Price Limits and Margin Requirements in Futures Markets

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Abstract

This paper investigates the hypothesis that futures exchanges could use daily price limits as a substitute for higher margin requirements. The empirical results show that the size of margin is negatively correlated with the presence of price limits. Evidence points to the portfolio adjustment costs theory as an explanation of the benefits from price limits. The empirical results cast doubt on the notion that price limits should be abolished. The results also confirm that exchanges have set margin requirements according to economic theories.

Keywords: margin, price limits, futures markets

JEL-Classifications: G10/G18

1. Introduction

Organized markets for futures trading in the U.S. impose limits on daily price movements. The daily price limits rule prohibits traders from buying contracts at a

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price above the daily upper limit price or selling contracts at a price below the lower limit price. This rule is controversial because it is a price control scheme and could hinder the process of price discovery.¹

One focal point in the controversy is whether price limits affect margin levels. There are two contrasting views. Telser (1981) argues that price limits should have no effect on margin levels. That is, price limits merely delay the equilibrium prices from prevailing in the market. Such a delay will not lower the default risk of positions by individual traders. In his view, prudent futures exchanges and brokers will still demand a margin large enough to protect themselves from default risk as if price limits were not imposed.

In contrast, Brennan (1986) presents a substitution theory. According to this theory, the true price is unobservable when price limits prevent trading from taking place, which in turn creates a problem for the losing party in projecting his true losses. A losing party will have fewer incentives to default he is not sure about his true losses. As a result, a reduction in anticipated default rates could allow futures exchanges to lower margin requirements. In this sense, price limits can substitute for a higher margin level. Other models are also presented with similar predictions.²

In this paper, I test the effect of price limits on margin levels for two reasons. First, it can help resolve the theoretical debate on whether price limits can reduce margin requirements as predicted in Brennan (1986). Second, it can shed light on the public policy debate about price limits. In practice, some small traders argue that the Commodity Futures Trading Commission (CFTC), the federal regulator of futures trading, should impose price limits on futures trading. These small traders claim that removal of price limits would increase their trading cost. They also argue that an increase in margin could give an edge to big traders, because small players presumably cannot afford to post Treasury bills to meet margin requirements.

On the other side of the debate, institutional investors oppose price limits.³ They not only question the effects of price limits on margin requirements, but also argue that price limits will severely hurt market liquidity. Thus, there is considerable public policy debate and its outcome will have serious implications on trading activities and market efficiency.

The research in this paper is the first in using exchanges’ data on margin and price limits to test whether price limits have any effect on margin requirements. The

¹ Kim and Rhee (1997), and Chen (1998) present evidence that price limits hinder the process of price discovery. Also see Ma, Rao, and Sears (1989), Lauterbach and Ben-Zion (1993), Kodres and O’Brien (1994), and Subrahmanyan (1994).

² See the models by Chowdhry and Nanda (1998), and Chou, Lin, and Yu (2000).

³ For example, Wall Street Journal (June 1, 1987, p. 1) reports that “small investors will also be affected, traders said. Daily price limits were in part intended to allow such investors to participate in the market by limiting their losses on any given day. But big players felt these rules limited their potential gains and ability to get in or out of the market.”
empirical results show that margin levels are negatively related to price limits. In addition, my results also indicate that information about future price movements, as measured by the correlation coefficient between daily changes in cash prices and futures prices, is an important factor. Although my results support the substitution hypothesis of price limits, further tests fail to show any evidence that such a substitution effect can be achieved only if price limits are set to be smaller than margin. The liquidity argument in Bernanke (1990) and Greenwald and Stein (1988) is provided as a potential explanation for the substitution effect of price limits.

The remainder of the paper is organized as follows. Section 2 reviews the history of the price limits rule and the institutional framework of setting margin requirements in futures markets. Section 3 formulates a testable hypothesis and outlines the testing procedure. Section 4 discusses data and presents empirical results. Summary and implications of the findings are in the concluding section.

2. Margin requirements and daily price limits in futures markets

2.1. Margin requirements

At the center of modern futures trading stands the futures exchange’s clearinghouse. The clearinghouse guarantees that every contract will be honored. Each trader settles directly with the clearinghouse. Therefore, individual buyers and sellers need not be concerned with the credit quality of the counter party. The clearinghouse and its members all wish to maintain market integrity and the reputation of being able to honor any futures contract. It is in the interest of each member that there is no default by any member of the clearinghouse.

However, as the guarantor, the futures clearinghouse exposes itself to the default risk from customers as well as the moral hazard problem from member firms. For example, knowing that other members will bail him out, an individual member could have an incentive to take excessive risk. Or member firms might be tempted to compete for more orders by reducing their protection against a customer’s credit history. Therefore, the clearinghouse sets up rules and standards for its members and monitors the members closely to protect itself as well as the market integrity.

