Journal of Business and Economics, ISSN 2155-7950, USA
December 2016, Volume 7, No. 12, pp. 1931-1948
DOI: 10.15341/jbe(2155-7950)/12.07.2016/002

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Can Commodity Futures Margin Requirements Control Risks Effectively? Evidence from China*

Song Jun, Li Jinliu, Ling Ruobing
(International Finance Department, Fudan University, Shanghai, China)

Abstract: This paper differentiates two types of margin requirement increase in Chinese futures market: regular margin increase and risk margin increase. We use SVAR model to study the relationship among the open interests, the price volatility and the margin level of six kinds of futures traded on SHFE. The result demonstrates that the volatility and open interests both decline after a regular margin increase while they do not decrease as expected after the risk margin increase. The result suggests that while the current Chinese margin system can reduce default risk related to deliveries, it has limited effect on controlling market risk.

Key words: margin requirement; structural vector auto-regression (SVAR); volatility; open interest
JEL codes: G14, G18

1. Introduction

Margins in futures market are funds deposited by investors, usually from 5% to 20% of the contract value. Exchanges often take default risk and market risk into consideration when setting the level of margins. An increase of margin level would decrease the possibility of default by raising investors' default costs (Telser, 1986). Price volatility, open interest and trading volume are usually used as signals of market activity and risk. In China, margin level will be raised when its corresponding open interest reaches a certain level. Currently there are two common practices to determine margin requirement in exchanges: dynamic way and static way. The dynamic one is more widely accepted in developed markets such as Chicago Board of Trade (CBOT) and London Mental Exchanges (LME). For instance, the SPAN system, a sophisticated calculation method, has been introduced to over 50 registered exchanges, clearing houses, operational and regulatory agencies throughout the world. However, some Asian exchanges, including those in China, have still maintained the static way of setting margins. Regulators chose this static method in order to minimize investors' default risk in a relatively new and immature market. It is safer for underdeveloped markets but less sensitive to price and volatility.

With the stunning growth in economy development, the futures markets in China have developed a lot and have exerted more and more influence on the pricing of certain commodities. According to FIA(Futures Industry Association)'s statistics, the volume of contracts traded on Shanghai Futures Exchange (SHFE), Dalian Commodity Exchange (DCE) and Zhengzhou Commodity Exchange (ZCE) ranked the ninth, tenth and thirteenth

* Thanks for the financial support from the National Natural Science Fund (No. 71371055).
Corresponding author: Song Jun, Doctor, Associate Professor, School of Economics, Fudan University; research areas/interests: derivatives, behavioral finance. E-mail: songjun@fudan.edu.cn.

among exchanges worldwide in 2014. Ten out of the top twenty agricultural contracts by volume are traded in Chinese exchanges. Notably, SHFE is becoming an important center for industrial and precious metals trading in Asia, contributing a lot to the total trading volume on exchanges all over the world. SHFE futures prices have more and more impact on the international markets. Xiao et al. (2004) and Wu et al. (2007) divide the time into different periods. They find that the price discovery and volatility spillover effect of copper futures are primarily originated from the LME in early years. However, with the development of the SHFE, it plays a more important role in the more lately years. Liu et al. (2008) examine data from the SHFE and LME, and point out that the information in one market can be absorbed by the other within a trading day. More than a decade ago, U.S. futures market is dominant in transmitting information to the Chinese market (Fung et al., 2003). But Hua et al. (2008) find the international pricing level in SHFE is close to that in New York Mercantile Exchange (NYMEX). According to Fung et al. (2010), the U.S. market does not appear to be more efficient than the Chinese market in incorporating information into prices. Rutledge et al. (2013) analyze the copper futures from LME, SHFE and NYMEX's Commodity Exchange division (COMEX). They discover a long-term equilibrium relationship and a significant bi-directional Granger cause among the three markets. The most significant integration is between the SHFE and LME (in both directions). As the increase of trading volume and price influence, China's futures markets will have closer linkage with other markets. The price information and risks in the Chinese markets may transmit to other markets. So it is necessary to consider whether risks in futures markets can be controlled effectively and whether this static method of margin requirement is still suitable for China's futures market.

