MARGIN REQUIREMENTS, PRICE LIMITS, AND THEIR RELATIONSHIP TO CANADIAN AGRICULTURE FUTURES PRICE VOLATILITY

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ABSTRACT

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Margin requirements for futures contracts represent the amount that traders have to deposit to protect the broker from default. Margin requirements may be used as a tool to prevent excessive volatility in the futures price by limiting excessive speculation in the futures market. Previous studies that examined the effectiveness of margin requirements upon price volatility have not found evidence that margins are able to stabilize the futures price volatility. However, none of these studies have considered the price limits specified by the futures exchange to reduce large movements in prices. Thus, the objective of this study is to examine two Canadian agriculture futures contracts—the canola and the western domestic barley futures contract which are traded on the ICE Futures Canada—over the period June 2002 through June 2009, to understand whether increases in margins are effective at stabilizing futures prices after considering the effect of price limits upon futures prices. The results show that increases in margins can reduce futures price volatility when price limits are taken into consideration for the canola contract, but not for the barley contract. Moreover, the existence of price limits appears to have a gravitation (destabilization) effect on canola futures price volatility but no effect on the barley futures price volatility.

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1. INTRODUCTION AND PURPOSE OF STUDY

An important economic function of the futures market is that it provides a channel for traders such as farmers and merchants to hedge their price exposure. On the other hand, the existence of the futures market also offers speculators a chance to make a profit. Speculators provide needed liquidity in the futures market, since it is unlikely that the demand for futures contracts by long hedgers will always be perfectly balanced by the demand for futures contracts by short hedgers. However, since too much speculation may distort prices in the short run leading to increased price volatility in the futures market and possibly trader default, the increased volatility may drive away hedgers who enter the futures market for reducing their risks. Margin requirements represent the amount that traders have to put down to protect the broker from default (Kline, 2001). They are therefore also used as a tool to prevent excessive volatility in the futures price by limiting excessive speculation in the futures market in addition to ensuring that traders fulfill their obligations (Hardouvelis & Kim, 1995; Hoyt & William, 1995; Spence, 1999). Previous researchers have studied the effect of margin requirements on futures price volatility, and different views about the effect of margin upon volatility arise in the literature. Some argue that margins may not be used to affect the composition of the traders in the market as they impose different costs to traders who have different preferences and expectations of risk. Thus, since it is hard to identify which type of investors exit or enter the markets when margins change, there should be no relationship between changes in margin and price volatility (Hartzmark, 1986; Kupiec & Sharpe, 1991). Some however suggest that changes in margins may actually increase the price volatility as the costs of margins drive out some of the informed traders in the markets and thus increase the price volatility, while the others agree with the policy makers in that margin increases will decrease speculative trading, and thus price volatility (Ma, Kao & Frohlich, 1993). Research that examines the effectiveness of the margin requirements typically investigates the relationship between the margin requirements and price volatility in the futures or stock markets. However, the studies seldom find a systematic relationship between the two variables (Adrangi & Chatrath, 1999; Fishe, Goldberg, Gosnell & Sinha, 1990; Hardouvelis & Kim, 1995; Hartzmark, 1986; Salinger, 1989). These tests have used different futures contracts, time periods and methodologies.

The findings among the researchers lead to the conclusion that margins imposed in the futures market may not be effective at stabilizing the price volatility in the futures market. However, these studies have not considered the daily price limits in their models, which are also set by the exchange to restrict the highest and the lowest prices at which futures contracts are traded during the trading period. Usually, trading is halted when the price limit is hit (Phylaktis, Kavussanos & Manalis, 1999; Ma, Rao & Sears, 1989). The existence of price limits may affect the behaviour of traders even if limits are not hit and thus influence the futures price volatility. Consequently, it is interesting to know whether a relationship between the margin and the price volatility can be detected when the effect of price limits is also considered. This is because the effect of price limits on the price volatility may be so large that, without taking these into account, it may be hard to detect the decrease in price volatility caused by increased margin requirements. Therefore, the purpose of this study is to examine the Canadian agriculture commodity futures contracts upon Canola and Western Domestic Feed Barley which are traded on the Winnipeg Commodity Exchange (now known as ICE Futures Canada) over the period June 2002 to June 2009 by taking into account the effect of price limits. Since the canola and western domestic feed barley futures contracts are actively traded as they are Canada's main crops produced for the Canadians and the world, studying these contracts is important for the study of factors responsible for the stability of the Canadian futures market.

The behaviour of the traders in the future market may be affected by the price limits before the prices hit the price limits. The effect can be either a gravitation (destabilization) effect or a stabilization effect. From the view of the gravitation effect, price limits may attract the prices toward the price limits as the traders advance trading before the price limits are hit when they observe the futures prices moving to a range near the price limits (Subrahmanyam, 1994). As a result, the futures price volatility is increased. However, from the view of the stabilization effect, the price limits may push the futures prices away from the price limits as traders reduce trading before price limit hits when the futures prices fall in a range near the price limits (Subrahmanyam, 1997; Balakrishnan, Gopinatha, Goswami & Shanker, 2008). As a result, the futures price volatility is stabilized as the traders delay their trades when futures prices are closer to the price limits. Therefore, the influence of the price limits should be stronger the closer the futures price is to the price limits. Thus, in my study, I will take into account the effect of the price limits by using the distance between futures prices and price limits to measure the effect of price limits upon futures price volatility.

To investigate whether the futures price volatility is stabilizing, destabilizing, or neutral as margins change, I incorporate the distance of the futures prices from the price limits into the study of the effectiveness of margins. In addition to the three hypotheses about the effect of margin changes upon futures price volatility, there are three hypotheses on the effect of price limits upon futures price volatility. If the futures price volatility increase is as a result of the small distance between futures prices and price limits, then the gravitation impact of the price limits is supported. If the futures price volatility decrease is as a result of the small distance between futures prices and futures limits, then the stabilization impact of the price limits is supported. If the above hypotheses cannot be supported, then the existence of price limits does not affect the futures price volatility. However, the distance from the price limits may have no impact upon the price volatility because 1) the futures prices are too far away from the price limits to have any effect on the trader behaviour, and thus futures price volatility, or 2) the futures prices fall in a range close to the price limits. The justification for this final hypothesis involves segmenting the distances into two distance pieces with one closer to the price limits and the other far away from the price limits in the regression analysis.

The result shows that there is a negative relationship between the futures price volatility and the margin requirements when the distance variables are included in the regression models for the canola contracts, while a neutral effect of the margin requirements upon the futures price volatility is observed for the barley contracts. There is also some evidence of a gravitation effect of the price limits upon the futures price volatility for the canola contracts, while there is no effect of the price limits upon the futures price volatility for the barley contracts.

The contribution of this thesis is to provide a deeper understanding of whether margin requirements are effective at stabilizing prices in the futures market, thus offering regulators clearer insight into how both margin requirements and price limits affect futures price volatility. Several issues will be addressed on the relationship between the margin requirement and futures price volatility. First, since price limits are important determinants of price volatility in the futures market, taking them into consideration strengthens the study. Second, examining different maturity contracts and commodity futures ensures that the results are reliable. Third, because the time periods covered by previous studies on the effect of margins only extend up to the early 1990s, my study based on time periods in the 2000s provides an update of the past studies. Finally, since most previous studies are based on U.S. futures contracts, focusing on the Canadian agriculture futures contracts would be useful to Canadian regulators.

2. LITERATURE REVIEW

In section 2.1, I provide the theoretical and empirical relationships between the margin requirements and the price volatility in stock and futures markets. Then, in section 2.2, I provide the theoretical and empirical relationships between price limits and price volatility in futures and stock markets.

Section 2.1- On the relationship between margin requirements and price volatility

Because margin requirements are imposed in both stock and futures markets, in this section, I combine and summarize the theoretical hypotheses and empirical evidence of the effectiveness of margin requirements on price volatility in both stock and futures markets. There are three theoretical views on the usefulness of margin requirements. The first is that margin increases will decrease speculative trading in the market because speculators are the ones who distort the price behaviour of the futures or stock markets. Their trading tends to exacerbate price trends, so the market becomes volatile. As a result, proponents of margin requirements argue that speculative trading activity will be lower when the margin level is increased, and this reduces the price volatility in the markets. Thus, there should be a negative relationship between changes in margin and price volatility (Ma et al., 1993). Papers that support this view that margins help to stabilize price volatility include Hardouvelis (1988) who finds a strong and significant negative relationship between initial margin requirements and stock market volatility. Another stream of research however argues that because margins impose costs on informed traders who are dominant in the market, an increase in the margin requirements will prevent the trading activity of those traders, resulting in a less competitive market. Thus, an increase in the margin level will reduce market participation which will cause an increase in the price volatility, so a positive relationship between changes in margin and price volatility should be observed (as cited in Ma et al., 1993; Hardouvelis & Kim, 1995). Finally, researchers such as Telser (1981), Hartzmark (1986) and Kupiec and Sharpe (1991) propose that margins impose liquidity costs on traders which affect the preferences and expectations of different groups of traders. As a result, because the sources of the price volatility such as investor preferences and expectations cannot be accurately identified as they may change over time, imposing margin requirements may increase or decrease price volatility. Therefore the relationship cannot be predicted prior to the imposition of margin requirements and should be neutral.

Although empirical evidence on the relationship between margins and volatility is mixed, a high proportion of studies suggest that no relationship between the two variables can be found. Studies of Hartzmark (1986), Hardouvelis and Kim (1995), Hsieh and Miller (1990), Salinger (1989), Fishe, Goldberg, Gosnell and Sinha (1990), and Schwert (1989) fall in this category. For the evidence on the stock market, Salinger (1989) investigates the relationship between stock market initial margin requirements and volatility of the New York Stock Exchange stock returns. Using a regression of the stock return volatility on margin level, changes in margin, margin debt, and changes in margin debt from 1934-1987, he finds that the upside volatility is not associated with margin requirements and the downside volatility is not associated with margin debt. Therefore, the margins cannot affect the price volatility in the stock market. The finding leads to the conclusion that the results on the effectiveness of changing margin requirements in the stock market can be applied to the futures market. Therefore, regulating futures margins is unlikely to affect the futures price volatility. Later, Schwert (1989) also investigates the relationship between the margin requirements and the stock market volatility using an autoregressive model with 12 leads and lags from 1935-1989. Similar to Salinger (1989), he does not find evidence that changes in margin requirements are able to reduce subsequent stock return volatility. It leads to his conclusion that the result with the stock market margin requirements can be applied to the futures market, and so regulating the futures market margins is unlikely to affect the futures price volatility. Another study by Hsieh and Miller (1990) attempts to investigate the relationship between margin requirements and stock market return volatility from 1934 to 1987 by dealing with flaws in previous test designs which result in high autocorrelation of the regression residuals. Using first differences when running the regressions to deal with the high autocorrelation problem, they detect no evidence of any effect of margin changes on stock market volatility in both the short and long term.

For the evidence on the futures market, Hardouvelis and Kim (1995) examine the relationship between the margin levels and the volatility in the futures market by employing eight metal futures contracts from the early 1970s to October 1990. In their research, the authors use a benchmark group of contracts that do not experience a margin change, and then compare the price behaviour and volatility between the target and benchmark futures contracts. By using these methods, the authors are able to study the true causality between the margin requirements and the target contracts. Even though the results show a negative relationship between the margin requirements and trading volume, there is no clear causal link between the margin change and the futures price volatility. This is because it is hard to determine which type of investors are driven away from the markets when margin changes. Similarly, Fishe et al., (1990) argues that the margin requirements have no systematic effect on the future price volatility. In their study, ten commodities are tested using the nearest four contracts excluding contracts expiring within one month of a margin change over the period 1972 to 1988. A twenty day period prior to a change in the initial margin level is considered in their regressions. They employ the initial margin level because other margin levels also move closely with the initial margin requirements. They first compare the price volatility of the ten commodities 20 days before and after the margin change. Then, using a regression analysis with the percentage change in price volatility as the dependent variable and the percentage changes in margins and open interest as independent variables, the authors find that there is an inconsistent relationship between margin changes and price volatility. Consequently, the setting of the margin requirements may not actually reduce the futures price volatility. Finally, Adrangi and Chatrath (1999) investigate the impact of the margin requirements on the trading activity and price volatility in soybean and corn futures markets and suggest that margins should only be used as an insurance device for insuring members of the futures exchange. This is because no strong evidence of a direct link between changes in margin and price volatility can be found.

Section 2.2- On the relationship between price limits and price volatility

Another policy tool which is actively used by regulators to reduce large movements in prices is the daily price limits specified in the stock or futures market. (Kim & Rhee, 1997; Ma et al., 1989). Studies that investigate the relationship between price limits and price volatility can be separated into two groups. The first group tries to examine the ex post influence of price limits on futures prices while the second group focuses on the ex ante effect of price limits on futures prices. The first group, for example Kim and Rhee (1997) and Ma et al. (1989), considers how the futures price volatility changes after the price limits are hit. There are two different views proposed by researchers on the ex post effectiveness of price limits. Proponents of price limits argue that traders systematically overreact to new information. As a result, price limits could help prevent excessive price movements because they offer time for the traders to assess the information. This is called the overreaction hypothesis which states that price limits could reduce futures price volatility (Kim & Rhee, 1997; Veld-Merkoulova, 2003). On the other hand, opponents of price limits argue that price limits increase futures price volatility on days following price limit hits as they delay prices from reaching their equilibrium values. Thus, the market will become less liquid on the day when the price limit is hit, and the trading activity will be intensified on the following days, increasing market volatility. This is called the delayed price discovery hypothesis which states that the price limits will increase the futures price volatility on days following limit hits (Kim & Rhee, 1997; Veld-Merkoulova, 2003).

However, similar to the studies of the margin requirements, research on the ex post influence of futures price limits has not arrived at a consensus. Some papers such as Ma et al. (1989) find a reduction in futures price volatility after the price limit is hit, while some find no change in futures price volatility. For example, Ma et al. (1989) examine the effectiveness of price limits on the behaviour of futures prices of commodities such as Treasury bonds, silver, corn and soybeans when there is a change in the price limits for the period 1977 to 1988. By using event study methodology applied to daily and intraday futures contracts, they find that there is a reduction in futures price volatility on the post-limit day with a higher trading volume. As a result, they argue that price limits stabilize the market and reduce the volatility. This is because they offer a cooling-off period for the market and give traders time to grasp and absorb the new information. Thus, setting price limits in the futures market is appropriate. Moreover, the results suggest that liquidity is maintained through stabilized price volatility and volume.

Phylaktis, Kavussanos and Manalis (1999) investigate the ex post effects of price limits upon stock price volatility in the Athens Stock Exchange. However, their conclusion is different from the findings of Ma et al. (1989). In their study, they examine the stock volatility after price limits change using ARCH/GARCH models from 1990 to 1996. In the test, they point out that trading activity represented by the daily number (volume) of transactions, or daily value of transactions is the factor determining the price volatility. Therefore, in their GARCH model using daily stock returns, they include an independent variable the value of transactions one period earlier and a dummy variable indicating whether price limits were imposed. Their results show that there is no change in the stock return volatility after the price limit is changed. Therefore, the price limits only slow down the process of price adjustment, but the prices continue to move towards equilibrium in the following periods.

Still, other papers conclude that the price volatility actually increases after the price limit is hit. For instance, Kim and Rhee (1997) study the influences of price limits on the Tokyo Stock Exchange. Using an event study with a 21-day event window to study the price volatility from 1989 to 1992, they find that the price limit may prevent the stock prices from moving to their true value because of the order imbalances resulting in volatility spillover to the following trading days. As a result, the price limit would not be useful to reduce stock price volatility. Finally, using both monthly and daily data from 1985-1990, Chen (1993) tests the effect of price limits on stock price volatility on the Taiwan Stock Exchange. He finds that the price limits do not help to reduce volatility in the stock market. This is counter to the proponents' view that the narrower the price limits, the lower the volatility. When testing the hypothesis of price limits slowing down price changes, Chen finds that the serial correlation of monthly stock returns is higher the narrower the price limits. As a result, the price limits do not protect the market from extreme price movements.

Even though these empirical studies examine the ex post effect of the price limits, another group of papers focuses on the influence of the price limits on the futures prices before the price limits are hit. There are also two views in this area. First, several papers are of the view that price limits are likely to produce a magnet (or gravitation) effect as the traders increase trading before price limits are hit when they see futures prices moving to a range near the price limits. This is because they value their desire to trade in advance higher; therefore, the futures price volatility is increased (Subrahmanyam, 1994). However, the others argue that the price limits have a stabilization effect on futures prices as traders reduce trading before price limit hits when they see futures prices moving to a range near the price limits (Subrahmanyam, 1997; Balakrishnan, et al., 2008).

Hall and Kofman (2001) investigate the futures prices process with a test on the S-shape relation between observed and theoretical futures prices using five different agricultural commodities traded on the Chicago Board of Trade for 227 trading days in 1988. They find that corn futures prices show an S-shape price stabilization effect while other commodities do not exhibit price stabilization. However, the result cannot be generalized to a gravitation effect either as the price process of those commodities behaves like a random walk. Similarly Berkman and Steenbeek (1998) do not find evidence supporting a gravitation effect by comparing the trading volume and price volatility of Nikkei 225 futures contract traded on a market with stringent price limits and the same contract traded on a market with less stringent price limits in 1992.

However, other papers investigating the behaviour of market makers find results consistent with the interpretation that they set a narrower price limit than that specified by the exchange, thus delaying or avoiding the price limit hit. This could explain why only a few limit hits are observed. As a result, price limits stabilize futures price volatility. In their study, Balakrishnan, Gopinatha, Goswami and Shanker (2008) find that the futures prices of the British pound, Canadian dollar and Deutschemark fall in a narrow range close to the daily price limits without hitting them. The number of observations of currency futures prices in that region exceeds the number of observations expected under the true futures price distribution when the price limits are in effect. Therefore, price limits can restrain futures prices set by the market markers. In the study of the effectiveness of price limits in futures markets by Shanker and Liu (2009), the authors examine the British pound and Canadian dollar currency futures contracts by conducting simulations to understand whether the market makers set implicit price limits which are narrower than the exchange specified price limits and whether applying narrower price limits help to reduce volatility and distortion. The authors find that the results are consistent with this interpretation. As a result, even if prices seldom hit the price limits, it does not mean that the price limits are ineffective in reducing volatility and distortion in the futures markets.

3. DATA

In section 3.1, the data collected for the empirical tests are provided. Then, I provide the contract specifications and the summary statistics of the margin levels in sections 3.2 and 3.3 respectively. Note, throughout the paper, I use margin levels, margins, and margin requirements interchangeably. From this chapter and onwards, all the discussions of the canola contracts are provided before that of the barley contracts.

Section 3.1- Data collection

Two Canadian agriculture commodity futures contracts are studied. One is the Canola Futures Contract; the other is the Western Domestic Feed Barley Futures Contract. The margins data from June 2002 to June 2009 are obtained from the ICE Futures Canada of the IntercontinentalExchange, Inc. ("ICE"). I employ the maintenance margin because 1) the initial margin requirement for hedgers and exchange participants (members) is the same as the maintenance margin requirement, 2) the maintenance margin requirements established for member hedgers (participants) and non-member (now called non-participants) speculators are the same, 3) the initial margin requirement for speculators is always 135% above the maintenance margin requirement since July 2002, and 4) before July 2002, the initial margin requirement for speculators was a dollar amount between 125% and 145% of the maintenance margin requirement, and was adjusted to 135% of the maintenance margin when it fell outside those limits (ICE, 2009). As a result, using the maintenance margin requirement in the study is reasonable as other margins move closely with the maintenance margin. Finally, the price limit data, the daily trading volume, open interest, opening, high, low, and settlement price from May 2002 to July 2009 are obtained from ICE Futures Canada as well. The nearest and the second nearest to maturity (or second nearest) contracts of both commodity contracts are studied as these contracts are more actively traded.

Section 3.2- Description of the contracts

The tables 3.1 and 3.2 provide the contract specifications for both contracts. Both canola and barley futures contracts have a contract size of 20 metric tonnes, and the minimum maintenance margins are established on a per contract basis (ICE, 2009). Moreover, there are no daily price limits in effect on the last trading day of the delivery month in the case of trading in a contract that is eligible for delivery in that month. The last trading day for both commodities is the trading day before the fifteenth calendar day of the delivery month. The trading activity for both contracts decreases and frequently becomes zero during the delivery month on and before the last trading day of the contract.

Table 3.1- Contract specifications for canola futures contract

Contract Symbol	RS
Pricing Basis	Freight on board value at points in the Par region.
Currency	Canadian dollars.
Delivery Months	January, March, May, July, November.
Deliverable Grades	Contract deliverable grades shall be based on primary elevator grade standards as established by the Canadian Grain Commission (CGC). Non-commercially clean Canadian canola with maximum dockage of 8%; all other specifications to meet No. 1 Canada canola at par; or Deliverable at $5.00/net tonne premium: commercially clean No. 1 Canada canola; or Deliverable at $8.00/net tonne discount: commercially clean No. 2 Canada canola; or Deliverable at $13.00/net tonne discount: non-commercially clean Canadian canola, with maximum dockage of 8%; all other specifications to meet No. 2 Canada canola. Varieties derived from GMOs are deliverable.
Delivery Points	Par Central East; Non-par locations in Saskatchewan at $0.00/tonne discount. Par Central West; Non-par locations in Saskatchewan at $2.00/tonne premium. Par Eastern; Non-par locations in Manitoba at $2.00/tonne discount. Par Western; Non-par locations in Alberta (excluding the Peace River District of Alberta) at $6.00/tonne premium. Par Peace River; Non-par locations in Alberta and British Columbia known as the Peace River District at $6.00/tonne premium.
Contract Size	1 contract = 20 tonnes.
Trade Match Algorithm	First-in-First-out (FIFO).
First Notice Day	One Trading Day prior to the first delivery day.
First Delivery Day	First Trading Day of the delivery month.
Last Trading Day	Trading Day preceding the fifteenth calendar day of the delivery month.
Final Notice Day	First Trading Day after the last Trading Day of the delivery contract.
Minimum Price Flux	$0.10/tonne ($2.00/contract).
Daily Price Limit	$45.00/tonne above or below previous settlement.
Reasonability Limit	120 ticks.
Speculative Position Limit	1,000 contracts.

Source: IntercontinentalExchange, Inc. ("ICE")

The canola futures contract was introduced in 1963 under the name Rapeseed Futures. The name "Canola" was derived from "Canadian oil, low acid" in 1978. It is a specialty crop in Canada, as the Canola seed, oil, and meal are produced not only for Canadians, but also for the world. The canola futures contract is settled by physical delivery at locations such as Alberta, Manitoba, Saskatchewan and British Columbia at different premiums and discounts. The delivery months include January, March, May, July, and November. There are four types of deliverable grades- commercially clean No. 1 Canada Canola, commercially clean No. 2 Canada Canola, non-commercially clean No. 1 Canada Canola, and non-commercially clean No. 2 Canada Canola- at different premiums and discounts (IntercontinentalExchange, Inc. [ICE], 2009).

Table 3.2- Contract specifications for barley futures contract under the new rule

Symbol	AB
Pricing Basis	Delivered to the buyer's facility in the Lethbridge-Calgary-Brooks area of Southern Alberta
Currency	Canadian dollars.
Delivery Months	November 2009 and January 2010. March, May, July, October, and December from March 2010 onward.
Deliverable Grades	Canadian barley with a maximum dockage of 2%, and all other specifications except test weight to meet No. 1 Canada Western Barley, and 1. Minimum test weight of 300 grams per 0.5 litre at par; or 2. Minimum test weight of 288 grams per 0.5 litre but less than 300 grams per 0.5 litre at a discount of five dollars (C$5.00) per net tonne; or 3. Minimum test weight of 276 grams per 0.5 litre but less than 288 grams per 0.5 litre at a discount of fifteen dollars (C$15.00) per net tonne.
Delivery Regions Map	Locations in Southern Alberta
Contract Size	1 contract = 20 tonnes.
Trade Match Algorithm	First-in-First-out (FIFO).
First Notice Day	One Trading Day prior to the first delivery day.
First Delivery Day	First Trading Day of the delivery month.
Last Trading Day	Trading Day preceding the fifteenth calendar day of the delivery month.
Minimum Price Flux	$0.10/tonne ($2.00/contract).
Daily Price Limit	$15.00/tonne above or below previous settlement.
Reasonability Limit	80 ticks.
Speculative Position Limit	250 contracts.

Source: IntercontinentalExchange, Inc. ("ICE")

The western domestic feed barley (or barley) futures contract was introduced in May 1989, and there are also four types of deliverable grades that can be delivered at different premiums and discounts until October 2009 under the old Rule 18. ICE Futures Canada introduced a revised western barley futures contract under Rule 19 on June 22, 2009 with the revised delivery regions in locations in Southern Alberta and some additional adjustments to the deliverable grade specifications and shipment requirements that reflect the common practice in the market.

Section 3.3- Summary statistics of the margin levels

Tables 3.3 and 3.4 provide the number of margin changes and the summary statistics of the margin levels for both the nearest and the second nearest canola and barley futures contracts from June 2002 to June 2009. Figure 3.1 shows the trend for the historical maintenance margin rates per contract.

Table 3.3- Number of margin changes from June 28, 2002 to June 15, 2009

Commodity	Total Margin Changes	Margin Increase	Margin Decrease
Canola	48	23	25
Barley	35	16	19

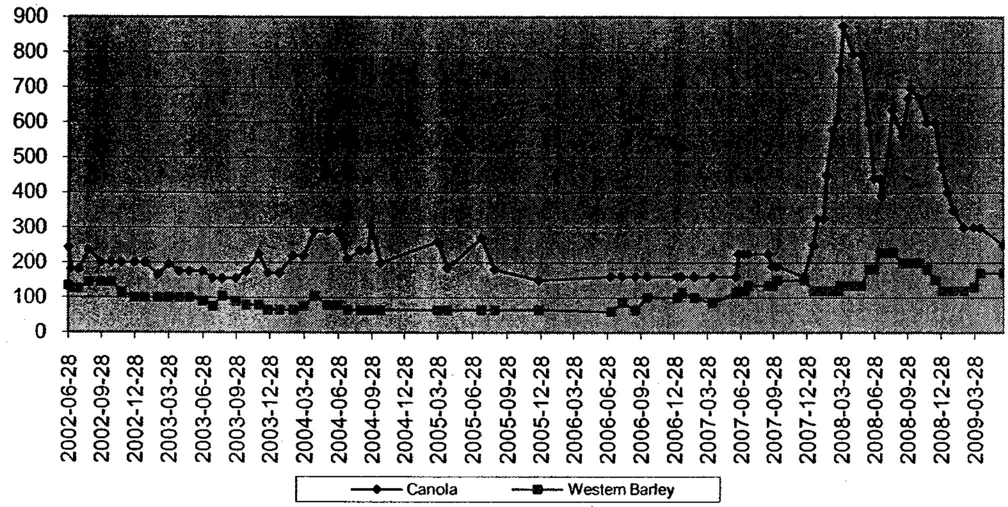
Shown in table 3.3, there are a total of 48 margin changes for canola contracts from June 28, 2002 to June 15, 2009 for both speculators and hedgers. Of the 48 margin changes, there are 23 margin increases and 25 margin decreases for both traders. There are a total of 35 margin changes for barley contracts from June 28, 2002 to June 15, 2009 for both speculators and hedgers. Of the 35 margin changes, there are 16 margin increases and 19 margin decreases for both traders. This shows that there are fewer margin increases than decreases for both contracts.

Table 3.4- Summary statistics of the maintenance margin levels from June 28, 2002 to June 15, 2009

	Canola	Barley	Ratio of Canola over Barley
Mean level	311	119	2.61
Standard deviation	188	45	4.20
Minimum level	150	60	2.50
Maximum level	875	230	3.80
Median level	225	120	1.88
Mode level	160	65	2.46
Excess Kurtosis	0.84	0.17	4.98
Skewness	1.40	0.79	1.76

The canola's average value of the maintenance margin level from June 28, 2002 to June 15, 2009 is \$310.71 per contract. This is 2.6 times the average value of the maintenance margin level of the barley futures which is \$119.27 per contract. However, the median and mode values of the maintenance margin level of the canola contract (\$225/contract and \$160/contract) are only 1.9 and 2.5 times greater than that of the barley contract (\$120/contract and \$65/contract). The standard deviation of the maintenance margin level for the canola contract is also greater than that for the barley contract by 4.2 times. The minimum value of the maintenance margin level for the canola contract is \$150/contract while the minimum value of the maintenance margin level for the barley contract is \$60/contract. The maximum value of the maintenance margin level for the canola and the barley contract contracts are \$875/contract and \$230/contract. Moreover, the skewness value of the maintenance margin level for the canola contract is 1.40 versus 0.80 for the barley contract. Distribution of the maintenance margin level for the canola contract has an excess kurtosis of 0.84, nearly 5 times greater than that of the barley contract with an excess kurtosis of 0.17. Since the excess kurtosis measures for both commodities are positive, the distributions of maintenance margin levels have narrower peak and fatter tails than a normal distribution.

Figure 3.1- Historical maintenance margin levels per contract



Source: IntercontinentalExchange, Inc. ("ICE")

From table 3.4, we know that the margin requirements and the variance of the margin requirements for the canola contract are greater than that of the barley contract. Hence, the range of the margin change on average should be greater for the canola contract. This can be confirmed by examining maintenance margin rates in figure 3.1. In figure 3.1, we observe that the ranges of the margin changes are greater especially in the period from 2007 to 2009 for the canola contract. Hardouvelis and Kim (1995) find that large margin changes provide the most precise margin beta estimates and statistical power to assess the relationship between margin and price volatility. This means that the effect of margins on canola futures price volatility should be stronger, and it should provide us more precise and reliable beta estimates.

4. HYPOTHESES

In section 4.1, I provide the hypotheses of the effect of changes in margin requirements on the futures price volatility. Then, in section 4.2, I provide the hypotheses of the effect of price limits on the futures price volatility.

Section 4.1- Hypotheses of the effect of changes in margin requirements on futures price volatility

As discussed in the literature review, three types of theoretical relationships between margins and futures price volatility have been proposed by researchers in the past. First, increases in margin reduce futures price volatility by reducing excessive speculation, so there is a negative relationship between changes in margin and futures price volatility. It is called the restriction hypothesis (H1) (Ma et al., 1993). Second, increases in margin increase futures price volatility by reducing the trades of informed traders, so there is a positive relationship between changes in margin and futures price volatility; and it is called the competitive hypothesis (H2) (as cited in Ma et al., 1993). Finally, changes in futures margin have no impact on the futures price volatility because the composition of traders cannot be identified and the effect of changes in margin on their trading may cancel each other out. This is the liquidity costs hypothesis (H3) (as cited in Ma et al., 1993). Because the difference between the three hypotheses rests on the direction of futures price volatility after the change in margin, the direction of the relationship between these two variables will be tested in this study.

Section 4.2- Hypotheses of the effect of price limits on futures price volatility

Since price limit hits are rarely found in the canola and barley futures markets, it will not be appropriate to study ex post effect of price limit hits on the price volatility. Hence, the influence of price limits on the futures price volatility even in the absence of limit hits is studied. If the destabilization (gravitation or magnet) effect (H4) is true, then as the daily high (low) price falls in a range close to the upper (lower) limit, the price limits serve as a magnet to attract the futures prices toward them because traders rush to trade. As a result, the futures price volatility is increased, and a negative relationship between the futures price volatility and the distance from the daily high (low) prices to the upper (lower) limits would be observed. However, if the stabilization effect (H5) holds, then when the distance between the daily high price and the upper price limit (or daily low price and the lower price limit) is small, futures prices would tend to move away from the limits in the following period as traders may delay trades. Consequently, futures price volatility is reduced, and a positive relationship between the futures price volatility and distance to the price limits would be obtained. However, the distance from the price limits may have no effect on the futures price volatility because 1) the futures prices are too far away from the price limits to have any effect on the trader behaviour, and thus futures price volatility, or 2) the existence of price limits does not have any effect on trader behaviour whether the futures prices fall in a range close to the price limits or not. This is the final hypothesis (H6) of the effect of price limits on futures price volatility.

5. RELATIONSHIP BETWEEN CHANGES IN TRADING ACTIVITY AND MARGIN REQUIREMENTS

In this chapter, I provide a simple analysis of the relationship between changes in trading activity (trading volume and open interest) and margin requirements. In section 5.1, I compare the average trading volume (open interest) in the period before and after margin changes. In section 5.2, I provide the analysis of the regression of percentage changes in average trading volume (open interest) on average margin level.

Section 5.1- Comparison of the average trading volume (open interest) in the period before and after margin changes

The three hypotheses about the effects of margins on futures price volatility suggest that trading activities change when margins change. The hypotheses H1 and H2 state that the trading activity reduces after the margin level increases, but the reduction in the trading activity leads to increases or decreases in futures price volatility depending on the types of traders dominant in the market. The hypothesis H3 states that the mix of trader groups may cause no change in trading activities. Thus, to understand the direction of the change in average trading activity after margin changes, I compare the average trading activity in periods before and after the margin changes in this section.

The average trading volume, $\overline{TV}$, and average open interest, $\overline{OI}$, are used as proxies for the average trading activity. The period preceding the margin changes is called "PRE", and the period following the margin changes is called "POST". The effective date of the margin changes is date 0. The tests are conducted for the nearest and the second nearest to maturity (or second nearest) canola and barley futures contracts. The nearest and the second nearest contracts are selected because they are more actively traded. Sometimes, the margin level lasts for several days or months before another change in the margin level takes place. However, the shortest time between margin changes is 3 trading days. Hence, to compare the trading activity in the period preceding and following the margin change, the average trading volume, $\overline{TV}$, and average open interest, $\overline{OI}$, are separately calculated over 3 trading days prior to the margin change and 3 trading days after the margin change. Therefore, the interval for each of the PRE and POST periods is 3 trading days so the effects of margin change do not overlap each other.

For calculating the average values in PRE and POST intervals for each variable, I exclude weekends, holidays, and business days with zero trading volume, with no open, high, and low prices available. Moreover, since there are no price limits imposed on the day before the last trading day in the delivery month, I also omit the days with no price limit in effect in the calculation of the average values. As these observations are skipped, new data points are added onward to have a large enough sample to carry out tests.

In addition, for the analysis based on the nearest to maturity contract, I switch to using the second nearest to maturity contract during the delivery month as trading activity decreases and frequently becomes zero on and before the last trading day in the delivery month for both commodity futures. Similarly, for the analysis based on the second nearest to maturity contract, I switch to using the next nearest to maturity contract during the delivery month. For the canola futures contract, because most of the September contracts were not traded at all, and the trading of the September contract was completely halted by the exchange after September 2005, I exclude the September delivery contract for the whole period from 2002 to 2009.

For robustness, I also conduct the tests based on 5, 10, 20, and 30 days around margin changes. The reason I use different windows is that 5, 10, 20, and 30 days after each margin change represent one week, two weeks, four weeks, and six weeks after the change. Even though many traders may react immediately to the change of margin requirements, some traders may delay their response as they need to take time to assess or to fully incorporate the new information (Tan & Gannon, 2002). From the analysis of Ma et al. (1993), they used an event study method over the observation period of 200 days to observe the effect of margin changes on several market variables such as cumulative percentage changes in price levels, trading volume, and open interests. Their result shows that the effects of margin changes on those variables continue to last for a period about twenty to forty days after the effective date of margin changes. Therefore, because the timing of action by different types of traders may be different when margins change depending on their needs and circumstances, different windows are employed in an attempt to capture different trader behaviour which may have an impact on the futures price volatility around margin changes. However, since those effects may dissipate after some period of time, I use a cut-off period of 30-day window.

Section 5.1a- Summary statistics of the average trading volume (open interest)

To understand the characteristics of the average trading volume and average open interest, their summary statistics for each window of 3, 5, 10, 20 and 30 days preceding and following margin changes are provided below for both nearest and second nearest canola and barley futures contracts in tables 5.1 to 5.4.