One of the rules is the margin requirement. Margin essentially acts as performance bond. The level of margin set by the clearinghouse is the minimum level that applies to every member firm. Individual member firms can ask certain customers for additional margins. Margin requirements are different for different trading strategies. For example, margin requirements are considerably lower for hedging positions than for speculative positions. Unlike the stock exchanges, which lost their control over

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4 Markham (1987) shows that margin requirements have been an integral part of the modern futures trading from the very beginning. For the purpose of margin, also see Telser (1981), and Kahl, Rutz, and Sinquefield (1985).
margin policy to the Federal Reserve Board in the 1930s, the futures industry has always retained the complete control of margin policy.

2.2. The daily price limits rule

The daily price limits rule restricts the amount by which today’s price for a contract can differ from yesterday’s settlement price. Limit prices are set symmetrically at a fixed dollar amount above and below the previous settlement price. No trading is allowed beyond the price range set by the upper and lower limit prices. In most cases, trading comes to a halt when the limit prices are hit. In some cases, price rebounds from the limit price and trading resumes. A variation of the normal daily price limits rule, the variable price limits rule stipulates that daily price limits should be expanded automatically after a contract closes at the limit price for several consecutive trading days. The scale of expansion is set at 50%. Normal limit level is restored on the next trading day if the market does not close at the expanded limit price. During the expansion periods, exchanges can increase margin requirements by the same scale that they expand limit levels.

Compared with margin requirements, the daily price limits rule is a relatively new feature in organized markets for futures trading in the United States. During World War I, daily price limits were first imposed on cotton, oats, and soybean oil futures contracts. In April 1925, under pressure from the Department of Agriculture, the Chicago Board of Trade (CBOT) adopted a rule to set price limits on grain contracts in emergency situations. After the market crash in 1929, there was heavy political pressure for more regulation in the security and commodity futures industries. In October 1935, the CBOT responded to this pressure by passing a resolution to impose price limits on all futures contracts. Since the number of people who lost money in futures trading was far smaller than those who lost money in stock markets, these rules helped futures exchanges avoid the fate of the stock exchanges.

In 1974, Congress enacted the Commodity Futures Trading Commission Act. Regulatory power on futures trading was transferred from the Department of Agriculture to the newly created Commodity Futures Trading Commission (CFTC). Individual exchanges have the discretion to change margin requirements temporarily, but any permanent change in the price limits has to be approved by the CFTC. Table 1 provides summary information about margin and daily price limits for five futures contracts.

Table 1 shows that futures exchanges frequently adjust margin requirements, although the clearinghouses rarely change the level of price limits for most contracts. Any permanent change in price limits has to be approved by the Commissioners of

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5 For many contracts, Chen (1998) shows that there is a 60% chance that trading will come to a complete halt for the rest of the session after limit prices are first hit.

6 See Markham (1987) and Moser (1990).
Table 1

**Summary contract information**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Exchanges</th>
<th>Sample Period</th>
<th>Daily Price Limits</th>
<th>Number of Changes in Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Pound</td>
<td>CME&lt;sup&gt;a&lt;/sup&gt;</td>
<td>February 1985–March 1994</td>
<td>Re-imposed&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30</td>
</tr>
<tr>
<td>Copper</td>
<td>COMEX&lt;sup&gt;c&lt;/sup&gt;</td>
<td>January 1980–December 1989</td>
<td>Re-imposed</td>
<td>46</td>
</tr>
<tr>
<td>Deutsche mark</td>
<td>CME</td>
<td>February 1985–March 1994</td>
<td>Re-imposed&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26</td>
</tr>
<tr>
<td>Gold</td>
<td>COMEX</td>
<td>January 1980–March 1994</td>
<td>Re-imposed</td>
<td>85</td>
</tr>
<tr>
<td>S&amp;P 500 index</td>
<td>CME</td>
<td>February 1982–March 1994</td>
<td>Imposed</td>
<td>18</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chicago Mercantile Exchange.

<sup>b</sup> Price limits are removed for the last half hour of trading.

<sup>c</sup> Commodity Exchange.

<sup>d</sup> I exclude those margin changes that happen within 20 days after the previous change. The number of excluded changes is less than 10% of the total observations.

the CFTC. The U.S. Senate must confirm these commissioners and senators from the Midwest farming states have a considerable influence over the commissioners.<sup>7</sup> Commissioners will often vote for changes in price limits when there is a change in public opinion for more or less government regulation. For example, price limits were imposed on almost all actively traded futures contracts before 1980, but in the early 1980s the trend reversed toward removing price limits. For example, price limits on interest rate, currency, and stock index futures contracts were removed. This trend reversed again after the market crash in 1987 as a result of public outcry for curbing speculation. Price limits were imposed on the index futures contracts. Currently, most futures contracts have price limits. Some economists consider this evidence that futures exchanges merely use price limits as a bargaining chip with the government to preserve their independence from government intervention (Miller, 1989; Moser, 1997).