The paper has seven sections: Section 2 presents related literatures. Section 3 introduces two types of margin increases. The data and primary event study is presented in section 4. Section 5 describes the SVAR methodology and empirical results. In section 6, we consider the price limit effect. This paper concludes in section 7.

2. Literature Review

Theoretically, according to Telser (1981), higher margin level will raise investors' trading costs, thus reducing open interest and volume traded. Telser (1981), Figlewski (1986), and Gay et al. (1986) find that margins have performed fairly well in preventing default risk. However, the effect of margin requirements on market risk remains a controversial issue. Hartzmark (1986) investigates 13 unrelated margin level changes on CBT and CME from 1977 to 1981 via Wilcoxon signal rank-sum test. The result indicates an inverse relationship between open interest and margin changes. Kalavathi and Shanker (1991) argue that there is a negative effect of initial margin requirements upon the demand for futures contracts by hedgers. They test this hypothesis with data from S&P 500 futures contracts. In contrast, in their analysis on 6 contracts over a 17-year time period, Dutt and Wein (2003) adjust margin for underlying price risk and find economically and statistically significant negative effects of margin requirements on trading volume. In contrast, Phylaktis and Aristidou (2010) also take endogeneity into consideration and adjust for underlying price risk proxied by market volatility, but find that there is little evidence of such effect.

Besides open interest, price volatility can also be used to reflect the characteristics of market risk. Our work focuses on the price volatility too. There are few theoretic studies explaining the effect of margin requirement on price volatility directly. But according to Shalen (1993), Black (1986) and De Long et al. (1990), lots of speculative participants and excessive speculation will lead to higher price volatility. Most empirical studies support that participation of speculators are associated with price volatility. Chang et al. (1997) find the relationship between volume and volatility becomes stronger when separating large speculator volume from volume associated with other traders in their study on futures of S&P 500, Treasury Bonds, gold, corn, and soybeans. Wang (2002) and Liao (2008) also reach similar conclusions. In practice, this point of view is widely accepted. For instance, according to Section 4a of the U.S. Commodity Exchange Act (CEA), excessive speculation in commodity futures will cause unreasonable fluctuations or unwarranted changes in price. To diminish such burden, CFTC and exchanges are allowed to limit speculative trading when necessary. In China, the rules of futures margin and price limit system are based on this relationship too. Futures margin is set to control various kinds of risks, including that triggered by speculation. Kupiec and Sharpe (1991) introduce a simple overlapping generation model to characterize the effects of initial margin requirements on price volatility. Their framework shows that imposing a binding initial margin requirement may either increase or decrease price volatility, depending on the microstructure of investor heterogeneity in the average investor's risk-bearing propensity. As for the empirical studies, there are also different conclusions. Fishe et al. (1990) suggest that the negative relationship between margin changes and price volatility does not exist. Hardouvelis (2002) concludes that higher initial margin requirements are associated with lower subsequent price volatility during normal and bull periods, but he also shows no relationship during bear periods. Chou et al. (2015) focus on the Taiwan Futures Exchange and find that rising margin requirement causes some traders who supply liquidity to exit the market, leading to a reduction in volume and resulting in greater price volatility. Furthermore, some studies suggest that different contract characters result in different conclusions. Fishe and Goldberg (1986) examine the initial margin changes for all contracts traded on the CBT from 1972 to 1978. Their results show that margin changes significantly affect open interest of nearby, actively traded contracts, but for more distant delivery months, margins do not have a significant effect on open interest. Similarly, Adrangi and Chatrath (1999) investigate the relationship between volatility, margins and trading activity in soybean and corn markets via the trivariate near-vector autoregressive (VAR) model. They find margin change only affect the activity of contracts that are close to delivery.