Table 5.1- Summary statistics of the average trading volume in the period preceding and following margin changes for the canola futures contract

Mean				
N= 48	Nearest Contract		Second Nearest Contract	
Window	PRE	POST	PRE	POST
3 days	5,597	5,471	4,206	3,575
5 days	5,446	5,545	4,073	3,428
10 days	5,524	5,452	3,886	3,080
20 days	5,542	5,448	3,813	3,190
30 days	5,645	5,508	3,737	3,283
Standard Deviation				
3 days	2,873	2,944	3,711	2,791
5 days	2,500	2,857	3,441	2,618
10 days	2,330	2,497	3,043	2,346
20 days	2,036	2,124	2,447	2,117
30 days	1,890	1,959	2,187	1,965
Minimum				
3 days	1,674	1,122	32	54
5 days	1,516	1,061	68	88
10 days	2,134	1,313	71	73
20 days	2,459	2,128	213	147
30 days	2,645	2,247	336	260
Maximum				
3 days	11,964	13,446	13,168	11,331
5 days	11,230	12,119	13,898	10,242
10 days	12,085	11,838	12,282	9,515
20 days	9,874	10,543	9,108	7,550
30 days	9,581	9,607	8,187	7,162
Median				
3 days	5,005	4,961	3,297	3,126
5 days	4,698	5,215	3,101	2,791
10 days	5,122	4,929	3,117	2,365
20 days	5,365	5,295	3,208	2,554
30 days	5,701	5,435	3,495	2,665
Excess Kurtosis				
3 days	-0.90	-0.13	-0.51	0.09
5 days	-0.83	-0.50	-0.01	-0.14
10 days	-0.15	-0.30	-0.17	0.12
20 days	-0.98	-0.65	-0.92	-0.86
30 days	-0.84	-0.90	-1.14	-0.95
Skewness				
3 days	0.41	0.58	0.76	0.84
5 days	0.46	0.47	0.84	0.77
10 days	0.67	0.56	0.74	0.88
20 days	0.37	0.43	0.44	0.46
30 days	0.31	0.28	0.26	0.39

Table 5.1: Most of the mean values of average trading volume in the period PRE are greater than in the period POST for both nearest and second nearest canola contracts in different windows. The mean values of average trading volume seem to be higher in the longer windows than in the shorter windows for the nearest contracts but lower in the longer windows for the second nearest contracts. For both nearest and second nearest canola contracts, the standard deviation values of the average trading volume in the

longer windows are lower than the standard deviation values in the shorter windows because the minimum values of average trading volume are higher and the maximum values of average trading volume are lower in the longer windows. The median values of average trading volume are greater for longer windows except for the longer windows of the second nearest contract in period POST. Since most of the excess kurtosis measures are negative, the distributions have lower and wider peak and thinner tails than a normal distribution. Finally, all the skewness measures for both canola contracts are positive, so the distributions have longer right tails and few high values of average trading volume.

Table 5.2: Half of the mean values of average trading volume in the period PRE are greater than in the period POST for both nearest and second nearest barley contracts concentrating in longer windows. The mean values of average trading volume seem to be higher in longer windows than in shorter windows for both maturity barley contracts. Moreover, the standard deviation values of the average trading volume in the longer windows are lower than that in the shorter windows because the minimum values of average trading volume are higher and the maximum values of average trading volume are lower in the longer windows. The median values of average trading volume are greater for longer windows for both barley contracts. Since most of the excess kurtosis measures are negative in the 20- and 30-day windows, the distributions of the average trading volume have lower and wider peak and thinner tails than a normal distribution. Finally, most of the skewness measures for both barley contracts are positive, so the distributions have longer right tails and few high values of average trading volume.

Overall, the distributions of average trading volume for the canola futures contracts in different windows are more consistent than the distribution for the barley future contracts. This may be due to the fewer average trading volume for the barley future contracts. Finally, for both canola and barley contracts, there is higher average trading volume for the nearest than for the second nearest contracts.

Table 5.2- Summary statistics of the average trading volume in the period preceding and following margin changes for the barley futures contract

Mean				
N= 35	Nearest Contract		Second Nearest Contract	
Window	PRE	POST	PRE	POST
3 days	302	311	247	263
5 days	297	328	260	278
10 days	393	364	360	301
20 days	360	376	352	318
30 days	370	362	363	313
Standard Deviation				
3 days	201	219	187	238
5 days	188	224	175	250
10 days	267	225	290	229
20 days	158	189	204	196
30 days	125	134	142	147
Minimum				
3 days	76	64	32	36
5 days	77	63	24	34
10 days	140	70	49	45
20 days	139	66	65	65
30 days	129	137	112	71
Maximum				
3 days	913	852	771	988
5 days	957	931	656	1,207
10 days	1,163	1,077	1,264	1,027
20 days	671	774	901	707
30 days	649	652	706	636
Median				
3 days	249	244	207	189
5 days	228	319	215	224
10 days	299	332	292	259
20 days	351	360	308	267
30 days	386	377	357	302
Excess Kurtosis				
3 days	2.62	0.07	0.35	1.85
5 days	3.62	0.41	-0.54	4.39
10 days	1.60	1.44	1.66	1.77
20 days	-0.78	-0.78	0.29	-1.15
30 days	-0.56	-0.61	0.40	-0.86
Skewness				
3 days	1.53	0.89	0.89	1.55
5 days	1.76	0.95	0.57	1.86
10 days	1.46	1.03	1.37	1.30
20 days	0.42	0.37	0.82	0.46
30 days	-0.17	-0.07	0.54	0.20

Table 5.3- Summary statistics of the average open interest in the period preceding and following margin changes for the canola futures contract

Mean				
N= 48	Nearest Contract		Second Nearest Contract	
Window	$\overline{OI}_{PRE}$	$\overline{OI}_{POST}$	$\overline{OI}_{PRE}$	$\overline{OI}_{POST}$
3 days	35,505	36,489	30,693	29,365
5 days	35,631	36,797	30,946	29,118
10 days	37,148	39,190	30,091	27,009
20 days	37,023	39,320	30,387	25,974
30 days	38,464	38,298	29,809	27,321
Standard Deviation				
3 days	24,636	23,096	24,337	23,165
5 days	23,736	22,959	23,730	23,304
10 days	22,006	19,044	22,314	19,795
20 days	17,161	16,418	19,247	15,710
30 days	15,893	14,388	17,126	14,274
Minimum				
3 days	2,382	2,761	1,066	1,058
5 days	3,260	2,077	1,032	1,051
10 days	7,400	11,451	975	1,039
20 days	13,196	11,527	2,757	1,295
30 days	15,597	14,189	4,009	2,867
Maximum				
3 days	94,325	88,797	93,120	100,498
5 days	94,867	85,481	87,440	100,282
10 days	84,800	78,738	87,938	82,730
20 days	82,910	68,316	82,453	54,217
30 days	83,067	75,191	73,722	57,438
Median				
3 days	34,878	35,776	23,461	24,076
5 days	33,199	35,989	22,380	22,839
10 days	36,248	39,649	21,420	21,238
20 days	33,393	40,432	25,474	22,283
30 days	36,448	36,528	25,715	24,034
Excess Kurtosis				
3 days	-0.72	-0.59	0.03	1.42
5 days	-0.42	-0.78	-0.13	1.53
10 days	-0.71	-1.00	-0.19	0.78
20 days	-0.16	-1.09	-0.29	-0.95
30 days	0.57	-0.40	-0.52	-0.99
Skewness				
3 days	0.37	0.44	0.96	1.31
5 days	0.52	0.24	0.95	1.37
10 days	0.48	0.27	0.89	1.13
20 days	0.65	0.11	0.74	0.43
30 days	0.86	0.36	0.52	0.16

Table 5.3: Most of the mean values of average open interest in the period PRE are greater than in the period POST for both nearest and second nearest canola contracts in different windows. The mean values of average open interest seem to be higher in the longer windows than in the shorter windows for the nearest contract but lower in the

longer windows for the second nearest contract. For both barley contracts, the standard deviation values of the average open interest in the longer windows are lower than the standard deviation values in the shorter windows because of the higher minimum values and the lower maximum values of average open interest in the longer windows. The median values of average open interest are greater in the longer windows for both barley contracts. Since most of the excess kurtosis measures for both contracts are negative, the distributions of the average open interest have lower and wider peak and thinner tails than a normal distribution. Finally, all the skewness measures for both contracts are positive, so the distributions have longer right tails and few high values of average open interest.

Table 5.4: Half of the mean values of average open interest in the period PRE are greater than in the period POST for both nearest and second nearest barley contracts concentrating in longer windows. For both barley contracts, the standard deviation values of the average open interest in the longer windows are lower than the standard deviation values of the average open interest in the shorter windows because of the higher minimum values and the lower maximum values of average open interest in the longer windows. The median values of average open interest are greater for the longer windows except for the longer windows in period PRE of the nearest contract. Since most of the excess kurtosis measures are negative, the distributions of the average open interest have lower and wider peak and thinner tails than a normal distribution. Finally, all the skewness measures for both barley contracts are positive, so the distributions have longer right tails and few high values of average open interest.

Overall, the distributions of average open interest for the nearest and second nearest canola and barley futures contracts are similar in different windows. However, the average open interest is lower for the barley future contracts than for the canola contracts. Finally, for both canola and barley contracts, higher average open interest shows up in the nearest contracts than in the second nearest contracts.

Table 5.4- Summary statistics of the average open interest in the period preceding and following margin changes for the barley futures contract

Mean				
N= 35	Nearest Contract		Second Nearest Contract	
Window	$\overline{OI}_{PRE}$	$\overline{OI}_{POST}$	$\overline{OI}_{PRE}$	$\overline{OI}_{POST}$
3 days	5,443	5,219	4,448	4,702
5 days	5,276	5,194	4,592	4,656
10 days	5,216	5,565	4,912	4,534
20 days	5,132	5,779	5,053	4,333
30 days	5,070	5,652	5,145	4,390
Standard Deviation				
3 days	3,954	3,943	3,598	3,527
5 days	3,689	3,875	3,519	3,536
10 days	3,208	3,343	3,262	3,148
20 days	2,461	2,610	2,539	2,202
30 days	2,145	2,247	2,164	2,033
Minimum				
3 days	692	565	471	785
5 days	827	489	727	819
10 days	1,039	597	866	868
20 days	1,469	1,315	1,342	1,173
30 days	1,817	1,823	2,226	1,534
Maximum				
3 days	12,595	11,738	12,868	13,056
5 days	11,889	11,666	12,894	13,055
10 days	11,976	11,631	12,835	12,974
20 days	11,976	11,329	11,211	9,013
30 days	10,466	11,430	9,889	8,622
Median				
3 days	5,032	4,715	3,293	4,267
5 days	4,550	4,583	4,378	3,600
10 days	4,656	4,640	4,238	3,769
20 days	4,880	5,325	4,284	4,058
30 days	4,389	5,182	4,541	4,295
Excess Kurtosis				
3 days	-1.19	-1.24	0.32	0.30
5 days	-1.08	-1.20	0.31	0.37
10 days	-0.50	-0.76	0.18	0.83
20 days	1.43	-0.29	-0.27	-0.61
30 days	0.35	0.43	-0.33	-0.98
Skewness				
3 days	0.46	0.45	1.11	1.07
5 days	0.49	0.44	1.05	1.14
10 days	0.66	0.57	0.96	1.18
20 days	1.17	0.51	0.78	0.57
30 days	0.94	0.65	0.94	0.35

Overall, all the canola and barley contracts have positively skewed distributions of average trading volume and open interest and lower standard deviation values in longer windows. All the nearest contracts have higher average trading activity than do the second nearest contracts. Finally, there is a lower average trading activity for the barley contracts than for the canola contracts.

Section 5.1b- Comparison of the average trading volume (open interest) before and after margin changes

A. Paired comparison Student's t-test of the mean differences between average trading volume (open interest) before and after margin changes

For the comparison between the trading volume before and after margin changes, I use a paired comparison Student's t-test. The paired comparison Student's t-test tests the mean of the differences between the paired observations of two dependent, normally distributed samples that are both affected by another factor and that each observation in the first sample can be matched with the corresponding observation in the second sample (Groebner, Shannon, Fry & Smith, 2008). For the hypothesis testing, I examine whether the mean difference between the average trading volume in the period preceding the margin changes, $\overline{TV}_{PRE}$, and in the period following the margin changes, $\overline{TV}_{POST}$ is zero:

$$(5.1) \quad \text{Ho: } \bar{d} = \overline{TV}_{PRE} - \overline{TV}_{POST} = 0$$

For calculating the Student's t-test statistic for the paired-sample test, suppose there are n paired observations from each of the PRE and POST groups, and i represents the i^{th}

observation in each of the two groups, I need to obtain each paired difference value between the matched observations from each sample calculated as $d_i = \overline{TV}_{PREi} - \overline{TV}_{POSTi}$ before I can compute the Student's t-statistic as follows:

$$(5.2) \quad t = (\bar{d} - \mu_d)/(S_d/\sqrt{n}), \qquad df = (n-1)$$

where $\bar{d}$ is the average paired difference of the n paired observation calculated as $\sum_i d_i/n$,

μ_d is the hypothesized population average paired difference which is 0 in this test,

S_d is the standard deviation for paired differences,

For a two-tailed test, the critical value of the Student's t from t distribution with $n-1$ degress of freedom is $t(\propto/2, n-1)$, where $\propto$ is the significance level for the test. The null hypothesis is rejected if the Student's t-statistics obtained from the test is greater than this critical value of t. For the paired comparison of the mean differences between average open interest in the period preceding the margin changes, $\overline{OI}_{PRE}$, and in the period following the margin changes, $\overline{OI}_{POST}$, the calculation procedure is the same.

In my test, I separately examine the effect of increases and decreases in margin on the trading activity. For the margin increase samples, 23 paired differences are obtained from the canola futures contract, while 16 paired differences are obtained from the barley futures contract. For the margin decrease samples, 25 paired differences are obtained from the canola futures contract, while 19 paired differences are obtained from the barley futures contract. To understand whether the mean difference between the average trading volume in the period preceding the margin changes, $\overline{TV}_{PRE}$, and in the period following the margin changes, $\overline{TV}_{POST}$, is zero, I need to compare the Student's t-statistic, t, to the critical value of $t(0.025, 22) = 2.074$ for a $\propto$=5% significance level, and to the critical value of $t(0.05,22) = 1.717$ for a $\propto$=10% significance level for the margin increase samples of the canola futures contract. For the margin increase samples of the barley futures contract, I compare the Student's t-statistic, t, to the critical value of $t(0.025, 15) = 2.131$ for a $\propto$= 5% significance level, and to the critical value of $t(0.05,15) = 1.753$ for a $\propto$=10% significance level. For the margin decrease samples of the canola futures contract, the critical value of $t(0.025, 24)$ is 2.064 for a $\propto$= 5% significance level, and $t(0.05,24)$ is 1.711 for a $\propto$=10% significance level. Finally, for the margin decrease samples of the barley futures contract, the critical value of $t(0.025, 18)$ is 2.101 for a $\propto$=5% significance level, and $t(0.05,18)$ is 1.734 for a $\propto$ =10% significance level. The same process is also done for the paired comparison Student's t-test of average open interest before and after margin changes.

B. Wilcoxon matched-pairs signed-rank test for the median differences between average trading volume (open interest) before and after margin changes

The paired Student's t-test is a parametric test that requires the populations of the samples to be normally distributed. However, as described in Groebner et al. (2008), the Wilcoxon matched-pairs signed-rank test is an alternative nonparametric test that does not require the populations of the samples to be normally distributed. It can be used when the distribution of the population differences is symmetric about their median and the measurement scale of the median differences is interval, meaning that the distance between two data points of a group can be measured precisely so that we can compare the group's difference to another group's difference. The Wilcoxon matched-pairs signed-rank test is also a useful test when the sample sizes are sample ($n \leq 25$). Thus, using the Wixcoxon matched-pairs signed-rank test, I can assess the whether the median difference of two paired groups of average trading volume, $\overline{TV}_{PRE}$ and $\overline{TV}_{POST}$, is zero. The null hypothesis for the two-tailed test is:

$$(5.3) \quad \text{H}_0\text{: } \widetilde{M}_D = \overline{TV}_{PRE} - \overline{TV}_{POST} = 0$$

where $\widetilde{M}_D$ is the median difference of the n paired observation

To determine the Wilcoxon signed-rank test statistic, S, the following steps are conducted:

1) Compute the deviation, M_{Di}, between each paired observations. For example, $M_{Di} = \overline{TV}_{PREi} - \overline{TV}_{POSTi}$, where i represents the i^{th} observation in each of the two groups.

2) Convert the deviation values to absolute differences, $|M_{Di}|$.

3) Determine the ranks for each difference, any zero difference value is not ranked and should be eliminated from consideration, as they provide no useful information. The remaining absolute differences are then ranked with the lowest difference value receiving a rank of 1. If there are tied absolute differences, the ranks for each tied absolute differences are averaged and assigned to each of them.

4) Assign back the original sign on the M_{Di} value to the ranks.

5) Sum all the positive ranks and all the negative ranks separately. Select the smallest sum of absolute values of either the positive or the negative ranks. This absolute-valued rank is the value of the test statistic, S.

To determine whether the null hypothesis should be rejected, I compare the calculated S to the critical S-value. If the calculated S is less than or equal to the critical $S(\propto/2, n)$, then the null hypothesis is rejected. Note: $\propto$ is the significance level for the test. For testing the hypothesis of whether the median differences between average open interest in the period preceding the margin changes, $\overline{OI}_{PRE}$, and in the period following the margin changes, $\overline{OI}_{POST}$, is zero, the procedure is also the same.

Thus, for my margin increase sample, with a significance level of 5% for the two-tailed test, the critical $S(0.025, 23)$ is 73 for the canola futures contracts while the critical $S(0.025, 16)$ is 30 for the barley futures contracts. For my margin decrease sample, with a significance level of 5% for the two-tailed test, the critical $S(0.025, 25)$ is 89 for the canola futures contracts while the critical $S(0.025, 19)$ is 46 for the barley futures contracts. The whole process is again conducted under the Wilcoxon matched-pairs signed-rank test for median differences between average open interest before and after margin changes.

Section 5.1c- Results of comparison of the average trading volume (open interest) before and after margin changes

The tables 5.5 to 5.14 below show the results of the paired comparison Student's t-test and Wilcoxon matched-pairs signed-rank test for both nearest and second nearest canola and barley futures contracts using different windows of 3, 5, 10, 20, and 30 days around margin changes. Note, PRE represents the period preceding margin changes and POST represents the period following margin changes. Only the tests with 20-day and 30-day windows are discussed.

Table 5.5- Results of comparison of average trading volume (open interest) 3 days before and after margin changes for the canola futures contract

3-day	Canola		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=23					
	PRE	Average	6,264	42,455	3,744	25,664
		Standard deviation	2,986	22,939	3,374	19,687
	POST	Average	5,840	40,321	3,646	26,315
		Standard deviation	3,017	23,571	3,014	20,517
	Difference = (PRE-POST)		424.19	2,134.48	97.81	-650.83
	Standard deviation of difference		2,420.08	9,333.10	2,333.18	5,964.01
	Student's t-test statistic		0.84	1.10	0.20	-0.52
	p-value		0.41	0.28	0.84	0.61
	Wilcoxon signed rank test statistic		102.00	56.00***	121.00	56.00***
	p-value		0.28	0.01***	0.62	0.01***
MARGIN DECREASE	N=25					
	PRE	Average	4,982	2,9110	4,631	35,319
		Standard deviation	2,677	24,846	4,018	27,534
	POST	Average	5,131	32,964	3,510	32,171
		Standard deviation	2,895	22,546	2,631	25,453
	Difference = (PRE-POST)		-148.56	-3,854.40	1,121.87	3,148.37
	Standard deviation of difference		2,499.14	1,5610.32	2,273.67	13,335.98
	Student's t-test statistic		-0.30	-1.23	2.47**	1.18
	p-value		0.77	0.23	0.0211**	0.25
	Wilcoxon signed rank test statistic		162.00	151.00	96.00*	145.00
	p-value		0.99	0.76	0.073*	0.65

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 5.6- Results of comparison of average trading volume (open interest) 5 days before and after margin changes for the canola futures contract

5-day	Canola		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=23					
	PRE	Average	5,763	41,790	3,533	26,662
		Standard deviation	2,573	22,122	2,920	20,034
	POST	Average	5,862	39,009	3,591	27,103
		Standard deviation	2,753	23,297	2,813	21,142
	Difference = (PRE-POST)		-99.66	2,780.19	-57.17	-441.13
	Standard deviation of difference		2,090.99	15,668.30	2,221.25	10,769.58
	Student's t-test statistic		-0.23	0.85	-0.12	-0.20
	p-value		0.82	0.40	0.90	0.85
	Wilcoxon signed rank test statistic		124.00	65.00**	113.00	72.00**
	p-value		0.68	0.02**	0.46	0.04**
MARGIN DECREASE	N=25					
	PRE	Average	5,154	29,965	4,649	34,887
		Standard deviation	2,447	24,185	3,913	26,479
	POST	Average	5,252	34,762	3,279	30,971
		Standard deviation	2,976	22,930	2,473	25,423
	Difference = (PRE-POST)		-97.34	-4,796.49	1,289.35	3,915.97
	Standard deviation of difference		2,970.31	21,005.19	2,746.67	17,606.07
	Student's t-test statistic		-0.16	-1.14	2.35**	1.11
	p-value		0.87	0.26	0.03**	0.28
	Wilcoxon signed rank test statistic		155.00	152.00	105.50	149.00
	p-value		0.84	0.78	0.13	0.72

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 5.7- Results of comparison of average trading volume (open interest) 10 days before and after margin changes for the canola futures contract

10-day	Canola		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=23					
	PRE	Average	5,821	42,153	3,526	27,355
		Standard deviation	2,423	20,902	2,621	20,739
	POST	Average	5,549	38,590	3,508	27,078
		Standard deviation	2,426	19,575	2,571	18,984
	Difference = (PRE-POST)		272.10	3,563.70	18.38	277.04
	Standard deviation of difference		2,291.55	20,941.77	2,146.89	15,880.60
	Student's t-test statistic		0.57	0.82	0.04	0.08
	p-value		0.57	0.42	0.97	0.93
	Wilcoxon signed rank test statistic		103.00	87.00	118.00	96.00
	p-value		0.30	0.12	0.55	0.21
MARGIN DECREASE	N=25					
	PRE	Average	5,251	32,542	4,217	32,610
		Standard deviation	2,256	22,401	3,405	23,813
	POST	Average	5,363	39,743	2,686	26,946
		Standard deviation	2,607	18,929	2,093	20,904
	Difference = (PRE-POST)		-112.32	-7,200.40	1,530.46	5,663.05
	Standard deviation of difference		2,385.63	21,728.91	3,035.50	19,402.56
	Student's t-test statistic		-0.24	-1.66	2.52**	1.46
	p-value		0.82	0.11	0.02**	0.16
	Wilcoxon signed rank test statistic		150.00	136.00	87.00**	135.00
	p-value		0.74	0.49	0.04**	0.47

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 5.8- Results of comparison of average trading volume (open interest) 20 days before and after margin changes for the canola futures contract

20-day	Canola		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=23					
	PRE	Average	5,657	40,663	3,709	28,893
		Standard deviation	1,858	16,130	2,591	20,644
	POST	Average	5,226	37,043	3,655	26,682
		Standard deviation	1,747	17,744	2,341	16,167
	Difference = (PRE-POST)		430.92	3,619.47	54.15	2,210.84
	Standard deviation of difference		1,547.52	21,343.44	2,326.72	19,586.57
	Student's t-test statistic		1.34	0.81	0.11	0.54
	p-value		0.20	0.42	0.91	0.59
	Wilcoxon signed rank test statistic		96.00	104.00	120.00	136.00
	p-value		0.21	0.31	0.60	0.95
MARGIN DECREASE	N=25					
	PRE	Average	5,436	33,674	3,909	31,762
		Standard deviation	2,220	17,716	2,356	18,185
	POST	Average	5,651	41,414	2,762	25,323
		Standard deviation	2,439	15,157	1,833	15,581
	Difference = (PRE-POST)		-215.58	-7,740.81	1,146.90	6,439.35
	Standard deviation of difference		1,996.45	19,056.32	2,677.09	18,948.00
	Student's t-test statistic		-0.54	-2.03*	2.14**	1.70*
	p-value		0.59	0.05*	0.04**	0.10*
	Wilcoxon signed rank test statistic		153.00	80.00**	89.00**	99.00*
	p-value		0.80	0.02**	0.05**	0.09*

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level;
*** indicates significant at 99% confidence level;

Table 5.8: For the canola margin increase cases, although there is an inverse relationship between changes in average trading volume (open interest) and margin level for both the nearest and the second nearest canola futures contract, they all are insignificant. They do not reject the null hypothesis of the equality of the average trading volume (open interest) 20 days before and after margin increases.

For the canola margin decrease cases, the results however are not systematic. For the nearest contracts, one case shows a statistically significant inverse relationship between changes in average open interest and margin level under both Student's t- and Wilcoxon signed-rank tests, although the other insignificant case provides an inverse relationship between the movements of the changes. For the second nearest contracts, both cases show a significant positive relationship between changes in average trading volume (open interest) and margin level under both Student's t- and Wilcoxon signed-rank tests.

Table 5.9: For the canola margin increase cases, although there is an inverse relationship found between changes in average trading volume (open interest) and margin level for both the nearest and the second nearest canola futures contract, only two of them are statistically significant under the Wilcoxon signed-rank tests for the nearest canola contracts.

For the canola margin decrease cases, even though all the results are insignificant, two of the nearest contract cases predict an inverse relationship between changes in average trading volume (open interest) and margin level and two of the second nearest contract cases predict a positive relationship between the movements of the changes.

Table 5.9- Results of comparison of average trading volume (open interest) 30 days before and after margin changes for the canola futures contract

30-day	Canola		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=23					
	PRE	Average	5,736	40,863	3,887	29,394
		Standard deviation	1,776	14,891	2,466	18,295
	POST	Average	5,051	36,642	3,547	28,419
		Standard deviation	1,629	15,559	2,195	14,608
	Difference = (PRE-POST)		684.90	4,221.13	340.14	974.89
	Standard deviation of difference		1,133.78	16,595.00	1,968.92	15,707.35
	Student's t-test statistic		2.90***	1.22	0.83	0.30
	p-value		0.01***	0.24	0.42	0.77
	Wilcoxon signed rank test statistic		60.00**	76.00*	131.00	114.00
	p-value		0.01**	0.06*	0.84	0.48
MARGIN DECREASE	N=25					
	PRE	Average	5,561	36,256	3,599	30,192
		Standard deviation	2,023	16,757	1,937	16,348
	POST	Average	5,928	39,822	3,041	26,312
		Standard deviation	2,169	13,357	1,738	14,184
	Difference = (PRE-POST)		-367.17	-3,565.31	557.96	3,880.06
	Standard deviation of difference		1,529.26	15,503.46	2,298.79	18,433.71
	Student's t-test statistic		-1.20	-1.15	1.21	1.05
	p-value		0.24	0.26	0.24	0.30
	Wilcoxon signed rank test statistic		130.00	110.00	111.00	130.00
	p-value		0.39	0.16	0.17	0.39

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level;

Table 5.10- Results of comparison of average trading volume (open interest) 3 days before and after margin changes for the barley futures contract

3-day	Barley		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=16					
	PRE	Average	317	6,176	290	4,724
		Standard deviation	211	4,679	232	4,112
	POST	Average	313	5,943	297	5,125
		Standard deviation	252	4,641	248	3,964
	Difference = (PRE-POST)		4.10	232.94	-7.81	-400.79
	Standard deviation of difference		249.52	383.10	226.24	865.49
	Student's t-test statistic		0.07	2.43**	-0.14	-1.85*
	p-value		0.95	0.03**	0.89	0.08*
	Wilcoxon signed rank test statistic		67.00	21.00**	60.00	22.00**
	p-value		0.98	0.01**	0.71	0.02**
MARGIN DECREASE	N=19					
	PRE	Average	290	4,826	211	4,215
		Standard deviation	197	3,225	135	3,199
	POST	Average	310	4,609	234	4,346
		Standard deviation	195	3,249	232	3,180
	Difference = (PRE-POST)		-20.67	217.12	-22.88	-131.05
	Standard deviation of difference		207.17	483.00	194.79	265.58
	Student's t-test statistic		-0.43	1.96*	-0.51	-2.15**
	p-value		0.67	0.07*	0.61	0.05**
	Wilcoxon signed rank test statistic		79.00	28.00***	74.00	23.00***
	p-value		0.54	0.01***	0.42	0.00***

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 5.11- Results of comparison of average trading volume (open interest) 5 days before and after margin changes for the barley futures contract

5-day	Barley		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=16					
	PRE	Average	319	6,080	294	4,829
		Standard deviation	225	4,429	219	4,044
	POST	Average	332	5,791	351	5,075
		Standard deviation	268	4,608	314	3,977
	Difference = (PRE-POST)		-12.55	289.78	-56.86	-246.73
	Standard deviation of difference		277.52	661.00	339.37	834.35
	Student's t-test statistic		-0.18	1.75	-0.67	-1.18
	p-value		0.86	0.10	0.51	0.26
	Wilcoxon signed rank test statistic		60.00	31.00*	57.00	16.00***
	p-value		0.71	0.06*	0.60	0.01***
MARGIN DECREASE	N=19					
	PRE	Average	277	4,599	231	4,393
		Standard deviation	153	2,881	127	3,109
	POST	Average	325	4,691	217	4,302
		Standard deviation	187	3,175	165	3,185
	Difference = (PRE-POST)		-47.79	-91.26	14.25	91.11
	Standard deviation of difference		170.49	1,468.53	141.27	987.67
	Student's t-test statistic		-1.22	-0.27	0.44	0.40
	p-value		0.24	0.79	0.67	0.69
	Wilcoxon signed rank test statistic		71.00	67.00	61.00	62.00
	p-value		0.35	0.28	0.18	0.20

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 5.12- Results of comparison of average trading volume (open interest) 10 days before and after margin changes for the barley futures contract

10-day	Barley		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=16					
	PRE	Average	400	5,768	398	5,312
		Standard deviation	268	3,795	281	3,877
	POST	Average	386	6,094	387	5,185
		Standard deviation	256	3,912	275	3,519
	Difference = (PRE-POST)		14.06	-325.66	10.87	126.73
	Standard deviation of difference		368.15	2,500.52	409.61	2,400.86
	Student's t-test statistic		0.15	-0.52	0.11	0.21
	p-value		0.88	0.61	0.92	0.84
	Wilcoxon signed rank test statistic		65.00	58.00	56.00	62.00
	p-value		0.90	0.63	0.56	0.78
MARGIN DECREASE	N=19					
	PRE	Average	387	4,752	328	4,575
		Standard deviation	273	2,633	301	2,703
	POST	Average	345	5,120	228	3,986
		Standard deviation	201	2,811	155	2,775
	Difference = (PRE-POST)		41.70	-367.65	100.11	589.05
	Standard deviation of difference		336.80	2,630.56	336.63	2,059.92
	Student's t-test statistic		0.54	-0.61	1.30	1.25
	p-value		0.60	0.55	0.21	0.23
	Wilcoxon signed rank test statistic		92.00	95.00	58.00	72.00
	p-value		0.92	1.00	0.14	0.37

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level;
*** indicates significant at 99% confidence level;

Table 5.13- Results of comparison of average trading volume (open interest) 20 days before and after margin changes for the barley futures contract

20-day	Barley		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=16					
	PRE	Average	339	5,275	383	5,770
		Standard deviation	158	2,572	257	3,088
	POST	Average	402	5,848	387	5,152
		Standard deviation	206	3,116	219	2,279
	Difference = (PRE-POST)		-62.92	-573.18	-4.28	617.63
	Standard deviation of difference		280.79	3,238.21	351.20	3,137.32
	Student's t-test statistic		-0.90	-0.71	-0.05	0.79
	p-value		0.38	0.49	0.96	0.44
	Wilcoxon signed rank test statistic		57.00	56.00	67.00	54.00
	p-value		0.60	0.56	0.98	0.50
MARGIN DECREASE	N=19					
	PRE	Average	377	5,011	326	4,449
		Standard deviation	161	2,427	150	1,841
	POST	Average	354	5,721	259	3,643
		Standard deviation	176	2,183	158	1,932
	Difference = (PRE-POST)		23.36	-710.78	66.76	805.77
	Standard deviation of difference		242.46	3,038.07	246.74	2,575.25
	Student's t-test statistic		0.42	-1.02	1.18	1.36
	p-value		0.68	0.32	0.25	0.19
	Wilcoxon signed rank test statistic		82.00	73.00	63.00	64.00
	p-value		0.62	0.40	0.21	0.23

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level;
*** indicates significant at 99% confidence level;

Table 5.13: For both barley margin increase and decrease cases, all the cases show insignificant relationship between changes in average trading volume (open interest) and margin levels. Therefore, the null hypothesis of the equality of the average trading volumes (open interests) before and after margin changes is not rejected. Moreover, for all the eight cases, two of them show an inverse relationship and all others show a positive relationship between the movements of the changes.

Table 5.14- Results of comparison of average trading volume (open interest) 30 days before and after margin changes for the barley futures contract

30-day	Barley		Nearest Contract Trading Volume	Nearest Contract Open Interest	2nd Nearest Contract Trading Volume	2nd Nearest Contract Open Interest
MARGIN INCREASE	N=16					
	PRE	Average	366	5,118	391	5,983
		Standard deviation	148	2,046	189	2,695
	POST	Average	347	5,588	351	5,183
		Standard deviation	132	2,764	161	2,202
	Difference = (PRE-POST)		18.25	-469.93	39.27	800.56
	Standard deviation of difference		178.03	2,815.88	248.05	2,948.11
	Student's t-test statistic		0.41	-0.67	0.63	1.09
	p-value		0.69	0.51	0.54	0.29
	Wilcoxon signed rank test statistic		60.00	54.00	54.00	55.00
	p-value		0.71	0.50	0.50	0.53
MARGIN DECREASE	N=19					
	PRE	Average	373	5,028	339	4,439
		Standard deviation	104	2,280	82	1,282
	POST	Average	374	5,706	281	3,723
		Standard deviation	138	1,778	131	1,655
	Difference = (PRE-POST)		-1.56	-678.06	58.27	715.78
	Standard deviation of difference		186.27	2,606.88	174.39	2,064.37
	Student's t-test statistic		-0.04	-1.13	1.46	1.51
	p-value		0.97	0.27	0.16	0.15
	Wilcoxon signed rank test statistic		93.00	68.00	55.00	56.00
	p-value		0.95	0.29	0.11	0.12

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level;
*** indicates significant at 99% confidence level;

Table 5.14: All the barley cases show insignificant relationship between changes in average trading volume (open interest) and margin levels. This means that average trading volumes (open interests) before and after margin changes are similar. For all the insignificant cases, only three of them show a positive relationship and all others show an inverse relationship between the movements of the changes.

Overall, for both canola and barley futures contracts, many of the relationships between changes in trading activity and margin levels are insignificant. However, for the canola contracts, the results are mixed in that, for the statistically significant cases, a positive relationship shows mainly in 20-day window while a negative relationship shows mainly in 30-day window.

The theoretical hypothesis for the trading volume that Hartzmark (1986) presents is that, in the short run, there should be a positive relationship between margin changes and trading volume. For example, when the margin increases, traders may close their positions, and by doing so, transactions in the contracts may increase. However, in the long run, since trading volume and open interest are positively related, we should see a reduction (increase) in the trading volume when the margin level increases (decreases). Hence, a further examination of the 3- to 10-day window of the canola contracts reveals that all statistically significant cases shows a positive relationship between changes in average trading volume and margin level. Since the statistically significant cases of the nearest canola contract for the 30-day window show a negative relationship, this seems to support Hartzmark's argument that, as the time period extends, the inverse relationship between trading volume and margin should be found. However, for the barley futures contracts, no support is found for Hartzmark's argument; instead, many insignificant cases suggest that the mix of trader groups cause no change in trading activities.

Section 5.2- Regression of changes in average trading volume (open interest) on average margin level

To have a simple understanding of the relationship between changes in average trading activity and margin requirements, I conduct a regression of the percentage change in average trading volume (open interest) on the percentage change in average margin. In the regression model, the percentage change in average trading volume (open interest) is the dependent variable and the percentage change in the average margin requirements is the independent variable:

$$(5.4) \quad PCH\overline{TV} = \beta_0 + \beta_1 * PCH\overline{M} + \varepsilon_t,$$

$$(5.5) \quad PCH\overline{OI} = \beta_0 + \beta_1 * PCH\overline{M} + \varepsilon_t,$$

where $\overline{TV}$ is the average trading volume,

$\overline{M}$ is the average margin requirements,

$\overline{OI}$ is the average open interest,

$PCH\overline{TV}$ is the percentage change in average trading volume,

$PCH\overline{M}$ is the percentage change in average margin requirement,

$PCH\overline{OI}$ is the percentage change in average open interest, and

ε_t is the random error term

To obtain $PCH\overline{TV}$ around each margin change, first I need to compute the PRE and POST average trading volume, $\overline{TV}$, over 3 days before and after margin change, as in the analysis of the paired comparison in section 5.1. Then, each of the 3-day window of the percentage change in average trading volume, $PCH\overline{TV}$, is calculated by dividing the POST average trading volume, $\overline{TV}_{POST}$, by the PRE average trading volume, $\overline{TV}_{PRE}$, , and then subtract the result by 1:

$$(5.6) \quad PCH\overline{TV} = (\overline{TV}_{POST}/\overline{TV}_{PRE}) - 1$$

where *POST* represents the window [0, 3], and

PRE represents the window [-3, -1],

Similar calculations are done for the $PCH\overline{OI}$ and $PCH\overline{M}$:

$$(5.7)\quad PCH\overline{OI} = (\overline{OI}_{POST}/\overline{OI}_{PRE}) - 1$$

$$(5.8)\quad PCH\overline{M} = (\overline{M}_{POST}/\overline{M}_{PRE}) - 1$$

where *POST* represents the window [0, 3], and

PRE represents the window [-3, -1],

Similarly, each of the 5-, 10-, 20-, and 30-day windows of $PCH\overline{TV}$ and $PCH\overline{OI}$ are also computed where POST represents the windows [0, 5], [0, 10], [0, 20], [0, 30], and PRE represents the windows [-5, -1], [-10, -1], [-20, -1], [-30, -1].