Although it shows no direct support for the political motivation story of price limits, the evidence in Table 1 does show that daily price limits and margin requirements are not affected by a common set of factors and that they are not simultaneously determined. It is a difficult and time-consuming process to change price limits because of hearing and debate procedures at the CFTC. Nevertheless, it is possible that regulatory and public perceptions of price limits are an integral part of the constraints under which private exchanges decide on margin requirements. The remaining question is whether or not the price limits have any effect on private exchanges regarding the level of margin requirements, as predicted in Brennan (1986).

<sup>7</sup> See Romano (1997) for an analysis of the political nature of regulation of commodity trading.
3. Hypotheses formulation and testing procedures

Telser (1981) regards it as natural that price limits are imposed. He argued that it is desirable to halt trading when a big price swing occurs. Acknowledging that brokers can consult with customers for further direction during the halt, he nevertheless notes that price limits will not change the risk of underlying positions. Consequently, he predicted that price limits will not affect margin levels.

In contrast, Brennan (1986) presents a theory that price limits can be used as a substitute for margin. According to his substitution theory, price limits will make it more difficult for a losing party to project his true losses. The less certain he is about his true losses, the less incentive he will have to default on his position. Such a decrease in the expected default rates would put downward pressure on margin.

Subrahmanyan (1994) discusses both the benefits and costs of the circuit breaker system, which resembles the price limits rules in many aspects. He shows that rules such as price limits can increase price volatility. In a different model, Kodres and O’Brien (1994) show that price limits can be effective in reducing transaction risk in stock markets. Harris (1998) provides a survey of literature on regulatory schemes such as price limits and trading halts. More recently, Chowdhry and Nanda (1998) shows that price limits can supplement margin requirements by reducing price volatility and stabilizing prices. Chou, Lin, and Yu (2000) develop a two-period model of price limits. Their model shows that even when traders receive no additional information, price limits can reduce the margin requirements. Price limits can also eliminate the default probability, though at the expense of a higher liquidity cost due to trading interruptions. When traders receive additional signals, the effect from price limits on margin levels diminishes. However, despite these theoretical models, there is no empirical study on this substitution hypothesis of price limits.

There is an extensive body of literature on setting margin requirements in both stocks and futures markets. For futures markets, researchers have shown theoretically that margin levels are determined by the default risk. In practice, exchange officials also suggest other factors including price level, trading volume, open interest, price limits, and other circumstantial factors. Previous empirical studies by Kuhn (1974), Telser and Higginbotham (1977), Fishe, Goldberg, Gosnell, andSinka (1990), and Goldberg and Hachey (1992) find the following:

P1. Margin is positively correlated with price volatility.

P2. Margin is positively correlated with price levels for some agricultural commodity futures contracts, but not for foreign exchange futures contracts.

P3. Margin is positively correlated with trading volume for some futures contracts.

P4. Margin is negatively correlated with open interest for some contracts.

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8 See, for example, studies byHardouvelis (1990), and Hsieh and Miller (1990) for stock markets, and Telser and Higginbotham (1977), Telser (1981), Figlewski (1984), Gay, Hunter and Kolb (1986), Hunter (1986), and Fishe and Goldberg (1986) for futures markets.
Based on these theoretical and empirical studies, I hypothesize that margin levels are determined by five variables, namely, price variability, price level, open interest, trading volume, and price limits. I use the ratio of the dollar amount of minimum regulatory margin over the contract value as the dependent variable. In essence, I use contract value to standardize the margin. Equation 1 represents a regression model in which I measure the effect of price limits through a dummy variable, which takes a value of one if price limits are imposed, and zero otherwise.

\[
\text{Ratio}_{it} = \alpha + \beta \text{Volatility}_{it} + \theta \text{Interest}_{it} + \gamma \text{Volume}_{it} + \lambda \text{Limit}_{it} + \varepsilon_{it} \tag{1}
\]

where:

- \(i, t\) represent individual contract and time period, respectively
- Ratio = (Margin/Value)
- Margin = margin level before the change
- Value = contract value
- Volatility = price variability
- Interest = open interest
- Volume = trading volume
- Limit = dummy variable for price limits, which takes a value of one if price limit are imposed, and zero otherwise

As discussed in the previous section, exchanges cannot rely on price limits as a flexible risk management tool because they cannot afford to go through the political process needed to deal with dynamic market situations that require immediate action. Hence, I take price limit as an exogenous variable that is beyond the control of private exchanges and determined by the external political process. Therefore, there is no endogeneity problem in Equation 1.

