The Relationship between Margin Changes and Volatility in Futures Markets

Ya Cai

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Signed by the final examining committee:

Rick Molz ________ Chair

Ravi Mateti ________ Examiner

Saif Ullah ________ Examiner

Latha Shanker ________ Thesis Supervisor

Approved by ______________________________

Graduate Program Director

______________2015 ________________________

Dean of School

Abstract

The Relationship between Margin Changes and Volatility in Futures Markets

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Traders in futures markets are required to deposit initial margin requirements for their open futures positions and maintain minimum margin requirements for these open positions. Futures exchanges set these margin requirements and require higher margin requirements for more volatile contracts. It has been argued that futures exchanges may use changing margin requirements to control the volatility of futures contracts and this question is still of interest. To address this question, I investigate the relationship between margin changes and futures price volatility for 24 different futures contracts, which include contracts on agricultural commodities, livestock, equity indices, interest rate and foreign currency. I provide evidence using univariate tests that the futures price volatility is significantly reduced following margin increases, while the futures price volatility increases but to a lesser extent following margin decreases. A regression analysis shows that larger margin changes have a greater negative effect on the futures price volatility. This relationship holds for the different futures contracts. Finally, it may be argued that margin requirements and futures price volatility are endogeneous variables. To address the potential presence of endogeneity, I employ the instrumental variables technique along with two stages least squares estimation and find that the inverse relationship between margin changes and volatility still holds.

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Contents

Chapter 1

1. Introduction

The margin requirement for a futures contract serves two purposes-it helps protect the integrity and reputation of the futures exchange, and it protects the broker from customer default. Normally in futures exchanges, the clearing house determines the "initial margin" , which is the margin that market participants must pay when they initiate their futures position with their clearing firm, as well as the "maintenance margin", the level at which market participants must maintain their margin over time. Specifically, if the balance of a trading account is lower than the maintenance margin, then a margin call will be issued and the customer is required to post an additional margin (variation margin) to bring the balance back to the initial margin level. Margins thus play an important role in guaranteeing contractual obligations by ensuring that both realized and potential losses will be covered. Furthermore, the existence of margins also decreases the likelihood of systemic instability (Longin 1999). Extreme volatility in futures market is a signal of high default risk and futures market instability. According to Hsiao and Shanker (2014), extreme volatility in futures markets may also lead to volatility in the underlying commodity market. Clearly, excessive volatility in futures market is undesirable. This raises the question of whether margin requirements can also be utilized to alter futures market volatility.

The Dodd–Frank Wall Street Reform and Consumer Protection Act that passed in 2010 gives the authority to the U.S. Commodity Futures Trading Commission (CFTC) to establish margin requirements for central clearing organizations in over-the-counter derivatives markets. This underscores the importance of margin requirements as an essential tool of derivatives exchanges.

In this paper, I investigate the relationship between margin changes and futures price volatility. The study of the effect of margin changes on price volatility is of interest for the following two reasons:

1. Whether margin requirements can be used as a tool to alter futures volatility is still under debate. Previous empirical results regarding the impact of margin changes on price volatility are mixed.
2. The effect is of interest to futures market regulators, who can take into account the effect of margin changes on price volatility when making margin change decisions, so as to supervise the futures markets in a more efficient way.

Previous empirical studies used limited data samples to examine the effects of margin requirements on futures price volatility, while I use a broader sample with 24 actively traded contracts and their corresponding latest margin change events.

I provide evidence using univariate tests that the futures price volatility is significantly reduced following margin increases, while the futures price volatility increases, but to a lesser extent, following margin decreases. A regression analysis indicates that larger margin changes have a greater negative effect on price volatility. This relationship holds for the different futures contracts. Finally, to address the potential effects of endogeneity, I employ an instrumental variables technique along with two stages least squares estimation and find that the inverse relationship between margin changes and futures price volatility still holds.

Chapter 2

2. Literature review

In this chapter, I review the research on margin requirements in futures markets under several heads. These are: 1) the function of margin requirements; 2) the determinants of margin requirements; 3) whether margin requirements affect futures trading cost; 4) whether margin requirements affect the composition of futures traders and futures price volatility.

2.1 The function of margin requirements

Initial margin requirements and subsequent variation margin payments are designed to guarantee that investors will perform according to the terms of the futures contract, that is, when there is a huge adverse price change in futures market, margins used as collateral can quickly cover the loss. According to Figlewski (1984), Kahl and Rutz (1985), Gay, Hunter and Kolb (1986), Hartzmark (1986), and Fenn and Kupiec (1993), margins set by futures exchanges are a payment that serves as a collateral deposit to reduce credit risk posed by customers. Telser (1981) asserts that it is more economical for the futures brokers to have deposits on hand in the form of margins that they can use to settle the amounts owed by their clients than to rely on legal proceedings to collect these amounts. Longin (1999) notes that the policy of requiring margin payments ensures the integrity of futures markets, as a high-level margin requirement protects brokers against insolvent customers and thus decreases default risk. He also notes that the existence of margins decreases the likelihood of brokers' bankruptcy and the systemic instability of the futures market. Fishe, Goldberg, Gosnell and Sinha (1990) explain that margin setting authorities can decrease the probability of trader default and market instability by increasing the level of margins. Abruzzo and Park (2014) state that initial or maintenance margins are collected to cover the potential future loss that may arise in futures price exchanges, whereas variation margins are collected to cover realized losses that have already occurred.