Section 5.2a- Summary statistics of the average margin level before and after margin changes and of the percentage changes in average trading volume, open interest, and margin level

To understand the characteristics of the average margin level, $\overline{M}$, percentage change in average trading volume, $PCH\overline{TV}$, open interest, $PCH\overline{OI}$, and margin level, $PCH\overline{M}$, the summary statistics of them for each window of 3, 5, 10, 20 and 30 days are provided below for both nearest and second nearest canola and barley futures contracts in tables 5.15 to 5.22 before the results of the regression of percentage changes in average trading volume (open interest) on average margin level are provided.

Table 5.15- Summary statistics of the average margin level in the period preceding and following margin changes for the canola futures contract

Mean				
N= 48	Nearest Contract		Second Nearest Contract	
Window	$\bar{M}_{PRE}$	$\bar{M}_{POST}$	$\bar{M}_{PRE}$	$\bar{M}_{POST}$
3 days	360	360	360	360
5 days	360	361	360	361
10 days	357	364	357	364
20 days	355	371	355	371
30 days	350	374	350	374
Standard Deviation				
3 days	206	205	206	205
5 days	205	207	205	207
10 days	201	211	201	211
20 days	201	217	201	217
30 days	198	219	198	219
Minimum				
3 days	150	150	150	150
5 days	150	150	150	150
10 days	150	150	150	150
20 days	150	150	150	150
30 days	150	150	150	150
Maximum				
3 days	875	875	875	875
5 days	875	875	875	875
10 days	875	875	875	875
20 days	869	871	869	871
30 days	810	846	810	846
Median				
3 days	265	265	265	265
5 days	265	265	265	265
10 days	265	268	265	268
20 days	264	280	264	280
30 days	248	265	248	265
Excess Kurtosis				
3 days	-0.46	-0.46	-0.46	-0.46
5 days	-0.45	-0.50	-0.45	-0.50
10 days	-0.38	-0.51	-0.38	-0.51
20 days	-0.38	-0.53	-0.38	-0.53
30 days	-0.58	-0.64	-0.58	-0.64
Skewness				
3 days	0.89	0.89	0.89	0.89
5 days	0.89	0.89	0.89	0.89
10 days	0.90	0.89	0.90	0.89
20 days	0.91	0.90	0.91	0.90
30 days	0.87	0.87	0.87	0.87

Table 5.15: Most of the mean values of average margin level in the period POST are greater than in the period PRE for both nearest and second nearest canola contracts in different windows. This increasing trend of the mean values of average margin levels is due to the generally greater mean values of average margin increases than decreases. This can be confirmed by the fact that there is less number of incidences of margin increases than decreases: 23 increases versus 25 decreases. For both canola contracts, the standard

deviation values of the average margin level for the longer windows are lower than the standard deviation values for the shorter windows because the maximum values of average margin level are lower in the longer windows. The median values of average margin level are lower for longer windows for both maturity canola contracts. Since all the excess kurtosis measures are negative, the distributions of the average margin level have lower and wider peak and thinner tails than a normal distribution. Finally, all the skewness measures are positive, so the distributions have longer right tails and few high values of average margin level.

Table 5.16: all the mean values of average margin level in the period POST are greater than in the period PRE for both nearest and second nearest barley contracts in different windows. This increasing trend of the mean values of average margin levels is due to the generally greater mean values of average margin increases than decreases. This can be confirmed by the fact that there is less number of incidences of margin increases than decreases: 16 increases versus 19 decreases. For both barley contracts, the standard deviation values of the average margin level for all the windows are quite similar because of similar minimum and maximum values of average margin level in all windows. The median values of average margin level are lower for longer windows for maturity barley contracts. Since all the excess kurtosis measures are positive, the distributions of the average margin level have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures are positive, so the distributions have longer right tails and few high values of average margin level.

Table 5.16- Summary statistics of the average margin level in the period preceding and following margin changes for the barley futures contract

Mean				
N= 35	Nearest Contract		Second Nearest Contract	
Window	$\bar{M}_{PRE}$	$\bar{M}_{POST}$	$\bar{M}_{PRE}$	$\bar{M}_{POST}$
3 days	115	116	115	116
5 days	115	116	115	116
10 days	115	116	115	116
20 days	114	117	115	116
30 days	114	117	115	117
Standard Deviation				
3 days	40	41	40	41
5 days	40	41	40	41
10 days	40	41	40	41
20 days	40	41	41	40
30 days	40	41	41	40
Minimum				
3 days	60	60	60	60
5 days	60	60	60	60
10 days	60	60	60	60
20 days	60	60	61	64
30 days	62	65	62	65
Maximum				
3 days	230	230	230	230
5 days	230	230	230	230
10 days	230	230	230	230
20 days	230	230	230	230
30 days	230	230	230	230
Median				
3 days	115	115	115	115
5 days	109	115	115	115
10 days	105	115	105	115
20 days	105	115	105	114
30 days	101	111	101	109
Excess Kurtosis				
3 days	0.98	0.61	0.98	0.61
5 days	0.99	0.60	0.91	0.67
10 days	0.95	0.63	0.79	0.70
20 days	0.93	0.58	0.68	0.76
30 days	0.98	0.79	0.79	0.91
Skewness				
3 days	0.97	0.90	0.97	0.90
5 days	0.99	0.90	0.96	0.92
10 days	1.00	0.90	0.97	0.92
20 days	1.02	0.90	1.00	0.93
30 days	1.07	1.03	1.05	1.06

Overall, both the canola and barley contracts are positively skewed and have greater mean values of average margin level in period POST than in period PRE in different windows due to greater values of mean values of average margin increases than decreases. Finally, the mean values of average margin level of the barley contracts are lower than that of the canola contracts.

Table 5.17- Summary statistics of the percentage change in average trading volume around margin changes for the canola futures contract

Mean		
N= 48	Nearest Contract	Second Nearest Contract
Window	$\overline{PCHTV}$	$\overline{PCHTV}$
3 days	8.49%	44.85%
5 days	10.81%	21.12%
10 days	6.30%	9.64%
20 days	2.49%	20.10%
30 days	-0.04%	27.80%
Standard Deviation		
3 days	57.78%	163.64%
5 days	57.57%	81.64%
10 days	50.15%	72.74%
20 days	35.12%	108.87%
30 days	26.64%	127.41%
Minimum		
3 days	-67.30%	-78.30%
5 days	-76.39%	-89.20%
10 days	-59.75%	-93.49%
20 days	-50.57%	-93.57%
30 days	-43.80%	-91.19%
Maximum		
3 days	187.20%	952.58%
5 days	219.83%	291.17%
10 days	164.84%	195.58%
20 days	117.56%	390.88%
30 days	83.92%	542.55%
Median		
3 days	-10.43%	-1.49%
5 days	-5.33%	-0.24%
10 days	-1.88%	-6.21%
20 days	-7.61%	-6.31%
30 days	-6.84%	-5.99%
Excess Kurtosis		
3 days	1.80	20.15
5 days	2.45	1.50
10 days	1.69	-0.25
20 days	1.95	3.12
30 days	1.04	6.93
Skewness		
3 days	1.40	3.98
5 days	1.32	1.19
10 days	1.30	0.72
20 days	1.26	1.73
30 days	0.92	2.51

Table 5.17: Nearly all of the mean values of percentage change in average trading volume are positive for both nearest and second nearest canola contracts in different windows. Moreover, the standard deviation of the percentage change in average trading volume for the longer windows are lower than that observed in the shorter windows

because of the generally higher minimum values and the lower maximum values of percentage change in average trading volume in the longer windows. The median values of percentage change in average trading volume are greater for longer windows for the nearest contracts, while the opposite holds for the second nearest contracts. Since most of the excess kurtosis measures for both maturity contracts are positive, the distributions have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures are positive, so the distributions have longer right tails and few high values of percentage change in average trading volume.

Table 5.18: All of the mean values of percentage change in average trading volume are positive for both nearest and second nearest barley contracts in different windows. For both maturity contracts, the standard deviation values of the percentage change in average trading volume for the longer windows are lower than that for the shorter windows because of the generally higher minimum values and the lower maximum values of percentage change in average trading volume in the longer windows. The median values of percentage change in average trading volume are lower for longer windows for both maturity barley contracts. Since most of the excess kurtosis measures are positive, the distributions of the percentage change in average trading volume have higher peaks and fatter tails than a normal distribution. Finally, all the skewness measures for both barley contracts are positive, so the distributions have longer right tails and few high values of percentage change in average trading volume.

Table 5.18- Summary statistics of the percentage change in average trading volume around margin changes for the barley futures contract

Mean		
N= 35	Nearest Contract	Second Nearest Contract
Window	$\overline{PCHTV}$	$\overline{PCHTV}$
3 days	14.85%	53.69%
5 days	21.08%	52.74%
10 days	19.72%	49.20%
20 days	29.54%	54.87%
30 days	13.19%	8.02%
Standard Deviation		
3 days	68.84%	178.20%
5 days	81.93%	195.31%
10 days	91.68%	197.53%
20 days	98.34%	214.01%
30 days	68.34%	93.17%
Minimum		
3 days	-83.67%	-91.60%
5 days	-70.92%	-84.19%
10 days	-88.94%	-86.81%
20 days	-77.71%	-77.30%
30 days	-70.26%	-85.10%
Maximum		
3 days	207.56%	768.83%
5 days	336.36%	958.42%
10 days	260.93%	813.97%
20 days	356.03%	890.16%
30 days	225.87%	306.17%
Median		
3 days	13.38%	-7.92%
5 days	1.72%	-10.95%
10 days	-8.44%	-22.50%
20 days	-0.77%	-28.77%
30 days	-5.45%	-24.01%
Excess Kurtosis		
3 days	0.25	9.88
5 days	5.21	13.77
10 days	0.99	6.99
20 days	2.49	8.26
30 days	1.95	4.40
Skewness		
3 days	0.76	3.05
5 days	1.85	3.43
10 days	1.20	2.58
20 days	1.53	2.82
30 days	1.42	2.09

Overall, both the distributions of the percentage change in average trading volume for the nearest and second nearest canola and barley futures contracts in different windows are quite similar. However, for both canola and barley contracts, there is greater standard deviation values, maximum values, excess kurtosis measures, and skewness measures of the percentage change in average trading volume for the nearest than for the second nearest contracts.

Table 5.19- Summary statistics of the percentage change in average open interest around margin changes for the canola futures contract

Mean		
N= 48	Nearest Contract	Second Nearest Contract
Window	$\overline{PCHOI}$	$\overline{PCHOI}$
3 days	116.36%	2.57%
5 days	96.81%	4.07%
10 days	57.74%	8.01%
20 days	28.37%	10.07%
30 days	10.33%	17.01%
Standard Deviation		
3 days	370.86%	23.83%
5 days	316.85%	37.82%
10 days	164.14%	49.81%
20 days	84.15%	73.56%
30 days	53.84%	76.71%
Minimum		
3 days	-80.00%	-61.38%
5 days	-90.45%	-89.19%
10 days	-66.22%	-90.51%
20 days	-73.29%	-90.09%
30 days	-49.56%	-87.81%
Maximum		
3 days	1734.61%	51.41%
5 days	1523.57%	70.32%
10 days	714.09%	149.38%
20 days	274.42%	234.50%
30 days	168.32%	284.68%
Median		
3 days	-4.62%	5.41%
5 days	-7.52%	10.93%
10 days	-8.76%	11.39%
20 days	3.47%	-3.85%
30 days	-3.81%	10.06%
Excess Kurtosis		
3 days	9.91	1.35
5 days	9.64	0.34
10 days	5.85	0.38
20 days	1.88	0.55
30 days	2.06	2.81
Skewness		
3 days	3.13	-0.85
5 days	3.04	-0.79
10 days	2.40	0.06
20 days	1.53	0.84
30 days	1.54	1.42

Table 5.19: All the mean values of percentage change in average open interest are positive for both nearest and second nearest canola contracts in different windows. For the nearest contract, the standard deviation values of the percentage change in average open interest for the longer windows are lower than that for the shorter windows because

of the higher minimum values and the lower maximum values of percentage change in average open interest in the longer windows. However, the opposite occurs for the second nearest contract. The median values of the percentage change in average open interest are greater for longer windows for both contracts. Since all the excess kurtosis measures for both contracts are positive, the distributions of the percentage change in average open interest have higher peak and fatter tails than a normal distribution. Finally, all of the skewness measures for both maturity canola contracts are positive, so the distributions have longer right tails and few high values of percentage change in average open interest.

Table 5.20: Most of the mean values of percentage change in average open interest are positive for both nearest and second nearest barley contracts in different windows. For the nearest contract, the standard deviation values of the percentage change in average open interest for the longer windows are lower than that for the shorter windows due to the generally higher minimum values and the lower maximum values of percentage change in average open interest in the longer windows. However, the opposite occurs for the second nearest contract. The median values of percentage change in average open interest in the longer windows are higher for the nearest contract, but lower for the second nearest contract. Since most of the excess kurtosis measures for both contracts are positive, the distributions of the percentage change in average open interest have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures for both barley contracts are positive, so the distributions have longer right tails and few high values of percentage change in average open interest.

Table 5.20- Summary statistics of the percentage change in average open interest around margin changes for the barley futures contract

Mean		
N= 35	Nearest Contract	Second Nearest Contract
Window	$PCH\overline{OI}$	$PCH\overline{OI}$
3 days	-5.39%	18.36%
5 days	-0.47%	8.89%
10 days	28.50%	10.23%
20 days	35.35%	2.66%
30 days	24.78%	-7.32%
Standard Deviation		
3 days	32.52%	56.03%
5 days	59.77%	32.70%
10 days	93.82%	83.28%
20 days	96.84%	61.91%
30 days	66.85%	43.52%
Minimum		
3 days	-50.05%	-10.72%
5 days	-60.87%	-71.63%
10 days	-81.21%	-81.47%
20 days	-62.79%	-82.85%
30 days	-54.87%	-79.97%
Maximum		
3 days	164.12%	278.05%
5 days	300.42%	148.78%
10 days	339.12%	426.40%
20 days	401.89%	158.65%
30 days	252.97%	105.61%
Median		
3 days	-4.47%	3.36%
5 days	-5.26%	6.65%
10 days	-5.46%	4.81%
20 days	10.04%	-7.36%
30 days	12.60%	-13.70%
Excess Kurtosis		
3 days	22.91	16.30
5 days	19.49	10.52
10 days	2.64	18.85
20 days	5.36	0.19
30 days	3.31	0.50
Skewness		
3 days	4.21	4.04
5 days	3.97	2.05
10 days	1.64	3.79
20 days	2.04	0.92
30 days	1.67	0.71

Overall, both the nearest and second nearest canola and barley futures contracts are similar in terms the standard deviation values, maximum values, minimum values, and skewness measures of the percentage change in average open interest in 20- and 30-day windows.

Table 5.21- Summary statistics of the percentage change in average margin level around margin changes for the canola futures contract

Mean		
N= 48	Nearest Contract	Second Nearest Contract
Window	$PCH\bar{M}$	$PCH\bar{M}$
3 days	2.90%	2.90%
5 days	3.15%	3.15%
10 days	4.61%	4.61%
20 days	8.21%	8.21%
30 days	11.79%	11.73%
Standard Deviation		
3 days	24.60%	24.60%
5 days	24.70%	24.70%
10 days	26.32%	26.32%
20 days	33.04%	33.04%
30 days	40.22%	40.19%
Minimum		
3 days	-34.43%	-34.43%
5 days	-34.43%	-34.43%
10 days	-34.43%	-34.43%
20 days	-39.43%	-39.43%
30 days	-41.42%	-41.42%
Maximum		
3 days	56.25%	56.25%
5 days	56.25%	56.25%
10 days	65.63%	65.63%
20 days	78.57%	78.57%
30 days	115.01%	115.01%
Median		
3 days	-6.71%	-6.71%
5 days	-6.71%	-6.71%
10 days	-6.71%	-6.71%
20 days	-0.73%	-0.73%
30 days	6.10%	6.10%
Excess Kurtosis		
3 days	-1.20	-1.20
5 days	-1.24	-1.24
10 days	-1.20	-1.20
20 days	-0.87	-0.87
30 days	0.51	0.52
Skewness		
3 days	0.30	0.30
5 days	0.27	0.27
10 days	0.29	0.29
20 days	0.50	0.50
30 days	1.04	1.05

Table 5.21: All of the mean values of percentage change in average margin level are positive for both nearest and second nearest canola contracts in different windows due to the greater mean values of average margin increases than decreases. For both maturity canola contracts, the standard deviation values of the percentage change in average

margin level are higher in the longer windows than in the shorter windows because of the lower minimum values and the higher maximum values of percentage change in average margin level in the longer windows. The median values of percentage change in average margin level are greater for longer windows for both maturity contracts. Since most of the excess kurtosis measures for both contracts are negative, the distributions of the percentage change in average margin level have lower and wider peak and thinner tails than a normal distribution. Finally, all the skewness measures are positive, so the distributions have longer right tails and few high values of percentage change in average margin level.

Table 5.22: All of the mean values of percentage change in average margin level are positive for both nearest and second nearest barley contracts in different windows due to the greater values of average margin increases than decreases. For both maturity barley contracts, the standard deviation values of the percentage change in average margin level in the longer windows is higher than in the shorter window because of the lower minimum values of percentage change in average margin level in the longer windows. The median values of percentage change in average margin level are higher for longer windows for both maturity contracts. Since all the excess kurtosis measures for both contracts are negative, the distributions of the percentage change in average margin level have lower and wider peak and thinner tails than a normal distribution. Finally, all the skewness measures are positive, so the distributions have longer right tails and few high values of percentage change in average margin level.

Table 5.22- Summary statistics of the percentage change in average margin level around margin changes for the barley futures contract

Mean		
N= 35	Nearest Contract	Second Nearest Contract
Window	$PCH\bar{M}$	$PCH\bar{M}$
3 days	2.98%	2.98%
5 days	3.18%	2.80%
10 days	3.54%	3.23%
20 days	4.63%	3.85%
30 days	5.67%	4.99%
Standard Deviation		
3 days	22.90%	22.90%
5 days	22.98%	23.08%
10 days	23.41%	23.95%
20 days	25.47%	25.30%
30 days	26.25%	26.28%
Minimum		
3 days	-23.81%	-23.81%
5 days	-23.81%	-23.81%
10 days	-23.81%	-28.57%
20 days	-27.93%	-32.98%
30 days	-32.11%	-35.42%
Maximum		
3 days	53.85%	53.85%
5 days	53.85%	53.85%
10 days	53.85%	53.85%
20 days	53.85%	53.85%
30 days	51.85%	46.91%
Median		
3 days	-7.69%	-7.69%
5 days	-7.69%	-7.69%
10 days	-7.69%	-7.69%
20 days	-7.69%	-7.41%
30 days	-6.38%	-4.63%
Excess Kurtosis		
3 days	-0.88	-0.88
5 days	-0.92	-0.90
10 days	-1.04	-1.08
20 days	-1.37	-1.29
30 days	-1.42	-1.45
Skewness		
3 days	0.66	0.66
5 days	0.64	0.64
10 days	0.58	0.51
20 days	0.43	0.36
30 days	0.32	0.21

Overall, all the mean values of percentage change in average margin level are positive for both nearest and second nearest canola and barley contracts in different windows due to the greater mean values of the average margin increases than decreases. The nearest and second nearest barley contracts have lower standard deviation values, higher minimum values, lower maximum values of the percentage change in average margin level than do the nearest and second nearest canola contracts. However, the distributions of both canola and barley futures contracts are quite similar in terms of excess kurtosis and skewness measures.

Section 5.2b- Results of regression of percentage change in average trading volume (open interest) on percentage change in average margin level

Tables 5.23 to 5.30 show the results of the simple linear regressions of the percentage changes in average trading volume (open interest) on average margin level for each window of 3, 5, 10, 20 and 30 days for both nearest and second nearest canola and barley futures contracts. Note that only the tests with 20-day and 30-day windows are discussed. Statistics given in the tables include skewness, excess kurtosis and a set of tests for normality and heteroskedasticity.

According to Shapiro and Wilk (1965), the Shapiro-Wilks test is a normality test that is based on the ratio of the ordered residuals to their expected values under normality. Thus, the Shapiro-Wilks test statistic is between zero and one. The small values of the statistic lead to the rejection of the null hypothesis of normality, however, large values such as 0.90 sometimes may also be considered small because the distribution of the statistic is highly skewed. Thus, it may also lead to the rejection of the null hypothesis. Because the Shapiro-Wilks test is insensitive to small samples as small as a size of 20, it is suitable for my sample to test whether the residuals are normality distributed. For my test, I compare the p-value of the test statistic with the significance level of 1%, 5% and 10%. Generally, if the p-value is smaller than the 10% significance level, the null hypothesis of normality is rejected.

The Breusch-Pagan and the White's tests are used to test for constancy of residual variance. According to Kutner, Nachtsheim and Neter (2004), the Breusch-Pagan test is a large-sample test that assumes that the error terms are independent and normally distributed. It tests the null hypothesis that the residual variance is uncorrelated with the independent variable(s), so the residual variance is constant. The test statistics is calculated by first obtaining the residuals from the regression of the dependent variable on the independent variable(s), then dividing the sum of the squared residuals by the sample size (call the result $\widehat{\sigma}^2$). Then, obtain the ratio of the squared residuals on $\widehat{\sigma}^2$, and regress this ratio on the independent variable(s). Next, dividing the regression sum of squares by 2 gives us the test statistics (Pindyck & Rubinfeld, 1998). Thus, the null hypothesis is rejected when the test statistics is higher than its critical value, which follows a chi-square distribution with the degrees of freedom equal to the number of independent variables. By comparing the p-value of the test statistic to the significance level of 1%, 5% and 10%, I can also decide whether the null hypothesis of constant variance should be rejected.

However, since the Breusch-Pagan test is suitable for large samples, I also employ the White's test to determine whether the error variance is constant because it can be used for smaller samples of 30 or more observations. The White's test is a general test that does not make assumptions about normality and the nature of any heteroscedasticity (Pindyck & Rubinfeld, 1998; White, 1980). The hypothesis tests whether the residual variance is constant. It is based on the regression of the residual variance on the cross-products of the independent variables, the independent variables and the squared independent variables. Thus, the null hypothesis is rejected when the test statistic, which is the product of the sample size and the R-squared from the above regression, is higher than its critical value, which follows a chi-square distribution with the degrees of freedom equal to the number of regression coefficients in the above regression minus one. By comparing the p-value of the test statistic to the significance level of 1%, 5% and 10%, I can also decide whether the null hypothesis of constant variance should be rejected.

The Heteroscedasticity-Corrected Covariance Matrix Estimator (HCCME) is used for correcting the heteroscedastic residual variance. White (1980) proposed a Heteroscedasticity-Corrected Covariance Matrix Estimator (HCCME0) to correct for heteroscedasticity when the form and the source of the heteroscedasticity are not clear. However, because this estimator is only correct in large samples, MacKinnon and White (1985) proposed HCCME1, HCCME2, and HCCME3. The difference between these methods, HCCME0, HCCME1, HCCME2, and HCCME3, rests on the use of the squared residuals in the estimation processes (Hayes, 2003). Using sampling experiments with finite samples, MacKinnon and White (1985) find that the HCCME3 performs better than the HCCME2 which performs better than the HCCME1 which in turn outperforms the original HCCME0. An assessment of these methods by Long and Ervin (2000) advocates that we should use HCCME3 whenever our sample size is small because using the HCCME0 would provide us an incorrect inference. I therefore choose to use HCCME3 in my test as it performs the best even in small samples of 25 observations (MacKinnon & White, 1985; Long & Ervin, 2000). In my test, the new estimates of standard errors and t-statistics will be calculated so as to become consistent estimates; however, the R-squared for the regression stays the same. In HCCME3, each squared OLS residual is weighted by a factor of $1/(1-h_{ii})^2$, where the h_{ii}s are the leverage values and the diagonal elements in the "hat" matrix (Hayes & Cai, 2007).

Table 5.23- Results of the regression analysis of the relationship between percentage changes in average trading volume and average margin level for the nearest canola futures contract

Results of regression						
Column	(1)	(2)	(3)	(4)	(5)	(6)
N= 48	3-day	5-day	10-day	20-day	30-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	With correction for hetero-scedasticity
Overall regression:						
F Value	0.57	0.16	0.29	1.50	9.08***	9.08***
Pr > F	0.45	0.69	0.59	0.23	0.00***	0.00***
β_0	0.09	0.11	0.07	0.04	0.03	0.03
Standard Error	0.08	0.08	0.07	0.05	0.04	0.04
t-statistics	1.10	1.33	0.94	0.78	0.85	0.76
Pr > |t|	0.28	0.19	0.35	0.44	0.40	0.45
β of $PCH\bar{M}$	-0.26	-0.14	-0.15	-0.19	-0.27	-0.27
Standard Error	0.34	0.34	0.28	0.15	0.09	0.09
t-statistics	-0.76	-0.40	-0.54	-1.22	-3.01***	-3.12***
Pr > |t|	0.45	0.69	0.59	0.23	0.00***	0.00***
R-square	0.01	0.00	0.01	0.03	0.16	0.16
Characteristics of the residual						
Skewness	1.36	1.27	1.27	1.09	0.54	
Excess Kurtosis	1.69	2.31	1.57	1.35	0.40	
Shapiro-Wilkes test						
for normality	0.87***	0.91***	0.89***	0.92***	0.98	
Pr < W	<0.0001***	0.00***	0.00***	0.00***	0.50	
White's test for						
homoscedasticity	1.48	1.27	2.22	3.26	4.65*	
Pr > ChiSq	0.48	0.53	0.33	0.20	0.10*	
Breusch-Pagan test						
For homoscedasticity	0.40	1.27	0.38	2.37	3.54**	
Pr > ChiSq	0.53	0.26	0.54	0.12	0.06**	

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.23: all the windows show an insignificant relationship between percentage changes in average trading volume and average margin level. However, in the 30-day window, there is a statistically significant negative relationship between the two variables at 99% confidence level.

Because most cases exhibit constant residual variances with the exception of the 30-day window under both the White's and the Breusch-Pagan test, I make a correction for the heteroscedasticity in 30-day window shown in the last column (column 6). However, it still makes no alteration on the significance of the relationship. Finally, the residuals for all the windows exhibit non-normality except for the 30-day window.

Table 5.24- Results of the regression analysis of the relationship between percentage changes in average trading volume and average margin level for the second nearest canola futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 48	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression: F Value Pr > F	 0.41 0.52	 0.77 0.38	 2.33 0.13	 1.02 0.32	 0.00 0.99
β_0 Standard Error t-statistics Pr > |t|	0.47 0.24 1.95* 0.06*	0.20 0.12 1.66 0.10	0.07 0.11 0.65 0.52	0.16 0.16 0.99 0.33	0.28 0.19 1.44 0.16
β of $PCH\bar{M}$ Standard Error t-statistics Pr > |t|	-0.63 0.98 -0.64 0.52	0.43 0.48 0.88 0.38	0.61 0.40 1.53 0.13	0.49 0.48 1.01 0.32	-0.01 0.47 -0.01 0.99
R-square	0.01	0.02	0.05	0.02	0.00
Characteristics of the residual					
Skewness	3.82	1.25	0.77	1.81	2.51
Excess Kurtosis	18.99	1.77	0.08	3.48	6.93
Shapiro-Wilkes test for normality Pr < W	0.62*** <0.0001***	0.90*** 0.00***	0.95** 0.03**	0.81*** <0.0001***	0.71*** <0.0001***
White's test for homoscedasticity Pr > ChiSq	2.29 0.32	1.67 0.43	1.82 0.40	1.44 0.49	1.06 0.59
Breusch-Pagan test for homoscedasticity Pr > ChiSq	1.66 0.20	0.09 0.77	0.01 0.92	0.01 0.91	0.30 0.58

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.24: All the windows show an insignificant relationship between the percentage change in average trading volume and the percentage change in average

margin level. Moreover, all the cases exhibit constant residual variances but non-normal residuals.

Table 5.25- Results of the regression analysis of the relationship between percentage changes in average trading volume and average margin level for the nearest barley futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 35	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression: F Value Pr > F	 1.41 0.24	 2.28 0.14	 0.06 0.81	 0.57 0.46	 0.56 0.46
β_0 Standard Error t-statistics Pr > |t|	0.19 0.12 1.64 0.11	0.25 0.14 1.87* 0.07*	0.23 0.16 1.42 0.16	0.27 0.17 1.62 0.12	0.15 0.12 1.28 0.21
β of $PCH\bar{M}$ Standard Error t-statistics Pr > |t|	-0.61 0.51 -1.19 0.24	-0.90 0.59 -1.51 0.14	-0.16 0.68 -0.24 0.81	0.50 0.66 0.75 0.46	-0.33 0.45 -0.75 0.46
R-square	0.04	0.06	0.00	0.02	0.02
Characteristics of the residual					
Skewness	0.71	2.09	1.29	1.40	1.51
Excess Kurtosis	0.45	7.21	1.37	2.04	2.54
Shapiro-Wilkes test for normality Pr < W	0.95 0.15	0.83*** <0.0001***	0.88*** 0.00***	0.88*** 0.00***	0.87*** 0.00***
White's test for homoscedasticity Pr > ChiSq	0.54 0.76	1.13 0.57	2.70 0.26	2.22 0.33	0.75 0.69
Breusch-Pagan test for homoscedasticity Pr > ChiSq	0.02 0.90	0.00 0.95	0.18 0.67	2.22 0.14	0.10 0.76

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.25: All the windows show an insignificant relationship between percentage changes in average trading volume and average margin level. Moreover, all the cases exhibit constant residual variances but non-normal residuals.

Table 5.26- Results of the regression analysis of the relationship between percentage changes in average trading volume and average margin level for the second nearest barley futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 35	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression:					
F Value	0.17	0.24	0.01	0.42	0.00
Pr > F	0.68	0.63	0.92	0.52	0.98
β_0	0.55	0.51	0.49	0.51	0.08
Standard Error	0.31	0.34	0.34	0.37	0.16
t-statistics	1.80*	1.51	1.42	1.39	0.49
Pr > |t|	0.08*	0.14	0.16	0.17	0.63
β of $PCH\tilde{M}$	-0.56	0.72	0.15	0.95	0.02
Standard Error	1.35	1.47	1.441	1.46	0.62
t-statistics	-0.42	0.49	0.11	0.65	0.03
Pr > |t|	0.68	0.63	0.92	0.52	0.98
R-square	0.01	0.01	0.00	0.01	0.00
Characteristics of the residual					
Skewness	3.00	3.36	2.55	2.75	2.09
Excess Kurtosis	9.66	13.32	6.82	7.89	4.43
Shapiro-Wilkes test for normality	0.62***	0.60***	0.65***	0.64***	0.75***
Pr < W	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***
White's test for homoscedasticity	0.47	2.37	3.60	1.06	0.29
Pr > ChiSq	0.79	0.31	0.17	0.59	0.87
Breusch-Pagan test for homoscedasticity	0.24	0.27	0.28	0.70	0.02
Pr > ChiSq	0.62	0.61	0.60	0.40	0.88

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.26: All the windows show a neutral relationship between the percentage changes in average trading volume and average margin level. All the cases exhibit constant residual variances but non-normality residuals.

Overall, most of the canola and all the barley contracts show a neutral relationship between the percentage changes in average trading volume and average margin level. However, one case of the nearest canola contract in the 30-day window exhibits a statistically significant negative relationship between the two variables. This result is similar to the paired-sample comparison test in section 5.1b.

Table 5.27- Results of the regression analysis of the relationship between percentage changes in average open interest and average margin level for the nearest canola futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 48	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression:					
F Value	1.38	1.70	2.09	3.79	5.10**
Pr > F	0.25	0.20	0.15	0.06	0.03**
β_0	1.24	1.04	0.64	0.34	0.15
Standard Error	0.54	0.46	0.24	0.12	0.08
t-statistics	2.31	2.28	2.68	2.81	1.97
Pr > |t|	0.03	0.03	0.01	0.01	0.05
β of $PCH\bar{M}$	-2.58	-2.42	-1.30	-0.70	-0.42
Standard Error	2.19	1.86	0.90	0.36	0.19
t-statistics	-1.18	-1.30	-1.45	-1.95*	-2.26**
Pr > |t|	0.25	0.20	0.15	0.06*	0.03**
R-square	0.03	0.04	0.04	0.08	0.10
Characteristics of the residual					
Skewness	2.99	2.87	2.26	1.38	1.47
Excess Kurtosis	9.42	9.21	5.43	1.34	1.82
Shapiro-Wilkes test for normality	0.59***	0.63***	0.72***	0.85***	0.86***
Pr < W	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***
White's test for homoscedasticity	1.60	1.88	1.89	1.85	1.33
Pr > ChiSq	0.45	0.39	0.39	0.40	0.51
Breusch-Pagan test for homoscedasticity	1.21	1.41	1.47	1.84	1.30
Pr > ChiSq	0.27	0.24	0.23	0.17	0.25

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.27: In the 20-day window, there is a statistically significant negative relationship between percentage changes in average open interest and average margin level at 90% confidence level. Also, the 30-day window shows a statistically significant negative relationship between the two variables at 95% confidence level. However, all

other windows show an insignificant relationship between the two variables. Moreover, all the cases exhibit constant residual variances but non-normal residuals.

Table 5.28- Results of the regression analysis of the relationship between percentage changes in average open interest and average margin level for the second nearest canola futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 48	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression: F Value Pr > F	 0.26 0.61	 0.81 0.37	 0.71 0.40	 0.22 0.64	 0.06 0.80
β_0 Standard Error t-statistics Pr > |t|	0.02 0.03 0.68 0.50	0.03 0.056 0.62 0.54	0.07 0.07 0.95 0.35	0.09 0.11 0.80 0.43	0.16 0.12 1.39 0.17
β of $PCH\bar{M}$ Standard Error t-statistics Pr > |t|	0.07 0.14 0.51 0.61	0.20 0.22 0.90 0.37	0.23 0.28 0.84 0.40	0.15 0.33 0.46 0.64	0.07 0.28 0.25 0.80
R-square	0.01	0.02	0.02	0.00	0.00
Characteristics of the residual					
Skewness	-0.77	-0.65	0.17	0.89	1.44
Excess Kurtosis	1.26	0.22	0.48	0.69	2.79
Shapiro-Wilkes test for normality Pr < W	0.89*** 0.00***	0.93*** 0.01***	0.97 0.26	0.93*** 0.01***	0.88*** 0.00***
White's test for homoscedasticity Pr > ChiSq	2.28 0.32	4.54 0.10	1.50 0.47	1.25 0.54	1.31 0.52
Breusch-Pagan test for homoscedasticity Pr > ChiSq	1.96 0.16	3.48 0.06	1.50 0.22	0.88 0.35	0.51 0.47

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.28: An insignificant relationship between percentage changes in average open interest and average margin level is found in all the windows. All the cases exhibit constant residual variances but non-normal residuals.

Table 5.29- Results of the regression analysis of the relationship between percentage changes in average open interest and average margin level for the nearest barley futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 35	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression:					
F Value	0.02	0.63	0.20	0.00	0.02
Pr > F	0.89	0.43	0.66	0.98	0.89
β_0	-0.06	0.00	0.34	0.37	0.25
Standard Error	0.06	0.10	0.18	0.17	0.12
t-statistics	-0.99	0.01	1.83	2.16	2.13
Pr > |t|	0.33	0.99	0.08	0.04	0.04
β of $PCH\bar{M}$	-0.03	-0.36	0.36	-0.02	0.06
Standard Error	0.25	0.45	0.79	0.66	0.44
t-statistics	-0.14	-0.79	0.45	-0.03	0.14
Pr > |t|	0.89	0.43	0.66	0.98	0.89
R-square	0.00	0.02	0.01	0.00	0.00
Characteristics of the residual					
Skewness	4.17	3.83	1.99	1.95	1.60
Excess Kurtosis	22.58	18.64	4.02	4.88	3.05
Shapiro-Wilkes test for normality	0.54***	0.62***	0.76***	0.82***	0.86***
Pr < W	<0.0001***	<0.0001***	<0.0001***	<0.0001***	0.0004***
White's test for homoscedasticity	0.58	0.69	1.61	2.07	3.58
Pr > ChiSq	0.75	0.71	0.45	0.35	0.17
Breusch-Pagan test for homoscedasticity	0.46	0.53	0.06	0.27	0.00
Pr > ChiSq	0.50	0.46	0.81	0.60	0.96

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.29: An insignificant relationship between percentage changes in average open interest and average margin level is observed in all the windows. All the cases exhibit constant residual variances but non-normal residuals.