The environment and margin rules in China's futures market are different from those abroad in some aspect. Hou (2009) studies 21 changes of initial margins in China's futures market. Only 10 of these are significant, of which 7 events show inverse relationship between margin requirement and volume. Zhang and Wei (2013) examine the specific points of margin changes by t test and find the raise of margin will reduce market liquidity and increase volatility. These studies are based on a limited number of events specific futures and far from convincing.

This paper studies the margins' effect on price volatility and open interest of six futures traded on SHFE. Our main contributions are: (1) margin requirement increases are divided into regular increase and increase triggered by risk events. (2) SVAR model is adopted to control endogeneity. Different from Adrangi and Chatrath (1999), we consider the simultaneous effects among variables. Dutt and Wein (2003) and Phylaktis and Aristidou (2010) adjust margins for underlying price risk to substitute for endogenous margin levels. Their method to control endogeneity may be applicable to analysis markets with margins that are dynamically adjusted to the market risk, it is not suitable to the Chinese futures market. Margin setting in Chinese futures exchange is static, which means when and how to change margin level is pre-stipulated in the rules and will seldom change according the market conditions.

3. Two Types of Margin Increases

According to the rules of Chinese futures exchanges, margin level for a certain contract will increase in three conditions: when a contract gets close to maturity, when it accumulates excessive open interest, or, when it hits the price limit.

Take fuel oil futures traded on SHFE as an example. The original margin level is 8%. When a contract gets close to maturity, the level will increase gradually. From the tenth trading date of the pre-expiration month (about 60 days before maturity), margin level increase to 10%. Afterwards, margin level is higher with the closer maturity, which enhances from 15% to 20% in the last two trading days. So are the rules for other futures. In this case, margin adjustment triggered by the rule is predictable to all investors, so that they will generally unwind the positions on near contracts and establish ones on further contracts. Given this, we define this phenomenon as ***regular margin increase*.**

In the second case, excessive open interest will trigger margin increase. When the open interest of a fuel oil contract is below 100 thousand lots, margin level remains 8%. Yet when it rises over 100 thousand, 150 thousand and 200 thousand, margin requirements will increase to 10%, 12% and 15%, respectively. High price fluctuation may also trigger margin increase in this case. The margin level will increase to 2% higher than the magnitude of price limit as long as the price hits the limit in last trading day. If the price hits the limit in the same direction consecutively in the next day and two, the level of price limit will be raised gradually and the margin requirement will be always 2% higher than the new price limit. We name these two cases as ***risk margin increase*.**

Regular margin adjustment is set by the fixed rules by exchanges to reduce default risk associated with delivery and can be forecasted accurately by all participants, while the risk margin is set for occasional risk events and is hard to forecast. As the latter one faces more uncertainty and pressure, evaluation on the efficacy of margin requirements should focus on it.

4. Data and Event Study

We employ daily price series, open interest series, and margin series of the Aluminium (AL), the Copper (CU), the Fuel Oil (FU), the Steel Rebar (RB), the Rubber (RU) and the Zinc (ZN) contracts traded on SHFE from January 2004 to November 2015. The series of FU, RB and ZN futures start from January 2005, March 2007 and March 2009, when these kinds of futures began trading on SHFE. All series come from SHFE (www.shfe.com.cn). In order to describe contract volatility (named as sigma or σ) during every trading day, we will employ the G-K method (Garman & Klass, 1980) and calculate the volatility as:

$$\sigma=\sqrt{\frac{1}{2}\times\left(\ln\left(\frac{p_h}{p_l}\right)\right)^2-\left(2\ln 2-1\right)\left(\ln\left(\frac{p_o}{p_c}\right)\right)^2} \tag{1}$$

Where p_h, p_l, p_o, and p_c, stand for the highest, lowest, opening and closing price in every trading day respectively.