2.2 Determinants of margin requirements

Volatility is considered the most important determinant of margin requirements. For example, some authors, such as Figlewski (1984), Gay, Hunter, and Kolb (1986), and Fenn and Kupiec (1993), investigate models that suggest that margin levels are proportional to the level of past volatility in futures prices, while others, such as Cotter (2001) and Longin (1999), use extreme value theory to capture the use of the tails of historical futures return distributions in setting margin requirements.

Telser (1981) conducts an analysis of margin from the point of view of economic theory, and asserts that competition among brokers for customers is a process that determines the optimal margin. He constructs several thought experiments to conclude that even in an economy in which the government did not impose a minimum required margin and would allow the margin requirement to be zero, margin requirements would still exist as a result of the self-interest of market participants. Specifically, Telser (1981) notes that the size of margin requirement depends on the risk to the broker, and it changes in response to changes in this risk. When it becomes more likely that prices may change by large amounts during a trading session, brokers will require customers to post larger margins. Telser emphasizes that margin requirements are based on the volatility of prices over short periods rather than long periods. This is because the size of the margin depends on the maximum price change that may occur during that time in which the customer can decide whether to deposit more margin or just leave the market, and this time period is short. Longin (1999) develops a new method for setting the margin level based on "extreme value theory", and his extreme value model incorporates volatility and Value at Risk. Telser (1981) and Hunter (1986) propose an economic model in which the margin level is endogenously determined. Abruzzo and Park (2014) document that the competition between futures exchanges is also a cause of margin changes, as they find evidence that the difference in margin requirements imposed by the Chicago Mercantile Exchange Group (CME Group) and the Intercontinental Exchange (ICE) is an important driver of margin changes even after changes in other risk factors are accounted for.

2.3 Whether Margin requirements affect futures trading costs?

Before one can consider whether altering margin levels is an effective tool for reducing excessive speculation and hence stabilize volatility, one must understand the magnitude of trading costs associated with margin requirements.

There are various opinions on the relationship between margin requirements and the cost of trading. Dusak (1973) assumes that the opportunity cost associated with an open futures positions is the full value of the contract. According to Dusak, buying a futures contract is like buying a spot asset on credit, hence the liability is the full value of a contract rather than the margin. Black (1976), however, concludes that the opportunity cost/value of the contract goes to zero as the clearinghouse debits and credits accounts on a daily basis.

According to Telser and Yamey (1965), Figlewski (1984), and Tomek (1984), margin requirements pose a cost. Telser (1981) states that even if interest-bearing Treasury Bills are used to satisfy some of the margin requirements, the Treasury bills thus deposited are unavailable to be used to meet either emergency needs or profitable investment opportunities. Hence the margin requirement surely imposes a cost on the investor. Telser concludes that the margin requirement provides insurance coverage against loss to the broker but only partially and not completely. The greater is the size of the margin requirement, the smaller is the risk of loss to the broker, but the higher is the cost of trading to the customers of the brokers. Tomek （1984） also explains that even if the initial margin for futures position is in the form of an interest-bearing Treasury bill, margins still impose a cost on the investor. Figlewski （1984） states that higher initial margin means higher trading costs, which lead to less participation. Hartzmark (1986) notes that equal margin requirements do not necessarily imply equal margin costs across individual traders; as a result, the liquidity cost associated with margin requirements varies across traders. Furthermore, Hartzmark (1986) supports the contention that margin requirements impose costs on traders through his empirical results, since he finds significant changes in trading activity after margin increases. Hartzmark states that "If margin levels were irrelevant to trader decisions, then changing them would have no effect on open interest, volume, and the composition of traders. As they impose costs on traders, exchanges wish to keep them as low as possible to guarantee that the markets remain liquid." Longin (1999) states that the margin mechanism should be seen as a trade-off between margin committees, brokers and investors, since a high-level margin requirement imposes extra trading costs on investors at the same time. It is in the self-interest of the exchanges to keep margins at appropriate levels: high enough to maintain market integrity yet low enough to maintain market liquidity.

2.4 Whether Margin Requirements affect the composition of futures traders and futures price volatility?

According to Black (1986), Delong, Shleifer, Summers, and Waldmann (1990), Campbell and Kyle (1993), Campell, Ltttau, and Xu (2001) and Scheinkman and Xiong (2003), the noise/uninformed traders are the ones who exacerbate market price volatility. Hence, if the exchange wants to limit volatility in the futures market, it needs to drive these traders out of the market. However, Hartzmark's (1986) analysis shows that the effect of changes in margin requirements will vary across different traders. "Since investors have their own unique liquidity cost and risk preferences, one cannot say unequivocally that an across-the-board margin increase will drive out relatively more uninformed, undercapitalized traders than informed, low-probability-of-default traders. Hence it will be impossible to predict the extent to which different groups of traders will exit the market when faced with these changes." As a result, we do not know whether increasing margin requirements increases or reduces futures price volatility.