There are several testable hypotheses. For example, I can test if margin requirements are positively related to price volatility. Telser (1981) argues that higher price volatility increases the default risk. Therefore, I would expect a positive relation between the ratio and price volatility. I do not make predictions for the signs for other variables such as volume and open interest since results in previous studies are mixed. My main task is to determine whether or not price limits have any effect on margin requirements. The no substitution hypothesis of price limits is that price limits have no effect on margin levels, i.e., \(H_0: \lambda = 0; H_1: \lambda \neq 0\)

Equation 1 presents a cross-section and time-series regression. Table 1 shows that the small number of observations makes it less meaningful to do a separate regression analysis for individual contracts. As a result, I pool all observations and conduct ordinary least squares (OLS) estimation. On the other hand, copper and gold futures contract have 46 and 85 observations, respectively. I perform OLS estimation...

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\(^9\)The main conclusions stay the same when the dollar amount of margin is used as the dependent variable and the contract value is added as an independent variable. The results are available from the author on request.
for copper and gold separately. In Equation 1, I assume that the constant term is the same for all contracts. There can be variations across contracts, which I will show later. Since the number of contracts is only five, I use the least squares dummy variable model (LSDV) to control for individual effects in the pooled regression.

Equation 1 does not directly test the substitution theory of price limits for two reasons. First, it does not take into consideration whether or not price limits are binding. Brennan (1986) suggests that price limits are non-binding if the margin is smaller than the limit level. That is, price limits cannot enforce the honoring of a contract if the losing party knows that his losses exceed the margin. Second, Equation 1 fails to include a variable that accounts for the information argument. That is, Brennan (1986) argues that a losing party in futures trading could use the changes in cash prices to project his losses in futures trading, if there exists a strong correlation between the price changes in cash and futures markets. For example, Brennan argues that currency futures markets have active cash markets in the sense that correlation between changes in cash and futures prices is extremely strong. In this case, Brennan suggests that price limits should be abolished since price limits are less effective in enforcing the honoring of futures contracts. I use Equation 2 to directly test the substitution theory of price limits.

\[
\text{Ratio}_{it} = \alpha + \phi \text{Inf}_{it} + \beta \text{Volatility}_{it} + \theta \text{Interest}_{it} + \\
+ \gamma \text{Volume}_{it} + \lambda \text{Limit-B}_{it} + \epsilon_{it} 
\]  

To account for the information factor, I add a new variable–Inf, which is the correlation coefficient between changes in cash prices and changes in futures prices. I also add to Equation 2 the new variable limit-B, which takes a value of one if the limit level is smaller than margin, and zero otherwise.

According to Brennan (1986), I would expect a positive coefficient between margin and the information variable, and a negative one between margin and the adjusted dummy variable. Therefore, the null hypotheses to be tested are \( \phi = 0 \) and \( \lambda = 0 \).

4. Data and empirical results

4.1. Data

I obtain daily data from the Futures Industry Institute (FII) for five futures contracts. The sample period is from 1980 to 1994, except for the copper contract data series that ends in 1989. I also obtained from the FII the margin levels and specific dates of margin changes and price limits changes.

The daily data set contains opening prices, high (low) prices, settlement prices, open interest, and trading volume. For each commodity, three types of contracts are usually traded simultaneously. The first is the expiring contract that is in the delivery month. The second is the nearby contract that has the next nearest delivery dates. The third kind is the more distant contracts. Price changes from all three kinds of contracts are highly correlated.
Earlier studies generally use prices from the nearby contracts, because trading is more active on the nearby contracts than on the other two types of contracts. Since all contracts have expiration dates, researchers compile price series by joining contracts with different maturity months. To avoid any spillover from the expiration effect, they join prices from nearby contracts some time before the delivery month. For example, Karpoff (1988) switches to the next nearby contract one month before the maturity month. Chang, Chou, and Nelling (2000), and Chatrath, Liang, and Song (1997) cut off right before the delivery month. In this study, prices from nearby contracts are compiled two weeks before the delivery month.\(^\text{10}\) Daily closing prices are not available and are thus replaced by settlement prices.

Previous studies on setting margin requirements such as those by Fishe, Goldberg, Gosnell, and Sinka (1990), and Goldberg and Hachey (1992) focus on the maintenance margin for speculative positions, since these speculative positions present the greatest risk to the clearinghouse. I too use the maintenance margin for speculative positions in this study. The sample period varies among contracts because of the different original trading dates and availability of information on the price limits. Table 1 presents summary information for the five futures contracts.