Table 5.30- Results of the regression analysis of the relationship between percentage changes in average open interest and average margin level for the second nearest barley futures contract

Results of regression					
Column	(1)	(2)	(3)	(4)	(5)
N= 35	3-day	5-day	10-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression: F Value Pr > F	 1.07 0.31	 0.13 0.72	 0.34 0.56	 0.54 0.47	 0.08 0.78
β_0 Standard Error t-statistics Pr > |t|	0.17 0.10 1.79 0.08	0.09 0.06 1.53 0.14	0.09 0.14 0.63 0.53	0.01 0.11 0.14 0.89	-0.08 0.08 -1.02 0.32
β of $PCH\bar{M}$ Standard Error t-statistics Pr > |t|	0.43 0.42 1.03 0.31	0.09 0.25 0.36 0.72	0.35 0.60 0.58 0.56	0.31 0.42 0.73 0.47	0.08 0.29 0.28 0.78
R-square	0.03	0.00	0.01	0.02	0.00
Characteristics of the residual					
Skewness	3.80	2.03	3.74	0.88	0.67
Excess Kurtosis	15.23	10.23	18.39	-0.05	0.44
Shapiro-Wilkes test for normality Pr < W	0.50*** <0.0001***	0.71*** <0.0001***	0.64*** <0.0001***	0.91*** 0.0102***	0.96 0.21
White's test for homoscedasticity Pr > ChiSq	1.79 0.41	3.39 0.18	1.90 0.39	1.34 0.51	3.79 0.15
Breusch-Pagan test for homoscedasticity Pr > ChiSq	1.01 0.32	0.06 0.81	0.13 0.71	0.69 0.41	1.03 0.31

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 5.30: An insignificant relationship between percentage changes in average open interest and average margin level is obtained for all the windows. All the cases exhibit constant residual variances but non-normal residuals except for the 30-day window.

Overall, most of the canola and all the barley contracts show insignificant relationship between percentage changes in average open interest and average margin level. However, two cases of the nearest canola contract in the 20- and 30-day windows exhibit a statistically significant inverse relationship between the two variables. This result is similar to the paired-sample comparison test in section 5.1b.

It therefore appears that the view of a negative impact on trading activities is only slightly supported in longer windows for two cases of the canola contracts while a neutral effect appears to hold for most cases of the canola contracts and all cases of the barley contracts. This suggests that the mix of trader groups may cause no change in trading activities especially for the barley contracts. The result is quite different from Hardouvelis and Kim (1995) who find with an overall negative relationship between margin and trading activities.

6. RELATIONSHIP BETWEEN CHANGES IN FUTURES PRICE VOLATILITY AND MARGIN REQUIREMENTS

In this chapter, I provide a simple analysis of the relationship between changes in futures price volatility and margin requirements. In section 6.1, a comparison of the futures price volatility, *V*, in the period before and after margin changes is examined. In section 6.2, I provide the analysis of the regression of percentages changes in futures price volatility on average margin level.

Section 6.1- Comparison of the futures price volatility in the period before and after margin changes

My hypotheses from chapter 4 state that there should be a reduction (increase) in the futures price volatility following margin increases (decreases) under the restriction hypothesis (H1) and an increase (decrease) in the futures price volatility following margin increases (decreases) under the competitive hypothesis (H2), while there will be no change in the futures price volatility following margin changes under the liquidity costs hypothesis (H3). Thus, to have a general idea of the direction of the volatility of the daily futures price around margin changes, I compare the futures price volatility, *V*, over 20 trading days before and after the margin changes in this section. The futures price volatility, *V*, is calculated as the standard deviation of the logarithmic daily futures return for 20 days before and after margin changes. For robustness, I also conduct the tests using a 30-day window. Note that for all the tests starting from this chapter and onwards, only the tests with 20-day and 30-day windows are conducted and discussed.

Section 6.1a- Summary statistics of the futures price volatility

To understand the characteristics of the futures price volatility, summary statistics of the futures price volatility for each window of 20 and 30 days before and after margin changes are provided below for both nearest and second nearest canola and barley futures contracts in tables 6.1 and 6.2. Note, V_{PRE} indicates the summary statistics of the futures price volatility in the period preceding margin changes and V_{POST} indicates the summary statistics of the futures price volatility in the period following margin changes.

Table 6.1- Summary statistics of the futures price volatility in the period preceding and following margin changes for the canola futures contract

Mean				
N= 48	Nearest Contract		Second Nearest Contract	
Window	V_{PRE}	V_{POST}	V_{PRE}	V_{POST}
20 days	1.82%	1.88%	1.76%	1.82%
30 days	1.82%	1.84%	1.77%	1.80%
Standard Deviation				
20 days	0.92%	0.99%	0.93%	0.99%
30 days	0.82%	0.88%	0.83%	0.86%
Minimum				
20 days	0.77%	0.72%	0.75%	0.76%
30 days	0.77%	0.87%	0.79%	0.85%
Maximum				
20 days	4.89%	4.99%	4.84%	4.90%
30 days	4.29%	4.36%	4.20%	4.26%
Median				
20 days	1.58%	1.65%	1.47%	1.54%
30 days	1.58%	1.56%	1.47%	1.56%
Excess Kurtosis				
20 days	2.26	1.62	2.09	1.52
30 days	1.02	1.22	0.73	1.21
Skewness				
20 days	1.50	1.43	1.49	1.41
30 days	1.22	1.28	1.18	1.27

Table 6.1: All the mean values of futures price volatility in period POST are greater than in period PRE for both nearest and second nearest canola contracts in 20- and 30-day windows. The mean values of futures price volatility seem to be quite similar in both windows for both canola contracts. For both canola contracts, the standard deviation values of the futures price volatility in the 30-day windows are lower than the

standard deviation values of the futures price volatility in the 20-day windows because of the higher minimum values and lower maximum values of the futures price volatility in the longer windows. The median values of the futures price volatility are quite similar in different windows of each maturity canola contract. Since all the excess kurtosis measures for both canola contracts are positive, the distributions of the futures price volatility have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures for both canola contracts are positive, so the distributions have longer right tails and few high values of the futures price volatility.

Table 6.2- Summary statistics of the futures price volatility in the period preceding and following margin changes for the barley futures contract

Mean				
N= 35	Nearest Contract		Second Nearest Contract	
Window	V_{PRE}	V_{POST}	V_{PRE}	V_{POST}
20 days	1.94%	1.98%	1.69%	1.78%
30 days	1.91%	1.88%	1.76%	1.68%
Standard Deviation				
20 days	1.08%	1.18%	0.82%	0.96%
30 days	0.85%	0.96%	0.82%	0.78%
Minimum				
20 days	0.62%	0.61%	0.51%	0.62%
30 days	0.81%	0.62%	0.78%	0.87%
Maximum				
20 days	5.14%	5.23%	4.40%	5.25%
30 days	4.27%	4.39%	4.68%	4.30%
Median				
20 days	1.61%	1.60%	1.51%	1.49%
30 days	1.60%	1.61%	1.53%	1.36%
Excess Kurtosis				
20 days	0.89	1.55	2.19	4.51
30 days	0.44	1.04	3.85	3.01
Skewness				
20 days	1.18	1.46	1.25	1.92
30 days	1.00	1.27	1.71	1.65

Table 6.2: The mean values of futures price volatility in period POST are greater than in period PRE for both nearest and second nearest barley contracts in 20-day windows, but the opposite occurs in the 30-day windows. For both maturity barley

contracts, the standard deviation values of the futures price volatility in the 30-day windows are lower than the standard deviation values in the 20-day windows because of the higher minimum values and the lower maximum values of the futures price volatility in the longer windows. The median values of the futures price volatility are quite similar in different windows of each barley contract. Since all the excess kurtosis measures for both contracts are positive, the distributions of the futures price volatility have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures for both barley contracts are positive, so the distributions have longer right tails and few high values of the futures price volatility.

Overall, the distributions of the futures price volatility for both canola and barley futures contracts are quite similar. This may be due to the similar mean, standard deviation, median, maximum, and minimum values of the futures price volatility of both canola and barley futures contracts.

Section 6.1b- Comparison of the futures price volatility before and after margin changes

For the analysis of the comparison of the futures price volatility before and after margin changes for both nearest and second nearest commodity futures contracts, I do not examine all the margin change cases due to the mixing of different margin changes within the 20-day period before and after margin changes. However, if a subsequent margin change immediately follows the previous change in the same direction, I compare the futures price volatility before the first margin change and after the second margin change.

Using the Modified Levene's statistic, I can evaluate the equality of variance of futures returns in different samples from June 2002 to June 2009. The reason for using the Modified Levene's (Brown-Forsythe) test is that the common F-ratio test can only be used under normally distributed data; thus, when the underlying distributions are not normal, it can produce highly significant test results when they should be insignificant. As a result, Brown and Forsythe (1974) modified the Levene's test and proposed using the median or the trimmed mean rather than the mean for each sample group as it is robust against non-normal distributions. To provide an example, Levene's test is originally calculated as follows:

Suppose there are G groups of data from i=1 to G. Each group has n_i observations. Let σ^2 be the variance of the i^{th} group. The null hypothesis is that $\sigma_1^2 = \sigma_2^2 = \ldots \sigma_G^2$. Let x_{ij} be the j^{th} observation in the i^{th} group. The Levene's test statistic is defined as:

$$(6.1) \quad z_{ij} = |x_{ij} - \bar{x}_{i\cdot}|\text{, where } \bar{x}_{i\cdot} = \textstyle\sum_j x_{ij}/n_i$$

$$(6.2) \quad W = \frac{\sum_i n_i (z_{i\cdot} - z_{\cdot\cdot})^2/(G-1)}{\sum_i \sum_j (z_{ij} - z_{i\cdot})^2/\sum_i (n_i - 1)}$$

where $z_{i\cdot} = \sum_j z_{ij}/n_i$ and $z_{\cdot\cdot} = \sum_i \sum_j z_{ij}/\sum_i n_i$

Literally, $z_{i\cdot}$ is the group means of z_{ij}, and $z_{\cdot\cdot}$ is the overall mean of z_{ij}. Then the null hypothesis of the equal variances is rejected if $W > F(\propto, G-1, \sum_i (n_i - 1))$, where $\propto$ is the significance level, and the critical value W has a $G-1$ and $\sum_i (n_i - 1)$ degrees of freedom. In their test, Brown and Forsythe (1974) extended Levene's test using the median or the trimmed mean instead of the mean of the i^{th} group. Therefore, z_{ij} became:

a) $z_{ij} = |x_{ij} - \tilde{x}_{i\cdot}|$, where $\tilde{x}_{i\cdot}$ is the median of the i^{th} group, or

b) $z_{ij} = |x_{ij} - \acute{x}_{i\cdot}|$, where $\acute{x}_{i\cdot}$ is the 10% trimmed mean of the i^{th} group

In this paper, I use the median recommended in Brown and Forsythe (1974) that provides both good robustness and power of the test when the underlying data distribution is suspected to be not normal. Thus, in my 20-day window sample, I have two groups of 19 observations of futures returns. The first group is the variance of the futures return in the period preceding the margin changes, σ^2_{PRE}, and the second group is the variance of the futures return in the period following the margin changes, σ^2_{POST}. Therefore, the null hypothesis is:

$$(6.3) \quad \text{H}_0\text{: } \sigma^2_{PRE} = \sigma^2_{POST}$$

To understand whether the variance of the futures return before and after the margin changes are equal, I need to compare the Modified Levene's Statistic, W, to the critical value of $F(0.05,1,36)$ =4.11 for a $\propto$=5% significance level, and to the critical value of $F(0.1,1,36)$ =2.85 for a $\propto$=10% significance level. In addition, for the 30-day window, I have two groups of 29 observations of futures returns; therefore, I need to compare the W to the critical value of $F(0.05,1,56)$ =4.01 for a $\propto$=5% significance level and the critical value of $F(0.1,1,56)$ =2.80 for a $\propto$=10% significance level. The tables 6.3 to 6.6 below show the results of the comparison for both nearest and second nearest canola and barley futures contracts. Notice that in the 6th and 7th columns, I show the results of the standard deviations of futures returns (also called futures price volatility, V) rather than the variance of futures returns.

Table 6.3- Comparison of futures price volatility before and after margin increase for the canola futures contract

Dates of margin increase	Margins		Type of contract	Days on each side of trading window	Standard deviations of futures returns (V)		Modified Levene's Statistic (W)	p-value
	PRE	POST			PRE	POST		
27-Feb-04	170	220	Nearest	20-day	1.07%	1.11%	0.26	0.62
			Nearest	30-day	1.26%	1.68%	1.46	0.23
			2nd Nearest	20-day	1.00%	1.08%	0.46	0.50
			2nd Nearest	30-day	1.18%	1.61%	1.67	0.20
23-Apr-04	220	290	Nearest	20-day	1.93%	1.91%	0.05	0.83
			Nearest	30-day	1.70%	2.14%	0.60	0.44
			2nd Nearest	20-day	1.82%	1.63%	0.11	0.74
			2nd Nearest	30-day	1.63%	1.95%	0.22	0.64
07-Jul-06	150	160	Nearest	20-day	2.06%	1.32%	0.08	0.77
			Nearest	30-day	1.75%	1.24%	0.01	0.90
			2nd Nearest	20-day	1.44%	1.31%	0.25	0.62
			2nd Nearest	30-day	1.25%	1.21%	0.92	0.34
21-Jun-07	160	225	Nearest	20-day	1.23%	1.71%	0.52	0.46
			Nearest	30-day	1.07%	1.54%	1.57	0.22
			2nd Nearest	20-day	1.20%	1.32%	0.00	0.99
			2nd Nearest	30-day	1.03%	1.25%	0.50	0.48

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 6.3: In the above 16 cases of the canola futures contracts, I do not observe any significant futures price volatility decreases or increases after margin increases. Moreover, half of the cases show the futures price volatility decreases (increases) after margins increase (decrease) even though they are not significant. During those periods, no price limit hits were found for 30 trading days before and after the margin increase. The discussion of how I obtain the price limit hits is provided in chapter 7. However, given that only 4 out of the 23 margin increases are examined, this result may not provide us any conclusion about the impact of margin changes on the futures price volatility.

Table 6.4- Comparison of futures price volatility before and after margin decrease for the canola futures contract

Dates of margin decrease	Margins		Type of contract	Days on each side of trading window	Standard deviations of futures returns (*V*)		Modified Levene's Statistic (*W*)	p-value
	PRE	POST			PRE	POST		
05-Jul-02	243	180	Nearest	20-day	1.45%	1.49%	0.28	0.60
			Nearest	30-day	1.34%	1.29%	0.01	0.93
			2nd Nearest	20-day	1.36%	1.42%	0.21	0.65
			2nd Nearest	30-day	1.21%	1.25%	0.08	0.78
25-Jul-03	175	155	Nearest	20-day	0.89%	1.02%	0.68	0.41
			Nearest	30-day	1.00%	1.02%	0.11	0.74
			2nd Nearest	20-day	0.90%	0.94%	0.10	0.76
			2nd Nearest	30-day	1.11%	1.02%	0.23	0.64
22-Dec-05	180	150	Nearest	20-day	1.02%	2.15%	0.37	0.54
			Nearest	30-day	0.85%	1.69%	0.64	0.43
			2nd Nearest	20-day	0.96%	2.03%	0.35	0.56
			2nd Nearest	30-day	0.85%	1.69%	0.25	0.62
24-Sep-07	225	190	Nearest	20-day	0.91%	1.05%	1.14	0.29
			Nearest	30-day	1.10%	0.93%	0.00	0.97
			2nd Nearest	20-day	0.88%	1.01%	0.89	0.35
			2nd Nearest	30-day	1.07%	0.90%	0.02	0.90

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 6.4: For the 16 margin decrease cases of the canola futures contracts examined, all of them are insignificant. This means that the PRE and POST futures price volatility are similar after margins decrease. Interesting, out of the 16 cases, 12 of them predict an inverse relationship between changes in futures price volatility and margin level. During those periods, no price limit hits were found for 30 trading days before and after the margin decrease.

Table 6.5- Comparison of futures price volatility before and after margin increase for the barley futures contract

Dates of margin increase	Margins		Type of contract	Days on each side of trading window	Standard deviations of futures returns (V)		Modified Levene's Statistic (W)	p-value
	PRE	POST			PRE	POST		
23-Aug-02	125	145	Nearest	20-day	2.11%	1.48%	2.74	0.11
			Nearest	30-day	2.04%	1.41%	5.80**	0.02**
			2nd Nearest	20-day	1.99%	1.40%	2.77	0.11
			2nd Nearest	30-day	1.94%	1.28%	6.54**	0.01**
05-Oct-07	135	150	Nearest	20-day	1.81%	1.37%	1.68	0.20
			Nearest	30-day	1.72%	1.21%	3.46*	0.07*
			2nd Nearest	20-day	2.12%	1.29%	4.54*	0.04*
			2nd Nearest	30-day	1.97%	1.14%	8.09***	0.01***
24-Mar-08	120	135	Nearest	20-day	2.29%	0.88%	8.53***	0.01***
			Nearest	30-day	2.04%	1.51%	2.83*	0.10*
			2nd Nearest	20-day	2.11%	1.06%	4.47**	0.04**
			2nd Nearest	30-day	1.84%	1.01%	5.71**	0.02**
13-Jun-08^ 14-Jul-08^^	135	230	Nearest	20-day	3.00%	1.89%	0.00	0.98
			Nearest	30-day	2.75%	1.96%	0.00	0.96
			2nd Nearest	20-day	2.24%	2.09%	0.07	0.80
			2nd Nearest	30-day	1.90%	2.01%	0.50	0.48
27-Mar-09^ 13-Apr-09^^	120	170	Nearest	20-day	2.84%	2.56%	0.82	0.37
			Nearest	30-day	2.47%	2.22%	0.38	0.54
			2nd Nearest	20-day	3.14%	2.30%	0.22	0.64
			2nd Nearest	30-day	2.90%	2.06%	0.75	0.39

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level; ^ indicates first margin change; ^^ indicates second margin change; For example, before the first margin change on June 13, 2008, margin was $135 per contract. However, after the second margin change on July 14, 2008, margin became $230 per contract.

Table 6.5: Nearly half of the tests (9 out of 20 tests) reject the equality of variance of the futures return before and after margin increases at 90%, 95% and 99% confidence levels. All these 9 significant cases show a reduction in futures price volatility after margins increase; and of the other 11 insignificant cases, 10 of them also indicate lower futures price volatility after margins increase. For some of the significant cases, margins change during the time period when some observations of price limit hits were found, which means that traders advance trading before price limits are hit leading to the prices reaching the price limits and so an increased futures price volatility.

For example, when the margin requirement changes on August 23, 2002, there was a price limit hit on that date for the nearest maturity contract and on August 12 and September 9 of the same year for both the nearest and the second nearest to maturity contracts. Also, another margin increase on October 5, 2007 occurred during the period when there were prices reaching the price limits consecutively on September 21, 24, 27, October 2, and 15 for both the nearest and the second nearest to maturity contracts. Consequently, we do not know whether the lower price volatility is as a result of the decreasing effect of margin or due to the higher price volatility before the price limits were hit, making the futures price volatility appear lower after they were hit. Moreover, for these cases, there is not much difference in the futures price volatility for a shorter period price volatility comparison (19-day sample); however, there are significant differences in futures price volatility when we extend the period to a longer time horizon (30-day sample).

Table 6.6- Comparison of futures price volatility before and after margin decrease for the barley futures contract

Dates of margin decrease	Margins		Type of contract	Days on each side of trading window	Standard deviations of futures returns (*V*)		Modified Levene's Statistic (*W*)	p-value
	PRE	POST			PRE	POST		
05-Jul-02	135	125	Nearest	20-day	3.09%	2.08%	0.98	0.33
			Nearest	30-day	2.65%	2.02%	0.30	0.59
			2nd Nearest	20-day	2.52%	1.98%	1.30	0.26
			2nd Nearest	30-day	2.50%	1.92%	2.32	0.13
23-Jul-04	80	65	Nearest	20-day	1.81%	1.25%	0.04	0.84
			Nearest	30-day	1.58%	1.43%	0.60	0.44
			2nd Nearest	20-day	1.02%	1.25%	0.70	0.41
			2nd Nearest	30-day	1.02%	1.36%	2.52	0.12
11-Apr-07	100	85	Nearest	20-day	0.71%	1.97%	4.70**	0.04**
			Nearest	30-day	1.17%	1.73%	3.03*	0.09*
			2nd Nearest	20-day	0.51%	5.25%	2.09	0.16
			2nd Nearest	30-day	1.05%	4.30%	1.38	0.25
14-Jan-08	150	120	Nearest	20-day	1.18%	1.68%	2.25	0.14
			Nearest	30-day	1.46%	1.66%	0.83	0.37
			2nd Nearest	20-day	1.42%	1.60%	0.38	0.54
			2nd Nearest	30-day	1.37%	1.49%	0.21	0.65
20-Nov-08^ 31-Dec-08^^	200	120	Nearest	20-day	1.87%	2.24%	0.28	0.60
			Nearest	30-day	2.14%	2.16%	0.15	0.70
			2nd Nearest	20-day	1.68%	2.22%	0.76	0.39
			2nd Nearest	30-day	2.33%	1.99%	0.75	0.39
15-Sep-08	230	200	Nearest	20-day	1.84%	3.62%	4.36**	0.04**
			Nearest	30-day	1.87%	3.16%	3.92**	0.05**
			2nd Nearest	20-day	1.85%	3.91%	5.12**	0.03**
			2nd Nearest	30-day	1.85%	3.39%	4.89**	0.03**

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level; ^ indicates first margin change; ^^ indicates second margin change;

Table 6.6: 6 out of 24 cases are significant at 90% and 95% confidence levels rejecting the null hypothesis of the equality of variance of the futures return before and after margin decreases. All these significant cases show futures price volatility increases after margin decreases. Although not significant, 11 out of the 18 cases show greater futures price volatility after margins decrease. Sometimes, because the price limit hits may occur before or after margin decreases, it is hard to distinguish which factor (price limits or margins) contributed to the reduction or increase in the futures price volatility. For example, on September 15, 2008, there was a margin decrease. However, in less than 19 trading days, there was a price limit hit on September 29, 2008 for the second nearest to maturity contract. Thus, it is hard to distinguish whether the increase in futures price volatility is due to the effect of the reduction in the margin level or the destabilization effect of the price limit.

Overall, all the nearest and second nearest canola futures contracts do not show differences in futures price volatility in the period preceding and following margin changes. However, most significant cases of the nearest and second nearest barley futures contracts follow the restriction hypothesis (H1) in that there is a reduction (increase) in the futures price volatility around margin increases (decreases). However, any conclusion based on these observations cannot be drawn yet as only few cases are examined and variables affecting futures price volatility have not yet been considered in the tests.

Section 6.2- Regression of changes in futures price volatility on average margin level

To have a simple understanding of the relationship between futures price volatility and margin requirements, I conduct a regression of the percentage change in futures price volatility on the percentage change in average margin. In the regression model, the percentage change in daily standard deviation of futures returns is the dependent variable and the percentage change in the average margin requirements is the independent variable:

$$(6.4) \quad PCHV = \beta_0 + \beta_1 * PCH\bar{M} + \varepsilon_t,$$

where V is the futures price volatility,

$\bar{M}$ is the average margin requirements,

$PCHV$ is the percentage change in the standard deviation of logarithmic daily futures returns, or the percentage change in futures price volatility,

$PCH\bar{M}$ is the percentage change in average margin requirement, and

ε_t is the random error term

To obtain *PCHV* around each margin change, first I need to compute the PRE and POST futures price volatility by calculating the standard deviation of the logarithmic daily futures return, *V*, over 20 days before and after margin change, as in the analysis of the comparison of futures price volatility before and after margin changes in section 6.1. Then, each of the 20-day window percentage change in futures price volatility, *PCHV*, is calculated by dividing the POST futures price volatility, V_{POST}, by the PRE futures price volatility, V_{PRE}, and then subtract the result by 1 shown below:

$$(6.5) \quad PCHV = (V_{POST}/V_{PRE}) - 1$$

where *POST* represents the window [0, 20], and

PRE represents the window [-20, -1],

Similarly, a 30-day window *PCHV* is also computed where *POST* represents the window [0, 30], and *PRE* represents the window [-30, -1].

Section 6.2a- Summary statistics of the percentage change in futures price volatility

To understand the characteristics of the percentage change in futures price volatility, *PCHV*, the summary statistics of it for each window of 20 and 30 days are provided below for both nearest and second nearest canola and barley futures contracts in tables 6.7 and 6.8:

Table 6.7- Summary statistics of the percentage change in futures price volatility around margin changes for the canola futures contract

Mean		
N= 48	Nearest Contract	Second Nearest Contract
Window	*PCHV*	*PCHV*
20 days	10.91%	13.15%
30 days	8.63%	11.40%
Standard Deviation		
20 days	47.81%	50.99%
30 days	47.53%	49.77%
Minimum		
20 days	-50.63%	-57.51%
30 days	-51.42%	-55.19%
Maximum		
20 days	142.00%	147.12%
30 days	166.64%	132.60%
Median		
20 days	1.22%	-0.64%
30 days	1.63%	-2.92%
Excess Kurtosis		
20 days	1.00	-0.05
30 days	1.81	-0.14
Skewness		
20 days	1.12	0.86
30 days	1.24	0.78

Table 6.7: All of the mean values of percentage change in futures price volatility are positive for both nearest and second nearest canola contracts in the 20- and 30-day windows. For the nearest contract, the standard deviation values of the percentage change in futures price volatility in both windows are similar. However, for the second nearest contract, the standard deviation values of the percentage change in futures price volatility in the 30-day windows are lower than that in the 20-day windows because of the higher minimum values and the lower maximum values percentage change in futures price volatility in the 30-day windows. The median values of percentage change in futures price volatility are greater for 30-day windows for the nearest contracts, while the opposite holds for the second nearest contracts. For the nearest contract, the excess kurtosis measures are positive, so the distributions of the percentage change in futures price volatility have higher peak and fatter tails than a normal distribution. For the second nearest contract, the excess kurtosis measures are negative, so the distributions of the percentage change in futures price volatility have lower peak and thinner tails than a normal distribution. Finally, even though all the skewness measures for both maturity contracts are positive, the distributions for the nearest contract have longer right tails and few high values of percentage change in futures price volatility than for the second nearest contract.

Table 6.8- Summary statistics of the percentage change in futures price volatility around margin changes for the barley futures contract

Mean		
N= 35	Nearest Contract	Second Nearest Contract
Window	*PCHV*	*PCHV*
20 days	28.76%	31.64%
30 days	9.67%	5.30%
Standard Deviation		
20 days	107.51%	162.05%
30 days	67.70%	61.01%
Minimum		
20 days	-64.67%	-49.92%
30 days	-58.91%	-63.20%
Maximum		
20 days	384.61%	929.96%
30 days	266.60%	308.58%
Median		
20 days	-5.51%	-1.61%
30 days	-10.17%	-8.40%
Excess Kurtosis		
20 days	4.75	29.87
30 days	6.09	18.38
Skewness		
20 days	2.18	5.30
30 days	2.26	3.79

Table 6.8: All of the mean values of percentage change in futures price volatility are positive for both nearest and second nearest barley contracts in the 20- and 30-day windows. For both maturity contracts, the standard deviation values of the percentage change in futures price volatility in the 30-day windows are lower than that in the 20-day windows because of the higher minimum values and the lower maximum values of the percentage change in futures price volatility in the 30-day windows. The median values of the percentage change in futures price volatility are lower in the 30-day windows for both maturity contracts. Since all the excess kurtosis measures are positive, the distributions of the percentage change in futures price volatility have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures for both maturity contracts are positive, so the distributions have longer right tails and few high values of percentage change in futures price volatility. However, the second nearest

contracts have higher excess kurtosis and skewness measures than do the nearest contracts.

Overall, the distributions of the percentage change in futures price volatility for the nearest and second nearest canola futures contract are quite different in terms of excess kurtosis. However, the distributions of the percentage change in futures price volatility for the nearest and second nearest barley futures contract are quite similar. The barley contacts have higher mean values of percentage change in futures price volatility in the 20-day windows than in the 30-day window. This difference in magnitude between the 20- and 30-day windows is larger than that of the canola futures contract between the two windows. This may be due to the lower trading activity of the barley contracts than that of the canola contracts. Both the canola and barley futures contracts have lower standard deviation values in the 30-day windows.

Section 6.2b- Results of regression of percentage change in futures price volatility on percentage change in average margin level

Tables 6.9 and 6.10 show the results of the simple linear regressions of percentage change in futures price volatility on percentage change in average margin level for 20- and 30-day windows of both nearest and second nearest canola and barley futures contracts. Statistics given in the tables include skewness, excess kurtosis and a set of tests for normality and heteroskedasticity. The Shapiro-Wilks test is a normality test, whereas the White's and the Breusch-Pagan tests are for testing the constancy of residual variance. The Heteroscedasticity-Corrected Covariance Matrix Estimation (HCCME) is used to correct the heteroscedastic residual variance. Descriptions of them are in chapter 5.

Table 6.9- Results of the regression analysis of the relationship between percentage changes in futures price volatility and average margin level for the canola futures contract

Results of regression					
	Nearest contract			Second nearest contract	
Column	(1)	(2)	(3)	(4)	(5)
N= 48	20-day	30-day	30-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	With correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression: F Value Pr > F	 0.09 0.76	 8.27*** 0.01***	 8.27*** 0.01***	 0.07 0.79	 3.69* 0.06*
β_0 Standard Error t-statistics Pr > |t|	0.10 0.07 1.44 0.16	0.03 0.07 0.48 0.63	0.03 0.06 0.52 0.61	0.14 0.08 1.78* 0.08*	0.07 0.07 1.02 0.31
β of $PCH\bar{M}$ Standard Error t-statistics Pr > |t|	0.07 0.21 0.31 0.76	0.46 0.16 2.87*** 0.01***	0.46 0.24 1.92* 0.06*	-0.06 0.23 -0.27 0.79	0.34 0.18 1.92* 0.06*
R-square	0.002	0.152	0.152	0.002	0.074
Characteristics of the residual					
Skewness	1.10	0.75		0.91	0.73
Excess Kurtosis	0.91	0.38		0.16	0.05
Shapiro-Wilkes test for normality Pr < W	0.91*** 0.00***	0.95* 0.06*		0.92 0.00***	0.95** 0.04**
White's test for homoscedasticity Pr > ChiSq	4.46 0.11	6.33** 0.04**		1.48 0.48	0.75 0.69
Breusch-Pagan test For homoscedasticity Pr > ChiSq	3.46* 0.06*	4.16** 0.04**		1.03 0.31	0.08 0.77

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 6.9: For the 20-day windows of both the nearest and the second nearest canola futures contracts, an insignificant relationship is found between percentage changes in futures price volatility and average margin level. However, in the 30-day windows of both the nearest and the second nearest canola futures contracts, there is a statistically significant positive relationship between the two variables at 90% and 99% confidence level.

Because most cases exhibit constant residual variances with the exception of the 30-day window of the nearest contract under both White's and Breusch-Pagan test, I make a correction for the case for the heteroscedasticity in 30-day window shown in the column 3. However, the relationship remains significant. Finally, the residuals for all the windows exhibit non-normality.

Table 6.10- Results of the regression analysis of the relationship between percentage changes in futures price volatility and average margin level for the barley futures contract

Results of regression					
	Nearest contract			Second nearest contract	
Column	(1)	(2)	(3)	(4)	(5)
N= 35	20-day	30-day	30-day	20-day	30-day
	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity	With correction for hetero-scedasticity	Without correction for hetero-scedasticity	Without correction for hetero-scedasticity
Overall regression:					
F Value	0.29	0.40	0.40	1.47	2.96*
Pr > F	0.59	0.53	0.53	0.23	0.10*
β_0	0.27	0.08	0.08	0.37	0.09
Standard Error	0.19	0.12	0.10	0.28	0.10
t-statistics	1.44	0.68	0.80	1.33	0.84
Pr > |t|	0.16	0.50	0.43	0.19	0.41
β of $PCH\bar{M}$	0.39	0.28	0.28	-1.32	-0.67
Standard Error	0.73	0.44	0.60	1.09	0.39
t-statistics	0.54	0.63	0.47	-1.21	-1.72*
Pr > |t|	0.59	0.53	0.64	0.23	0.10*
R-square	0.009	0.012	0.012	0.043	0.082
Characteristics of the residual					
Skewness	2.03	2.04		5.27	3.73
Excess Kurtosis	4.04	5.12		29.83	17.99
Shapiro-Wilkes test for normality	0.76***	0.81***		0.39***	0.64***
Pr < W	<0.0001***	<0.0001***		<0.0001***	<0.0001***
White's test for homoscedasticity	3.31	5.48*		0.77	0.81
Pr > ChiSq	0.19	0.07*		0.66	0.67
Breusch-Pagan test for homoscedasticity	3.28*	4.24*		0.43	0.74
Pr > ChiSq	0.07*	0.04*		0.51	0.39

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 6.10: For the 20-day windows of both the nearest and the second nearest barley futures contracts and the 30-day window of the nearest barley contract, an insignificant relationship is found between percentage changes in futures price volatility and average margin level. However, for the 30-day windows of the second nearest barley futures contracts, there is a statistically significant negative relationship between the two variables at 90% confidence level.

Because most cases exhibit constant residual variances with the exception of the 30-day window of the nearest contract under both the White's and the Breusch-Pagan test, I make a correction for the case for the heteroscedasticity in 30-day window shown in the column 3. However, the relationship remains insignificant. Finally, the residuals for all the windows exhibit non-normality.

Overall, since most of the cases show insignificant or mixed results, it seems that the liquidity costs hypothesis (H3) of no change in futures price volatility after the margin changes explains the result. These are similar to many empirical findings of the effect of margin requirements on futures price volatility, such as Hartzmark (1986), Hardouvelis and Kim (1995), Hsieh and Miller (1990), and, Fishe, Goldberg, Gosnell and Sinha (1990).

7. IDENTIFYING PRICE LIMIT HITS AND CHARACTERISTICS OF THE PRICE LIMITS

In section 7.1, I describe how I identify the days with the price limit hits and show that very few observations of price limit hits are obtained in my sample period. In section 7.2, I present the summary statistics of the average upper and lower price limits for both nearest and second nearest canola and barley futures contracts.

Section 7.1- Identifying the price limit hits

The two futures commodities have different regular and expanded price limits, and different limits apply to different periods. Table 7.1 shows the price limits for both commodities in different periods. The price limits applied to the western barley futures ranges from \$7.5/tonne to \$20/tonne which is lower than the price limits applied to the canola futures ranging from \$30/tonne to \$60/tonne:

Table 7.1- Daily price limits in effect from October 2000 and onward

	Canola		Western Barley	
	Regular	Expanded	Regular	Expanded
Oct 10, 2000 - Dec 9, 2007	30.00	None	7.50	None
Dec 10, 2007 - Mar 13, 2008	30.00	None	10.00	None
Mar 13, 2008 and onward	45.00	60.00	15.00	20.00

Source: IntercontinentalExchange, Inc. ("ICE")

For identifying the days with prices hitting the price limits, I match the daily high or low price to the previous day's settlement price plus or minus its daily price limits. (Kim & Rhee, 1997). Before I determine whether there is any price limit hit observation, I need to understand the rules for the price limits expansion. Under the ICE Futures Canada Price Limit Expansion Rule for both canola and barley futures contracts on and after March 13, 2008, the price limit is expanded when the settlement price of any two of the nearest contract months is at the regular price limits. It is when at least two contract months do not settle at the regular limit or more that the price limits are returned to their regular levels. Therefore, to see whether the daily price limits should be expanded, I then identify the days with settlement prices hitting the price limits by matching the daily settlement price to the daily upper or lower price limits. However, since it is possible that prices trade at the upper or lower price limits during the day but do not settle at the limit, the price limit is not expanded on the next trading day (ICE, 2009).

The ICE Futures Canada Rule for the price limits states that trading is halted during any trading day at a price which falls outside the daily price limits. Because I could only obtain the inter-day data on the daily futures prices, I compare the daily high or low prices to the price limits. If a daily high (low) price bid is greater than (lower than) the upper (lower) daily price limits, I also consider those days as days of price limit hits. Finally, there will never be observations of price limit hits on the last trading day in the case of trading in a contract that is eligible for delivery in that month since there are no daily price limits imposed on that day.

Section 7.1a- Observations of price limit hits during the period from May 2002 to July 2009 for canola and barley futures contracts

Tables 7.2 and 7.3 show the price limit hits obtained following the above procedures and rules for both canola and barley futures contracts over the period from May 2002 to July 2009.