Previous empirical results regarding the impact of margin changes on price volatility are mixed. For example, Hardouvelis and Kim (1995), Chatrath, Adrangi and Allender (2001), Daskalaki and Skiadoopoulos (2012), report a positively significant relation between margin changes and price volatility, while Ma, Kao, and Frohlich (1993) examine the silver market and find a strong negative impact of margin changes on volatility across various subperiods. Further, Hsiao and Shanker (2014) study the effect and document a negative relationship between margin changes and volatility after taking into account the effect of price limits. Hartzmark (1986), Kupiec (1987), and Fishe, Goldberg, Gosnell, and Sinha (1990), however, do not find a consistent relationship between margin changes and price volatility.

Hartzmark's empirical results are based on only 13 margin requirement changes and suggest that margin levels are directly related to market activity, and the composition of traders. Specifically, if margins are increased to very high levels, certain trader groups will be driven from the market, making the market thinner. With a 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. On the other hand, if the margin change is small, "the effects of margin changes on composition are equivalent to coin tossing." Thus, the margin requirements should be used as performance bonds only.

As noted by Miller (1988), "driving major classes of users to seek alternatives to futures exchanges not only reduces the revenues of these exchanges but undermines the liquidity and market depth that is the very reason for their existence." Telser (1981) notes that, when margin requirements increase, assuming no change in the expected returns per unit of each asset, the effect is a reduction in the size of the open interest and in the volume of trade of that commodity. This is because, the higher margin induces higher trading costs, while higher trading costs in turn reduce the size of the open interest and the volume of trade. Whether the margin requirement increase reduces the futures price volatility depends on the nature of the forces that determine price volatility. Burghardt, and Kohn (1981) suggest, "Margin requirements even if it were desirable to constrain the behavior of financial market participants, it might do no good to try." Anderson (1981) addresses Telser's model and its applicability to reality. He notes that Telser's conclusion is somewhat wrong and the result of the positive relationship between margin requirements and the variance of futures prices is biased as the model is inaccurate. Garleanu and Pedersen (2011) assume that speculators are more sensitive than hedgers to changes in margin requirements. Similarly, Daskalaki and Skiadopoulos (2013) document that speculators decrease their open interest positions more than hedgers do when facing margin increases.

As reported by Hardouvelis and Kim (1995), margin changes affect the volume of trades. Chou, Wang and Wang (2014) examine the effects of margin changes on futures trading activity on the Taiwan Futures Exchange and find that margin increases reduce trading activity for all trader types. These results are consistent with the hypothesis that higher margins increase the costs of trading.

They also find that institutional traders are more sensitive to changes in margin requirements than individual traders. These findings suggest that raising margin requirements causes all types of traders to leave the market, but as institutional traders are more sensitive to such changes and are subsequently more likely to leave the market, thus markets are left with relatively more noise traders (individuals) and this in turn leads to greater price volatility and less market liquidity. These results imply that changing margin requirements is not an effective policy tool in limiting the trading activity of noise traders to reduce market volatility.

Chapter 3

3. Data

3.1 Futures contracts addressed

In this thesis, I examine the relationship between margin changes and volatility in futures markets. 24 actively traded futures contracts on the CME Group (Chicago Mercantile Exchange & Chicago Board of Trade) are studied. The sample covers four different asset classes, including agriculture, equity, interest rates and currency. The agriculture futures contracts include Corn Futures, Feeder Cattle Futures, Lean Hog Futures, Live Cattle Futures, Soybean Meal Futures, Soybean Oil Futures, Soybean Futures and Chicago SRW Wheat Futures; the equity futures contracts include the DJIA ($10) Futures, NASDAQ 100 Futures, Nikkei/USD Futures and S&P 500 Futures; the currency futures contracts include Australian Dollar Futures, British Pound Futures, Canadian Dollar Futures, Euro FX Futures, Japanese Yen Futures, New Zealand Dollar Futures, and Swiss Franc Futures; the interest rate futures contracts include 2-Year T-Note Futures, 5-Year T-Note Futures, 10-Year T-Note Futures, U.S. Treasury Bond Futures, and Ultra U.S. Treasury Bond Futures. I exclude Energy, Metal and Eurodollar contracts since the historical data on margin requirements changes from the CME Group for these contracts do not apply to all contract months, but are applicable to specific contracts in different tiers or with different expiry months, so it is extremely hard to calculate percentage margin changes for those contracts as one has to find the previous margin value for the specific contracts.

3.2 Historical data on margin requirements

The historical data on margin requirements available from the CME Group website starts on different dates for the various contracts included in the sample but extend through December 2014 for all contracts. Table 1 provides a list of the futures contracts included in the empirical test, the period for which margin requirement changes are provided and the corresponding number of changes in margin requirements. The historical data provides initial margin and maintenance margin for both speculators and hedgers. For speculators, the initial margin requirement would be a certain percent higher than the maintenance margin, while for hedgers the initial margin is the same as the maintenance margin. At the same time, the maintenance margin level for both speculators and hedgers is identical. The exchange sets the initial margin requirement for speculators a certain percent higher than that for hedger. This is rational as speculators normally pose higher default risk than hedgers. Telser (1981) explains the reasoning as follows: “a long hedger has a long futures position and a short spot position while a short hedger has the opposite. The prices of the commodities in which the hedger has long positions move in the same direction as the prices of the commodities in which he has short positions, there is an offsetting of the gains and losses on balance. As a result, the default risk of the hedger is lower than that of the speculator as speculators normally have naked positions.” The maintenance margin represents the minimum levels that the futures exchange and brokers must impose on their customers. These are determined by the futures clearing house.