Wilcoxon signal rank-sum test is applied for event study in this paper. We will compare the average open interests (*oi*) and volatilities (σ) before and after margin increases, and see whether they differ significantly. The open interest series of a certain contract presents an inverted U-shape when approaching expiration. The relatively short time window (5 days before and after margin increases) will help to avoid the bias resulted from this kind of change. In order to use as much as information from the contracts, we include all the margin increase events of the six futures, and divide them into three categories: all margin increases, regular margin increases near expiration, and risk margin increases at emergent events.

Table 1 shows the results of event study. In the case of regular increase, six futures open interests after margin adjustments decrease significantly. In contrast, when risk margin increases, the open interests of CU, FU, RU and ZN futures go up significantly according to *p-value*, with the rest differences are not significant. So the activity cannot be reduced when emergent events happen. All the six futures volatilities decreased after regular margin increases, and all of them are statistically significant. But they increase significantly when risk margin adjustments happen, which indicates margin's limited control of market risk.

Table 1 Event Study Results of Open Interest and Volatility

Open Interest							
	Futures	AL	CU	FU	RB	RU	ZN
All margin increases	Obs.	721	1238	572	299	915	818
	Mean of 5 days before events	36942.30	53686.41	16936.48	282023.74	28464.98	41976.66
	Mean of 5 days after events	33473.04	53441.21	13480.95	288102.98	29036.12	41271.01
	Difference	-3469.26	-245.20	-3455.53	6079.24	571.14	-705.66
	p-value	< 0.0001	0.1459	0.0690	0.1110	0.8976	0.0933
Regular margin increases	Obs.	399	431	418	198	419	312
	Mean of 5 days before events	37935.24	47721.66	19292.31	34622.39	13170.13	34034.96
	Mean of 5 days after events	31135.20	38911.94	13277.34	20767.18	9479.86	22798.71
	Difference	-6800.04	-8809.72	-6014.97	-13855.21	-3690.27	-11236.25
	p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Risk margin increases	Obs.	322	807	154	101	496	506
	Mean of 5 days before events	35698.79	56871.46	10542.10	767169.28	41416.77	46892.96
	Mean of 5 days after events	36378.95	61203.13	14033.62	811742.17	45556.43	52683.60
	Difference	680.16	4331.67	3491.52	44572.89	4139.66	5790.64
	p-value	0.5924	0.0021	0.0208	0.1035	0.0125	0.0017
Volatility							
	Futures	AL	CU	FU	RB	RU	ZN
All margin increases	Obs.	721	1238	572	299	915	818
	Mean of 5 days before events	0.0078	0.0092	0.0102	0.0089	0.0119	0.0116
	Mean of 5 days after events	0.0084	0.0102	0.0113	0.0083	0.0125	0.0127
	Difference	0.0006	0.0010	0.0010	-0.0006	0.0007	0.0011
	p-value	0.0004	< 0.0001	0.0086	0.0015	0.0125	< 0.0001
Regular margin increases	Obs.	399	431	418	198	419	312
	Mean of 5 days before events	0.0059	0.0086	0.0088	0.0079	0.0110	0.0100
	Mean of 5 days after events	0.0057	0.0081	0.0087	0.0061	0.0105	0.0094
	Difference	-0.0001	-0.0005	-0.0001	-0.0018	-0.0005	-0.0006
	p-value	0.0932	0.0054	0.0337	0.0054	0.0036	0.0002
Risk margin increases	Obs.	322	807	154	101	496	506
	Mean of 5 days before events	0.0102	0.0096	0.0136	0.0107	0.0127	0.0127
	Mean of 5 days after events	0.0118	0.0114	0.0168	0.0117	0.0144	0.0148
	Difference	0.0016	0.0017	0.0032	0.0010	0.0017	0.0021
	p-value	< 0.0001	< 0.0001	< 0.0001	0.3426	< 0.0001	< 0.0001

The event study result shows that unexpected market risk is not well controlled by margin increases. However, the endogeneity problem is not considered in this method, so we introduce Structural VAR in the following sections.

