 1978	4.60	4.23	1.09	2.85	2.04	1.01
August 23, 1978	5.61	4.30	1.30	3.58	2.91	.37
June 25, 1979*	8.17	10.69	1.31	6.51	7.15	−1.28
U.S. Treasury bonds:						
May 25, 1979*	.12	.18	1.58	.06	.12	−3.74
February 26, 1980	2.56	2.63	1.03	1.61	2.15	−2.19
June 3, 1980*	1.66	1.32	1.26	1.34	1.32	−.35

NOTE.—Asterisks denote margin decrease; otherwise, margin was raised.

lem in the sample period. Garman and Klass (1980, p. 74) also derive a theoretical measure that combines both interday and intraday prices; however, the estimates I calculated using their formula appear incorrect, so I have omitted them from this study.

The *F*-statistics presented in table 4 indicate whether the ratios of the before and after mean squared absolute percentage changes in price are different from one. The *t*-statistics for the OHLC volatility index come from the Wilcoxon rank-sum test and are used to determine whether the before and after means are different. This nonparametric test was used because the distribution of OHLC has yet to be determined.

The results is table 4 indicate that there is little, if any, relationship between margin changes and price volatility. In only four of 13 cases is there a significant change in OHLC (at the 2.5% level). In only one of 13 cases is there a significant change (at the 5% level) in the squared absolute price change.

There is no support for any of the hypotheses that predict a systematic relationship between margin changes and price volatility. In only seven of 13 cases for the change in price and eight of 13 cases for the OHLC index does the mean volatility decrease (increase) when the margin is increased (decreased). Additionally, if one compares tables 3 and 4, they will be unable to find any significant relationship between changes in the relative proportions of different trader groups and changes in price volatility.

IX. Conclusion

In this paper a model of trader behavior was derived that demonstrates that the level of margin required of a trader plays an important role in the individual's investment decision. It was shown theoretically that margin levels play an important role in determining contract demand, the price level, and the volatility of prices. In the empirical section, changes in margin requirements were shown to affect only the activity in and the composition of the futures market. Therefore, at their present levels, margin requirements do not cut the strong link between the spot and the futures markets, and margin changes seem unrelated to price performance.

The empirical results also support the contention that margin requirements impose costs on traders. If margin levels were irrelevant to trader decisions, then changing them would have no effect on open interest, volume, and the composition of traders. Because they impose costs on traders, exchanges wish to keep them as low as possible to guarantee that the markets remain liquid.

Unfortunately, these results cannot be generalized to state that there is no level of margin (however high) that will have only minor effects on trading and price performance. In fact, the kinked demand curve demonstrates just the opposite. These markets are in a delicate balance, and margin changes affect overall activity. However, because changes in margin requirements may have offsetting effects on both the short and the long traders, the small margin changes examined here do not seem to significantly affect price performance. However, if margins are increased to very high levels, certain trader groups will be driven from the market, making the market thinner. This will result in a mix of trader groups that is less continuous in terms of price expectations. With the thinly traded market, margin changes might then cause drastic or discontinuous changes in the composition of the market with the result being less stable futures prices.[18]

Therefore, if futures margin requirements are increased by 900% (from 5% to 50%), there may be major effects on both composition and price performance when the margins are initially changed. Additionally, because of a thinner market, subsequent smaller changes in margin requirements may find their effects amplified.

Exchange officials are quick to point out that margin requirements are used as performance bonds only and that they are not utilized as a tool to alter the composition of the market (e.g., drive out certain groups like small speculators). This paper would support such an approach since it was shown both theoretically and empirically that a priori estimates of the effects of margin changes on composition are

18. Heal (1984), using a portfolio approach to modeling trader behavior, also shows that changes in margin can have discontinuous and destabilizing effects on futures prices.

equivalent to coin tossing. Therefore, margins should be used only as a mechanism to prevent trader default. They should be kept low enough so as not to inhibit trade. They are an inappropriate tool to drive out speculators who are supposedly causing unwarranted price fluctuations. If this action is desired by a regulator or an exchange, then direct action should be taken (e.g., liquidation-only orders, variable position limits, and so on).

Finally, it is important to understand that the margin changes, at least the increases, examined in this paper resulted from internal changes in the underlying conditions in the specific markets. A discussion of federal regulation of margin levels should focus on exogenous changes. These changes are made for reasons unrelated to changes in the conditions of the underlying commodity market. The purpose of these changes would most likely be related to general economic policy, such as selective credit controls, the fight against inflation, or the reduction in interest rates, to name a few. Even though the analysis above dealt with internally derived changes, the major implications are applicable to outside changes as well. Legislators must consider that outside changes might have significant effects in both the futures and the spot markets (where internally derived changes seem only to affect the futures market) and might lead to a disruption in the processes determining the prices in both markets.

Is any regulation of margin levels necessary? This paper suggests that regulation of margin levels to reduce excessive speculation is unnecessary and unwise. The issues remaining include the level playing field and cutthroat competition among the exchanges and the other financial institutions. These issues are dealt with in Figlewski (1984) and Hartzmark (1985). Overall, it seems clear that federal regulation of margin requirements is unnecessary.

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