I set a few rules to ensure that I collect comparable margins for each contract over time. For agriculture contracts, margins are differently set for new-crop and old-crop contracts, although these margins are rarely different. Due to the nature of the underlying product and the different times at which it is harvested, (for example the crop season for soybean meal usually goes from December to November of the next year), there is a different risk profile for the new crop versus the old crop due to differences in supply, weather, expected demand, etc. I choose to use the margin data when the margin levels for the new-crop and the old-crop are identical. If neither old- nor new-crop is specified, I still collect the margin data as in that case the margin level is effective for both the new-crop and the old-crop. For live cattle and feeder cattle contracts, margin requirements are different for delivery months and for other months. The delivery month margin requirement is only applicable to the contract with delivery month the same as the margin change month. For example, for the live cattle futures contract, on Jan 1st, 2000, when both delivery and other month margin requirements are provided, the delivery month margin requirement is only applied to the contract with a delivery month of January 2000, while the general margin requirement applies to the contracts with delivery in subsequent months. In this case, I collect the margin data when the margin level for the delivery month and other months are identical, similarly, if neither delivery nor other month is specified, I still record the data. I exclude changes in margin requirements which are too close (within 20 days), since overlapping time periods preceding and following margin changes may have confounding effects on the results. After cleaning the data in accordance with the above, 1040 margin requirement changes in total are obtained.

3.3 Futures price data

I obtain data on daily settlement prices, open interest, and trading volume for individual futures contracts from Thomson Reuters Datastream. Data are collected for each front month contract, which is the closest to delivery contract traded for each product at the time of a margin change, excluding contracts expiring within one month, or those with insufficient trading volume and open interest. The reasoning is that the closest to delivery contract is usually the most actively traded and liquid contract. I also examine contracts which are the second closest to delivery at the time of a margin requirement change and find insufficient trading activity for most of them.

Chapter 4

4. Hypothesis

Margin requirements are often viewed by regulators as an important policy tool to reduce excessive volatility and maintain stability. The hypotheses that I investigate are as follows.

Hypothesis 1: There should be a significant difference between the futures price volatility that follows the margin change from the futures price volatility that preceded the margin change. If the margin change is an increase in the margin, then the volatility should decrease, while if the margin change is a decrease in the margin, then the volatility should increase.

Hypothesis 2: Larger margin changes should be expected to produce greater effects on the futures price volatility.

The existing literature presents different views upon how margin requirements affect the composition of futures traders and thus affect futures price volatility. As noted by Hartzmark (1986), margin requirements pose a unique liquidity cost to traders. One cannot predict whether the traders who contribute to stabilizing or destabilizing the market volatility will leave. However, it is widely accepted by scholars that margin requirements do pose a cost to futures market customers. The higher the margin level, the higher the liquidity cost. The psychology effect of investors then may play a part in futures transactions. That is, customers, especially speculators, might be inclined to trade more cautiously, thus stabilizing volatility when margin requirements are higher. Speculators might be willing to trade more aggressively and destabilize volatility when only a small margin (cost) is required. This assumption is based on a mental accounting effect. The accounting effect might be amplified when the margin requirement changes by a considerable amount.

Hypothesis 3: The relationship between margin changes and the futures price volatility may differ for different asset classes of futures contracts.

Due to the different features of financial and non-financial assets, the level of margin requirements that affects volatility should differ for different asset classes of futures contracts. Financial asset are easier to get access to as there are broader markets for investing in financial assets, and hence investors can diversify these investments better. As a result, investors in financial futures contracts should be less sensitive to market adjustments (margin requirement changes) than investors in non-financial futures contracts.

Chapter 5

5. Estimators of variables

5.1 Estimate of the change in margin

Since in futures market the maintenance margin level for both speculators and hedgers is identical, for speculators, the initial margin requirement would be a certain percentage higher than the maintenance margin, and for hedgers, the initial margin requirement will be the same as the maintenance margin. In most cases, when the margin requirement changes, the initial margin for speculators, the initial margin for hedgers, the maintenance margin for speculators and the maintenance margin for hedgers, all change by the same percentage. For this reason, the empirical analysis that follows is based on initial margins only. Then, percentage changes in the initial margin levels are calculated. These represent the dollar change in the margin requirement divided by the dollar amount of the margin prior to the change. For example, for the CME S&P 500 futures contract the initial margin requirement for speculators was increased from \$22,275 to \$24,750 effective October 1, 2008. This represents an 11% increase in the initial margin requirement.