5. Structural VAR Model Methodology

5.1 Econometric Model

We also employ the data of six futures here, and replace the open interest with its natural logarithm (named as *LNOI*) so as to obtain more comparable parameters. Nearby series and three-month series of the six futures are constructed to get the continuous data required by SVAR, named as AL1, AL3, CU1, CU3, FU1, FU3, RB1, RB3, RU1, RU3, ZN1 and ZN3, respectively. The nearby series, also named as one-month series, contain data within 30 days away from expiration and thus are basically subject to regular margin adjustment. Meanwhile, three-month series contain data from 60 to 90 days away from expiration and therefore are only subject to risk adjustments. Thus, we can distinguish the difference in market responses to two kinds of margin adjustment by observing the SVAR coefficients of the two series.

Table 2 presents the descriptive statistics of these series. It is obvious that the averages and standard deviations of three-month series open interests are higher than those of nearby ones generally, and most average volatilities of three-month series are also higher. All these indicate the three-month series are more active and need more attention to their risks.

Table 2 Descriptive Statistics of Contract Series

	Sample Period		Margin	LnOi	$\sigma(*10^{-2})$
AL1	20040102~20151130	Mean	0.1436	9.8390	0.5297
		S.D.	0.0480	0.7093	0.5001
AL3	20040102~20151130	Mean	0.0584	10.8992	0.6488
		S.D.	0.0093	0.7710	0.5103
CU1	20040102~20151130	Mean	0.1585	9.8689	0.7917
		S.D.	0.0551	0.7200	0.6079
CU3	20040102~20151130	Mean	0.0765	11.4665	0.8801
		S.D.	0.0165	0.8130	0.5568
FU1	20050104~20151130	Mean	0.2194	6.5483	0.9408
		S.D.	0.0846	3.1464	1.1586
FU3	20050104~20151130	Mean	0.0804	7.3678	0.8755
		S.D.	0.0032	3.9706	0.7951
RB1	20090327~20151130	Mean	0.1591	7.6748	0.7431
		S.D.	0.0499	1.9723	0.7564
RB3	20090327~20151130	Mean	0.0659	9.2394	0.6740
		S.D.	0.0130	2.9146	0.5176
RU1	20040102~20151130	Mean	0.2091	8.1540	1.0306
		S.D.	0.0848	1.2004	0.7415
RU3	20040102~20151130	Mean	0.0860	9.1323	1.2396
		S.D.	0.0218	2.2211	0.7478
ZN1	20070326~20151130	Mean	0.1575	9.1907	0.8559
		S.D.	0.0355	0.7083	0.7727
ZN3	20070326~20151130	Mean	0.0637	11.4583	1.0145
		S.D.	0.0212	0.6745	0.7012

Since margin requirement can be influenced by open interest in China, it is an endogenous variable when open interest serve as a dependent variable, so ordinary OLS is unsuitable. Structural Vector Auto-Regression model (Sims, 1981; Bernanke, 1986; Shapiro & Watson, 1988) can be used in our study, as it can not only deal with endogeneity, but also figure out the simultaneous structural relationship among variables. The SVAR (n) model, with n lags, is specified as follows:

$$\mathbf{A}y_t = \mathbf{\Gamma}_0 + \sum_{i=1}^{n} \mathbf{\Gamma}_i y_{t-i} + \mathbf{B}u_t \tag{2}$$