Table 7.2- Canola price limit hits from May 2002 to July 2009

Dates of Price Limit Hit	Nearest Contract	Upper Price Limit Hit	Lower Price Limit Hit	2nd Nearest Contract	Upper Price Limit Hit	Lower Price Limit Hit
29-Jun-07				o	o	
14-Feb-08	o	o		o	o	
4-Mar-08	o		o	o		o
5-Mar-08	o		o	o		o
6-Mar-08	o		o	o		o
7-Mar-08	o		o	o		o
10-Mar-08	o		o	o		o
11-Mar-08	o	o		o	o	
17-Mar-08	o		o	o		o
25-Mar-08	o	o		o	o	
31-Mar-08	o		o	o		o

o indicates a price limit hit on that day

Table 7.2: Only 10 and 11 price limit hits are found for the nearest and second nearest canola futures contracts over a seven-year period with over 1700 trading days (there are 250 trading days per year) from May 2002 to July 2009.

Table 7.3- Barley price limit hits from May 2002 to July 2009

Dates of Price Limit Hit	Nearest Contract	Upper Price Limit Hit	Lower Price Limit Hit	2nd Nearest Contract	Upper Price Limit Hit	Lower Price Limit Hit
29-May-02				o	o	
3-Jun-02				o		o
10-Jun-02				o		o
13-Jun-02	o	o				
24-Jun-02	o	o				
26-Jun-02	o	o		o	o	
27-Jun-02	o	o				
28-Jun-02	o		o			
2-Jul-02				o	o	
31-Jul-02	o	o		o	o	
12-Aug-02	o	o		o	o	
23-Aug-02	o	o				
9-Sep-02	o	o		o	o	
20-May-03	o		o	o		o
25-Aug-03	o		o	o		o
10-Oct-06	o	o				
30-Nov-06				o	o	
25-May-07	o	o				
11-Jun-07				o	o	
5-Jul-07	o	o		o	o	
16-Jul-07	o		o	o		o
1-Aug-07	o		o	o		o
4-Sep-07				o	o	
21-Sep-07				o	o	
24-Sep-07	o	o		o	o	
27-Sep-07	o	o		o	o	
2-Oct-07				o		o
29-Sep-08				o		o
7-Apr-09	o		o	o		o

o indicates a price limit hit on that day

Table 7.3: Only 19 and 22 price limit hits are obtained for the nearest and second nearest barley futures contracts over a seven-year period with over 1700 trading days (there are 250 trading days per year) from May 2002 to July 2009.

Overall, this is similar to the findings of Balakrishnan, Gopinatha, Goswami and Shanker (2008). Therefore, since very few observations of price limit hits can be obtained, my analysis will only focus on the influence of the price limits when they are not hit.

Section 7.2- Summary statistics of the average upper and lower price limits

Tables 7.4 and 7.7 show the summary statistics of the average daily upper and lower price limits for both nearest and second nearest canola and barley futures contracts. The daily upper price limit, H, is computed as the previous day's settlement price plus the daily price limit set by the exchange. The daily lower price limit, L, is computed as the previous day's settlement price minus the daily price limit set by the exchange. Then, for the 20-day window around margin changes, the PRE average upper price limit, $\overline{H}_{PRE}$, is obtained by averaging the daily upper price limits 20 days before the margin changes; while the POST average upper price limit, $\overline{H}_{POST}$, is obtained by averaging the daily upper price limits 20 days after the margin changes. This is similarly done for the PRE and POST average lower price limits, $\overline{L}_{PRE}$, and, $\overline{L}_{POST}$.

Also, shown below in tables 7.4 to 7.7 are the summary statistics for the 30-day window using the same computation methodology for obtaining $\overline{H}_{PRE}$, $\overline{H}_{POST}$, $\overline{L}_{PRE}$, and, $\overline{L}_{POST}$.

Table 7.4- Summary statistics of the average upper daily price limit in the period preceding and following margin changes for the canola futures contract

Mean				
N= 48	Nearest Contract		Second Nearest Contract	
Window	$\bar{H}_{PRE}$	$\bar{H}_{POST}$	$\bar{H}_{PRE}$	$\bar{H}_{POST}$
20 days	481.00	476.87	489.53	484.49
30 days	479.37	474.90	488.03	482.46
Standard Deviation				
20 days	128.84	125.84	132.52	129.15
30 days	126.86	124.70	130.33	128.03
Minimum				
20 days	272.61	269.88	279.31	276.80
30 days	278.06	270.13	285.17	277.23
Maximum				
20 days	720.46	719.27	738.20	739.01
30 days	708.97	705.01	728.99	721.93
Median				
20 days	452.26	458.15	460.04	461.14
30 days	449.30	458.55	456.69	461.81
Excess Kurtosis				
20 days	-0.90	-0.87	-0.92	-0.88
30 days	-0.96	-0.92	-0.97	-0.94
Skewness				
20 days	0.48	0.46	0.50	0.50
30 days	0.45	0.44	0.49	0.48

Table 7.4: All the mean values of average upper price limit in period POST are lower than in period PRE for both nearest and second nearest canola contracts in 20- and 30-day windows. For both maturity canola contracts, the standard deviation values of the average upper price limit in the 30-day windows are lower than in the 20-day windows because of the higher minimum values and the lower maximum values of the average upper price limit in the 30-day windows. The median values of the average upper price limit are quite similar in different windows of each maturity contract. Since all the excess kurtosis measures for both maturity canola contracts are slightly negative, the distributions of the average upper price limit have slightly lower peak and thinner tails than a normal distribution. Finally, all the skewness measures are slightly positive, so the distributions have longer right tails and few high values of the average upper price limit.

Table 7.5- Summary statistics of the average upper daily price limit in the period preceding and following margin changes for the barley futures contract

Mean				
N= 35	Nearest Contract		Second Nearest Contract	
Window	$\bar{H}_{PRE}$	$\bar{H}_{POST}$	$\bar{H}_{PRE}$	$\bar{H}_{POST}$
20 days	175.88	175.65	173.75	179.40
30 days	175.60	175.52	175.89	178.97
Standard Deviation				
20 days	36.36	35.76	41.44	36.91
30 days	35.40	34.33	37.88	35.77
Minimum				
20 days	127.35	125.03	88.78	126.04
30 days	128.49	127.92	127.78	129.69
Maximum				
20 days	270.85	276.97	281.51	281.82
30 days	264.32	269.78	273.13	278.66
Median				
20 days	164.77	169.20	163.40	171.40
30 days	167.55	168.27	164.64	168.63
Excess Kurtosis				
20 days	0.29	1.18	0.70	1.24
30 days	0.23	1.12	0.56	1.38
Skewness				
20 days	0.85	1.05	0.82	1.14
30 days	0.83	1.05	1.06	1.20

Table 7.5: All the mean values of average upper price limit in period POST are higher than in period PRE for the second nearest barley contracts in 20- and 30-day windows. The mean values of average upper price limit in periods PRE and POST are similar for the nearest barley contracts. For both maturity contracts, the standard deviation values of the average upper price limit in the 30-day windows are lower than the standard deviation values in the 20-day windows because of the higher minimum values and the lower maximum values of the average upper price limit in the 30-day windows. The median values of the average upper price limit are quite similar in different windows of each maturity contract. Since all the excess kurtosis measures for both barley contracts are positive, the distributions of the average upper price limit have higher peak and fatter tails than a normal distribution. Finally, all the skewness measures for both

barley contracts are positive, so the distributions have longer right tails and few high values of the average upper price limit.

Table 7.6- Summary statistics of the average lower daily price limit in the period preceding and following margin changes for the canola futures contract

Mean				
N= 48	Nearest Contract		Second Nearest Contract	
Window	$\bar{L}_{PRE}$	$\bar{L}_{POST}$	$\bar{L}_{PRE}$	$\bar{L}_{POST}$
20 days	410.34	404.37	418.87	411.91
30 days	408.97	401.99	417.64	409.54
Standard Deviation				
20 days	122.12	117.75	125.71	121.06
30 days	119.92	116.65	123.32	119.95
Minimum				
20 days	212.61	209.88	219.31	216.80
30 days	218.06	210.13	225.17	217.23
Maximum				
20 days	648.83	645.63	659.89	656.69
30 days	623.60	616.81	638.99	631.93
Median				
20 days	376.85	374.14	383.32	382.33
30 days	375.54	373.06	381.73	381.32
Excess Kurtosis				
20 days	-0.79	-0.77	-0.83	-0.80
30 days	-0.89	-0.84	-0.91	-0.86
Skewness				
20 days	0.56	0.54	0.57	0.57
30 days	0.51	0.53	0.54	0.56

Table 7.6: All the mean values of average lower price limit in period POST are lower than in period PRE for both nearest and second nearest canola contracts in 20- and 30-day windows. For both maturity contracts, the standard deviation values of the average lower price limit in the 30-day windows are lower than the standard deviation values in the 20-day windows because of the higher minimum values and the lower maximum values of the average lower price limit in the 30-day windows. The median values of the average lower price limit are quite similar in different windows of each maturity contract. Since all the excess kurtosis measures for both maturity contracts are slightly negative, the distributions of the average lower price limit have slightly lower

peak and thinner tails than a normal distribution. Finally, all the skewness measures are slightly positive, so the distributions have longer right tails and few high values of the average lower price limit.

Table 7.7- Summary statistics of the average lower daily price limit in the period preceding and following margin changes for the barley futures contract

Mean				
N= 35	Nearest Contract		Second Nearest Contract	
Window	$\bar{L}_{PRE}$	$\bar{L}_{POST}$	$\bar{L}_{PRE}$	$\bar{L}_{POST}$
20 days	157.11	156.65	157.42	160.40
30 days	156.88	156.52	157.19	159.97
Standard Deviation				
20 days	34.08	33.53	35.85	34.38
30 days	33.07	32.12	34.83	33.22
Minimum				
20 days	112.35	110.03	111.16	111.04
30 days	113.49	112.92	112.78	114.69
Maximum				
20 days	240.85	246.97	251.51	251.82
30 days	234.32	239.78	243.13	248.66
Median				
20 days	149.44	154.20	146.80	154.27
30 days	146.61	153.27	147.96	153.17
Excess Kurtosis				
20 days	-0.36	0.34	0.32	0.51
30 days	-0.44	0.23	0.11	0.62
Skewness				
20 days	0.69	0.82	1.02	0.95
30 days	0.66	0.82	0.96	1.01

Table 7.7: All the mean values of average lower price limit in period POST are lower than in period PRE for the nearest barley contracts in 20- and 30-day windows, however, the opposite occurs for the second nearest barley contracts. For both maturity barley contracts, the standard deviation values of the average lower price limit in the 30-day windows are lower than in the 20-day windows because of the higher minimum values of the average lower price limit and lower maximum values of the average lower price limit in the 30-day windows. The median values of the average lower price limit are quite similar in different windows of each maturity contract. Since most of the excess

kurtosis measures are slightly positive, the distributions of the average lower price limit have slightly higher peak and fatter tails than a normal distribution. Finally, all the skewness measures for both maturity barley contracts are slightly positive, so the distributions have slightly longer right tails and few high values of the average lower price limit.

Overall, the distributions of the upper and lower price limits for the nearest and second nearest canola and barley futures contract are quite different in terms of excess kurtosis. In addition, the mean, maximum, minimum, standard deviation, and median values of average upper and lower price limits for the canola contract in all windows are higher than those values for the barley contract.

8. MULTIPLE REGRESSION ANALYSIS

In this chapter, a multiple regression analysis which incorporates the effect of price limits, when considering the effect of margin requirements upon the futures price volatility is provided. In section 8.1, I present the regression models and a description of various components of the regression models, the hypotheses of each variable's relationship to the futures price volatility, and the summary statistics of some of the variables not yet shown in the previous chapters. In section 8.2, the results of the multiple regression models are provided. In section 8.3, I provide the conclusion of the results.

Section 8.1- Description of the multiple regression model on the relationship between futures price volatility and margin requirements when the effect of price limits are considered

In the regression model, since the futures price volatility may be affected by price limits imposed in the futures market, I incorporate the effects of the price limits on the futures price by using distance variables. This is because the distance between daily high (low) prices and the upper (lower) price limits may affect trader behaviour and thus the futures price process. Recall that the daily upper price limit is denoted as *H*, and the daily lower price limit is denoted as, *L*. The daily distance variables are calculated as follows:

$$(8.1) \qquad DL = (Daily\ low\ price - L)/(H - L),$$

$$(8.2) \qquad DH = (H - Daily\ high\ price)/(H - L)$$

where DL is the distance variable indicating the distance between the daily low price and the lower price limit, and

DH is the distance variable indicating the distance between the daily high price and the upper price limit.

For example, as the daily high or low price gets closer to the relevant price limit, the distance variable becomes a smaller number, and vice versa. This means that when the daily high or low price reaches the relevant price limit, the distance variable is zero. In addition, when the daily high or low price is outside the price limits, the distance variable is given a value of zero.

In my regression, the average values of the distance of the futures prices from the price limits in the period following the margin change are considered. This is because I consider the distance to the price limits in the period following margin changes to be more important than in the period preceding margin changes. The reason is that the futures price volatility, in the period after margin changes, which we are interested in, should be affected by the distance to the price limits in this period rather than in the period preceding margin changes. Thus, the average distance between the daily high prices and the upper price limits in the period after margin changes, $\overline{DH}_{POST}$, and the average the average distance between the daily low prices and the lower price limits in the period after margin changes, $\overline{DL}_{POST}$, are included in the regression models.

As discussed in several papers such as Fishe et al. (1990) and Phylaktis et al. (1999), changes in trading volume or open interest may also affect the futures price volatility. As cited in Grammatikos and Saunders (1986) and Chatrath, Ramchander and Song (1996), the futures price volatility and the trading activity should be positively related. This is because both the futures price volatility and trading activity are jointly caused by the same directing variable which is the rate of information flow over the period (day). When new information arrives, traders revise their trading positions which cause both the price and trading volume to change simultaneously. Therefore, the relationship between price volatility and the trading activity should be positive (Grammatikos & Saunders, 1986; Phylaktis et al., 1999). Because open interest reflect hedgers' trading activity which has a minor effect on the trading volume in the shorter term and is positively related to the trading volume in the longer term (Chatrath, Ramchander & Song, 1996; Hartzmark 1996), the trading volume and open interest are both used as proxies for trading activity in my test and are separately included in the regression models as control variables.

Several other possible influences upon futures price volatility such as inventory, spot price volatility, maturity and seasonality, are not modeled explicitly in the regression analysis, due to lack of data on these variables. Thus, only the futures markets variables such as trading volume, open interest, and margin are included in the regressions and all other variables are captured by the error term of the regression models. The regression models thus are:

$$(8.3) \quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{DH}_{POST} + \beta_3 * \overline{DL}_{POST} + \beta_4 * PCH\overline{TV} + \varepsilon_t,$$

$$(8.4) \quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{DH}_{POST} + \beta_3 * \overline{DL}_{POST} + \beta_4 * PCH\overline{OI} + \varepsilon_t\ ,$$

$$(8.5) \quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{Min}\,(DH_{POST}, DL_{POST}) + \beta_3 * PCH\overline{TV} + \varepsilon_t,$$

$$(8.6) \quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{Min}\,(DH_{POST}, DL_{POST}) + \beta_3 * PCH\overline{OI} + \varepsilon_t,$$

where

$PCHV$ is the percentage change in the logarithmic daily standard deviation of futures returns, or the percentage change in futures price volatility,

$PCH\overline{M}$ is the percentage change in average margin requirement,

$PCH\overline{TV}$ is the percentage change in average trading volume,

$PCH\overline{OI}$ is the percentage change in average open interest,

$\overline{Min}\ (DH_{POST}, DL_{POST})$ is the average distance of the minimum of DH_{POST} and DL_{POST}, and

ε_t is the random error term

Each interval chosen for periods PRE and POST when calculating the percentage changes in each of the independent variables (futures price volatility, margin requirement, trading volume and open interest) and the average distance variables is 20 trading days before and after the margin changes for both nearest and second nearest canola and barley futures contracts. For robustness, I also conduct the tests using a 30-day window.

Section 8.1a- Hypotheses of each variable's relationship to the futures price volatility

In this analysis of equations 8.3 to 8.6, we can obtain the effects of changes in margin requirement on changes in futures price volatility by examining the coefficients. If the coefficient β_1 of percentage change in average margin requirement is significantly positive, the competitive hypothesis (H2) will be supported, and the futures price volatility is increased after margin increases. If it is significantly negative, the restriction hypothesis (H1) will be supported, and the margins have a decreasing effect on the futures price volatility. However, the margin requirements may produce no effect on the futures price volatility if it is insignificant supporting the liquidity costs hypothesis (H3).

For the coefficient β_2 of $\overline{DH}_{POST}$ in regression equations 8.3 and 8.4, if it is positive, then there is a stabilization effect of the average distance of futures prices from the upper price limits upon the futures price volatility (H5). Thus, the price limits serve to push the prices away from themselves stabilizing the futures price volatility when the distance between the high prices and the upper price limits is small. Hence, the relationship between the futures price volatility and the average distance variable is positive. However, if the coefficient is negative, then there is a destabilization effect of average distance of futures prices from the upper price limits upon the futures price volatility, and the gravitation effect (H4) is supported. Thus, the price limits are able to attract the prices towards themselves, destabilizing the futures price volatility when the average distance between the daily high prices and the upper price limits is small. As a result, the relationship between the futures price volatility and the average distance variable is negative. Finally, if the coefficient is not significant, then the no effect hypothesis (H6) is supported. For the coefficient β_3 of $\overline{DL}_{POST}$ in equations 8.3 and 8.4, and the coefficient β_2 of $\overline{Min}\,(DH_{POST}, DL_{POST})$ in equations 8.5 and 8.6, the hypothesized relationship between the futures price volatility and the average distance variables is the same as that hypothesized for the coefficient β_2 of $\overline{DH}_{POST}$.

One thing to be aware of is that two possible explanations for supporting H6 can emerge, 1) the average distance between the futures prices and the price limits may be too high (the futures prices are too far away from the price limits) to have any effect upon the trader behaviour, and thus the futures price volatility, 2) the average distance from the price limits actually produce no effect on the futures price volatility because the existence of the price limits does not affect trader behaviour regardless of whether the futures price falls in a range close to the price limits or not. To distinguish between the two possible explanations, I will conduct piecewise linear regressions in chapter 9.

Finally, since the relationship between the futures price volatility and the trading activity should be positive, I expect to see a positive coefficient β_4 of percentage changes in average trading volume and open interest in equations 8.3 and 8.4 and a positive coefficient β_3 of percentage changes in average trading volume and open interest in equations 8.5 and 8.6.

Section 8.1b- Summary statistics of the average distance variables

To understand the characteristics of the average distance variables, $\overline{DH}_{POST}$, $\overline{DL}_{POST}$, and $\overline{Min}\,(DH_{POST}, DL_{POST})$, the summary statistics of them for each period of 20 and 30 days following the margin changes are provided below for both nearest and second nearest canola and barley futures contracts in tables 8.1 and 8.2 shown below.

Table 8.1- Summary statistics of the distance of futures prices from the price limits in the period following margin changes for the canola futures contract

Mean						
N= 48	Nearest Contract			Second Nearest Contract		
Window	$\overline{DH}_{POST}$	$\overline{DL}_{POST}$	$\overline{Min}\ (DH_{POST}, DL_{POST})$	$\overline{DH}_{POST}$	$\overline{DL}_{POST}$	$\overline{Min}\ (DH_{POST}, DL_{POST})$
20 days	0.432	0.416	0.365	0.438	0.417	0.365
30 days	0.432	0.418	0.367	0.438	0.425	0.372
Standard Deviation						
20 days	0.038	0.056	0.075	0.043	0.066	0.082
30 days	0.035	0.051	0.070	0.041	0.050	0.071
Minimum						
20 days	0.337	0.216	0.127	0.314	0.163	0.122
30 days	0.349	0.276	0.165	0.322	0.281	0.147
Maximum						
20 days	0.480	0.484	0.443	0.481	0.494	0.449
30 days	0.475	0.478	0.443	0.481	0.488	0.450
Median						
20 days	0.444	0.436	0.392	0.455	0.443	0.393
30 days	0.442	0.438	0.388	0.452	0.442	0.394
Excess Kurtosis						
20 days	0.005	2.116	1.062	0.893	4.598	1.566
30 days	-0.230	0.526	0.380	0.935	0.952	1.347
Skewness						
20 days	-1.055	-1.360	-1.246	-1.364	-1.908	-1.425
30 days	-0.859	-1.052	-1.060	-1.347	-1.135	-1.313

Table 8.1: The mean values of $\overline{Min}\ (DH_{POST}, DL_{POST})$ are lower than the mean values of $\overline{DH}_{POST}$ and $\overline{DL}_{POST}$ for both nearest and second nearest canola contracts in different windows because of the way I compute $\overline{Min}\ (DH_{POST}, DL_{POST})$. The mean and median values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$are around 36% to 46% for both maturity canola contracts. But the minimum values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ are between 12% to 35% and the maximum values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ are between 43% to 50%. The mean values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ appear to be higher in the 30-day windows than in the 20-day windows for both maturity contracts. Moreover, the standard deviation values of the $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ in the 30-day windows are lower than the standard deviation values in the 20-day windows because of the higher minimum values and the lower maximum values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ in the 30-day windows for both maturity contracts. Since most of the excess kurtosis measures are positive, the distributions of the average distance

variables have higher and narrower peak and fatter tails than a normal distribution. Finally, all the skewness measures are negative, so the distributions have longer left tails and relatively few low values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$.

Table 8.2- Summary statistics of the distance of futures prices from the price limits in the period following margin changes for the barley futures contract

Mean						
N= 35	Nearest Contract			Second Nearest Contract		
Window	$\overline{DH}_{POST}$	$\overline{DL}_{POST}$	$\overline{Min}\ (DH_{POST}, DL_{POST})$	$\overline{DH}_{POST}$	$\overline{DL}_{POST}$	$\overline{Min}\ (DH_{POST}, DL_{POST})$
20 days	0.426	0.419	0.335	0.441	0.425	0.346
30 days	0.425	0.424	0.341	0.440	0.430	0.353
Standard Deviation						
20 days	0.044	0.041	0.055	0.049	0.039	0.053
30 days	0.036	0.033	0.050	0.041	0.033	0.049
Minimum						
20 days	0.306	0.336	0.221	0.303	0.343	0.232
30 days	0.322	0.342	0.231	0.334	0.352	0.240
Maximum						
20 days	0.487	0.504	0.414	0.516	0.498	0.415
30 days	0.467	0.474	0.408	0.499	0.475	0.417
Median						
20 days	0.444	0.423	0.348	0.452	0.429	0.357
30 days	0.434	0.430	0.364	0.446	0.434	0.373
Excess Kurtosis						
20 days	1.373	-0.429	-1.150	1.464	-0.833	-0.862
30 days	1.046	-0.161	-0.853	0.328	0.000	-0.447
Skewness						
20 days	-1.303	-0.235	-0.444	-1.266	-0.261	-0.580
30 days	-1.248	-0.780	-0.599	-0.880	-0.835	-0.754

Table 8.2: The mean values of $\overline{Min}\ (DH_{POST}, DL_{POST})$ are lower than the mean values of $\overline{DH}_{POST}$ and $\overline{DL}_{POST}$ for both nearest and second nearest barley contracts in different windows because of the way I calculate the $\overline{Min}\ (DH_{POST}, DL_{POST})$. The mean and median values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$are around 33% to 45% for both maturity barley contracts. However, the minimum values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ are between 22% to 35% and the maximum values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ are between 40% to 52%. The mean values of $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ appear to be higher in the 30-day windows

than in the 20-day windows for both maturity contracts. Moreover, the standard deviation values of the $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ in the 30-day windows are lower than the standard deviation values in the 20-day windows because the higher minimum values and the lower maximum values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ in the 30-day windows for both maturity contracts. Since all of the excess kurtosis measures of $\overline{DH}_{POST}$ are positive, the distributions of it have higher and narrower peak and fatter tails than a normal distribution. However, this is the opposite for the $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ which have negative excess kurtosis measures. Finally, all the skewness measures are negative, so the distributions have longer left tails and relatively few low values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$, and $\overline{Min}\,(DH_{POST}, DL_{POST})$.

Overall, the distributions of the canola futures contracts in different windows are more consistent than the distribution of the barley future contracts in terms of excess kurtosis measures. However, the range of the mean, minimum, maximum and median values of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ for both canola and barley contracts are quite similar.

Section 8.2- Analysis of the results of the multiple regression models

The result of the equations 8.3 to 8.6 are shown in this section for each window of 20 and 30 days of both the nearest and the second nearest canola and barley futures contracts in tables 8.3 to 8.10. Statistics given in the tables include skewness, excess kurtosis and a set of tests for normality, heteroskedasticity, and multicollinearity. The Shapiro-Wilks test is a normality test, whereas the White's and the Breusch-Pagan tests are for testing constancy of residual variance. The Heteroscedasticity-Corrected Covariance Matrix Estimation (HCCME) is used to correct the heteroscedastic residual variance. Descriptions of them are provided in chapter 5.

For the test of multicollinearity, the Variance Inflation Factors (VIF) is computed for each independent variable. Multicollinearity exists in the regression model when the independent variables are highly correlated, impacting the interpretation of the coefficients. To detect the multicolllinearity problems, I compute the Variance Inflation Factors (VIF) for each variable by obtaining the R-squares of the regression of each independent variable, x_j, on all of the other independent variables, and the $VIF_j = 1/1 - R_j^2$. If the VIF is greater than 10, it indicates possible problems of multicollinearity (Kutner, Nachtsheim & Neter, 2004).

For each commodity in each column of each table, the percentage change in futures price volatility, $PCHV$, is always the dependent variable. The first column of each window shows only the percentage change in average margin requirements, $PCH\overline{M}$ as the independent variable. In the second column, both the percentage change in average margin requirements, $PCH\overline{M}$, and the percentage change in average trading volumes, $PCH\overline{TV}$, are the independent variables. In the third column, both the percentage change in average margin requirements, $PCH\overline{M}$, and the percentage change in average open interests, $PCH\overline{OI}$ are the independent variables. The fourth to seventh columns show the regression results from equations 8.3 to 8.6. Note also in the third row of each column, the "NC" indicates the regression without the correction for the heteroscedasticity and the "C" indicates the regression with the correction for the heteroscedasticity.

Table 8.3- Results of the regressions for the 20-day window of nearest canola futures contract

Results of regression							
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NC	NC	NC	NC	NC	NC	NC
Overall regression:							
F Value	0.09	0.07	0.06	4.75***	4.28***	7.11***	6.37***
Pr > F	0.76	0.94	0.94	0.00***	0.01***	0.00***	0.00***
β_0	0.10	0.11	0.10	2.57	2.39	1.87	1.77
Standard Error	0.07	0.07	0.08	0.90	0.90	0.39	0.39
t-statistics	1.44	1.44	1.26	2.87***	2.65**	4.81***	4.54***
Pr > |t|	0.16	0.16	0.22	0.01***	0.01**	<.0001***	<.0001***
β of $\overline{PCHM}$	0.07	0.06	0.08	-0.48	-0.41	-0.62	-0.55
Standard Error	0.21	0.22	0.22	0.24	0.25	0.24	0.24
t-statistics	0.31	0.26	0.34	-1.96*	-1.67	-2.65**	-2.31**
Pr > |t|	0.76	0.79	0.74	0.06*	0.10	0.01**	0.03**
β of $\overline{DH}_{POST}$				-0.32	-0.16		
Standard Error				2.47	2.50		
t-statistics				-0.13	-0.06		
Pr > |t|				0.90	0.95		
β of $\overline{DL}_{POST}$				-5.47	-5.23		
Standard Error				1.56	1.57		
t-statistics				-3.50***	-3.33***		
Pr > |t|				0.00***	0.00***		
β of $Min\ (DH_{POST}, DL_{POST})$						-4.68	-4.41
Standard Error						1.02	1.01
t-statistics						-4.60***	-4.35***
Pr > |t|						<.0001***	<.0001***
β of $\overline{PCHTV}$		-0.04		-0.21		-0.22	
Standard Error		0.21		0.18		0.18	
t-statistics		-0.21		-1.16		-1.25	
Pr > |t|		0.84		0.25		0.22	
β of $\overline{PCHOI}$			0.01		-0.01		-0.01
Standard Error			0.09		0.08		0.08
t-statistics			0.16		-0.14		-0.12
Pr > |t|			0.88		0.89		0.90
R-square	0.002	0.003	0.003	0.306	0.285	0.326	0.303
N	48	48	48	48	48	48	48
Characteristics of the residual							
Skewness	1.10	1.10	1.07	0.59	0.76	0.55	0.75
Excess Kurtosis	0.91	0.96	0.86	0.39	0.48	0.58	0.53
Shapiro-Wilkes test for normality	0.91***	0.91***	0.92***	0.98	0.96*	0.97	0.96*
Pr < W	0.00***	0.00***	0.00***	0.42	0.08*	0.37	0.07*
White's test for homoscedasticity	4.46	5.65	6.00	11.90	5.55	11.90	5.86
Pr > ChiSq	0.11	0.34	0.31	0.61	0.98	0.22	0.75
Breusch-Pagan test for homoscedasticity	3.46*	3.62	3.52	6.21	1.39	7.19**	1.53
Pr > ChiSq	0.06*	0.16	0.17	0.18	0.85	0.07**	0.68
Variance inflation factor							
$\overline{PCHM}$	1.00	1.03	1.08	1.73	1.74	1.71	1.70
$\overline{DH}_{POST}$				2.38	2.37		
$\overline{DL}_{POST}$				2.09	2.05		
$Min\ (DH_{POST}, DL_{POST})$						1.66	1.59
$\overline{PCHTV}$		1.03		1.09		1.08	
$\overline{PCHOI}$			1.08		1.09		1.09

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.3: For the 20-day windows of the nearest canola futures, the coefficients of $PCH\overline{M}$ in regressions where the effect of the price limits is not included are insignificant (columns 1 to 3) similar to many other empirical studies. However, they become significantly negative statistically at the 90% and 95% confidence levels when the effects of the price limits are included in the regressions (columns 4, 6, and 7) indicating an inverse relationship between the percentage changes in futures price volatility and average margin levels, which follows the restriction hypothesis (H1). The coefficients of $\overline{DL}_{POST}$ and $\overline{Min}\ (DH_{POST}, DL_{POST})$ are significantly negative statistically at the 99% confidence level, but the coefficients of $\overline{DH}_{POST}$ are insignificant. The negative relationship indicates a gravitation effect of the price limits upon the futures price volatility (H4) where smaller average distance between the futures prices and the price limits destabilizes the futures price volatility. However, even though the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are not expected indicating no relationship between percentage changes in futures price volatility and average trading activity, this is similar to the findings of Fishe et al. (1990) and Phylaktis et al. (1999).

Finally, all the regressions without the inclusion of the effect of the price limits exhibit non-normality residuals (columns 1 to 3), whereas some of the regressions with the inclusion of the effect of the price limits exhibit normality residual distributions (columns 4 and 6). Moreover, all the canola regressions exhibit constant residual variances under the White's test. Since all the VIFs of each independent variable are less than 10, no problems of multicollinearity are found.

Table 8.4- Results of the regressions for the 30-day window of nearest canola futures contract

	Results of regression							
Column	(1)		(2)	(3)	(4)	(5)	(6)	(7)
	NC	C	NC	NC	NC	NC	NC	NC
Overall regression:								
F Value	8.27***	8.27***	4.61**	4.74**	4.62***	4.92**	7.49***	7.92***
Pr > F	0.01***	0.01***	0.02**	0.01**	0.00***	0.00***	0.00***	0.00***
β_0	0.03	0.03	0.02	0.01	2.31	2.33	1.60	1.57
Standard Error	0.07	0.06	0.07	0.07	1.05	1.01	0.47	0.45
t-statistics	0.48	0.52	0.35	0.16	2.21**	2.31**	3.36***	3.45***
Pr > |t|	0.63	0.61	0.73	0.88	0.03**	0.03**	0.00***	0.00***
β of $\overline{PCHM}$	0.46	0.46	0.53	0.52	0.10	0.12	-0.03	0.00
Standard Error	0.16	0.24	0.18	0.17	0.23	0.21	0.23	0.21
t-statistics	2.87***	1.92*	3.02***	3.08***	0.42	0.55	-0.14	0.02
Pr > |t|	0.01***	0.06*	0.00***	0.00***	0.67	0.59	0.89	0.99
β of $\overline{DH}_{POST}$					-1.52	-1.53		
Standard Error					2.86	2.80		
t-statistics					-0.53	-0.55		
Pr > |t|					0.60	0.59		
β of $\overline{DL}_{POST}$					-3.78	-3.83		
Standard Error					1.90	1.87		
t-statistics					-1.99*	-2.05**		
Pr > |t|					0.05*	0.05**		
β of $\overline{Min}\ (DH_{POST}, DL_{POST})$							-4.10	-4.08
Standard Error							1.23	1.18
t-statistics							-3.34***	-3.46***
Pr > |t|							0.00***	0.00***
β of $\overline{PCHTV}$			0.26		0.10		0.05	
Standard Error			0.27		0.26		0.25	
t-statistics			0.98		0.39		0.19	
Pr > |t|			0.33		0.70		0.85	
β of $\overline{PCHOI}$				0.14		0.12		0.11
Standard Error				0.13		0.12		0.11
t-statistics				1.09		1.00		0.94
Pr > |t|				0.28		0.32		0.35
R-square	0.152	0.152	0.170	0.174	0.300	0.314	0.338	0.351
N	48	48	48	48	48	48	48	48
	Characteristics of the residual							
Skewness	0.75		0.79	0.71	0.75	0.77	0.78	0.82
Excess Kurtosis	0.38		0.44	0.46	0.62	0.91	0.87	1.13
Shapiro-Wilkes test for normality	0.95*		0.95**	0.96*	0.96	0.96	0.96	0.96
Pr < W	0.06*		0.04**	0.08*	0.12	0.12	0.11	0.11
White's test for homoscedasticity	6.33**		8.23	6.05	10.84	10.30	8.10	5.71
Pr > ChiSq	0.04**		0.14	0.30	0.70	0.74	0.52	0.77
Breusch-Pagan test for homoscedasticity	4.16**		3.89	4.46	3.32	2.11	2.80	1.35
Pr > ChiSq	0.04**		0.14	0.11	0.51	0.72	0.42	0.72
	Variance inflation factor							
$\overline{PCHM}$	1.00		1.20	1.11	2.40	2.06	2.55	2.19
$\overline{DH}_{POST}$					2.76	2.70		
$\overline{DL}_{POST}$					2.53	2.52		
$\overline{Min}\ (DH_{POST}, DL_{POST})$							2.16	2.03
$\overline{PCHTV}$			1.20		1.28		1.28	
$\overline{PCHOI}$				1.11		1.12		1.12

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.4: For the 30-day windows of the nearest canola futures, the coefficients of $PCH\overline{M}$ in regressions where the effects of the price limits are not included are significantly positive statistically at 99% confidence level (columns 1 to 3). However, they become insignificant when the effects of the price limits are included in the regressions (columns 4 to 7) indicating a neutral relationship between percentage changes in futures price volatility and average margin levels. This follows the liquidity costs hypothesis (H3). Despite we observe the inconsistent finding between the 20- and 30-day windows of the nearest canola contracts in tables 8.3 and 8.4, including the effects of the price limits can reverse the results found when the effects of price limits are excluded from the regression equations. The coefficients of $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ are significantly negative statistically at the 90%, 95% and 99% confidence levels, but the coefficients of $\overline{DH}_{POST}$ are insignificant. The negative relationship indicates a gravitation effect of the price limits upon the futures price volatility (H4). Finally, the coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are again insignificant, which are different from what I expected.

The residuals of the regressions without the inclusion of the effect of the price limits exhibit non-normal distributions (columns 1 to 3), whereas the residuals of the regressions with the inclusion of the effect of the price limits exhibit normal distributions (columns 4 to 7). Moreover, all the canola regressions exhibit constant residual variances under both the White's and the Breusch-Pagan tests except for the first regression where I make a correction for the heteroscedasticity, and the results remain the same. Since all the VIFs of each independent variable are less than 10, no problems of multicollinearity are found.