5.2 Estimators of the change in volatility

In this paper, I use two estimators of volatility, which I term volatility measure 1 and volatility measure 2. The first is called the Close-to-Close Volatility Estimator which is also known as the "classical" estimator. This estimator of volatility for day t, σ_t is the standard deviation of the previous N days' log returns on the futures contract.

$$\sigma_t = \sqrt{\frac{1}{N}\sum_{i=t-1}^{t-N}(x_i - \bar{x})^2} \tag{5.1}$$

where the log return xi is defined as:.

$$x_i = Ln\left(\frac{c_i}{c_{i-1}}\right) \quad (5.2)$$

where c_i is the futures contract's closing price on day i, and c_{i-1} is the futures contract's closing price on the previous day $i - 1$.

and $\bar{x} = Average\ (x_i)$ for the days t-1 through t-N.

Bennett and Gil (2012) note that, "The calculation for standard deviation calculates the deviation from the average log return (or drift). This average log return has to be estimated from the sample, which can cause problems if the return over the period sampled is very high or negative. As over the long term very high or negative returns are not realistic, the calculation of volatility can be corrupted by using the sample log return as the expected future return. For example, if an underlying rises 10% a day for 10 days, the volatility of the stock is zero (as there is zero deviation from the 10% average return). This is why volatility calculations are normally more reliable if a zero return is assumed." Based on the above explanation of Bennett and Gil, volatility measure 2 is the square root of the average of the past N squared log returns.

In order to test the robustness as well as the trend of the effect, I use three different values for N, 3 days, 5 days and 10 days and term the corresponding volatilities as 3-days-volatility, 5-days-volatility and 10-days-volatility. Suppose that day 0 is the day of the margin requirement change. For example, to estimate the 3-day volatility preceding the margin change I use days -1 to -3 and to estimate the volatility following the margin change I use days 0 through 2. The percentage change in the volatility is calculated as the difference between the volatility following the margin change and the volatility preceding the margin change as a percentage of the volatility which precedes the margin change.

5.3 Estimators of the change in market activity

The corresponding percentage change in market activity is estimated by two variables:

percentage change in the open interest and the percentage change in the trading volume change for the 3 horizons, 3 days, 5 days and 10 days.

5.4 Summary statistics on data used in the analysis

After merging the data on changes in the margin with the data on the changes in volatility, 839 valid observations are obtained. The summary statistics are reported in Table 2. This table shows the mean, median, minimum, maximum and standard deviation of the percentage change in margin, volatility, open interest and volume. The 3 day change is based on comparing the statistic for days 0 to 2 to that for days -1 to -3, The 5 day change is based on comparing the statistic for days 0 to 4 to that for days -1 to -5, The 10 day change is based on comparing the statistic for days 0 to 9 to that for days -1 to -10. Notice that volatility percentage change for short horizon is higher than that for long horizon in terms of means.

Chapter 6

6. Methodology and results of empirical tests.

6.1 Univariate analysis

Paired t-tests are used to verify if there is significant difference between the average futures price volatility preceding and following the change in margin. Table 3 shows the results. In what follows, I describe the results for: 1) All margin changes; 2) Margin increases; 3) Margin decreases.

6.1.1. All margin changes

In Table 3, panel 1, we can see that for the 3-day and 5-day intervals, the hypothesis that the average futures price volatility before and after the margin changes are equal is rejected at the 1% level for all the futures contracts combined.

6.1.2. Margin increases

For margin increases, both volatility measurements show very similar results. The volatility preceding the margin change is significantly higher than the volatility following the margin change for all three horizons. For example, with volatility measure 1, the mean differences for the 3-day volatility, 5-day volatility and 10-day volatility are 0.3506, 0.2372, and 0.0931 respectively. From the trend of the three numbers we can conclude that margin increases reduce volatility over a short horizon, and this effect gradually weakens as time passes.

6.1.3. Margin decreases

For margin decreases, the volatility change is ambiguous. For the volatility estimator 2, only the 10-day interval exhibits a statistically (5% level) significant volatility difference. For volatility measure 2, while both the 5-day and 10-day volatility differences are statistically significant, the magnitude of the differences are relatively small. Since the differences are negative, the conclusion is that margin decreases increase volatility, but to a lesser extent than margin increases decrease volatility. This result may partially explain Abruzzo and Park's (2014) results. They find that the CME Group raises margins quickly following volatility spikes but does not immediately lower margins following volatility declines. As compared to increasing margin, decreasing margin is a less effective way to affect futures price volatility, so there is no need to lower margin requirements immediately after experiencing volatility declines.

6.2 Multivariate analysis.

6.2.1. Regression analysis of the effect of the margin change

The univariate analysis does not differentiate among margin changes of different sizes. Larger margin changes should have a greater effect on the futures price volatility than smaller changes. The univariate analysis cannot also consider the simultaneous effect of other factors such as market activity upon the futures price volatility. To address these effects, the percentage change in the futures price volatility is regressed on the percentage change in margins and the percentage change in open interest, in accordance with equation 6.1, which follows.

$$\% \, change \, in \, volatility = \beta_0 + \beta_1 \% \, change \, in \, margin + \beta_2 \% \, change \, in \, open \, interest + \varepsilon \quad (6.1)$$

Where β_0, β_1 and β_2 are the coefficients of the regression, and ε represents the error term

Table 4 presents the results of the regression analysis.