I use the event study methodology to sample the variables in Equation 1. That is, I identify any change in margin as an event. To ensure that variables such as price volatility are meaningful, I measure all independent variables within a window period of 20 trading days before the event dates of margin changes. This period provides a more accurate representation of the conditions under which a particular margin value is regarded as appropriate.\(^\text{11}\) Therefore, the amount of margin in my analysis is the margin level prior to the margin change. I exclude those margin changes with fewer trading days in between. Consequently, the margin changes under the variable price limits rule are always excluded from the sample.\(^\text{12}\)

Trading volume is the average daily volume during each window period. I measure the average contract value by multiplying the underlying unit of the contract by the daily average unit price during each window period. I perform a logarithm transformation for both volume and open interest data, since they are more right skewed.\(^\text{13}\)

\(^{10}\) Although not reported here, the results remain unchanged when prices are cut off one week, instead of two weeks, before the delivery month.

\(^{11}\) This length of time is also used in previous studies such as Fishe, Goldberg, Gosnell, and Sinka (1990), and Goldberg and Hachey (1992).

\(^{12}\) Because I join contracts with different maturity months, a jump in the data could create bias if I join contracts during these 20 days. As a result, I exclude 15 observations because of the joining of different contracts. They are 7 for copper, 7 for gold, and 1 for S&P 500 index contracts, respectively. I thank an anonymous referee for pointing it out to me.

\(^{13}\) I thank an anonymous referee for suggesting it to me.
Table 2

### Summary statistics for sample means and standard deviations

I calculate all variables for a window of 20 days prior to the margin change date. Margin is in dollar amounts. Volume is the daily average trading volume. Open interest is the daily average open interest. Value is the daily average contract value. Price volatility is based on Garman and Klass (1980). Correlation is the correlation coefficient between daily changes in cash and in futures prices. Standard deviations are in parentheses.

<table>
<thead>
<tr>
<th>Contract</th>
<th>N</th>
<th>Margin</th>
<th>Value</th>
<th>Ratio</th>
<th>Volume</th>
<th>Open Interest</th>
<th>Correlation</th>
<th>Price Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>British</td>
<td>30</td>
<td>2,444</td>
<td>95,040</td>
<td>0.026</td>
<td>9,710</td>
<td>22,005</td>
<td>0.78</td>
<td>0.0001</td>
</tr>
<tr>
<td>Pound</td>
<td>(617)</td>
<td>(26,179)</td>
<td>(0.012)</td>
<td>(3,905)</td>
<td>(8,967)</td>
<td>(0.27)</td>
<td>(0.00013)</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>46</td>
<td>1,584</td>
<td>22,093</td>
<td>0.071</td>
<td>5,575</td>
<td>27,812</td>
<td>0.49</td>
<td>2.16</td>
</tr>
<tr>
<td></td>
<td>(1,001)</td>
<td>(5,563)</td>
<td>(0.034)</td>
<td>(2,153)</td>
<td>(14,013)</td>
<td>(0.33)</td>
<td>(2.37)</td>
<td></td>
</tr>
<tr>
<td>Deutsch</td>
<td>26</td>
<td>1,871</td>
<td>71,187</td>
<td>0.027</td>
<td>27,318</td>
<td>54,492</td>
<td>0.77</td>
<td>0.000013</td>
</tr>
<tr>
<td>mark</td>
<td>(399)</td>
<td>(9,942)</td>
<td>(0.007)</td>
<td>(16,201)</td>
<td>(40,740)</td>
<td>(0.20)</td>
<td>(0.00002)</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>85</td>
<td>1,913</td>
<td>40,718</td>
<td>0.047</td>
<td>24,740</td>
<td>43,300</td>
<td>0.41</td>
<td>20.08</td>
</tr>
<tr>
<td></td>
<td>(752)</td>
<td>(7,248)</td>
<td>(0.014)</td>
<td>(11,473)</td>
<td>(17,691)</td>
<td>(0.28)</td>
<td>(21.83)</td>
<td></td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>18</td>
<td>15,458</td>
<td>16,593</td>
<td>0.093</td>
<td>46,299</td>
<td>10,7201</td>
<td>0.96</td>
<td>19.18</td>
</tr>
<tr>
<td>Index</td>
<td>(4,555)</td>
<td>(33,150)</td>
<td>(0.036)</td>
<td>(19,770)</td>
<td>(25,079)</td>
<td>(0.03)</td>
<td>(50.28)</td>
<td></td>
</tr>
</tbody>
</table>

As in previous studies on setting margin, I use three price volatility measurements. They are the traditional measurement, i.e., the standard deviation of return; Parkinson (1980) measurement based on daily high and low prices, and the Garman and Klass (1980) measurement of volatility.\(^\text{14}\) Table 2 contains summary sample statistics.

Table 2 shows that margin is different for different contracts. For example, the average margin for currency futures contract is roughly 3% of underlying contract values and the average margin for precious metal contracts is 5% of underlying contract values. Table 2 also shows that the average daily trading volume for S&P 500 index futures is much higher than that for other futures contracts. The S&P 500 contracts also have the highest open interest. The correlation coefficient between changes in daily cash prices and changes in daily futures prices is higher for stock index contract than that for currency futures contracts. In turn, currency futures contracts have a higher correlation coefficient than the precious metal futures. The standard deviation of correlation coefficient is also lower for index and currency contracts than for other contracts. These facts are consistent with the observation by Brennan (1986) that the more active the cash market, the strong the link between changes in cash and futures prices.