Table 8.5- Results of the regressions for the 20-day window of second nearest canola futures contract

Results of regression							
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NC	NC	NC	NC	NC	NC	NC
Overall regression:							
F Value	0.07	0.85	1.17	1.96	2.02	3.47**	3.48**
Pr > F	0.79	0.44	0.32	0.12	0.11	0.02**	0.02**
β_0	0.14	0.15	0.15	1.99	1.98	1.32	1.28
Standard Error	0.08	0.08	0.08	0.97	0.97	0.41	0.41
t-statistics	1.78*	1.96*	1.97*	2.05**	2.05**	3.23***	3.11***
Pr > |t|	0.08*	0.06*	0.06*	0.05**	0.05**	0.00***	0.00***
β of $PCH\overline{M}$	-0.06	-0.02	-0.04	-0.42	-0.43	-0.50	-0.50
Standard Error	0.23	0.23	0.22	0.29	0.28	0.27	0.27
t-statistics	-0.27	-0.08	-0.17	-1.45	-1.52	-1.86*	-1.88*
Pr > |t|	0.80	0.94	0.87	0.15	0.14	0.07*	0.07*
β of $\overline{DH}_{POST}$				-1.58	-1.72		
Standard Error				2.18	2.16		
t-statistics				-0.73	-0.80		
Pr > |t|				0.47	0.43		
β of $\overline{DL}_{POST}$				-2.67	-2.51		
Standard Error				1.32	1.32		
t-statistics				-2.03**	-1.90*		
Pr > |t|				0.05**	0.06*		
β of $\overline{Min}\,(DH_{POST}, DL_{POST})$						-3.10	-3.00
Standard Error						1.07	1.08
t-statistics						-2.91***	-2.78***
Pr > |t|						0.01***	0.01***
β of $PCH\overline{TV}$		-0.09		-0.08		-0.07	
Standard Error		0.07		0.07		0.06	
t-statistics		-1.27		-1.18		-1.15	
Pr > |t|		0.21		0.25		0.26	
β of $PCH\overline{OI}$			-0.15		-0.12		-0.11
Standard Error			0.10		0.10		0.10
t-statistics			-1.51		-1.27		-1.16
Pr > |t|			0.14		0.21		0.25
R-square	0.002	0.036	0.050	0.154	0.158	0.192	0.192
N	48	48	48	48	48	48	48
Characteristics of the residual							
Skewness	0.91	0.78	0.91	0.30	0.43	0.51	0.61
Excess Kurtosis	0.16	-0.05	0.17	0.00	0.16	-0.02	0.21
Shapiro-Wilkes test for normality	0.92***	0.94**	0.91***	0.98	0.97	0.97	0.96
Pr < W	0.00***	0.01**	0.00***	0.44	0.17	0.33	0.12
White's test for homoscedasticity	1.48	5.64	3.11	13.61	12.20	12.47	12.22
Pr > ChiSq	0.48	0.34	0.68	0.48	0.59	0.19	0.20
Breusch-Pagan test for homoscedasticity	1.03	3.26	1.50	8.45*	5.99	5.42	3.94
Pr > ChiSq	0.31	0.20	0.47	0.08*	0.20	0.14	0.27
Variance inflation factor							
$PCH\overline{M}$	1.00	1.02	1.00	1.76	1.73	1.65	1.64
$\overline{DH}_{POST}$				1.71	1.69		
$\overline{DL}_{POST}$				1.48	1.49		
$\overline{Min}\,(DH_{POST}, DL_{POST})$						1.62	1.65
$PCH\overline{TV}$		1.02		1.05		1.03	
$PCH\overline{OI}$			1.00		1.02		1.03

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.5: For the 20-day windows of the second nearest canola futures, the coefficients of $PCH\overline{M}$ in regressions where the effects of the price limits are not included are insignificant (columns 1 to 3). In columns 4 and 5, the results do not change when the effects of the price limits are included following the liquidity costs hypothesis (H3). However, in columns 6 and 7, the coefficients again become significantly negative statistically at the 90% confidence level indicating an inverse relationship between percentage changes in futures price volatility and average margin levels, which follows the restriction hypothesis (H1). The coefficients of $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ are significantly negative statistically at the 90%, 95% and 99% confidence levels, but the coefficients of $\overline{DH}_{POST}$ are insignificant. The negative relationship indicates a gravitation effect of the price limits upon the futures price volatility (H4). Finally, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are not expected indicating no relationship between percentage changes in futures price volatility and average trading activity.

The regressions without the inclusion of the effect of the price limits exhibit non-normality residuals (columns 1 to 3), whereas the regressions with the inclusion of the effect of the price limits exhibit normally distributed residuals (columns 4 to 7). Moreover, all the 20-day windows of the second nearest canola regressions exhibit constant residual variances under both the White's and the Breusch-Pagan tests. Since all the VIFs of each independent variable are less than 10, no problems of multicollinearity are found.

Table 8.6- Results of the regressions for the 30-day window of second nearest canola futures contract

Results of regression							
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NC	NC	NC	NC	NC	NC	NC
Overall regression:							
F Value	3.69*	2.68*	2.96*	2.83**	2.68**	4.64***	4.41***
Pr > F	0.06*	0.08*	0.06*	0.04**	0.04**	0.01***	0.01***
β_0	0.07	0.09	0.10	1.63	1.48	1.60	1.50
Standard Error	0.07	0.07	0.07	1.16	1.18	0.55	0.55
t-statistics	1.02	1.27	1.31	1.40	1.26	2.94***	2.72***
Pr > |t|	0.31	0.21	0.20	0.17	0.22	0.01***	0.01***
β of $PCH\overline{M}$	0.34	0.34	0.35	0.03	0.07	-0.18	-0.14
Standard Error	0.18	0.17	0.17	0.26	0.27	0.25	0.25
t-statistics	1.92*	1.93*	2.00*	0.12	0.27	-0.73	-0.55
Pr > |t|	0.06*	0.06*	0.05*	0.90	0.79	0.47	0.59
β of $\overline{DH}_{POST}$				1.11	0.95		
Standard Error				2.79	2.80		
t-statistics				0.40	0.34		
Pr > |t|				0.69	0.74		
β of $\overline{DL}_{POST}$				-4.66	-4.17		
Standard Error				2.07	2.06		
t-statistics				-2.25**	-2.03**		
Pr > |t|				0.03**	0.05**		
β of $\overline{Min}\,(DH_{POST}, DL_{POST})$						-3.89	-3.63
Standard Error						1.40	1.42
t-statistics						-2.8***	-2.56**
Pr > |t|						0.01***	0.01**
β of $PCH\overline{TV}$		-0.07		-0.09		-0.07	
Standard Error		0.05		0.05		0.05	
t-statistics		-1.27		-1.61		-1.41	
Pr > |t|		0.21		0.11		0.16	
β of $PCH\overline{OI}$			-0.13		-0.13		-0.10
Standard Error			0.09		0.09		0.09
t-statistics			-1.46		-1.45		-1.20
Pr > |t|			0.15		0.16		0.24
R-square	0.074	0.107	0.116	0.209	0.200	0.241	0.231
N	48	48	48	48	48	48	48
Characteristics of the residual							
Skewness	0.73	0.57	0.62	0.53	0.63	0.55	0.66
Excess Kurtosis	0.05	-0.10	-0.07	0.20	0.25	0.21	0.27
Shapiro-Wilkes test							
for normality	0.95**	0.97	0.96	0.97	0.96	0.97	0.96*
Pr < W	0.04**	0.23	0.14	0.28	0.12	0.27	0.10*
White's test for							
homoscedasticity	0.75	5.75	3.73	14.00	11.63	5.03	4.48
Pr > ChiSq	0.69	0.33	0.59	0.45	0.64	0.83	0.88
Breusch-Pagan test							
for homoscedasticity	0.08	3.32	2.19	3.01	1.53	2.66	0.94
Pr > ChiSq	0.77	0.19	0.34	0.56	0.82	0.45	0.82
Variance inflation factor							
$PCH\overline{M}$	1.00	1.00	1.00	2.46	2.50	2.30	2.34
$\overline{DH}_{POST}$				2.84	2.83		
$\overline{DL}_{POST}$				2.33	2.26		
$\overline{Min}\,(DH_{POST}, DL_{POST})$						2.30	2.34
$PCH\overline{TV}$		1.00		1.04		1.00	
$PCH\overline{OI}$			1.00		1.03		1.02

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.6: For the 30-day windows of the second nearest canola futures, the coefficients of $PCH\overline{M}$ in regressions where the effects of the price limits are not included are significantly positive statistically at 90% confidence level (columns 1 to 3). However, they become insignificant when the effects of the price limits are included in the regressions (columns 4 to 7) indicating no relationship between percentage changes in futures price volatility and average margin levels, which follows the liquidity costs hypothesis (H3). Despite we observe the inconsistent finding between the 20- and 30-day windows of the second nearest canola contracts in tables 8.5 and 8.6, including the effects of price limits can reverse the results found when the effects of price limits are excluded from the regression equations. The coefficients of $\overline{DL_{POST}}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ are significantly negative statistically at the 95% and 99% confidence levels, but the coefficients of $\overline{DH_{POST}}$ are insignificant. The negative relationship indicates a gravitation effect of the price limits upon the futures price volatility (H4). Finally, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are again different from what I expected, indicating no relationship between percentage changes in futures price volatility and average trading activity.

Most of the 30-day windows of the second nearest canola regressions exhibit non-normality residuals (columns 2 to 6) except the very first and last regressions which show non-normally distributed residuals (columns 1 and 7). Moreover, all the 30-day windows of second nearest canola regressions exhibit constant residual variances under both the White's and the Breusch-Pagan tests. Since all the VIFs of each independent variable are less than 10, no problems of multicollinearity are found.

Overall, for the nearest and second nearest canola contracts, when the effects of the price limits are included in the regressions, the coefficients of $PCH\overline{M}$ either become significantly negative statistically at 90%, 95% and 90% confidence levels for the 20-day windows, indicating a negative relationship between percentage changes in futures price volatility and average margin levels (H1), or become insignificant for the 30-day windows, indicating a neutral relationship between the two variables (H3), similar to findings of Hartzmark (1986) and Hardouvelis and Kim (1995).

Moreover, for both 20- and 30-day windows of nearest and second nearest canola contracts, the coefficients of $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ are always significantly negative at the 90%, 95% and 99% confidence levels, indicating a gravitation effect of the price limits upon the futures price volatility (H4). Thus, smaller average distances between the futures prices and the price limits destabilize the futures price volatility. However, the coefficients of $\overline{DH}_{POST}$ are always insignificant for both windows of the nearest and second nearest canola contracts which may imply 1) no relationship between change in futures price volatility and the average distance of futures prices from upper price limits as the observations of the futures prices are too far away from the upper price limits, or 2) no relationship between change in futures price volatility and the average distance of futures prices from upper price limits regardless of where the observations of the futures prices fall within the distance segments.

Finally, even though the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are not expected indicating no relationship between percentage changes in futures price volatility and average trading activity, this is similar to the findings of Fishe et al. (1990) and Phylaktis et al. (1999).

Table 8.7- Results of the regressions for the 20-day window of nearest barley futures contract

Results of regression								
Column	(1)	(2)	(3)	(4)	(5)	(6)		(7)
	NC	NC	NC	NC	NC	NC	C	NC
Overall regression:								
F Value	0.29	1.67	0.37	1.13	0.42	1.54	1.54	0.57
Pr > F	0.59	0.20	0.69	0.36	0.79	0.22	0.22	0.64
β_0	0.27	0.36	0.22	4.01	3.45	1.69	1.69	1.45
Standard Error	0.19	0.19	0.20	3.34	3.59	1.20	1.56	1.26
t-statistics	1.44	1.90*	1.10	1.20	0.96	1.41	1.08	1.15
Pr > |t|	0.16	0.07*	0.28	0.24	0.34	0.17	0.29	0.26
β of $PCH\bar{M}$	0.39	0.55	0.39	0.07	-0.08	0.28	0.28	0.14
Standard Error	0.73	0.71	0.73	0.85	0.89	0.75	0.80	0.78
t-statistics	0.54	0.78	0.54	0.09	-0.09	0.38	0.35	0.18
Pr > |t|	0.59	0.44	0.60	0.93	0.93	0.71	0.73	0.86
β of $\overline{DH}_{POST}$				-2.97	-2.00			
Standard Error				4.37	4.63			
t-statistics				-0.68	-0.43			
Pr > |t|				0.50	0.67			
β of $\overline{DL}_{POST}$				-5.65	-5.59			
Standard Error				5.42	5.73			
t-statistics				-1.04	-0.98			
Pr > |t|				0.31	0.34			
β of $\overline{Min}\,(DH_{POST}, DL_{POST})$						-3.92	-3.92	-3.62
Standard Error						3.49	4.32	3.65
t-statistics						-1.12	-0.91	-0.99
Pr > |t|						0.27	0.37	0.33
β of $PCH\overline{TV}$		-0.32		-0.32		-0.33	-0.33	
Standard Error		0.19		0.19		0.19	0.19	
t-statistics		-1.74*		-1.71*		-1.78*	-1.72*	
Pr > |t|		0.10*		0.10*		0.10*	0.10*	
β of $PCH\overline{OI}$			0.13		0.09			0.12
Standard Error			0.19		0.20			0.19
t-statistics			0.68		0.47			0.61
Pr > |t|			0.50		0.64			0.55
R-square	0.009	0.095	0.023	0.131	0.053	0.130	0.130	0.053
N	35	35	35	35	35	35	35	35
Characteristics of the residual								
Skewness	2.03	1.79	1.78	1.55	1.62	1.56		1.58
Excess Kurtosis	4.04	3.42	3.41	2.63	2.78	2.60		2.69
Shapiro-Wilkes test								
for normality	0.76***	0.82***	0.82***	0.86***	0.84***	0.86***		0.85***
Pr < W	<0.0001***	<0.0001***	<0.0001***	0.00***	0.00***	0.00***		0.00***
White's test for								
homoscedasticity	3.31	6.72	7.76	16.65	14.16	15.09*		13.75
Pr > ChiSq	0.19	0.24	0.17	0.28	0.44	0.09*		0.13
Breusch-Pagan test								
for homoscedasticity	3.28*	5.77*	5.09*	7.90*	8.07*	7.48*		8.42**
Pr > ChiSq	0.07*	0.07*	0.08*	0.10*	0.09*	0.06*		0.04**
Variance inflation factor								
$PCH\bar{M}$	1.00	1.02	1.00	1.42	1.41	1.13		1.12
$\overline{DH}_{POST}$				1.10	1.13			
$\overline{DL}_{POST}$				1.48	1.52			
$\overline{Min}\,(DH_{POST}, DL_{POST})$						1.12		1.13
$PCH\overline{TV}$		1.02		1.03		1.02		
$PCH\overline{OI}$			1.00		1.05			1.00

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.7: For the 20-day windows of the nearest barley futures, all the coefficients of $PCH\overline{M}$ are insignificant regardless of whether the effects of the price limits are included or not. This implies a neutral effect of the percentage change in average margin levels upon the futures price volatility, which follows the liquidity costs hypothesis (H3). All the coefficients of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}$ (DH_{POST}, DL_{POST}) are also insignificant. Finally, the coefficients of $PCH\overline{TV}$ are significantly negative at 90% confidence levels. The insignificant coefficients of $PCH\overline{OI}$ indicates no relationship between percentage changes in futures price volatility and average trading activity.

All the residuals of the regressions exhibit non-normal distributions (columns 1 to 7). Moreover, all the 20-day windows of nearest canola regressions exhibit constant residual variances under the White's test except for the regression in column 6 where I make a correction for heteroscedasticity, but the results stay the same. Since all the VIFs values are less than 10, no problems of multicollinearity are found.

Table 8.8: For the 30-day windows of the nearest barley futures, all the coefficients of $PCH\overline{M}$ in regressions are insignificant regardless of whether the effects of the price limits are included or not, reflecting the liquidity costs hypothesis (H3). All the coefficients of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}$ (DH_{POST}, DL_{POST}) are also insignificant after making corrections for the heteroscedasticity. Finally, all the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ indicates no relationship between percentage changes in futures price volatility and average trading activity.

All the regressions exhibit non-normality residuals (columns 1 to 7), while most regressions exhibit non-constant residual variances under the White's test except for the regression in columns 2 and 3. No problems of multicollineariy are found.

Table 8.8- Results of the regressions for the 30-day window of nearest barley futures contract

Results of regression						
Column	(1)		(2)	(3)	(4)	
	NC	C	NC	NC	NC	C
Overall regression:						
F Value	0.40	0.40	0.59	0.26	1.18	1.18
Pr > F	0.53	0.53	0.56	0.77	0.34	0.34
β_0	0.08	0.08	0.10	0.07	4.34	4.34
Standard Error	0.12	0.10	0.12	0.13	2.27	3.22
t-statistics	0.68	0.80	0.85	0.51	1.91*	1.34
Pr > |t|	0.50	0.43	0.40	0.62	0.07*	0.19
β of $PCH\overline{M}$	0.28	0.28	0.23	0.28	-0.13	-0.13
Standard Error	0.44	0.60	0.45	0.45	0.49	0.35
t-statistics	0.63	0.47	0.51	0.62	-0.27	-0.38
Pr > |t|	0.53	0.64	0.61	0.54	0.79	0.71
β of $\overline{DH}_{POST}$					-3.80	-3.80
Standard Error					3.22	3.68
t-statistics					-1.18	-1.03
Pr > |t|					0.25	0.31
β of $\overline{DL}_{POST}$					-6.14	-6.14
Standard Error					4.00	5.18
t-statistics					-1.53	-1.19
Pr > |t|					0.14	0.25
β of $\overline{Min}\ (DH_{POST}, DL_{POST})$						
Standard Error						
t-statistics						
Pr > |t|						
β of $PCH\overline{TV}$			-0.15		-0.10	-0.10
Standard Error			0.17		0.18	0.11
t-statistics			-0.88		-0.56	-0.90
Pr > |t|			0.39		0.58	0.38
β of $PCH\overline{OI}$				0.06		
Standard Error				0.18		
t-statistics				0.35		
Pr > |t|				0.73		
R-square	0.012	0.012	0.035	0.016	0.136	0.136
N	35	35	35	35	35	35
Characteristics of the residual						
Skewness	2.04		2.05	1.86	1.47	
Excess Kurtosis	5.12		5.12	4.47	3.29	
Shapiro-Wilkes test for normality	0.81***		0.80***	0.84***	0.88***	
Pr < W	<0.0001***		<0.0001***	0.00***	0.00***	
White's test for homoscedasticity	5.48*		6.31	8.71	23.54**	
Pr > ChiSq	0.07*		0.28	0.12	0.05**	
Breusch-Pagan test for homoscedasticity	4.24*		4.17	6.38**	10.02**	
Pr > ChiSq	0.04*		0.13	0.04**	0.04**	
Variance inflation factor						
$PCH\overline{M}$	1.00		1.02	1.00	1.27	
$\overline{DH}_{POST}$					1.01	
$\overline{DL}_{POST}$					1.35	
$\overline{Min}\ (DH_{POST}, DL_{POST})$						
$PCH\overline{TV}$			1.02		1.08	
$PCH\overline{OI}$				1.00		

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Results of regression						
Column	(5)		(6)		(7)	
	NC	C	NC	C	NC	C
Overall regression: F Value Pr > F	 1.10 0.38	 1.10 0.38	 1.55 0.22	 1.55 0.22	 1.33 0.28	 1.33 0.28
β_0 Standard Error t-statistics Pr > |t|	4.61 2.34 1.97* 0.06*	4.61 3.32 1.39 0.18	1.59 0.82 1.95* 0.06*	1.59 1.21 1.32 0.20	1.63 0.85 1.91* 0.07*	1.63 1.20 1.36 0.18
β of $PCH\overline{M}$ Standard Error t-statistics Pr > |t|	-0.14 0.50 -0.27 0.79	-0.14 0.36 -0.37 0.71	0.00 0.45 0.00 0.99	0.00 0.45 0.00 0.99	0.04 0.45 0.08 0.94	0.04 0.48 0.07 0.94
β of $\overline{DH}_{POST}$ Standard Error t-statistics Pr > |t|	-3.84 3.34 -1.15 0.26	-3.84 3.54 -1.09 0.29				
β of $\overline{DL}_{POST}$ Standard Error t-statistics Pr > |t|	-6.76 3.95 -1.71* 0.10*	-6.76 5.72 -1.18 0.25				
β of $\overline{Min}\ (DH_{POST}, DL_{POST})$ Standard Error t-statistics Pr > |t|			-4.34 2.36 -1.84* 0.08*	-4.34 3.30 -1.32 0.20	-4.51 2.43 -1.86* 0.07*	-4.51 3.32 -1.36 0.19
β of $PCH\overline{TV}$ Standard Error t-statistics Pr > |t|			-0.13 0.17 -0.76 0.45	-0.13 0.12 -1.07 0.20		
β of $PCH\overline{OI}$ Standard Error t-statistics Pr > |t|	-0.02 0.18 -0.13 0.90	-0.02 0.29 -0.08 0.94			-0.01 0.17 -0.04 0.97	-0.01 0.24 -0.03 0.98
R-square	0.128	0.128	0.130	0.130	0.114	0.114
N	35	35	35	35	35	35
Characteristics of the residual						
Skewness	1.46		1.49		1.44	
Excess Kurtosis	2.95		3.60		3.23	
Shapiro-Wilkes test for normality Pr < W	 0.88*** 0.00***		 0.89*** 0.00***		 0.90*** 0.00***	
White's test for homoscedasticity Pr > ChiSq	 23.03** 0.06**		 19.42** 0.02**		 18.77** 0.03**	
Breusch-Pagan test for homoscedasticity Pr > ChiSq	 12.10** 0.02**		 10.43** 0.02**		 12.27*** 0.01***	
Variance inflation factor						
$PCH\overline{M}$	1.28		1.10		1.09	
$\overline{DH}_{POST}$	1.07					
$\overline{DL}_{POST}$	1.30					
$\overline{Min}\ (DH_{POST}, DL_{POST})$			1.10		1.14	
$PCH\overline{TV}$			1.02			
$PCH\overline{OI}$	1.08				1.05	

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.9- Results of the regressions for the 20-day window of second nearest barley futures contract

Results of regression							
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NC	NC	NC	NC	NC	NC	NC
Overall regression:							
F Value	1.47	1.02	1.81	0.82	1.49	0.72	1.26
Pr > F	0.23	0.37	0.18	0.53	0.23	0.55	0.31
β_0	0.37	0.42	0.36	5.58	5.23	1.28	1.31
Standard Error	0.28	0.29	0.27	5.65	5.38	2.01	1.96
t-statistics	1.33	1.47	1.32	0.99	0.97	0.63	0.67
Pr > |t|	0.19	0.15	0.20	0.33	0.34	0.53	0.51
β of $PCH\overline{M}$	-1.32	-1.23	-1.52	-1.96	-2.28	-1.43	-1.74
Standard Error	1.09	1.10	1.08	1.32	1.25	1.21	1.18
t-statistics	-1.21	-1.11	-1.41	-1.49	-1.83*	-1.18	-1.47
Pr > |t|	0.23	0.27	0.17	0.15	0.08*	0.25	0.15
β of $\overline{DH}_{POST}$				-2.00	0.17		
Standard Error				6.39	6.31		
t-statistics				-0.31	0.03		
Pr > |t|				0.76	0.98		
β of $\overline{DL}_{POST}$				-10.05	-11.58		
Standard Error				9.00	8.44		
t-statistics				-1.12	-1.37		
Pr > |t|				0.27	0.18		
$\beta$of$\overline{Min}\ (DH_{POST}, DL_{POST})$						-2.46	-2.72
Standard Error						5.72	5.55
t-statistics						-0.43	-0.49
Pr > |t|						0.67	0.63
β of $PCH\overline{TV}$		-0.10		-0.06		-0.09	
Standard Error		0.13		0.14		0.13	
t-statistics		-0.76		-0.47		-0.70	
Pr > |t|		0.45		0.64		0.49	
β of $PCH\overline{OI}$			0.64		0.74		0.64
Standard Error			0.44		0.46		0.45
t-statistics			1.45		1.63		1.42
Pr > |t|			0.16		0.11		0.17
R-square	0.043	0.060	0.102	0.098	0.165	0.065	0.109
N	35	35	35	35	35	35	35
Characteristics of the residual							
Skewness	5.27	5.12	4.74	4.77	4.28	5.08	4.71
Excess Kurtosis	29.83	28.57	25.93	25.43	22.96	28.20	25.80
Shapiro-Wilkes test for normality	0.39***	0.42***	0.49***	0.46***	0.55***	0.42***	0.49***
Pr < W	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***
White's test for homoscedasticity	0.77	1.98	4.60	6.95	8.18	4.27	5.14
Pr > ChiSq	0.68	0.85	0.47	0.94	0.88	0.89	0.82
Breusch-Pagan test for homoscedasticity	0.43	0.71	2.84	1.51	5.15	0.71	2.90
Pr > ChiSq	0.51	0.70	0.24	0.83	0.27	0.87	0.41
Variance inflation factor							
$PCH\overline{M}$	1.00	1.01	1.02	1.41	1.37	1.19	1.18
$\overline{DH}_{POST}$				1.25	1.32		
$\overline{DL}_{POST}$				1.55	1.47		
$\overline{Min}\ (DH_{POST}, DL_{POST})$						1.18	1.17
$PCH\overline{TV}$		1.01		1.07		1.02	
$PCH\overline{OI}$			1.02		1.10		1.02

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.9: For the 20-day windows of the second nearest barley futures, all the coefficients of $PCH\overline{M}$ in regressions are insignificant when the effects of the price limits are not included (columns 1 to 3). When the effects of the price limits are included in the regressions, only the case in column 5 reverses the result and shows a statistically significant negative coefficient of $PCH\overline{M}$ at the 90% confidence level. This indicates either a neutral effect of the percentage change in average margin levels upon the futures price volatility, the liquidity costs hypothesis (H3), or a decreasing effect of the percentage change in average margin levels upon the futures price volatility, the restriction hypothesis (H1). All the coefficients of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ show insignificant relationship between the percentage change in futures price volatility and the average distances of the futures prices from the price limits. Finally, the coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are again insignificant indicating no relationship between percentage changes in futures price volatility and average trading activity.

All the regressions exhibit non-normal residuals (columns 1 to 7) while all the regressions exhibit constant residual variances under both the White's and the Breusch-Pagan tests. Since all the VIFs values are less than 10, no problems of multicollinearity are found.

Table 8.10- Results of the regressions for the 30-day window of second nearest barley futures contract

Results of regression							
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NC	NC	NC	NC	NC	NC	NC
Overall regression: F Value Pr > F	 2.96* 0.10*	 1.92 0.16	 2.62* 0.09*	 1.21 0.33	 1.79 0.16	 1.35 0.28	 1.76 0.18
β_0 Standard Error t-statistics Pr > |t|	0.09 0.10 0.84 0.41	0.09 0.10 0.92 0.37	0.11 0.10 1.10 0.28	2.34 2.32 1.01 0.32	1.38 2.31 0.60 0.56	0.55 0.82 0.66 0.51	0.46 0.81 0.56 0.58
β of $PCH\overline{M}$ Standard Error t-statistics Pr > |t|	-0.67 0.39 -1.72* 0.10*	-0.66 0.39 -1.71* 0.10*	-0.69 0.38 -1.82* 0.08*	-0.89 0.45 -1.97* 0.06*	-0.87 0.44 -1.98* 0.06*	-0.76 0.43 -1.77* 0.09*	-0.76 0.42 -1.82* 0.08*
β of $\overline{DH}_{POST}$ Standard Error t-statistics Pr > |t|				-1.36 2.80 -0.49 0.63	1.08 2.93 0.37 0.72		
β of $\overline{DL}_{POST}$ Standard Error t-statistics Pr > |t|				-3.79 3.64 -1.04 0.31	-4.00 3.51 -1.14 0.26		
$\beta$of$\overline{Min}\,(DH_{POST}, DL_{POST})$ Standard Error t-statistics Pr > |t|						-1.27 2.29 -0.55 0.58	-0.97 2.26 -0.43 0.67
β of $PCH\overline{TV}$ Standard Error t-statistics Pr > |t|		-0.10 0.11 -0.94 0.35		-0.10 0.11 -0.83 0.41		-0.10 0.11 -0.93 0.36	
β of $PCH\overline{OI}$ Standard Error t-statistics Pr > |t|			0.34 0.23 1.47 0.15		0.43 0.26 1.66 0.11		0.33 0.23 1.41 0.17
R-square	0.082	0.107	0.141	0.139	0.193	0.116	0.146
N	35	35	35	35	35	35	35
Characteristics of the residual							
Skewness	3.73	3.54	3.38	3.27	2.91	3.54	3.34
Excess Kurtosis	17.99	16.93	15.63	15.75	13.38	17.13	15.67
Shapiro-Wilkes test for normality Pr < W	 0.64*** <0.0001***	 0.67*** <0.0001***	 0.69*** <0.0001***	 0.70*** <0.0001***	 0.74*** <0.0001***	 0.66*** <0.0001***	 0.69*** <0.0001***
White's test for homoscedasticity Pr > ChiSq	 0.81 0.67	 4.12 0.53	 6.95 0.23	 10.89 0.70	 11.76 0.63	 5.32 0.81	 9.11 0.43
Breusch-Pagan test for homoscedasticity Pr > ChiSq	 0.74 0.39	 1.74 0.42	- 2.48 0.29	 2.29 0.68	 4.83 0.31	 1.65 0.65	 2.51 0.47
Variance inflation factor							
$PCH\overline{M}$	1.00	1.00	1.00	1.33	1.33	1.19	1.19
$\overline{DH}_{POST}$				1.24	1.45		
$\overline{DL}_{POST}$				1.38	1.37		
$\overline{Min}\,(DH_{POST}, DL_{POST})$						1.19	1.20
$PCH\overline{TV}$		1.00		1.06		1.00	
$PCH\overline{OI}$			1.00		1.24		1.01

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 8.10: For the 30-day windows of the second nearest barley futures, all the coefficients of $PCH\overline{M}$ are significantly negative at the 90% confidence level regardless of whether the effects of the price limits are included or not (columns 1 to 7). Including the effects of the price limits thus do no reverse the results. This indicates a decreasing effect of the percentage change in average margin levels upon the futures price volatility, supporting the restriction hypothesis (H1). All the coefficients of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ show insignificant relationship between the percentage change in futures price volatility and average distances of the futures prices from the price limits. Finally, the coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are again insignificant indicating no relationship between percentage changes in futures price volatility and average trading activity.

All the regressions exhibit non-normal residuals (columns 1 to 7) while all the regressions exhibit constant residual variances under both the White's and the Breusch-Pagan tests. Since all the VIFs values are less than 10, no problems of multicollinearity are found.

Overall, for both the 20- and 30-day windows of the nearest and second nearest barley futures contracts, most of the results on the coefficient of $PCH\overline{M}$ do not change when the effects of the price limits are included in the regression models except one case under the 20-day window of the second nearest barley futures contract which exhibits a significant negative coefficient of $PCH\overline{M}$ at the 90% confidence level. Moreover, all the coefficients of $\overline{DH}_{POST}$, $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ show an insignificant relationship between the percentage change in futures price volatility and average distances of the futures prices from the price limits. Most of the coefficients of $PCH\overline{TV}$

and $PCH\overline{OI}$ are also insignificant, indicating no relationship between percentage changes in futures price volatility and average trading activity.

Section 8.3- Overall conclusion about the results of the multiple regression models

In general, the coefficients of $PCH\overline{M}$ reverse when the effect of the price limits are included in the regression model for the canola futures contracts, becoming either significantly negative statistically at 90%, 95% and 90% confidence levels from an insignificant coefficient for the 20-day windows, or insignificant from a statistically positive coefficient for the 30-day windows. As a result, it suggests the importance of including the effects of the price limits in the regressions. Although this may not be obvious for the barley contracts, we still observe no change in the most of results of the coefficients in both nearest and second nearest contracts when including the effects of the price limits in the regressions. Thus, even though Fishe et al. (1990) find an inconsistent relationship between changes in futures price volatility and margins when they run their regression with the percentage change in futures price volatility as dependent variable and the percentage change in margins and percentage change in open interest as independent variables, this can be explained by the absence of the price limit distance variables in the model.

Since we observe the coefficients of $PCH\overline{M}$ in two of the four canola contracts and two of the four barley contracts becoming or staying negative when the effects of the price limits are included, it indicates that there is a reduction effect of the average margin level upon the futures price volatility (H1). Still, some of the contracts exhibit neutral relationship between the percentage changes in futures price volatility and average margin levels (H3). Even though there is a mixed result on the direction of the relationship between the two variables, I believe that the restriction hypothesis (H1) can be supported since the 20-day windows should be more representative due to the ability to capture an immediate effect around margin changes, and since the canola contracts can provide us a more precise and reliable coefficient estimates from our discussion of the margin levels in chapter 3.

The coefficients of $\overline{DH}_{POST}$ are always insignificant in 20- and 30-day windows of the nearest and second nearest canola and barley contracts. Most of the coefficients of $\overline{DL}_{POST}$ and $\overline{Min}\,(DH_{POST}, DL_{POST})$ are also insignificant for both commodity contracts even though some of them follows the gravitation effect of destabilizing the futures price volatility. Before we can conclude that the price limits actually produce no effects upon the futures price volatility, we need to understand whether these results are due to effects of observations lying at 1) a higher distance away from the price limits, or 2) a lower distance away from the price limits. This is because when futures prices are further away from the price limits, the price limits should have no influences upon the futures prices volatility because traders may not consider trading in advance or later that important. On the contrary, the price limits should produce some effects upon the futures price volatility when the futures prices move closer to the price limits as traders may desire to change their trading strategy due to the possibility of a trading halt as the prices hit the limits. As they alter their trading plan, the level of the futures prices may also be changed leading to changes in the futures price volatility. Therefore, until we examine the relationship between the futures price volatility and different segments of the distances from price limits, it is not possible to draw a conclusion about the effect of price limits upon the futures price volatility. To investigate further, a discussion of the piecewise linear regression is provided in chapter 9.

Finally, because I obtain most of the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ which are not expected, it indicates that there is no relationship between percentage changes in futures price volatility and average trading activity. This is similar to the findings of Fishe et al. (1990) and Phylaktis et al. (1999).

9. PIECEWISE REGRESSION ANALYSIS

In this chapter, I provide a piecewise linear regression analysis which segments the effect of price limits when considering the effect of margin requirements upon the futures price volatility. In section 9.1, I present the piecewise linear regression models and a description of several components of the regression models not yet shown in the previous chapters and the hypotheses of their relationship to the futures price volatility. In sections 9.2 and 9.3, I present the results and conclusion of the piecewise regressions.

Section 9.1- Description of the piecewise linear regression model on the relationship between futures price volatility and margin requirements when the effect of price limits are segmented

In the previous chapter, I obtain many insignificant coefficients of the distance variables. Two possible explanations for this result are 1) the futures prices are too far away from the price limits to produce any effect on the trader behaviour, and thus the futures price volatility, or 2) the existence of price limits does not have any effect on trader behaviour regardless of whether the futures prices fall in a range close to the price limits or not. To understand which explanation applies to my result, I extend the equations 8.3 to 8.6 in chapter 8 by segmenting the effect of the distances of futures prices from the price limits in the regression models similar to Morck, Shleifer and Vishny (1998).

In a piecewise linear regression model, the slope of the regression line changes and the regression line is segmented by certain breakpoints according to the characteristics of the independent variable (Ertel & Fowlkes, 1976). Therefore, the purpose of conducting a piecewise linear regression in this analysis is to capture the effects of the average distance variable upon the futures price volatility for different distance segments. Remember that traders may change their trading strategy when they observe prices falling in a range close to the price limits. However, since the turning point at which the distance from the price limits triggers traders' desire to change their trading strategy is unknown, I employ a breakpoint at 35%. This is because most observations of the futures prices fall in the range between 35% and 45% to the price limits as shown in tables 8.1 and 8.2 in chapter 8. Now the regressions become:

$$(9.1)\quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{DH}_{0\ to\ 0.35} + \beta_3 * \overline{DH}_{over\ 0.35} + \beta_4 * \overline{DL}_{0\ to\ 0.35} + \beta_5 * \overline{DL}_{over\ 0.35} + \beta_6 * PCH\overline{TV} + \varepsilon_t,$$

$$(9.2)\quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{DH}_{0\ to\ 0.35} + \beta_3 * \overline{DH}_{over\ 0.35} + \beta_4 * \overline{DL}_{0\ to\ 0.35} + \beta_5 * \overline{DL}_{over\ 0.35} + \beta_6 * PCH\overline{OI} + \varepsilon_t\ ,$$

$$(9.3)\quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{Min}_{0\ to\ 0.35} + \beta_3 * \overline{Min}_{over\ 0.35} + \beta_4 * PCH\overline{TV} + \varepsilon_t,$$

$$(9.4)\quad PCHV = \beta_0 + \beta_1 * PCH\overline{M} + \beta_2 * \overline{Min}_{0\ to\ 0.35} + \beta_3 * \overline{Min}_{over\ 0.35} + \beta_4 * PCH\overline{OI} + \varepsilon_t,$$

where

$\overline{DH}_{0\ to\ 0.35}$ is the average distance, from the daily high price to the upper price limit, between 0% and 35% in the period following margin changes,

$= \overline{DH}_{POST}$ if distance < 0.35, otherwise

= 0.35 if distance $\geq$ 0.35;

$\overline{DH}_{over\ 0.35}$ is the average distance, between the daily high price and the upper price limit, over 35% in the period following margin changes,

= 0 if distance < 0.35, otherwise,

= distance minus 0.35 if distance > 0.35

$\overline{DL}_{0\ to\ 0.35}$ is the average distance, from the daily low price to the lower price limit, between 0% and 35% in the period following margin changes,

= $\overline{DL}_{POST}$ if distance < 0.35, otherwise

= 0.35 if distance $\geq$ 0.35;

$\overline{DL}_{over\ 0.35}$ is the average distance, between the daily low price and the lower price limit, over 35% in the period following margin changes,

= 0 if distance < 0.35, otherwise,

= distance minus 0.35 if distance > 0.35

$\overline{Min}_{0\ to\ 0.35}$ is the average distance, of the minimum of DH_{POST} and DL_{POST}, between 0% and 35% in the period following margin changes,

= $\overline{Min}\ (DH_{POST}, DL_{POST})$ if distance < 0.35, otherwise

= 0.35 if distance $\geq$ 0.35;

$\overline{Min}_{over\ 0.35}$ is the average distance, of the minimum of DH_{POST} and DL_{POST}, over 35% in the period following margin changes,

= 0 if distance < 0.35, otherwise,

= distance minus 0.35 if distance > 0.35

ε_t is the random error term

For example, when the average distance between the daily high price and the upper price limit is equal to 37%, then $\overline{DH}_{0\ to\ 0.35} = 0.35$, and $\overline{DH}_{over\ 0.35} = 0.02$. For robustness, I also conduct another set of piecewise linear regressions using a breakpoint of 40%.