The results are similar for both volatility estimates. For example, with volatility measure 1, the coefficients of the percentage change in the margin for 3-day volatility, 5-day volatility and 10-day volatility are -0.76585, -0.51041, and -0.37862 respectively, and are statistically significant at the 5%, 1% and 1% level, respectively. The negative sign indicates that when the margin requirement increases, the volatility declines. Also from the magnitude of the three numbers we conclude that the effect is stronger for shorter time intervals and weakens as time passes. The results are almost the same as when I substitute volume for open interest as the control variable, so I do not include those results in the table. I report t-statistics based on heteroskedasticity-adjusted standard errors throughout the analysis, since White's test indicates the presence of heteroscedasticity for all regressions.

6.2.2. Effect of the asset class

To study the relationship between changes in the margin requirement and changes in the futures price volatility for the different asset classes, I use two dummy variables, "Financial" and "Non-Financial", which assume values of zero or one under certain conditions, as explained in what follows.

$$\text{"Financial"} = \begin{cases} 1, \text{ if the futures contract is an equity, interest rate or currency futures contract} \\ 0, \text{ otherwise;} \end{cases}$$

$$\text{"Non-Financial"} = \begin{cases} 1, \text{ if the futures contract is an agriculture futures contract} \\ 0, \text{ otherwise;} \end{cases}$$

The regression model is described in equation 6.2 which follows:

$$\%\, change\ in\ volatility = \beta_0 + \beta_1 \% change\ in\ margin * Financial + \beta_2 \% change\ in\ margin * Non\text{-Financial} + \beta_3 \%\ change\ in\ open\ interest + \varepsilon \tag{6.2}$$

Where β_0, β_1, β_2 and β_3 are the coefficients of the regression and ε is the error term

The interaction terms "%change in margin*Financial" and "%change in margin*Non-Financial" are included to determine if the effect of the margin change differs by the underlying asset class.

Table 5 presents the results. The coefficients for the two interaction terms are negative, which indicates that the negative relationship between the change in the margin requirement and the change in the volatility holds for both types of futures contracts. However, in other respects, the results for the two volatility estimates exhibit somewhat different results. For volatility estimate 1, for both the 5-day volatility and 10-day volatility, the coefficients of the two interaction terms are statistically significant, with the effect of the margin change being higher for the non-financial asset class than for the financial asset class. This suggests that compared to financial futures contracts, margin increases for non-financial futures contracts decrease volatility more significantly. However this result does not hold for volatility estimate 2. The interaction of the Non-Financial dummy variable with the percentage change in margin is not significant for the 3-day and 5-day volatility changes. The coefficients of both interaction terms are statistically significant for the volatility estimate 2 for the 10-day volatility change, with the effect being smaller for the non-financial asset class than for the financial asset class.

Summing up, the negative relationship between changes in margin requirements and changes in volatility holds for both financial and non-financial futures contracts. The results are almost the same when I substitute volume for open interest as the control variable, so I do not include those results in the table.

6.2.3. Accounting for endogeneity in the changes in margin

According to Greene and William (2012), in a statistical model, a variable is said to be endogenous when there is a correlation between the variable and the error term. Two common causes of endogeneity are: 1) a loop of causality between the independent and dependent variables of a model; 2) an uncontrolled confounder causing both independent and dependent variables of a model. Endogeneity may cause spurious regression and thus induce false relationships. For example, in a simple supply and demand model, the price is endogenous as customers change their demand in response to price and producers change their price in response to demand. In this case, a simple linear regression model with price and demand may obtain a false result given the effect of a loop of causality.

In using an ordinary least squares regression analysis, an endogeneity issue might arise in analyzing the effect of margin changes on the futures price volatility, since futures exchanges increase margin requirements in response to increases in the futures price volatility.

To address the potential presence of endogeneity, I employ the instrumental variables technique and two stages least squares estimation. There are two criteria that a reasonable instrumental variable should satisfy. First, there should be a high correlation between the endogenous variable and the instrumental variable. Second, the correlation between the instrumental variable and the error term in the regression should be as small as possible.

I choose the 30-day volatility percentage change preceding the margin change as the instrumental variable, the volatility percentage change preceding the margin change is calculated as comparing the volatility for days -30 to -1 to that for days -60 to -31. This is for two reasons. 1) As margins in futures markets are set based on the historical futures price volatility, the higher is the volatility change in the two months preceding the margin requirement change, the greater should be the size of the change. 2) As a length of 30 days is comparatively large, the correlation between the 30-day volatility percentage change preceding the margin change and percentage change in volatility based on a much smaller interval should be small.

The two stage least-squares estimation is described by the following equations 6.3 and 6.4.

First stage:

$$Percentage\ change\ in\ margin = \beta_0 + \beta_1 Futures\ price\ volatility\ percentage\ change\ in\ the\ preceding\ 60\ days + \varepsilon \tag{6.3}$$

Where β_0 and β_1 are the coefficients of the regression, and ε is the error term

Second stage:

$$Percentage\ change\ in\ volatility = \beta_0 + \beta_1 Estimated\ percentage\ change\ in\ margin + \beta_2 Percentage\ change\ in\ open\ interest + \varepsilon \tag{6.4}$$

Where β_0, β_1, and β_2 are the coefficients of the regression, and ε is the error term

Table 6 provides the results. The results of the regression analysis for the first stage indicate that as expected, the margin requirement is set on the basis of historical volatility change and that this effect is positive and statistically significant. The estimated percentage change in margin requirements as estimated by the first stage regression analysis is used as the dependent variable in the second stage regression analysis. The results of table 6 indicate that the coefficients of the estimated percentage change in margin requirements are still statistically significant and negative. Thus, that the results indicate that the negative relationship between margin changes and futures price volatility still holds, even when the endogeneity of margin requirements is addressed.