\(^{14}\) Empirical evidence in Wiggins (1992) show that Parkinson (1980) and Garman and Klass (1980) estimators show little downward bias, and are much more efficient than the traditional close-to-close estimator.
4.2. Empirical results

4.2.1. Normal price limits rule

As discussed in the previous section, there are enough observations to conduct a meaningful analysis for copper and gold contracts on their own. I report only the results from Garman and Klass (1980) volatility measurement. To account for heteroskedasticity, I use the method developed in White (1980) to calculate the heteroskedasticity consistent standard error. Table 3, Panels A and B show the regression results.

In Table 3, Panel A, the coefficient for price volatility is positive and statistically significant, which I interpret as evidence that higher price volatility is associated with larger margins. The coefficient for the dummy variable for price limits is negative and also statistically significant, which suggests that those contracts with price limits tend to have a smaller margin than those contracts without price limits. Therefore, the results in Table 3, Panel A, support the perception by many small traders that the presence of price limits might result in a smaller margin.

Table 3, Panel B presents results from the regression that includes the variable Inf. This is the variable that tests the argument in Brennan (1986) that active cash market reduces the effect of price limits. For both markets, a better signal from the cash market, which is represented by a higher degree of correlation between changes in cash prices and changes in futures prices, does not seem to affect margins.

Table 4, Panel A presents results from a regression that includes all observations from the five contracts. Since the variable Inf is not included, I do not test the cash market argument in Brennan (1986). Table 4, Panel A also presents results from the least squares dummy variable (LSDV) model, which uses four contract dummies, in addition to the constant, to account for differences across the five contracts. The main findings from the LSDV model are:

- There is a positive relation between price volatility and margin;
- Margin is positively related to trading volume;
- Margin is negatively related to open interest; and
- Margin is negatively related to price limits.

The first three findings are consistent with those in previous studies. The more interesting result is that the coefficient for the dummy variable for price limits is negative and highly significant. Consequently, I reject the null hypothesis that price limits have no effect on margin levels.

Table 4, Panel B presents results from the LSDV model that includes the variable Inf to account for the cash market argument by Brennan (1986). Panel B shows that all independent variables are significant statistically. The coefficient for the variable Inf is positive, which is consistent with Brennan’s argument that active cash markets

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15 The regression results are almost the same with the traditional volatility measurement or the extreme value estimator in Parkinson (1980). These results are available from the author on request.
Table 3

Regression results for unconditional effect of price limits on margins

Model: \( \text{Ratio}_{it} = \alpha + \beta \text{Volatility}_{it} + \theta \text{Interest}_{it} + \gamma \text{Volume}_{it} + \lambda \text{Limit}_{it} + \epsilon_{it} \)

The total number of observations is 46 for copper and 85 for gold, respectively. I calculate all variables for a period of 20 days prior to margin change. Ratio is the dollar amount of margin over contract value. Volatility is price variability, based on Garman and Klass (1980). Interest is the log transformation of open interest. Volume is the log transformation of trading volume. Limit is the dummy variable for price limits that takes a value of one if price limits are imposed, zero otherwise. \( t \)-statistics are in parentheses and computed with White (1980) heteroskedasticity consistent standard errors.

<table>
<thead>
<tr>
<th></th>
<th>Copper</th>
<th>Gold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.10</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(1.8)</td>
</tr>
<tr>
<td>Volatility</td>
<td>0.0048</td>
<td>0.0004</td>
</tr>
<tr>
<td></td>
<td>(2.2**)</td>
<td>(6.6***)</td>
</tr>
<tr>
<td>Interest</td>
<td>-0.011</td>
<td>-0.0015</td>
</tr>
<tr>
<td></td>
<td>(-0.7)</td>
<td>(-0.4)</td>
</tr>
<tr>
<td>Volume</td>
<td>0.01</td>
<td>0.000035</td>
</tr>
<tr>
<td></td>
<td>(0.7)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Limit</td>
<td>-0.024</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(-2.4**)</td>
<td>(-3.1***)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.52</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Panel B. With signals from cash markets