Section 9.1a- Hypotheses of the average distance variables' relationship to the futures price volatility

To understand which explanation applies to my result, one needs to understand that the relationship between the futures price volatility and the average distance of futures prices from price limits may change with the value of the average distance. For example, if the average distance of futures price from the price limit exceeds 35% (or 40%), the distance may be too big for the price limit to produce any influence on the trader behaviour. However, there should be some relationship between the percentage change in futures price volatility and the average distance to the price limit if the average distance is lower than 35% (or 40%) because the response of traders may push prices closer to or away from price limits resulting in greater or lower futures price volatility. Therefore, if one observes positive coefficients of β_2 in equations 9.1 to 9.4, and β_4 in equations 9.1 and 9.2, then price limits should produce a stabilization effect upon the futures price volatility when the average distance to the price limit is less than 35% (or 40%). Otherwise, if one sees negative coefficients of β_2 in equations 9.1 to 9.4, and β_4 in equations 9.1 and 9.2, then price limits should generate a destabilization effect upon the futures price volatility. Finally, if insignificant results for the coefficients of β_2 in equations 9.1 to 9.4, and β_4 in equations 9.1 and 9.2 are obtained, then the distance from the price limit actually produces no effect upon the futures price volatility.

Section 9.2- Analysis of the results of the multiple regression models

The results of the equations 9.1 to 9.4 are shown in tables 9.1 to 9.8 for 20- and 30-day windows of both nearest and second nearest canola and barley contracts. Statistics given in the tables include skewness, excess kurtosis, tests for normality, heteroskedasticity, and multicollinearity. The Shapiro-Wilks test is a normality test, whereas the White's and the Breusch-Pagan tests are for testing the constancy of residual variance. The Heteroscedasticity-Corrected Covariance Matrix Estimation (HCCME) is used to correct the heteroscedastic residual variance. Descriptions of them are in chapters 5 and 8.

For each commodity, columns 1 to 4 and 6 to 9 show the results from equations 9.1 to 9.4. Columns 4 and 10 show the breakdown of the number of observations of futures prices within each segment of the average distance from upper and lower price limits. In all the regressions, the percentage change in futures price volatility is the dependent variable. Note in the third row of each table, the "NC" indicates the regression without the correction for heteroscedasticity and the "C" indicates the regression with the correction for heteroscedasticity. Moreover, only the regressions with a breakpoint of 40% are discussed as the numbers of observations in each distance segment do not differ too much.

Table 9.1- Results of the regressions for the 20-day window of nearest canola futures contract

N= 48	Distance Break at 0.35				N	Distance Break at 0.4				N
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	NC	NC	NC	NC		NC	NC	NC	NC	
Overall regression:										
F Value	4.47***	3.95***	6.91***	6.35***		3.96***	3.44***	5.39***	4.90***	
Pr > F	0.00***	0.00***	0.00***	0.00***		0.00***	0.01***	0.00***	0.00***	
β_0	7.27	6.18	2.77	2.69		4.39	4.14	2.04	1.96	
Standard Error	12.55	12.83	0.56	0.57		2.48	2.55	0.46	0.46	
t-statistics	0.58	0.48	4.93***	4.75***		1.77*	1.62	4.47***	4.28***	
Pr > |t|	0.57	0.63	<.0001***	<.0001***		0.08*	0.11	<.0001***	0.00***	
β of $PCH\overline{M}$	-0.57	-0.51	-0.73	-0.65		-0.60	-0.52	-0.65	-0.57	
Standard Error	0.24	0.24	0.23	0.23		0.26	0.26	0.24	0.24	
t-statistics	-2.39**	-2.07**	-3.17***	-2.79***		-2.30**	-1.97*	-2.71*	-2.38**	
Pr > |t|	0.02**	0.05**	0.00***	0.01***		0.03**	0.06*	0.01*	0.02**	
β of $\overline{DH}_{0\ to\ break}$	-7.20	-4.75			1	-1.94	-1.97			10
Standard Error	35.19	36.03				6.57	6.79			
t-statistics	-0.20	-0.13				-0.30	-0.29			
Pr > |t|	0.84	0.90				0.77	0.77			
β of $\overline{DH}_{over\ break}$	5.86	3.54			47	1.04	1.52			38
Standard Error	36.32	37.20				9.18	9.54			
t-statistics	0.16	0.10				0.11	0.16			
Pr > |t|	0.87	0.93				0.91	0.87			
β of $\overline{DL}_{0\ to\ break}$	-12.42	-11.84			6	-8.86	-8.21			16
Standard Error	3.23	3.30				2.34	2.36			
t-statistics	-3.84***	-3.59***				-3.79***	-3.48***			
Pr > |t|	0.00***	0.00***				0.00***	0.00***			
β of $\overline{DL}_{over\ break}$	9.67	9.32			42	7.93	7.06			32
Standard Error	3.95	4.09				4.29	4.38			
t-statistics	2.45**	2.29**				1.85*	1.61			
Pr > |t|	0.020**	0.03**				0.07*	0.12			
β of $\overline{Mtn}_{o\ to\ break}$			-7.95	-7.81	15			-5.24	-5.08	25
Standard Error			1.82	1.85				1.30	1.32	
t-statistics			-4.38***	-4.23***				-4.03***	-3.86***	
Pr > |t|			<.0001***	0.00***				0.00***	0.00***	
β of $\overline{Mtn}_{over\ break}$			7.62	7.92	33			4.05	4.79	23
Standard Error			3.56	3.66				5.82	6.00	
t-statistics			2.14**	2.16**				0.70	0.80	
Pr > |t|			0.04**	0.04**				0.49	0.43	
β of $PCH\overline{TV}$	-0.26		-0.20			-0.26		-0.21		
Standard Error	0.17		0.17			0.18		0.18		
t-statistics	-1.51		-1.21			-1.46		-1.16		
Pr > |t|	0.14		0.23			0.15		0.25		
β of $PCH\overline{OI}$		-0.04		0.02			-0.02		0.00	
Standard Error		0.07		0.07			0.08		0.08	
t-statistics		-0.52		0.22			-0.25		0.04	
Pr > |t|		0.60		0.83			0.80		0.97	
R-square	0.396	0.366	0.391	0.371		0.367	0.335	0.334	0.313	
Skewness	0.62	0.82	0.48	0.70		0.59	0.83	0.51	0.70	
Excess Kurtosis	0.25	0.29	-0.04	0.13		0.18	0.41	0.22	0.19	
Shapiro-Wilkes test for normality	0.97	0.94**	0.98	0.95*		0.97	0.94**	0.98	0.95*	
Pr < W	0.26	0.02**	0.45	0.06*		0.24	0.02**	0.41	0.06*	
White's test for homoscedasticity	10.88	10.10	11.46	7.99		17.94	15.59	15.88	9.63	
Pr > ChiSq	0.95	0.97	0.57	0.84		0.85	0.93	0.26	0.72	
Breusch-Pagan test for homoscedasticity	6.80	2.00	6.93	0.68		7.08	1.53	8.93*	2.03	
Pr > ChiSq	0.34	0.92	0.14	0.95		0.31	0.96	0.06*	0.73	
$PCH\overline{M}$	1.85	1.85	1.80	1.77		2.10	2.06	1.75	1.73	
$\overline{DH}_{0\ to\ break}$	528.54	528.52				17.55	17.91			
$\overline{DH}_{over\ break}$	543.23	543.65				15.39	15.84			
$\overline{DL}_{0\ to\ break}$	9.80	9.73				4.90	4.74			
$\overline{DL}_{over\ break}$	8.97	9.10				4.27	4.24			
$\overline{Mtn}_{o\ to\ break}$			5.72	5.74				2.68	2.66	
$\overline{Mtn}_{over\ break}$			4.43	4.54				1.85	1.91	
$PCH\overline{TV}$	1.10		1.09			1.12		1.10		
$PCH\overline{OI}$		1.13		1.12			1.14		1.13	

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 9.1: For the 20-day windows of the nearest canola futures with a breakpoint of 40%, all the coefficients of $PCH\overline{M}$ remain significantly negative statistically at the 90% and 95% confidence levels when the effects of the price limits are segmented in the regressions (columns 6 to 9), similar to the results shown in table 8.3 in chapter 8. This indicates an inverse relationship between the percentage changes in futures price volatility and average margin levels, which follows the restriction hypothesis (H1).

The coefficients of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ (columns 6 and 7) are insignificant, suggesting that the price limits actually have no effects on the futures price volatility regardless of whether the futures prices are close to or far away from the upper price limits. However, the coefficients of $\overline{DL}_{0\ to\ 0.40}$ and $\overline{Min}_{o\ to\ 0.40}$ (columns 6 to 9) are significantly negative statistically at the 99% confidence level, implying that the closer the futures prices to the price limits, the greater the futures price volatility. The negative relationship indicates a gravitation (destabilization) effect of the price limits on the futures price volatility (H4). For the coefficients of $\overline{Min}_{over\ 0.40}$ in columns 8 and 9 and the coefficient of $\overline{DL}_{over\ 0.40}$ in column 7, an insignificant relationship between the percentage change in futures price volatility and the average distance of futures prices to the price limit is found, supporting the argument that the influence of the price limits upon the movements of the futures prices diminishes the further away the futures prices are to the price limits. Nevertheless, we observe a significant positive coefficient of $\overline{DL}_{over\ 0.40}$ in column 6 at the 90% confidence level suggesting some of the stabilization effect of the lower price limits upon the futures price volatility when the futures prices are far away from the lower price limits.

Again, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are observed which indicates that there is no relationship between the percentage changes in futures price volatility and average trading activity.

Finally, the regressions in columns 7 and 9 exhibit non-normally distributed residuals, whereas the regressions in columns 6 and 8 exhibit normally distributed residuals. Moreover, all the regressions exhibit constant residual variances under the White's test. Because the VIF values of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ are greater than 10 in columns 6 and 7, it indicates some multicollinearity problems in these two regressions.

Table 9.2- Results of the regressions for the 30-day window of nearest canola futures contract

N= 48	Distance Break at 0.35				N	Distance Break at 0.4				N
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	NC	NC	NC	NC		NC	NC	NC	NC	
Overall regression:										
F Value	5.13***	5.34***	7.89***	8.78***		6.91	7.18***	5.96***	6.47***	
Pr > F	0.00***	0.00***	<.0001***	<.0001***		<.0001***	<.0001***	0.00***	0.00***	
β_0	142.48	147.41	3.18	3.25		11.86	11.72	1.98	2.04	
Standard Error	126.06	124.85	0.77	0.74		2.63	2.58	0.59	0.57	
t-statistics	1.13	1.18	4.12***	4.41***		4.50***	4.55***	3.37***	3.55***	
Pr > |t|	0.27	0.25	0.00***	<.0001***		<.0001***	<.0001***	0.00***	0.00***	
β of $PCH\overline{M}$	-0.08	-0.05	-0.30	-0.24		-0.37	-0.31	-0.10	-0.08	
Standard Error	0.23	0.21	0.24	0.22		0.23	0.21	0.24	0.22	
t-statistics	-0.35	-0.26	-1.22	-1.10		-1.60	-1.46	-0.41	-0.35	
Pr > |t|	0.73	0.80	0.23	0.28		0.12	0.15	0.68	0.73	
β of $\overline{DH}_{0\ to\ break}$	-393.51	-408.00			1	-20.83	-20.84			10
Standard Error	363.55	360.04				6.41	6.33			
t-statistics	-1.08	-1.13				-3.25***	-3.29***			
Pr > |t|	0.28	0.26				0.00***	0.00***			
β of $\overline{DH}_{over\ break}$	391.20	405.75			47	22.86	23.23			38
Standard Error	363.92	360.37				7.74	7.67			
t-statistics	1.07	1.13				2.96***	3.03***			
Pr > |t|	0.29	0.27				0.01***	0.00***			
β of $\overline{DL}_{0\ to\ break}$	-12.56	-12.20			4	-9.28	-8.96			15
Standard Error	5.77	5.71				2.63	2.57			
t-statistics	-2.18**	-2.14**				-3.54***	-3.48***			
Pr > |t|	0.04**	0.04**				0.00***	0.00***			
β of $\overline{DL}_{over\ break}$	10.94	10.48			44	9.37	8.66			33
Standard Error	6.30	6.25				4.39	4.33			
t-statistics	1.73*	1.68				2.13**	2.00**			
Pr > |t|	0.09*	0.10				0.04**	0.05**			
β of $\overline{Min}_{o\ to\ break}$			-9.41	-9.75	16			-5.34	-5.57	27
Standard Error			2.40	2.32				1.66	1.63	
t-statistics			-3.92***	-4.21***				-3.23***	-3.42***	
Pr > |t|			0.00***	0.00***				0.00***	0.00***	
β of $\overline{Min}_{over\ break}$			9.83	10.69	32			6.79	8.04	21
Standard Error			3.90	3.84				6.11	6.10	
t-statistics			2.52**	2.78***				1.11	1.32	
Pr > |t|			0.02**	0.01***				0.27	0.19	
β of $PCH\overline{TV}$	0.07		0.00			-0.02		0.09		
Standard Error	0.24		0.23			0.23		0.25		
t-statistics	0.27		0.01			-0.11		0.34		
Pr > |t|	0.79		0.99			0.92		0.74		
β of $PCH\overline{OI}$		0.10		0.15			0.09		0.14	
Standard Error		0.11		0.11			0.10		0.11	
t-statistics		0.89		1.43			0.90		1.20	
Pr > |t|		0.38		0.16			0.37		0.24	
R-square	0.429	0.439	0.423	0.450		0.503	0.512	0.357	0.376	
Skewness	0.75	0.75	0.87	0.89		1.01	1.04	0.72	0.70	
Excess Kurtosis	0.52	0.73	0.14	0.42		0.65	0.78	0.18	0.26	
Shapiro-Wilkes test for normality	0.96*	0.96	0.92***	0.93***		0.92***	0.92***	0.95**	0.96*	
Pr < W	0.09*	0.11	0.01***	0.01***		0.00***	0.00***	0.06**	0.09*	
White's test for homoscedasticity	11.23	9.55	9.48	7.60		21.81	18.99	15.85	12.02	
Pr > ChiSq	0.88	0.95	0.74	0.87		0.65	0.80	0.26	0.53	
Breusch-Pagan test for homoscedasticity	3.11	2.14	1.55	0.88		5.53	4.77	3.94	2.77	
Pr > ChiSq	0.80	0.91	0.82	0.93		0.48	0.57	0.41	0.60	
$PCH\overline{M}$	2.64	2.27	3.13	2.60		3.21	2.75	2.71	2.37	
$\overline{DH}_{0\ to\ break}$	52145.00	52038.00				18.62	18.48			
$\overline{DH}_{over\ break}$	52035.00	51920.00				15.53	15.57			
$\overline{DL}_{0\ to\ break}$	27.42	27.28				6.51	6.37			
$\overline{DL}_{over\ break}$	23.56	23.56				5.56	5.52			
$\overline{Min}_{o\ to\ break}$			9.29	9.05				3.95	3.95	
$\overline{Min}_{over\ break}$			5.84	5.95				2.21	2.27	
$PCH\overline{TV}$	1.30		1.29			1.33		1.31		
$PCH\overline{OI}$		1.13		1.15			1.15		1.17	

* indicates significant at 90% confidence level

** indicates significant at 95% confidence level

*** indicates significant at 99% confidence level

Table 9.2: For the 30-day windows of the nearest canola futures with a breakpoint of 40%, the coefficients of $PCH\overline{M}$ remain insignificant when the effects of the price limits are segmented in the regressions (columns 6 to 9). This is the same as the results shown in table 8.4 in chapter 8. Thus, it indicates a neutral relationship between the percentage changes in futures price volatility and average margin levels, which follows the liquidity costs hypothesis (H3).

The coefficients of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$, $\overline{DL}_{0\ to\ 0.40}$ and $\overline{DL}_{over\ 0.40}$ (columns 6 and 7) and $\overline{Min}_{o\ to\ 0.40}$ (columns 8 and 9) are significantly negative at 95% and 99% confidence levels, suggesting that the price limits have the destabilization impact upon the futures price volatility regardless of whether the futures prices are close to or far away from the upper price limits. The negative relationship indicates a gravitation (destabilization) effect of the price limits on the futures price volatility (H4). However, the coefficients of $\overline{Min}_{over\ 0.40}$ (columns 8 and 9) are insignificant, supporting the hypothesis that the influence of the price limits upon the movements of the futures prices diminishes the further away the futures prices are to the price limits.

Again, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are observed which indicates that there is no relationship between the percentage changes in futures price volatility and average trading activity.

Finally, all the regressions in columns 6 to 9 exhibit non-normally distributed residuals. Moreover, all the regressions exhibit constant residual variances under both the White's the Breusch-Pagan tests. Because the VIF values of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ are greater than 10 in columns 6 and 7, it indicates some multicollinearity problems in these two regressions.

Table 9.3- Results of the regressions for the 20-day window of second nearest canola futures contract

N= 48	Distance Break at 0.35				N	Distance Break at 0.4				N
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	NC	NC	NC	NC		NC	NC	NC	NC	
Overall regression:										
F Value	1.67	1.78	2.62**	2.68**		1.67	1.73	2.55*	2.61**	
Pr > F	0.15	0.13	0.05**	0.04**		0.15	0.14	0.05*	0.05**	
β_0	9.22	9.88	1.50	1.51		4.68	4.75	1.36	1.38	
Standard Error	5.25	5.23	0.55	0.55		2.18	2.16	0.48	0.48	
t-statistics	1.76*	1.89*	2.73***	2.76***		2.15**	2.19**	2.82***	2.89***	
Pr > |t|	0.09*	0.07*	0.01***	0.01***		0.04**	0.03**	0.01***	0.01***	
β of $PCH\overline{M}$	-0.43	-0.44	-0.52	-0.52		-0.53	-0.55	-0.51	-0.52	
Standard Error	0.29	0.28	0.27	0.27		0.30	0.29	0.30	0.27	
t-statistics	-1.50	-1.57	-1.89**	-1.92**		-1.77*	-1.86*	-1.83*	-1.90*	
Pr > |t|	0.14	0.13	0.07**	0.06**		0.08*	0.07*	0.07*	0.06*	
β of $\overline{DH}_{0\ to\ break}$	-23.74	-25.81			4	-9.57	-9.85			10
Standard Error	15.46	15.44				5.86	5.85			
t-statistics	-1.54	-1.67				-1.63	-1.68***			
Pr > |t|	0.13	0.10				0.11	0.01***			
β of $\overline{DH}_{over\ break}$	23.94	25.98			44	12.29	12.40			38
Standard Error	16.41	16.41				8.33	8.31			
t-statistics	1.46	1.58				1.48	1.49			
Pr > |t|	0.15	0.12				0.15	0.14			
β of $\overline{DL}_{0\ to\ break}$	-1.51	-1.36			4	-1.89	-1.81			14
Standard Error	2.53	2.52				2.00	2.00			
t-statistics	-0.60	-0.54				-0.94	-0.90			
Pr > |t|	0.55	0.59				0.35	0.37			
β of $\overline{DL}_{over\ break}$	-1.91	-1.81			44	-1.77	-1.44			34
Standard Error	3.93	3.84				4.37	4.26			
t-statistics	-0.48	-0.47				-0.40	-0.34			
Pr > |t|	0.63	0.64				0.69	0.74			
β of $\overline{Mm}_{0\ to\ break}$			-3.79	-3.89	16			-3.23	-3.36	26
Standard Error			1.78	1.77				1.39	1.37	
t-statistics			-2.13**	-2.20**				-2.33**	-2.45**	
Pr > |t|			0.04**	0.03**				0.03**	0.02**	
β of $\overline{Mm}_{over\ break}$			1.80	2.34	32			0.86	2.51	22
Standard Error			3.68	3.65				5.88	5.86	
t-statistics			0.49	0.64				0.15	0.43	
Pr > |t|			0.63	0.52				0.88	0.67	
β of $PCH\overline{TV}$	-0.09		-0.07			-0.09		-0.07		
Standard Error	0.07		0.07			0.07		0.07		
t-statistics	-1.25		-1.08			-1.24		-1.11		
Pr > |t|	0.22		0.29			0.22		0.27		
β of $PCH\overline{OI}$		-0.15		-0.11			-0.14		-0.12	
Standard Error		0.10		0.10			0.10		0.10	
t-statistics		-1.46		-1.17			-1.35		-1.19	
Pr > |t|		0.15		0.25			0.19		0.24	
R-square	0.197	0.207	0.196	0.200		0.197	0.202	0.192	0.195	
Skewness	0.46	0.57	0.38	0.45		0.36	0.45	0.49	0.53	
Excess Kurtosis	0.96	1.21	-0.05	0.17		0.03	0.24	-0.03	0.10	
Shapiro-Wilkes test for normality	0.97	0.94**	0.98	0.97		0.96	0.95*	0.97	0.97	
Pr < W	0.19	0.02**	0.49	0.24		0.15	0.07*	0.35	0.20	
White's test for homoscedasticity	25.39	21.81	15.56	14.69		23.58	22.03	13.92	14.06	
Pr > ChiSq	0.15	0.29	0.27	0.33		0.54	0.63	0.38	0.37	
Breusch-Pagan test for homoscedasticity	10.46	8.50	8.98*	8.15*		6.36	4.52	8.72*	8.36*	
Pr > ChiSq	0.11	0.20	0.06*	0.09*		0.39	0.61	0.07*	0.08*	
$PCH\overline{M}$	1.76	1.73	1.68	1.66		1.91	1.88	1.71	1.68	
$\overline{DH}_{0\ to\ break}$	86.54	87.47				12.46	12.47			
$\overline{DH}_{over\ break}$	85.89	87.08				10.67	10.67			
$\overline{DL}_{0\ to\ break}$	5.44	5.46				3.42	3.44			
$\overline{DL}_{over\ break}$	6.04	5.84				3.45	3.31			
$\overline{Mm}_{0\ to\ break}$			4.43	4.38				2.66	2.62	
$\overline{Mm}_{over\ break}$			3.53	3.49				1.82	1.81	
$PCH\overline{TV}$	1.16		1.04			1.15		1.05		
$PCH\overline{OI}$		1.10		1.03			1.08		1.04	

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

Table 9.3: For the 20-day windows of the second nearest canola futures with a breakpoint of 40%, all the coefficients of $PCH\overline{M}$ remain significant when the effects of the price limits are segmented (columns 6 to 9). This is the same as the results shown in table 8.5 in chapter 8. Thus, a negative relationship between percentage changes in futures price volatility and average margin levels follows the restriction hypothesis (H1).

The coefficients of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{Min}_{o\ to\ 0.40}$ (columns 7 to 9) are significantly negative at 95% and 99% confidence levels, suggesting that the price limits generate a destabilization impact upon the futures price volatility when the futures prices are close to the price limits. The negative relationship supports a gravitation (destabilization) effect (H4). However, since the coefficients of $\overline{DL}_{over\ 0.40}$, $\overline{Min}_{over\ 0.40}$ are insignificant, it supports the hypothesis that the influence of the price limits on the movements of the futures prices diminishes the further away the futures prices are to the price limits.

Again, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ suggest a neutral relationship between the percentage changes in futures price volatility and average trading activity.

Finally, the regressions in columns 6, 8 and 9 exhibit normally distributed residuals, and all the regressions exhibit constant residual variances under the White's test. Because the VIF values of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ are greater than 10 in columns 6 and 7, the multicollinearity problem exists in these two regressions.

Table 9.4- Results of the regressions for the 30-day window of second nearest canola futures contract

N=48	Distance Break at 0.35				N	Distance Break at 0.4				N
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	NC	NC	NC	NC		NC	NC	NC	NC	
Overall regression:										
F Value	3.00**	3.01**	3.98***	3.90***		3.03**	3.01**	3.51**	3.41**	
Pr > F	0.02**	0.02**	0.01***	0.01***		0.02**	0.02**	0.02**	0.02**	
β_0	13.08	13.40	2.53	2.51		7.21	7.26	1.85	1.83	
Standard Error	5.28	5.28	0.88	0.88		2.56	2.56	0.71	0.71	
t-statistics	2.48**	2.54**	2.86***	2.82***		2.81***	2.83***	2.62**	2.58**	
Pr > |t|	0.02**	0.02**	0.01***	0.01***		0.01***	0.01***	0.01**	0.01**	
β of $PCH\overline{M}$	-0.09	-0.05	-0.34	-0.31		-0.27	-0.24	-0.24	-0.21	
Standard Error	0.26	0.26	0.27	0.27		0.28	0.28	0.27	0.27	
t-statistics	-0.34	-0.20	-1.25	-1.13		-0.95	-0.85	-0.88	-0.78	
Pr > |t|	0.73	0.84	0.22	0.27		0.35	0.40	0.38	0.44	
β of $\overline{DH}_{0\ to\ break}$	-26.19	-27.29			2	-12.42	-12.91			10
Standard Error	15.84	15.86				7.08	7.06			
t-statistics	-1.65	-1.72*				-1.75*	-1.83*			
Pr > |t|	0.11	0.09*				0.09*	0.08*			
β of $\overline{DH}_{over\ break}$	28.93	30.02			46	17.61	18.15			38
Standard Error	16.52	16.56				8.65	8.65			
t-statistics	1.75*	1.81*				2.04**	2.10**			
Pr > |t|	0.09*	0.08*				0.05**	0.04**			
β of $\overline{DL}_{0\ to\ break}$	-10.82	-10.74			3	-5.83	-5.51			14
Standard Error	6.11	6.12				3.91	3.92			
t-statistics	-1.77*	-1.76*				-1.49	-1.41			
Pr > |t|	0.08*	0.09*				0.14	0.17			
β of $\overline{DL}_{over\ break}$	7.11	7.55			45	2.40	2.57			34
Standard Error	6.73	6.70				5.47	5.47			
t-statistics	1.06	1.13				0.44	0.47			
Pr > |t|	0.30	0.27				0.66	0.64			
β of $\overline{Min}_{o\ to\ break}$			-6.97	-6.98	15			-4.65	-4.66	26
Standard Error			2.71	2.72				1.96	1.97	
t-statistics			-2.57**	-2.57*				-2.37**	-2.36**	
Pr > |t|			0.01**	0.01**				0.02**	0.02**	
β of $\overline{Min}_{over\ break}$			5.52	6.06	33			3.41	4.65	22
Standard Error			4.17	4.21				6.13	6.20	
t-statistics			1.32	1.44				0.56	0.75	
Pr > |t|			0.19	0.16				0.58	0.46	
β of $PCH\overline{TV}$	-0.08		-0.07			-0.076		-0.072		
Standard Error	0.05		0.05			0.05		0.05		
t-statistics	-1.57		-1.46			-1.45		-1.39		
Pr > |t|	0.12		0.15			0.16		0.17		
β of $PCH\overline{OI}$		-0.14		-0.12			-0.12		-0.11	
Standard Error		0.09		0.09			0.09		0.09	
t-statistics		-1.57		-1.38			-1.42		-1.28	
Pr > |t|		0.12		0.18			0.16		0.21	
R-square	0.305	0.306	0.270	0.266		0.307	0.306	0.246	0.241	
Skewness	0.70	0.78	0.57	0.66		0.69	0.76	0.52	0.60	
Excess Kurtosis	0.29	0.41	-0.04	0.01		0.15	0.21	0.07	0.04	
Shapiro-Wilkes test for normality	0.95**	0.95**	0.97	0.95**		0.95**	0.95**	0.97	0.96*	
Pr < W	0.06**	0.04**	0.18	0.04**		0.05**	0.03**	0.29	0.10*	
White's test for homoscedasticity	12.94	10.36	10.88	9.81		19.15	21.36	11.66	10.92	
Pr > ChiSq	0.80	0.92	0.62	0.71		0.79	0.67	0.55=6	0.62	
Breusch-Pagan test for homoscedasticity	3.94	2.88	3.98	2.54		3.81	2.72	3.93	2.88	
Pr > ChiSq	0.69	0.82	0.41	0.64		0.70	0.84	0.42	0.58	
$PCH\overline{M}$	2.57	2.60	2.88	2.89		3.06	3.10	2.68	2.69	
$\overline{DH}_{0\ to\ break}$	99.68	99.99				19.97	19.81			
$\overline{DH}_{over\ break}$	94.48	94.97				13.69	13.66			
$\overline{DL}_{0\ to\ break}$	22.00	22.02				9.03	9.04			
$\overline{DL}_{over\ break}$	19.07	18.92				6.44	6.42			
$\overline{Min}_{o\ to\ break}$			8.82	8.83				4.48	4.48	
$\overline{Min}_{over\ break}$			5.18	5.25				2.19	2.23	
$PCH\overline{TV}$	1.06		1.00			1.05		1.00		
$PCH\overline{OI}$		1.04		1.03			1.03		1.04	

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 9.4: For the 30-day windows of the second nearest canola futures with a breakpoint of 40%, all the coefficients of $PCH\bar{M}$ remain insignificant when the effects of the price limits are segmented in the regressions (columns 6 to 9). This is the same as the results shown in table 8.6 in chapter 8. Thus, the neutral relationship between the percentage changes in futures price volatility and average margin levels follows the liquidity costs hypothesis (H3).

The coefficients of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{Min}_{o\ to\ 0.40}$ (columns 6 to 9) are significantly negative at 95% and 99% confidence levels, suggesting that the price limits produce a destabilization impact upon the futures price volatility when the futures prices are close to the price limits. The negative relationship supports a gravitation (destabilization) effect (H4). However, the coefficients of $\overline{DL}_{over\ 0.40}$, $\overline{Min}_{over\ 0.40}$ are insignificant, supporting the hypothesis that the influence of the price limits on the movements of the futures prices diminishes the further away the futures prices are to the price limits.

Again, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ suggest a neutral relationship between the percentage changes in futures price volatility and average trading activity.

Finally, the regressions in columns 6, 7 and 9 exhibit normally distributed residuals, and all the regressions exhibit constant residual variances under both the White's and the Breusch-Pagan tests. Because the VIF values of $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ are greater than 10 in columns 6 and 7, the multicollinearity problem exists in these two regressions.

Overall, for the 20- and 30-day windows of the nearest and second nearest canola contracts, the direction and the significance of the coefficients of $PCH\bar{M}$ do not change from that of the coefficients in chapter 8 when the effects of the price limits are segmented in the regressions in this chapter. Although I find inconsistent results for the coefficients of the average distance variables in different windows and maturity contracts in this chapter, the direction and the significance of the coefficients of $\overline{Min}_{o\ to\ 0.40}$ and $\overline{Min}_{over\ 0.40}$ are always the same for both maturity contracts in both windows. For example, the coefficients of $\overline{Min}_{o\ to\ 0.40}$ are always significantly negative and the coefficients of $\overline{Min}_{over\ 0.40}$ are always insignificant. Thus, the price limits produce a destabilization impact upon the futures price volatility the closer the futures prices are to the price limits (H4), but the influence of the price limits upon the futures price volatility diminishes the further away the futures prices are from the price limits.

Sometimes when the effects of the average distance to the upper price limits increase, the effects of the average distance to the lower price limits reduce, and vice versa. This may be due to the higher average distance values of the futures prices to the lower price limits when the average distances values of the futures prices to the upper price limits are low, and thus diminishing the effect of the lower price limits upon the futures price movements, and vice versa for the upper price limits. Thus, using the average distance of the minimum of the two upper and lower distance values have the advantage of selecting the smaller distance observations that have greater influences on the movements of the futures prices. This helps us to know whether the price limits inflict any effect upon the futures price volatility when the futures prices are close to the limits.

Finally, insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are always observed and the multicollinearity problem exists in the regressions where both $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ are included.

Table 9.5- Results of the regressions for the 20-day window of nearest barley futures contract

N= 35	Distance Break at 0.35					N
Column	(1)		(2)	(3)	(4)	(5)
	NC	C	NC	NC	NC	
Overall regression:						
F Value	1.16	1.16	0.68	1.29	0.49	
Pr > F	0.35	0.35	0.67	0.30	0.75	
β_0	-33.93	-33.93	-28.55	2.72	2.21	
Standard Error	26.45	24.55	27.40	1.81	1.94	
t-statistics	-1.28	-1.38	-1.04	1.50	1.14	
Pr > |t|	0.21	0.18	0.31	0.14	0.26	
β of $PCH\overline{M}$	0.20	0.20	-0.04	0.26	0.12	
Standard Error	0.87	0.90	0.90	0.76	0.79	
t-statistics	0.23	0.22	-0.05	0.35	0.15	
Pr > |t|	0.83	0.83	0.96	0.73	0.88	
β of $\overline{DH}_{0\ to\ break}$	9.79	9.79	22.13			2
Standard Error	23.88	13.46	23.90			
t-statistics	0.41	0.73	0.93			
Pr > |t|	0.69	0.47	0.36			
β of $\overline{DH}_{over\ break}$	-14.11	-14.11	-27.63			33
Standard Error	27.68	17.51	27.72			
t-statistics	-0.51	-0.81	-1.00			
Pr > |t|	0.61	0.43	0.33			
β of $\overline{DL}_{0\ to\ break}$	90.93	90.93	62.88			2
Standard Error	79.17	74.74	80.66			
t-statistics	1.15	1.22	0.78			
Pr > |t|	0.26	0.23	0.44			
β of $\overline{DL}_{over\ break}$	-98.50	-98.50	-69.06			33
Standard Error	81.35	79.13	82.82			
t-statistics	-1.21	-1.24	-0.83			
Pr > |t|	0.24	0.23	0.41			
β of $\overline{Min}_{o\ to\ break}$				-7.57	-6.26	18
Standard Error				5.91	6.31	
t-statistics				-1.28	-0.99	
Pr > |t|				0.21	0.33	
β of $\overline{Min}_{over\ break}$				12.20	8.76	17
Standard Error				15.88	16.94	
t-statistics				0.77	0.52	
Pr > |t|				0.45	0.61	
β of $PCH\overline{TV}$	-0.33	-0.33		-0.34		
Standard Error	0.20	0.21		0.19		
t-statistics	-1.69	-1.56		-1.81*		
Pr > |t|	0.10	0.13		0.08*		
β of $PCH\overline{OI}$			0.11		0.10	
Standard Error			0.20		0.20	
t-statistics			0.53		0.49	
Pr > |t|			0.60		0.63	
R-square	0.200		0.127	0.147	0.061	
Skewness	1.1		1.22	1.33	1.48	
Excess Kurtosis	2.05		2.00	2.16	2.36	
Shapiro-Wilkes test for normality	0.90***		0.90***	0.89***	0.87***	
Pr < W	0.00***		0.01***	0.00***	0.00***	
White's test for homoscedasticity	26.48*		21.20	18.34	17.71	
Pr > ChiSq	0.09*		0.27	0.15	0.17	
Breusch-Pagan test for homoscedasticity	11.64*		13.00**	11.78**	9.61**	
Pr > ChiSq	0.07*		0.04**	0.02**	0.05**	
$PCH\overline{M}$	1.51		1.47	1.14	1.12	
$\overline{DH}_{0\ to\ break}$	33.26		30.55			
$\overline{DH}_{over\ break}$	33.12		30.44			
$\overline{DL}_{0\ to\ break}$	321.12		305.57			
$\overline{DL}_{over\ break}$	318.64		302.83			
$\overline{Min}_{o\ to\ break}$				3.17	3.28	
$\overline{Min}_{over\ break}$				3.01	3.11	
$PCH\overline{TV}$	1.14			1.02		
$PCH\overline{OI}$			1.05		1.04	

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level; *** indicates significant at 99% confidence level

N= 35	Distance Break at 0.4					N
Column	(6)	(7)		(8)	(9)	(10)
	NC	NC	C	NC	NC	
Overall regression:						
F Value	1.06	0.63	0.63	1.29	0.67	
Pr > F	0.41	0.70	0.70	0.30	0.62	
β_0	-1.06	-2.24	-2.24	1.88	1.74	
Standard Error	5.95	6.17	5.80	1.23	1.29	
t-statistics	-0.18	-0.36	-0.39	1.53	1.35	
Pr > |t|	0.86	0.72	0.70	0.14	0.19	
β of $PCH\overline{M}$	0.09	-0.06	-0.06	0.31	0.19	
Standard Error	0.86	0.89	0.72	0.76	0.78	
t-statistics	0.11	-0.06	-0.08	0.40	0.24	
Pr > |t|	0.92	0.95	0.94	0.69	0.81	
β of $\overline{DH}_{0\ to\ break}$	10.75	12.70	12.70			8
Standard Error	11.29	11.69	10.22			
t-statistics	0.95	1.09	1.24			
Pr > |t|	0.35	0.29	0.22			
β of $\overline{DH}_{over\ break}$	-23.96	-26.35	-26.35			27
Standard Error	17.67	18.53	20.49			
t-statistics	-1.36	-1.42	-1.29			
Pr > |t|	0.19	0.17	0.21			
β of $\overline{DL}_{0\ to\ break}$	-5.77	-4.89	-4.89			10
Standard Error	12.85	13.52	13.66			
t-statistics	-0.45	-0.36	-0.36			
Pr > |t|	0.66	0.72	0.72			
β of $\overline{DL}_{over\ break}$	4.08	2.85	2.85			25
Standard Error	19.78	20.70	21.41			
t-statistics	0.21	0.14	0.13			
Pr > |t|	0.84	0.89	0.90			
β of $\overline{Min}_{o\ to\ break}$				-4.62	-4.57	33
Standard Error				3.63	3.77	
t-statistics				-1.27	-1.21	
Pr > |t|				0.21	0.24	
β of $\overline{Min}_{over\ break}$				61.97	81.41	2
Standard Error				80.52	82.42	
t-statistics				0.77	0.99	
Pr > |t|				0.45	0.33	
β of $PCH\overline{TV}$	-0.29			-0.30		
Standard Error	0.19			0.19		
t-statistics	-1.52			-1.61		
Pr > |t|	0.14			0.12		
β of $PCH\overline{OI}$		0.05	0.05		0.105	
Standard Error		0.20	0.42		0.20	
t-statistics		0.24	0.12		0.54	
Pr > |t|		0.82	0.91		0.593	
R-square	0.185	0.120		0.147	0.083	
Skewness	1.16	1.18		1.60	1.62	
Excess Kurtosis	1.78	1.86		2.79	2.85	
Shapiro-Wilkes test for normality	0.91***	0.90***		0.85***	0.84***	
Pr < W	0.01***	0.01***		0.00***	0.00***	
White's test for homoscedasticity	30.30	34.05		15.86	14.64	
Pr > ChiSq	0.21	0.11		0.15	0.20	
Breusch-Pagan test for homoscedasticity	13.23**	13.38**		7.47	8.99*	
Pr > ChiSq	0.04**	0.04**		0.11	0.06*	
$PCH\overline{M}$	1.43	1.41		1.14	1.12	
$\overline{DH}_{0\ to\ break}$	7.31	7.25				
$\overline{DH}_{over\ break}$	6.37	6.48				
$\overline{DL}_{0\ to\ break}$	8.32	8.51				
$\overline{DL}_{over\ break}$	9.04	9.15				
$\overline{Min}_{o\ to\ break}$				1.20	1.20	
$\overline{Min}_{over\ break}$				1.12	1.10	
$PCH\overline{TV}$	1.04			1.05		
$PCH\overline{OI}$		1.09			1.01	

* indicates significant at 90% confidence level; ** indicates significant at 95% confidence level;

*** indicates significant at 99% confidence level

Table 9.5: For the 20-day windows of the nearest barley futures with a breakpoint of 40%, all the coefficients of $PCH\overline{M}$ remain insignificant when the effects of the price limits are segmented in the regressions (columns 6 to 9). This is the same as the results shown in table 8.7 in chapter 8. Thus, a neutral relationship between the percentage changes in futures price volatility and average margin levels follows the liquidity costs hypothesis (H3).