Chapter 7

7 Conclusions

The Dodd–Frank Wall Street Reform and Consumer Protection Act was passed in 2010. One aspect of the act provides the U.S. Commodity Futures Trading Commission (CFTC) the authority to establish margin requirements for over-the-counter derivatives contracts cleared through central counterparties and underlines the importance of margin requirements as a tool that could be used by the exchanges to control volatility of derivatives instruments' prices. However, whether margin requirements can be utilized as a tool to alter the market volatility or they are used as performance bonds only is still controversial. To address this question, I investigate the relationship between margin changes and futures price volatility.

First, I provide evidence that the futures price volatility following margin increases is significantly reduced, while the effect of margin decreases on futures price volatility increases is much weaker. This may partially explain Abruzzo and Park's findings (2014), which show that, as compared to increasing margin, decreasing margin is a less effective way to affect futures market volatility, hence there is no need to lower margin requirement immediately after experiencing volatility declines. Second, my empirical results differentiate among margin changes by the size of the margin change and suggest that larger margin changes produce a greater effect on price volatility. Third, I study the relationship between margin and volatility changes for different underlying asset classes. I find that the negative relationship between margin requirements and volatility holds for both financial and non-financial futures contracts, and there is no indication that the relationship varies for different asset classes.

Lastly, I address the potential effect of endogeneity of changes in margin requirements by employing an instrumental variables technique and two stage least squares estimation and find that the negative relationship between changes in margin requirements and changes in the futures price volatility continues to exist.

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Appendix

Table 1: Futures contracts included in the empirical tests

This table reports the list of historical margins from CME Group. The margin data start on different dates for various contracts but end at December 2014 for all contracts. 24 actively traded futures contracts on the CME Group (Chicago Mercantile Exchange & Chicago Board of Trade) are studied. The sample covers four different asset classes, agriculture, equity, interest rates and currency.

Futures contract	Asset Class	Exchange	Period	Number of changes in margin requirements
Corn	Agriculture	CBOT	2003-2014	32
Feeder Cattle	Agriculture	CME	2003-2014	40
Lean Hog	Agriculture	CME	2003-2014	33
Live Cattle	Agriculture	CME	2003-2014	41
Soybean Meal	Agriculture	CBOT	2003-2014	37
Soybean Oil	Agriculture	CBOT	2003-2014	32
Soybean	Agriculture	CBOT	2003-2014	45
Chicago SRW Wheat	Agriculture	CBOT	2003-2014	40
DJIA ($10)	Equity	CBOT	2003-2014	17
NASDAQ 100	Equity	CME	2003-2014	25
Nikkei/USD	Equity	CME	2003-2014	5
S&P 500	Equity	CME	2003-2014	18
Australian Dollar	Currency	CME	2000-2014	51
British Pound	Currency	CME	2000-2014	47
Canadian Dollar	Currency	CME	2000-2014	53
Euro FX	Currency	CME	2000-2014	58
Japanese Yen	Currency	CME	2000-2014	48
New Zealand Dollar	Currency	CME	2000-2014	15
Swiss Franc	Currency	CME	2000-2014	52
2-Year T-Note	Interest rates	CBOT	2003-2014	24
5-Year T-Note	Interest rates	CBOT	2003-2014	37
10-Year T-Note	Interest rates	CBOT	2003-2014	41
U.S. Treasury Bond	Interest rates	CBOT	2003-2014	45
Ultra U.S. Treasury Bond	Interest rates	CBOT	2008-2014	3

Table 2: Summary statistics on the variables used in the analysis

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Percentage change in		N	Mean %	Median %	Minimum %	Maximum %	Standard Deviation %
Margin (%)		839	3.39	5.88	-56.77	124.07	20.49
Volatility measure 1	10 day change	839	4.13	-3.21	-68.06	196.42	39.29
	5 day change	839	7.90	-4.36	-85.38	628.87	64.84
	3 day change	839	21.24	-11.85	-94.87	936.49	185.56
Volatility measure 2	10 day change	839	6.19	-2.48	-75.95	260.95	44.24
	5 day change	839	12.82	-4.30	-86.32	696.99	74.28
	3 day change	839	54.87	-11.72	-98.87	1593.23	328.76
Open Interest	10 day change	839	163.94	5.89	-51.36	4868.43	700.91
	5 day change	839	45.73	3.07	-32.67	1133.18	181.03
	3 day change	839	19.86	1.77	-28.52	568.05	81.76
	10 day change	839	385.79	6.50	-84.35	11319.70	2048
Volume	5 day change	839	159.37	3.00	-85.00	2133.00	2308.00
	3 day change	839	40.18	-1.00	-90.00	994.00	181.34

Table 3: Comparison of the futures price volatility preceding and following the change in the margin