Where t is the trading day, $y_{t-i} = \begin{pmatrix} m_{t-i} \\ \sigma_{t-i} \\ lnoi_{t-i} \end{pmatrix}, i = 1 \sim n$, m_t is the margin level , $ln\,oi_t$ is the natural logarithm of open interest, σ_t is the daily price volatility obtained from G-K method, $\mathbf{A}$ and $\mathbf{B}$ are squares matrices (order k=3), $\mathbf{A} = \begin{pmatrix} 1 & a_{12} & a_{13} \\ a_{21} & 1 & a_{23} \\ a_{31} & a_{32} & 1 \end{pmatrix}$, $\mathbf{\Gamma}_0 = \begin{pmatrix} a_{10} \\ a_{20} \\ a_{30} \end{pmatrix}$, $\mathbf{\Gamma}_i = \begin{pmatrix} a_{11}^i & a_{12}^i & a_{13}^i \\ a_{21}^i & a_{12}^i & a_{23}^i \\ a_{31}^i & a_{32}^i & a_{33}^i \end{pmatrix}$, lag order $i = 1 \sim n$, $u_t = \begin{pmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{pmatrix}$, $\mathbf{E}(u_t u_t') = \mathbf{I}_3$.

Multiplying $\mathbf{A}^{-1}$ on both sides, we get the reduced form of equation (2):

$$y_t = \mathbf{A}^{-1}\mathbf{\Gamma}_0 + \sum_{i=1}^{n} \mathbf{A}^{-1}\mathbf{\Gamma}_i y_{t-1} + \varepsilon_t \tag{3}$$

Where $\varepsilon_t = \mathbf{A}^{-1}\mathbf{B}u_t$. This equation equals to

$$\mathbf{A}\varepsilon_t = \mathbf{B}u_t \tag{4}$$

Matrix **A** and **B** are the structural parameters need to be estimated.

Based on the results above, we can defer the impulse response functions as follows:

$$\frac{dy_{t+\tau}}{du_{k\tau}} = \mathrm{f}(\tau), \quad k = 1,2,3, \quad \tau = 0,1,2,3 \ldots \tag{5}$$

Where k is the innovation order, it equals 1, 2, 3 respectively; τ is the time lag order, ranging from 1 to 10; f(τ) is the coefficients derived from the polynomials.

5.2 Empirical Results

The AR roots tests show that for all six models, when lag orders are selected by Schwarz information criterion, all roots of the characteristic polynomials lie inside the unit cycle. This means that the all of the stability conditions are satisfied. Table 3 shows the optimal lag orders of six futures models.

Table 3 Optimal Lag Orders by Schwarz Information Criterion

	AL	CU	FU	RB	RU	ZN
One-month series	4	5	1	1	3	5
Three-month series	4	4	4	2	3	4

In order to identify matrix **A** and **B**, we need to impose $k^2 + k(k\text{-}1)/2 = 12$ restrictions on the model. Firstly, since the residuals of the three equations in equation (2) are independent, **B** is a diagonal matrix:

$$\mathbf{B} = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix} \tag{6}$$

For matrix **A**, whether margin level is raised or maintained is determined before the trade day, so the open interest and the volatility of that day impose no influence on the margin level, which indicates that $a_{12} = 0$, $a_{13} = 0$, The open interest of day t is a stock variable at the end of the trading. It will not affect the price volatility, that is, $a_{23} = 0$. Thus, matrix **A** can be reduced to a lower triangular matrix:

$$\mathbf{A} = \begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{pmatrix} \tag{7}$$

We report the parameters estimated in Table 4. In matrix **A**, the parameters are opposite numbers of coefficient. Specifically, $-a_{21}$ represents margin requirement's influence to σ_t, and $-a_{31}$ represents margin requirement's influence to $LnOi_t$. In the case of one-month series, all the six commodities open interests drop significantly when their margins increase. The coefficients also show the decline in volatility, and half of the six estimates are significant. On the contrary, the a_{21} estimates of three-month series are negative and statistically significant in five out of six models, which indicate the increase of volatility. In addition, most estimates of a_{31} are also negative. Margin increases of one-month series are caused by approaching of expiration, and they usually have effect on the risks by reducing open interests and volatilities. While the margin increases of three-month series are caused by risk events in the market. There is no evidence of risk margin's effective control of open interests. Rather, the volatilities of three-month series become higher after the risk margin are raised.