<table>
<thead>
<tr>
<th></th>
<th>Copper</th>
<th>Gold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.097</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>(1.0)</td>
<td>(1.7)</td>
</tr>
<tr>
<td>Inf</td>
<td>0.0013</td>
<td>0.0068</td>
</tr>
<tr>
<td></td>
<td>(0.1)</td>
<td>(1.6)</td>
</tr>
<tr>
<td>Volatility</td>
<td>0.0048</td>
<td>0.00043</td>
</tr>
<tr>
<td></td>
<td>(2.1**)</td>
<td>(6.6***)</td>
</tr>
<tr>
<td>Interest</td>
<td>-0.01</td>
<td>-0.0015</td>
</tr>
<tr>
<td></td>
<td>(-0.7)</td>
<td>(-0.4)</td>
</tr>
<tr>
<td>Volume</td>
<td>0.01</td>
<td>0.00006</td>
</tr>
<tr>
<td></td>
<td>(0.7)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Limit</td>
<td>-0.023</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(-2.2**)</td>
<td>(-3.1***)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.51</td>
<td>0.38</td>
</tr>
</tbody>
</table>

*** Indicates statistical significant at the 0.01 level.
** Indicates statistical significant at the 0.05 level.

provide good venue to project true losses, and that exchanges should set an appropriate higher margin level.

Table 5 presents results from a direct test on whether price limits must be smaller than margin to have a substitution effect, as predicted by Brennan (1986). Not only
Table 4

Regression results for unconditional effect of price limits on margins

Model: \[ \text{Ratio}_{it} = \alpha + \beta \text{Volatility}_{it} + \theta \text{Interest}_{it} + \gamma \text{Volume}_{it} + \lambda \text{Limit}_{it} + \varepsilon_{it} \]

There are 205 observations. I calculate all variables are calculated during a period of 20 days prior to margin change. Ratio is the dollar amount of margin over contract value. Inf is the correlation coefficient between changes in cash and futures prices. Volatility is price variability, based on Garman and Klass (1980). Interest is the log transformation of open interest. Volume is the log transformation of trading volume. Limit is the dummy variable for price limits that takes a value of one if price limits are imposed, zero otherwise. \( t \)-statistics are in parentheses and computed with White (1980) heteroskedasticity consistent standard errors.

Panel A. With no signals from cash markets

<table>
<thead>
<tr>
<th>Ordinary least squares</th>
<th>Least squares dummy variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.2)</td>
</tr>
<tr>
<td>Volatility</td>
<td>0.00038</td>
</tr>
<tr>
<td></td>
<td>(4.1***)</td>
</tr>
<tr>
<td>Interest</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>(2.9***)</td>
</tr>
<tr>
<td>Volume</td>
<td>–0.01</td>
</tr>
<tr>
<td></td>
<td>(–2.8***)</td>
</tr>
<tr>
<td>Limit</td>
<td>–0.0076</td>
</tr>
<tr>
<td></td>
<td>(–1.8)</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Panel B. With signals from cash markets

|                        | all contract dummies are positive and significant except for German mark |
| Inf                    | 0.011                       |                             |
|                        | (2.1**)                     |                             |
| Volatility             | 0.00021                     |                             |
|                        | (3.1***)                    |                             |
| Interest               | –0.016                      |                             |
|                        | (–4.4***)                   |                             |
| Volume                 | 0.0066                      |                             |
|                        | (2.3**)                     |                             |
| Limit                  | –0.018                      |                             |
|                        | (–6.0***)                   |                             |
| Adjusted R^2           | 0.08                        | 0.62                        |

*** Indicates statistical significant at the 0.01 level.
** Indicates statistical significant at the 0.05 level.

do I include the variable Inf, but I also adjust the dummy variable for price limits as defined in Equation 2. I adjust it based on whether or not margin is greater than the price limits level.

The dummy variable in Table 5 is different from that in Table 4, Panel B. The dummy variable in Equation 2, as used in Table 5, measures the conditional effect of
Table 5
Regression results for conditional effect of price limits on margins

Model: \( \text{Ratio}_{it} = \alpha + \phi \text{Inf}_{it} + \beta \text{Volatility}_{it} + \theta \text{Interest}_{it} + \gamma \text{Volume}_{it} + \lambda \text{Limit-B}_{it} + \epsilon_{it} \)

There are 205 observations. I calculate all variables during a period of 20 days prior to margin change. Ratio is the dollar amount of margin over contract value. Inf is the correlation coefficient between changes in cash and futures prices. Volatility is price variability, based on Garman and Klass (1980). Interest is the log transformation of open interest. Volume is the log transformation of trading volume. Limit-B is the adjusted dummy variable for price limits, which takes a value of one if the limit level is greater than the margin level, zero otherwise. \( t \)-statistics are in parentheses and computed with White (1980) heteroskedasticity consistent standard errors.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>( t )-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.016</td>
<td>(3.1***</td>
</tr>
<tr>
<td>Inf</td>
<td>0.00013</td>
<td>(1.6)</td>
</tr>
<tr>
<td>Volatility</td>
<td>-0.016</td>
<td>(-4.0***</td>
</tr>
<tr>
<td>Interest</td>
<td>0.0098</td>
<td>(3.2***</td>
</tr>
<tr>
<td>Volume</td>
<td>0.0095</td>
<td>(1.2)</td>
</tr>
<tr>
<td>Limit-B</td>
<td>0.55</td>
<td></td>
</tr>
</tbody>
</table>

*** Indicates statistical significant at the 0.01 level.

price limits on margin. In contrast, the dummy variable in Equation (1), as in Table 4, Panel B, measures the unconditional effect of price limits on margin. Table 5 shows that the coefficients for both volatility and the adjusted dummy variable are positive, but not significant. A positive coefficient for the adjusted dummy variable does not support the argument by Brennan (1986) that price limit levels must be smaller than the level of margin to have a downward effect.