	Average 10 day volatility			Average 5 day volatility			Average 3 day volatility		
	Preceding Margin change	Following Margin change	Difference/ t statistic	Preceding Margin change	Following Margin change	Difference/ t statistic	Preceding Margin change	Following Margin change	Difference/ t statistic
Panel A: All margin changes (839)									
Volatility Estimate 1	1.1145	1.0918	-0.0227	1.1512	1.0484	-0.1028***	1.1668	0.9965	-0.1704***
			(-1.21)			(-4.02)			(-5.44)
Volatility Estimate 2	1.1034	1.0909	-0.0125	1.1398	1.0374	-0.1024***	1.1397	0.9704	-0.1693***
			(-0.65)			(-3.66)			(-4.69)
Panel B: Margin increases alone (436)									
Volatility Estimate 1	1.3897	1.2966	-0.0931***	1.4863	1.2492	-0.2372***	1.5334	1.1829	-0.3506***
			(-2.97)			(-5.53)			(-6.69)
Volatility Estimate 1	1.3709	1.2996	-0.0712**	1.4609	1.2353	-0.2257***	1.4743	1.1565	-0.3178***
			(-2.22)			(-4.76)			(-5.22)
Panel C: Margin decreases alone (403)									
Volatility Estimate 1	0.8167	0.8703	0.0536***	0.7886	0.8311	0.0425*	0.7702	0.7948	0.0246
			(2.9)			(1.75)			(0.84)
Volatility Estimate 1	0.8140	0.8650	0.0510**	0.7925	0.8234	0.0310	0.7776	0.7690	-0.0086
			(2.58)			(1.19)			(-0.25)

Note * statistically significant at the 10% level, ** statistically significant at the 5% level, *** statistically significant at the 1% level

Table 4: Results of the regression analysis of the percentage change in the volatility on the percentage change in the margin and the percentage change in the open interest

	Coefficient/t statistic					
	Dependent variable					
	Percentage change in volatility estimate 1			Percentage change in volatility estimate 2		
Independent variable	10 day	5 day	3 day	10 day	5 day	3 day
Percentage change in the margin	-0.3786***	-0.5104***	-0.7659**	-0.3471***	-0.4439***	-1.3130**
	(-5.82)	(-4.72)	(-2.45)	(-4.71)	(-3.56)	(-2.37)
Percentage change in the open interest	-0.0013	-0.0164	-0.0742	-0.0022	-0.0111	-0.0893
	(-0.69)	(-1.34)	(-0.95)	(-1.03)	(-0.78)	(-0.64)
Intercept	5.6280***	10.3754***	25.3061***	7.7250***	14.8291***	61.0850***
	(4.06)	(4.48)	(3.79)	(4.91)	(5.56)	(5.16)
Number of Observations	839	839	839	839	839	839

Note * statistically significant at the 10% level, ** statistically significant at the 5% level, *** statistically significant at the 1% level

Table 5: The effect of asset class upon the relationship between changes in margin requirements and changes in volatility

	Volatility Measure 1			Volatility Measure 2		
Independent variable	10 day	5 day	3 day	10 day	5 day	3 day
% change in margin requirement*Financial	-0.3548***	-0.5099***	-1.0050**	-0.3534***	-0.5100***	-1.8722**
	(-4.10)	(-3.54)	(-2.42)	(-3.61)	(-3.08)	(-2.54)
%change in margin requirement*Non-Financial	-0.4090***	-0.5111***	-0.4623	-0.3390***	-0.3601**	-0.6032
	(-4.20)	(-3.16)	(-0.99)	(-3.07)	(-1.93)	(-0.73)
%Change in open interest	-0.0013	-0.0164	-0.0762	-0.0022	-0.0114	-0.0938
	(-0.68)	(-1.33)	(-0.97)	(-1.03)	(-0.80)	(-0.68)
Intercept	5.6193***	10.3751***	25.4087***	7.7273***	14.8591***	61.3249***
	(4.05)	(4.48)	(3.81)	(4.91)	(5.56)	(5.18)
Number of Observations	839	839	839	839	839	839

Note * statistically significant at the 10% level, ** statistically significant at the 5% level, *** statistically significant at the 1% level

Table 6: Results of the two-stage least squares analysis of the relationship between changes in margin requirements and changes in the futures price volatility

	Coefficients/t statistics			
	Dependent variable			
	First Stage	Second Stage		
	Percentage change in margin	Percentage change in volatility		
Independent variable		10 day	5 day	3 day
	Coefficient/t statistic	Coefficient/t statistic	Coefficient/t statistic	Coefficient/t statistic
Futures price volatility percentage change preceding margin change	0.0545***			
	(12.54)			
Percentage change in margin		-0.9996***	-1.3763***	-1.9856**
		(-5.81)	(-4.88)	(-2.51)
Percentage change in open interest		-0.0010	-0.0152	-0.0720
		(-0.50)	(-1.20)	(-0.91)
Intercept	-0.0263	7.6791***	13.2556***	29.3941***
	(-0.04)	(4.93)	(5.17)	(4.09)
Number of Observations	839	839	839	839

Note * statistically significant at the 10% level, ** statistically significant at the 5% level, *** statistically significant at the 1% level