Table 4 Estimated Matrix Parameters of SVAR Model

	One-month			Three-month		
Futures	$\boldsymbol{a_{21}}$	a_{31}	a_{32}	a_{21}	a_{31}	a_{32}
AL	0.0082***	5.8880***	-0.0232	-0.0730***	-0.6503	-2.1386***
	(2.59)	(41.14)	(-0.03)	(-3.71)	(-1.08)	(-3.76)
CU	0.0042	6.7445***	1.0867	-0.0418***	-7.8560***	-1.4103*
	(1.36)	(50.14)	(1.33)	(-3.30)	(-14.88)	(-1.82)
FU	0.0121**	0.8878***	4.4373***	-0.4873***	-5.7116	-4.3924
	(2.24)	(4.55)	(4.62)	(-12.59)	(-1.19)	(-1.52)
RB	0.0244***	2.0075***	0.6787	-0.0028	-54.0432***	-10.0485**
	(3.53)	(5.60)	(0.44)	(0.12)	(-13.86)	(-2.25)
RU	0.0028	2.0790***	-1.8981*	-0.0764***	-25.0809 ***	-3.0924
	(1.03)	(14.83)	(-1.95)	(-4.07)	(-13.16)	(-1.63)
ZN	0.0087	9.6379***	1.1946*	-0.0702***	-8.6269***	0.6093
	(1.14)	(40.35)	(1.73)	(-5.88)	(-16.49)	(0.63)

Notes: Z-statistics are reported in parentheses. Symbols ***, ** and * represent significance at a 1%, 5%, and 10% level, respectively.

Figures 1-12 in appendix plot the impulse functions of these futures, one-month contract and 3-months contract in pairs respectively. What we concern most is the effect that changes in margin level impose on price volatility and open interest (column 1, row 2 and row 3). For regular margin increase, both open interests and volatilities in all kinds of futures decrease after an increase in margin level. On the contrary, they positively respond to risk margin level adjustment in most futures. The impulse function figures directly present that, margin level increase can effectively reduce the default risk but not the market risk.

6. SVAR Model with Price Limit Dummy

We discovered margin's inefficiency in the case of market risk increase on SHFE. According to the rule in

China's futures market, the triggers of risk margin increase can be divided into two types, open interests and price limit. In this static rule, margin will be raised when a contract price hit its price limit. The price limit is exogenously set and can be a pause of market in extreme situation. By contrast, futures open interest comes from market trading itself and is not exogenous. So the changes of open interest and price in the following days may also result from price limit instead of higher margin requirement. Thus, we added a dummy *DM* on the basis of equation (3) as follows:

$$DM_t = \begin{cases} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \left(p_t\text{-}p_{t-1}\right)/p_{t-1} \geq \textit{price-limit} \\ \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \left(p_t\text{-}p_{t-1}\right)/p_{t-1} < \textit{price-limit} \end{cases} \tag{8}$$

$$Ay_t = \Gamma_0 + \sum_{i=1}^{n} \Gamma_i y_{t-i} + \Phi DM_t + Bu_t \tag{9}$$

Where *price limit* is the upper or lower price limit by the rule of SHFE.

We will compare the effects with previous estimates. The specific estimation steps are familiar with those of equation (3) and we present the estimates of matrix parameters in Table 5. Results of one-month series are similar to those in the model without dummy. Both open interest (-a_{31}) and volatility (-a_{21}) of one-month series declined after margin adjustment and the former is relatively more significant. The increase of open interest is still significant when we added dummy of price limit to SVAR model, which indicates that the open interests of three-month series usually keep growing when futures margins increase. But some estimates of volatility (-a_{21}) in three-month series become no longer significant. However, this difference can not reject our judgement of risk margin's inefficiency, since there is still no evidence to support margin's control of emergency risks.