All the coefficients of the average distance variables are also insignificant (columns 6 to 9) even though the effects of the price limits are segmented in the regressions and the correction for the heteroscedasticity is made for the regression in column 7. This suggests that there is no relationship between the average distances of the futures prices from the price limits regardless of regardless of whether the futures prices fall in a range close to the price limits or not.

Again, insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are observed which indicates that there is no relationship between the percentage changes in futures price volatility and average trading activity.

Finally, all the regressions in columns 6 to 9 exhibit non-normally distributed residuals, and all the regressions except for the regression in column 7 exhibit constant residual variances under the White's test. Because all the VIF values of each independent variable are less than 10, no problem of multicollinearity exists in these regressions.

Table 9.6- Results of the regressions for the 30-day window of nearest barley futures contract

N=35	Distance Break at 0.35								N
Column	(1)		(2)		(3)		(4)		(5)
	NC	C	NC	C	NC	C	NC	C	
Overall regression:									
F Value	1.02	1.02	0.94	0.94	1.18	1.18	1.06	1.06	
Pr > F	0.43	0.43	0.48	0.48	0.34	0.34	0.40	0.40	
β_0	-27.56	-27.56	-25.56	-25.56	1.15	1.15	1.04	1.04	
Standard Error	34.83	52.09	34.92	59.95	1.34	2.33	1.36	2.34	
t-statistics	-0.79	-0.53	-0.73	-0.43	0.85	0.49	0.77	0.45	
Pr > |t|	0.44	0.60	0.47	0.67	0.40	0.63	0.45	0.66	
β of $PCH\overline{M}$	-0.13	-0.13	-0.13	-0.13	0.04	0.04	0.08	0.08	
Standard Error	0.51	0.40	0.51	0.42	0.47	0.43	0.46	0.46	
t-statistics	-0.25	-0.32	-0.26	-0.31	0.08	0.09	0.17	0.17	
Pr > |t|	0.80	0.75	0.80	0.76	0.94	0.93	0.87	0.87	
β of $\overline{DH}_{0\ to\ break}$	22.29	22.29	22.21	22.21					2
Standard Error	28.33	37.14	28.83	55.67					
t-statistics	0.79	0.60	0.77	0.40					
Pr > |t|	0.44	0.55	0.45	0.69					
β of $\overline{DH}_{over\ break}$	-27.95	-27.95	-27.83	-27.83					33
Standard Error	30.52	40.47	30.95	58.68					
t-statistics	-0.92	-0.69	-0.90	-0.47					
Pr > |t|	0.37	0.50	0.38	0.64					
β of $\overline{DL}_{0\ to\ break}$	59.51	59.51	53.95	53.95					1
Standard Error	99.23	148.70	99.52	169.40					
t-statistics	0.60	0.40	0.54	0.32					
Pr > |t|	0.55	0.69	0.59	0.75					
β of $\overline{DL}_{over\ break}$	-66.12	-66.12	-61.12	-61.12					34
Standard Error	100.51	152.40	100.90	173.30					
t-statistics	-0.66	-0.43	-0.61	-0.35					
Pr > |t|	0.52	0.67	0.55	0.73					
β of $\overline{Min}_{o\ to\ break}$					-2.80	-2.80	-2.47	-2.47	15
Standard Error					4.35	7.23	4.36	7.29	
t-statistics					-0.64	-0.39	-0.57	-0.34	
Pr > |t|					0.52	0.70	0.58	0.74	
β of $\overline{Min}_{over\ break}$					-4.85	-4.85	-6.37	-6.37	20
Standard Error					11.43	14.27	11.27	14.05	
t-statistics					-0.42	-0.34	-0.57	-0.45	
Pr > |t|					0.68	0.74	0.58	0.65	
β of $PCH\overline{TV}$	-0.11	-0.11			-0.11	-0.11			
Standard Error	0.177	0.13			0.17	0.14			
t-statistics	-0.62	-0.83			-0.65	-0.81			
Pr > |t|	0.54	0.41			0.53	0.43			
β of $PCH\overline{OI}$			-0.01	-0.01			-0.01	-0.01	
Standard Error			0.18	0.33			0.18	0.24	
t-statistics			-0.03	-0.02			-0.05	-0.04	
Pr > |t|			0.97	0.99			0.96	0.97	
R-square	0.179		0.168		0.136		0.124		
Skewness	1.16		1.15		1.58		1.57		
Excess Kurtosis	2.87		2.46		3.92		3.71		
Shapiro-Wilkes test for normality	0.91***		0.92**		0.88***		0.88***		
Pr < W	0.01***		0.01**		0.00***		0.00***		
White's test for homoscedasticity	28.03**		28.77**		26.31**		25.98**		
Pr > ChiSq	0.05**		0.04**		0.02**		0.02**		
Breusch-Pagan test for homoscedasticity	14.35**		17.47***		11.07**		12.62**		
Pr > ChiSq	0.03**		0.01***		0.03**		0.01**		
$PCH\overline{M}$	1.32		1.32		1.14		1.12		
$\overline{DH}_{0\ to\ break}$	76.82		78.48						
$\overline{DH}_{over\ break}$	77.18		78.27						
$\overline{DL}_{0\ to\ break}$	816.60		810.24						
$\overline{DL}_{over\ break}$	811.08		806.43						
$\overline{Min}_{o\ to\ break}$					3.63		3.60		
$\overline{Min}_{over\ break}$					3.50		3.36		
$PCH\overline{TV}$	1.09				1.07				
$PCH\overline{OI}$			1.10				1.05		

* indicates significant at 90% confidence level

** indicates significant at 95% confidence level

*** indicates significant at 99% confidence level

N= 35	Distance Break at 0.4						N
Column	(6)	(7)		(8)		(9)	(10)
	NC	NC	C	NC	C	NC	
Overall regression: F Value Pr > F	 2.84** 0.03**	 2.86** 0.03**	 2.86** 0.03**	 1.14 0.36	 1.14 0.36	 0.97 0.44	
β_0 Standard Error t-statistics Pr > |t|	2.53 4.76 0.53 0.600	3.10 4.84 0.64 0.526	3.10 7.40 0.42 0.678	1.66 0.88 1.89* 0.069*	1.66 1.31 1.26 0.216	1.66 0.91 1.81* 0.080*	
β of $PCH\overline{M}$ Standard Error t-statistics Pr > |t|	-0.48 0.46 -1.06 0.30	-0.51 0.46 -1.12 0.27	-0.51 0.40 -1.27 0.22	-0.01 0.46 -0.02 0.99	-0.01 0.46 -0.02 0.99	0.03 0.46 0.07 0.94	
β of $\overline{DH}_{0\ to\ break}$ Standard Error t-statistics Pr > |t|	16.72 7.58 2.21** 0.04**	16.85 7.56 2.23** 0.03**	16.86 10.82 1.56 0.13				8
β of $\overline{DH}_{over\ break}$ Standard Error t-statistics Pr > |t|	-34.19 11.92 -2.87*** 0.01***	-35.01 11.93 -2.93*** 0.01***	-35.01 18.34 -1.91* 0.07*				27
β of $\overline{DL}_{0\ to\ break}$ Standard Error t-statistics Pr > |t|	-21.77 9.97 -2.18** 0.04**	-23.24 10.12 -2.30** 0.03**	-23.24 17.93 -1.30 0.21				7
β of $\overline{DL}_{over\ break}$ Standard Error t-statistics Pr > |t|	27.34 13.87 1.97* 0.06*	28.46 14.01 2.03* 0.05*	28.46 22.39 1.27 0.21				28
β of $\overline{Mtn}_{o\ to\ break}$ Standard Error t-statistics Pr > |t|				-4.55 2.56 -1.77* 0.09*	-4.55 3.63 -1.25 0.22	-4.59 2.64 -1.74* 0.09*	31
β of $\overline{Mtn}_{over\ break}$ Standard Error t-statistics Pr > |t|				18.77 82.76 0.23 0.82	18.77 71.06 0.26 0.79	7.16 82.21 0.09 0.93	4
β of $PCH\overline{TV}$ Standard Error t-statistics Pr > |t|	-0.08 0.15 -0.54 0.59			-0.14 0.17 -0.78 0.44	-0.14 0.14 -0.99 0.33		
β of $PCH\overline{OI}$ Standard Error t-statistics Pr > |t|		-0.10 0.16 -0.60 0.56	-0.10 0.17 -0.57 0.57			-0.01 0.18 -0.04 0.97	
R-square	0.378	0.380		0.132		0.115	
Skewness	0.92	0.88		1.45		1.38	
Excess Kurtosis	1.37	1.01		3.48		3.00	
Shapiro-Wilkes test for normality Pr < W	 0.95* 0.08*	 0.95 0.15		 0.89*** 0.00***		 0.90*** 0.01***	
White's test for homoscedasticity Pr > ChiSq	 34.08 0.11	 34.40* 0.10*		 21.31* 0.07*		 19.66 0.10	
Breusch-Pagan test for homoscedasticity Pr > ChiSq	 11.73* 0.07*	 11.74** 0.07**		 10.68** 0.03**		 12.57* 0.01*	
$PCH\overline{M}$	1.42	1.43		1.11		1.10	
$\overline{DH}_{0\ to\ break}$	7.27	7.25					
$\overline{DH}_{over\ break}$	7.29	7.31					
$\overline{DL}_{0\ to\ break}$	10.89	11.22					
$\overline{DL}_{over\ break}$	9.86	10.08					
$\overline{Mtn}_{o\ to\ break}$				1.25		1.31	
$\overline{Mtn}_{over\ break}$				1.19		1.15	
$PCH\overline{TV}$	1.09			1.06			
$PCH\overline{OI}$		1.11				1.05	

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 9.6: For the 30-day windows of the nearest barley futures with a breakpoint of 40%, all the coefficients of $PCH\overline{M}$ remain insignificant when the effects of the price limits are segmented in the regressions (columns 6 to 9). This is the same as the results shown in table 8.8 in chapter 8. This indicates a neutral relationship between percentage changes in futures price volatility and average margin levels, which follows the liquidity costs hypothesis (H3).

All the coefficients of the average distance variables in column 6 are statistically significant at the 90%, 95%, and 99% confidence levels showing a negative relationship between the percentage change in futures price volatility and the distance to the price limits. Yet, when the correction for the heteroscedasticity is made for the regression in column 7, only the coefficient of $\overline{DH}_{over\ 0.40}$ is significantly negative at the 90% confidence level. Also, the coefficient of $\overline{Min}_{o\ to\ 0.40}$ in column 9 remains significantly negative at the 90% confidence level, while the coefficient of $\overline{Min}_{o\ to\ 0.40}$ in column 8 becomes insignificant when the correction for the heteroscedasticity is made. Because the coefficients of $\overline{Min}_{over\ 0.40}$ are insignificant, the influence of the price limits on the futures price volatility diminishes the further away the futures prices are to the limits.

Again, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are observed indicating no relationship between the percentage changes in futures price volatility and average trading activity.

Finally, most of the regressions exhibit non-normally distributed residuals, and the regressions in columns 6 and 9 exhibit constant residual variances under the White's test. The multicollinearity problem exists in the regressions where both $\overline{DL}_{0\ to\ 0.40}$ and $\overline{DL}_{over\ 0.40}$ are included (columns 6 and 7).

Table 9.7- Results of the regressions for the 20-day window of second nearest barley futures contract

N= 35	Distance Break at 0.35				N	Distance Break at 0.4				N
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	NC	NC	NC	NC		NC	NC	NC	NC	
Overall regression:										
F Value	0.67	1.05	2.37*	1.97		0.96	1.15	0.90	1.09	
Pr > F	0.67	0.41	0.08*	0.13		0.47	0.36	0.48	0.38	
β_0	-74.88	-59.55	-4.46	-3.41		-5.31	0.30	0.53	0.82	
Standard Error	86.50	84.30	2.85	3.07		10.82	11.07	2.09	2.07	
t-statistics	-0.87	-0.71	-1.56	-1.11		-0.49	0.03	0.25	0.40	
Pr > $\lvert t\rvert$	0.39	0.49	0.13	0.28		0.63	0.979	0.80	0.70	
β of $\overline{PCHM}$	-2.22	-2.38	-1.91	-2.07		-1.98	-2.17	-1.81	-1.98	
Standard Error	1.40	1.32	1.13	1.14		1.35	1.31	1.25	1.23	
t-statistics	-1.59	-1.80*	-1.70	-1.81*		-1.46	-1.66	-1.45	-1.62	
Pr > $\lvert t\rvert$	0.12	0.08*	0.10	0.08*		0.16	0.11	0.16	0.12	
β of $\overline{DH}_{0\ to\ break}$	5.22	-5.33			2	-8.64	-9.86			6
Standard Error	36.78	36.23				17.60	17.31			
t-statistics	0.14	-0.15				-0.49	-0.57			
Pr > $\lvert t\rvert$	0.89	0.88				0.63	0.57			
β of $\overline{DH}_{over\ break}$	-9.03	5.70			33	7.81	13.54			29
Standard Error	41.80	41.61				26.17	26.11			
t-statistics	-0.22	0.14				0.30	0.52			
Pr > $\lvert t\rvert$	0.83	0.89				0.77	0.61			
β of $\overline{DL}_{0\ to\ break}$	214.00	179.71			1	25.38	11.41			11
Standard Error	248.83	241.70				24.44	25.40			
t-statistics	0.86	0.74				1.04	0.45			
Pr > $\lvert t\rvert$	0.40	0.46				0.31	0.66			
β of $\overline{DL}_{over\ break}$	-227.29	-194.29			34	-50.79	-34.05			24
Standard Error	252.58	245.20				32.62	34.21			
t-statistics	-0.90	-0.79				-1.56	-1.00			
Pr > $\lvert t\rvert$	0.38	0.44				0.13	0.33			
β of $\overline{Mm}_{o\ to\ break}$			17.56	13.76	15			0.15	-0.99	28
Standard Error			9.24	10.03				6.09	5.99	
t-statistics			1.90*	1.37				0.03	-0.17	
Pr > $\lvert t\rvert$			0.07*	0.18				0.98	0.87	
β of $\overline{Mm}_{over\ break}$			-56.15	-47.08	20			-108.34	-74.07	7
Standard Error			21.35	24.27				91.09	93.04	
t-statistics			-2.63**	-1.94*				-1.19	-0.80	
Pr > $\lvert t\rvert$			0.01**	0.06*				0.24	0.43	
β of $\overline{PCHTV}$	-0.06		-0.15			-0.09		-0.11		
Standard Error	0.14		0.12			0.14		0.13		
t-statistics	-0.42		-1.21			-0.64		-0.80		
Pr > $\lvert t\rvert$	0.68		0.24			0.53		0.43		
β of $\overline{PCHOI}$		0.72		0.20			0.60		0.54	
Standard Error		0.49		0.48			0.51		0.47	
t-statistics		1.47		0.41			1.17		1.16	
Pr > $\lvert t\rvert$		0.15		0.68			0.25		0.26	
R-square	0.126	0.184	0.240	0.208		0.170	0.197	0.107	0.127	
Skewness	4.67	4.21	4.16	4.35		4.02	3.91	5.03	4.75	
Excess Kurtosis	24.40	22.44	20.40	23.18		18.74	20.65	27.77	26.10	
Shapiro-Wilkes test for normality	0.46***	0.56***	0.55***	0.55***		0.54***	0.59***	0.43***	0.48***	
Pr < W	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	
White's test for homoscedasticity	7.34	8.51	17.82	11.09		31.57	18.99	5.19	6.22	
Pr > ChiSq	0.98	0.95	0.16	0.60		0.14	0.75	0.97	0.94	
Breusch-Pagan test for homoscedasticity	1.74	5.64	4.63	5.19		3.60	7.11	1.17	2.97	
Pr > ChiSq	0.94	0.46	0.33	0.27		0.73	0.31	0.88	0.56	
$\overline{PCHM}$	1.53	1.47	1.22	1.21		1.50	1.46	1.27	1.26	
$\overline{DH}_{0\ to\ break}$	39.97	41.54				9.64	9.64			
$\overline{DH}_{over\ break}$	39.80	42.23				9.15	9.41			
$\overline{DL}_{0\ to\ break}$	1140.95	1152.66				11.57	12.94			
$\overline{DL}_{over\ break}$	1149.07	1159.57				12.00	13.65			
$\overline{Mm}_{o\ to\ break}$			3.67	4.14				1.35	1.34	
$\overline{Mm}_{over\ break}$			3.74	4.64				1.36	1.45	
$\overline{PCHTV}$	1.07		1.05			1.09		1.03		
$\overline{PCHOI}$		1.18		1.30			1.35		1.09	

* indicates significant at 90% confidence level
** indicates significant at 95% confidence level
*** indicates significant at 99% confidence level

Table 9.7: For the 20-day windows of the second nearest barley futures with a breakpoint of 40%, most of the coefficients of $PCH\overline{M}$ remain insignificant when the effects of the price limits are segmented in the regressions (columns 6 to 9). This is the same as the results shown in table 8.9 in chapter 8. Thus, a neutral relationship between percentage changes in futures price volatility and average margin levels follows the liquidity costs hypothesis (H3).

All the coefficients of the average distance variables remain insignificant even though the effects of the price limits are segmented in the regressions (columns 6 to 9). This suggests that there is no relationship between the percentage change in futures price volatility and the average distances of futures prices from the price limits regardless of whether the average distance of the futures prices to the price limits are high or low.

Again, insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are observed which indicates no relationship between the percentage changes in futures price volatility and average trading activity.

Finally, all the regressions exhibit non-normally distributed residuals under the Shapiro-Wilkes test and constant residual variances under both the White's and the Breusch-Pagan tests. The multicollinearity problem exists in the regressions where both $\overline{DL}_{0\ to\ 0.40}$ and $\overline{DL}_{over\ 0.40}$ are included (columns 6 and 7).

Table 9.8- Results of the regressions for the 30-day window of second nearest barley futures contract

N= 35	Distance Break at 0.35				N	Distance Break at 0.4				N
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	NC	NC	NC	NC		NC	NC	NC	NC	
Overall regression:										
F Value	1.11	1.48	2.62**	1.85		1.58	1.47	1.79	1.70	
Pr > F	0.38	0.23	0.06**	0.15		0.19	0.23	0.16	0.18	
β_0	-10.11	-7.20	-1.94	-1.13		-5.52	-2.10	0.07	0.13	
Standard Error	14.69	14.22	1.28	1.38		5.29	5.12	0.85	0.85	
t-statistics	-0.69	-0.51	-1.51	-0.81		-1.04	-0.41	0.08	0.15	
Pr > |t|	0.50	0.62	0.14	0.42		0.31	0.69	0.94	0.88	
β of $\overline{PCHM}$	-0.98	-0.93	-0.90	-0.85		-0.81	-0.77	-0.90	-0.87	
Standard Error	0.46	0.45	0.40	0.42		0.46	0.46	0.42	0.43	
t-statistics	-2.10**	-2.04**	-2.23**	-2.04**		-1.76*	-1.66	-2.12**	-2.03*	
Pr > |t|	0.05**	0.05**	0.03**	0.05**		0.09*	0.11	0.04**	0.05*	
β of $\overline{DH}_{0\ to\ break}$	34.84	26.05			1	-1.00	-2.30			6
Standard Error	42.27	40.96				8.46	8.44			
t-statistics	0.82	0.64				-0.12	-0.27			
Pr > |t|	0.42	0.53				0.91	0.79			
β of $\overline{DH}_{over\ break}$	-37.53	-25.93			34	-2.62	3.07			29
Standard Error	43.73	42.42				11.52	11.30			
t-statistics	-0.86	-0.61				-0.23	0.27			
Pr > |t|	0.40	0.55				0.82	0.79			
β of $\overline{DL}_{0\ to\ break}$	-3.98	-4.16			0	16.71	8.62			6
Standard Error	3.66	3.56				10.53	10.55			
t-statistics	-1.09	-1.17				1.59	0.82			
Pr > |t|	0.29	0.25				0.12	0.42			
β of $\overline{DL}_{over\ break}$	--	--			35	-28.62	-17.90			29
Standard Error						13.86	14.07			
t-statistics						-2.06**	-1.27			
Pr > |t|						0.05**	0.21			
β of $\overline{Min}_{o\ to\ break}$			7.24	4.43	13			0.33	0.12	29
Standard Error			4.12	4.46				2.41	2.42	
t-statistics			1.75*	0.99				0.14	0.05	
Pr > |t|			0.09*	0.33				0.89	0.96	
β of $\overline{Min}_{over\ break}$			-22.23	-14.54	22			-50.82	-36.59	6
Standard Error			9.24	10.40				30.02	30.47	
t-statistics			-2.41**	-1.40				-1.69	-1.20	
Pr > |t|			0.02**	0.17				0.10	0.24	
β of $\overline{PCHTV}$	-0.11		-0.18			-0.17		-0.14		
Standard Error	0.12		0.11			0.12		0.11		
t-statistics	-0.94		-1.69			-1.41		-1.25		
Pr > |t|	0.36		0.10			0.17		0.22		
β of $\overline{PCHOI}$		0.41		0.16			0.33		0.27	
Standard Error		0.26		0.26			0.27		0.24	
t-statistics		1.58		0.59			1.21		1.11	
Pr > |t|		0.13		0.56			0.24		0.28	
R-square	0.160	0.203	0.259	0.198		0.253	0.239	0.193	0.185	
Skewness	3.25	2.90	3.61	3.67		2.99	2.86	3.37	3.34	
Excess Kurtosis	15.75	13.39	17.28	17.60		13.04	12.72	15.66	15.45	
Shapiro-Wilkes test for normality	0.69***	0.74***	0.66***	0.65***		0.73***	0.75***	0.69***	0.69***	
Pr < W	<0.0001 ***	<0.0001 ***	<0.0001 ***	<0.0001 ***		<0.0001 ***	<0.0001 ***	<0.0001 ***	<0.0001 ***	
White's test for homoscedasticity	11.00	11.88	8.83	12.61		16.13	15.23	6.54	11.37	
Pr > ChiSq	0.75	0.69	0.79	0.48		0.88	0.91	0.92	0.58	
Breusch-Pagan test for homoscedasticity	2.38	4.90	2.27	2.36		3.20	4.99	2.61	2.77	
Pr > ChiSq	0.79	0.43	0.69	0.67		0.78	0.55	0.63	0.60	
$\overline{PCHM}$	1.38	1.39	1.21	1.21		1.46	1.46	1.23	1.23	
$\overline{DH}_{0\ to\ break}$	279.21	276.34				12.14	11.85			
$\overline{DH}_{over\ break}$	282.15	279.73				12.89	12.18			
$\overline{DL}_{0\ to\ break}$	1.38	1.37				12.40	12.24			
$\overline{DL}_{over\ break}$	--	--				11.97	12.11			
$\overline{Min}_{o\ to\ break}$			4.46	4.82				1.40	1.39	
$\overline{Min}_{over\ break}$			4.62	5.42				1.37	1.40	
$\overline{PCHTV}$	1.08		1.10			1.23		1.03		
$\overline{PCHOI}$		1.25		1.31			1.38		1.06	

* indicates significant at 90% confidence level

** indicates significant at 95% confidence level

*** indicates significant at 99% confidence level

-- indicates zero or unsolved value as the least-squares solutions for the parameters are not unique

Table 9.8: For the 30-day windows of the second nearest barley futures with a breakpoint of 40%, all the coefficients of $PCH\bar{M}$ remain significant at the 90% and 95% confidence levels when the effects of the price limits are segmented in the regressions (columns 6 to 9). This is the same as the results shown in table 8.10 in chapter 8. Thus, a negative relationship between the percentage changes in futures price volatility and average margin levels follows the restriction hypothesis (H1).

Most of the coefficients of the average distance variables remain insignificant even though the effects of the price limits are segmented in the regressions (columns 6 to 9). This suggests that there is no relationship between the percentage change in futures price volatility and the average distances of futures prices from the price limits regardless of regardless of whether the futures prices fall in a range close to the price limits or not.

Again, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are observed indicating no relationship between the percentage changes in futures price volatility and average trading activity.

Finally, all the regressions exhibit non-normally distributed residuals under the Shapiro-Wilkes test and constant residual variances under both the White's and the Breusch-Pagan tests. The multicollinearity problem exists in the regressions where $\overline{DH}_{0\ to\ 0.40}$, $\overline{DH}_{over\ 0.40}$, $\overline{DL}_{0\ to\ 0.40}$ and $\overline{DL}_{over\ 0.40}$ are included as their VIF values are greater than 10 in columns 6 and 7.

Overall, for the 20- and 30-day windows of the nearest and second nearest barley contracts, the significance and the direction of the coefficients of $PCH\bar{M}$ do not change when the effects of the price limits are segmented in the piecewise regressions. Even though I find some inconsistent results for the coefficients of the average distance variables, most of them including the coefficients of $\overline{Mın}_{o\ to\ 0.40}$ and $\overline{Mın}_{over\ 0.40}$ remain insignificant when the effects of the price limits are segmented in the regressions. This implies that the price limits have the no impact on the futures price volatility regardless of whether the futures prices are the closer to or far away from the price limits (H6).

Finally, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are always observed, and the multicollinearity problem especially exists in the regressions where both $\overline{DL}_{0\ to\ 0.40}$ and $\overline{DL}_{over\ 0.40}$ are included.

Section 9.3- Overall conclusion about the results of the piecewise linear regression models

Overall, for the 20- and 30-day windows of the nearest and second nearest canola and barley contracts, the significance and the direction of the coefficients of $PCH\overline{M}$ do not change from that obtained in chapter 8 when the effects of the price limits are segmented in this chapter. For the nearest and the second nearest canola contracts, the coefficients of $PCH\overline{M}$ are significantly negative in the 20-days windows statistically at the 90% and 95% confidence levels, but insignificant in the 30-day windows. For the nearest and the second nearest barley contracts, most of the coefficients of $PCH\overline{M}$ remain insignificant except in the 30-day window of the second nearest barley contract which shows significantly negative coefficients at the 90% and 95% confidence levels. Thus, even though there is a mixed result for the relationship between the percentage changes in futures price volatility and average margin levels, I believe that the restriction hypothesis (H1) can supported for the canola futures contract similar to the argument in chapter 8, although the liquidity costs hypothesis (H3) may also be at work. In addition, for the barley futures contract, the liquidity costs hypothesis (H3) can be supported although the restriction hypothesis (H1) may also be at work for this contract.

For the canola and barley contracts, the coefficients of $\overline{Min}_{o\ to\ 0.40}$ and $\overline{Min}_{over\ 0.40}$ should be the ones that we emphasize on because they have an advantage of selecting the smaller distance observations that produce stronger influences upon the futures price volatility when the futures prices are close to the price limits. Therefore, for the canola contracts, since the coefficients of $\overline{Min}_{o\ to\ 0.40}$ are always significantly negative and the coefficients of $\overline{Min}_{over\ 0.40}$ are always insignificant, I find support for the gravitation (destabilization) effect of the price limits upon the futures price volatility when distance between the futures prices and the price limits is small, but the influence of the price limits on the futures price volatility diminishes the further away the futures prices are from the price limits (H4). For the barley contracts, since most of the average distance coefficients are insignificant, the price limits have the no impact on the futures price volatility regardless of whether the futures prices are the closer to or far away from the price limits (H6). Thus, no strong support for either the gravitation or stabilization effect is found. The inconsistent results obtained for both the canola and barley futures contracts may be due to the fewer trading activity in the barley futures market and a narrower range of price limits of the barley futures contract. Thus, traders may find that advancing trades in a low trading activity market not as important as in a high trading activity market. As a result, the probability that traders delay trades when prices are near the price limits may be higher. With this mix of traders delaying and advancing trades, it is possible that we do not observe a clear influence of the distance to price limits upon the futures price volatility.

Finally, the insignificant coefficients of $PCH\overline{TV}$ and $PCH\overline{OI}$ are almost always observed for both the nearest and the second nearest canola and barley contracts. It indicates that the changes in trading activities seldom influence the futures price volatility. Moreover, the multicollinearity problem exists in the regressions where both $\overline{DH}_{0\ to\ 0.40}$ and $\overline{DH}_{over\ 0.40}$ are included for the canola contracts and both $\overline{DL}_{0\ to\ 0.40}$ and $\overline{DL}_{over\ 0.40}$ are included for the barley contracts.

10. IMPLICATIONS AND CONCLUSION

In section 10.1, I discuss the implications on the results from chapters 8 and 9. In section 10.2, I provide the conclusions of this thesis.

Section 10.1- Implications on the results of both the multiple and piecewise linear regressions

There are three implications from the results on the regression analysis. First, even though changes in the margin provide some evidence of lower futures price volatility, an opposing and destabilization effect of the price limits on the futures price volatility may offset the effects of the margins. For instance, for all the significant cases in both the multiple and piecewise linear regressions, we expect the percentage change in futures price volatility to decrease when the percentage change in average margin levels increases, holding all other variables constant. This effect however is offset by the effect of the price limits, which is associated with an increase in the futures price volatility as the futures prices move closer to the price limits, holding all other variables constant. Since the decreasing effects of the margin requirements are offset by the destabilization effects of the price limits on futures price volatility, it explains my insignificant coefficients of the percentage change in margin levels when I only regress the percentage changes in futures price volatility on margin levels. Therefore, this may also help to explain why many studies including Hardouvelis and Kim (1995) and Fishe et al. (1990) find inconsistent or no impact of margin changes on futures price volatility.

Second, for the implication on the stabilization effect of margin requirements in this study, if the exit of informed traders increases the futures price volatility after margin levels increase, and if the exit of speculators decreases the futures price volatility after margin levels increase, then my results of some stabilization effects of margin requirements indirectly support the view that speculators are the ones that increase the futures price volatility. Thus, increases in margin levels have some effectiveness at reducing the participation of speculators in the market. However, since the futures price volatility only reduces by about 1% and only weak evidence of trading activity reduction after margin increases is observed in the tests of chapter 5, trading activity of speculators may not be restricted greatly. Yet, since speculators can provide the needed liquidity and some of the risk bearing ability that can benefit the trades of hedgers, margin requirements may also be used to stimulate market participation by lowering margin levels, but to the extent that the price volatility is not destabilized (Ma et al., 1993).

A final implication is that we cannot totally reject the margin requirements' contribution to stabilization of the futures price volatility, even though its effect may not be large enough to offset some of the gravitation effect of the price limits. This is because without the margin requirements specified in the futures market to counter some of the destabilization effect of the price limits, the futures price volatility in futures markets may even be higher. As a result, having the margin requirements developed in futures markets is important. On the other hand, because we cannot totally eliminate the price limits in the futures market as the futures price volatility will be higher if the price limits are not specified in the futures market (Shanker & Liu, 2009), margin requirements in the futures market should act as an assisting tool to the price limits in reducing futures price volatility, but at the same time boosting trades if the market participation is too inactive.

Section 10.2- Conclusion

In this paper, I examine the effect of the margin level changes on the futures price volatility taking into account the effect of the existence of the price limits in canola and western domestic feed barley futures contracts from June 2002 to June 2009. I first investigate the effect of the margin changes on trading activity using paired comparisons and simple linear regression analysis. In general, I find that increases in margin levels do not affect trading activity in shorter windows but have some evidence of a reduction in trading activity in longer windows. Next, I examine the effects of margin changes on the futures price volatility using the Modified Levene's statistic and simple linear regression analysis. Generally, the results are mixed in that margin increases may increase, decrease or not affect the futures price volatility; however, this may be in part due to not controlling for the effect of the price limits on the futures price volatility.

When I analyze the influence of margin requirements on futures price volatility, I hypothesize that the restriction hypothesis is supported if there is a negative relationship between the percentage changes in futures price volatility and average margin levels. However, if there is a positive relationship between the percentage changes in futures price volatility and average margin levels, the competitive hypothesis is supported. Otherwise, the liquidity costs hypothesis should be supported if a neutral effect of the margin changes on the futures price volatility is obtained. For the effect of the price limits to be considered in the regression analysis, I focus on the influences of the price limits on futures price volatility when they are not hit using average distance measures as a proxy to assess the effect of the price limits. If the futures price volatility increase is due to the small distance between prices and the limits, then the gravitation impact of the price limits is supported. If the futures price volatility decrease is as a result of a small distance between prices and the limits, then the stabilization impact of the price limits is supported. If the above hypotheses cannot be supported, then the existence of price limits does not affect the futures price volatility. However, the justification for this final hypothesis involves the use the piecewise linear regression.

The overall result of the regression analysis shows us that there is a negative relationship between the percentage changes in futures price volatility and average margin levels when the price limit distance variables are included in the regression models for the canola contracts, supporting the restriction hypothesis. However, the liquidity costs hypothesis is supported for the barley contracts, which shows a neutral effect of the margin requirements on the futures price volatility.

Finally, there is some evidence of a gravitation effect of price limits on the futures price volatility for the canola contracts; however, there is no effect of price limits on barley's future price volatility. This can be explained by the lower market participation and a narrower range of price limits in the barley futures market.

Even though many other studies find that there is no or unclear relationship between margin change and futures price volatility, I argue that this is due to the destabilization influence of the price limits that appears to offset the decreasing effects of margins change on the futures price volatility. It therefore implies that, without margin requirements specified in the futures market to counter some of the destabilization effects of the price limits, the price volatility in futures markets may even be higher. Thus, it is important to develop the margin requirements in the futures market in the presence of the price limits to assist the price limits in reducing futures price volatility, but at the same time boosting trades if the market participation is too inactive.

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