4.2.2. Variable price limits rule

The regression analysis excludes those margin changes surrounding the variable price limits rule. The variable price limits rule does not occur very often. Usually, trading is extremely volatile in the days prior to the expansion of the normal price limits. In these special cases, the signal is clear that the exchange should adjust margin levels. Telser (1981) argues that price limits should not influence exchanges’ decision on margin changes. If exchanges do not adjust margins in these special cases, such a finding would contradict Telser’s argument.

To examines the argument by Telser (1981), I search on the Lexis/Nexis database and Dow Jones News Wire to sample the dates on which the variable price limits rule occurs. There are 33 occurrences. Out of these 33 occurrences, there are 19 cases in
which clearinghouses changed margins during the three days before the expansion of the limits.

I can test the hypothesis that exchanges randomly change margin levels in these special cases. The fact that there are 19 successes out of 33 trials indicates that the probability is between 50% and 100%. Under binomial distribution, with a 5% margin of error, I can calculate the probability (X) that exchanges adopt an active policy of changing margin levels by solving the following equation:

\[
\binom{33}{19} X^{19} (1-X)^{14} = 0.05
\]

The probability is about 70%, which I interpreted as evidence that exchanges do take an active approach in adjusting margin requirements, and purposely adjust margins before expanding price limits. Since there is no other specific information, this probability does not seem to contradict the argument by Telser (1981), at least in these special cases. However, it seems that futures exchanges take a long-term view in setting margin requirements, and that price limits do have a downward effect on margin levels in those normal cases.

5. Summary and implications

This study tests the null hypothesis that the presence of price limits reduces margin levels in futures markets. I examine the normal daily price limits and the variable price limits rules separately. There is not sufficient evidence to support the claim that the margins are affected by the variable price limits rule. Exchanges frequently adjust margins even before the activation of the variable price limits rule, under which normal price limits are expanded automatically for one or two days. My finding supports the argument in Telser (1981) that exchanges take a prudent approach and adjust margins according to default risk.

However, for the case of normal daily price limits, I find a negative relation between margin and price limits. The margin is smaller when price limits are imposed than what I would expect when price limits are not imposed. This finding supports the theoretical predictions in Brennan (1986), Chowdhry and Nanda (1998), and Chou, Lin, and Yu (2000). I also find that price volatility is an important factor in setting margin, which is also consistent with the findings in previous studies on setting margin. In addition, I find that signals for true futures prices, which I measure by the correlation coefficient between changes in cash prices and changes in futures prices, are also an important factor.

However, a further test shows no evidence that price limits can be effective in substituting for margin only if margin level is greater than the limit level, as predicted in Brennan (1986). Price limits have an unconditional downward effect on margin levels. This finding raises the question of how to interpret the mechanism that price limits contribute to lowering margins.
It seems we can best understand benefits from price limits by linking price limits with margin calls and daily settlement. Member firms must have cash reserves or cash equivalents to meet the margin calls. Price limits reduce cash liquidity risk for both customers and clearinghouse members, even though price limits cannot reduce the underlying default risk. As discussed in Coleman (1988), practitioners especially appreciate the fact that price limits can help customers and clearinghouse member firms to meet the margin calls, and to better project the maximum daily funds needed. During a big price swing, stop-loss orders will not be executed with certainty, and little money can be collected quickly from the customers, which could put even big member firms at liquidity risk. For example, both Bernanke (1990) and Greenwald and Stein (1988) argue that many members firms would have been overwhelmed by the liquidity problem and would have defaulted during the market crash in October 1987, if the Federal Reserve Board had not intervened by providing extra credit to these firms. Although price limits cannot change the risk of underlying positions, a delay caused by price limits makes the settlement process smoother and reduces the uncertainty of the amount of funds member firms must budget for a day.

Despite of the benefits from imposing price limits, there are costs associated with price limits. Price limits can impose liquidity costs on some participants. For example, some customers cannot get in or out of the market after price limits are hit. In addition, Fama (1988) and Chance (1994) discuss the hypothesis that price limits may act as “absorbing barriers.” That is, price limits act as a magnetic field and pull prices toward them, which can result in more trading halts unnecessarily. These issues are future research topics.

References