Table 5　Estimated Matrix Parameters of the Model with Dummy

	One-month			Three-month		
Futures	a_{21}	a_{31}	a_{32}	a_{21}	a_{31}	a_{32}
AL	0.0090***	5.8822***	-0.0313	0.0055	-1.7439***	-2.6841***
	(2.84)	(40.98)	(-0.04)	(0.26)	(-2.72)	(-4.67)
CU	0.0046	6.7432***	0.9845	-0.0039	-8.3102***	-2.5964***
	(1.55)	(50.13)	(1.17)	(-0.32)	(-15.57)	(-3.21)
FU	0.0118**	0.8876***	4.3980***	-0.3015***	-12.6651*	-4.8764
	(2.23)	(4.54)	(4.48)	(-5.14)	(-1.72)	(-1.58)
RB	0.0248***	2.0182***	0.7704	0.0451	-64.6324***	-13.2742***
	(3.60)	(5.62)	(0.50)	(1.81)	(-15.44)	(-3.00)
RU	0.0027	2.0784***	-2.2506**	-0.0493***	-25.3520***	-3.9385**
	(1.03)	(14.83)	(-2.26)	(-2.71)	(-13.26)	(-2.01)
ZN	0.0095	9.6376***	1.1759	-0.0285**	-9.5275***	-0.6978
	(1.31)	(40.34)	(1.61)	(-2.33)	(-17.55)	(-0.71)

Notes: Z-statistics are reported in parentheses. Symbols ***, ** and * represent significance at a 1%, 5%, and 10% level, respectively.

The results in Table 5 tell us that the open interests will fall in one-month series and rise in three-month ones when the margins increase for other reasons except price limit. In Table 6, the coefficients of dummies indicate that if the price hits the limit in a trading day and the margin is raised, the futures price will become more volatile subsequently either in one-month or three-month case. While the effect of price limit to open interests here is not significant.

Table 6 Estimated Coefficients of Dummies

Series	One-month		Three-month	
Dependent Variable	σ	LNOI	σ	LNOI
AL	0.0053***	-0.0005	0.0080***	-0.0630***
	[5.89]	[-0.01]	[11.64]	[-3.08]
CU	0.0074***	-0.0353	0.0075***	-0.0245
	[13.08]	[-1.01]	[17.06]	[-1.24]
FU	0.0186***	-0.0965	0.0152***	0.1585
	[7.88]	[-1.10]	[12.92]	[1.09]
RB	0.0082**	0.1266	0.0092***	-0.0409
	[2.24]	[0.66]	[3.93]	[-0.10]
RU	0.0091***	-0.0589	0.0092***	0.0136
	[10.80]	[-1.28]	[14.76]	[0.20]
ZN	0.0185***	-0.0365	0.0088***	-0.0045
	[15.46]	[-0.69]	[12.16]	[-0.13]

Notes: T-statistics are reported in parentheses. Symbols ***, ** and * represent significance at a 1%, 5%, and 10% level, respectively.

We can conclude from Table 5 and Table 6 that the two types of risk margin increase causes have different influences on the futures. Margin raised for high open interest may affect the open interest in return mainly, while the price-limit cause usually has more effect on the volatility. But overall, both the results point to the inefficacy of this static margin rule.

7. Conclusions

In this paper, based on the data of the six futures traded on SHFE, we employ a SVAR model to examine the effects of margin adjustment in reducing default risk and market risk. The results suggest that although the current margin policy can effectively control the default risk, it does little to control market risk when emergencies happen, whether we consider the price limit or not. The open interests and volatilities of nearby contracts decrease significantly with the stepwise improving of margins. To the opposite, when margins increase unexpectedly, both open interests and volatilities of most-active contracts continue going up in the following days. When comparing the effects of margin and price limit, we find that the price limit system will increase price volatility of contract whether in one-month series or three-month ones, while the margin requirement has more significant positive effect on open interest. According to event study results, with the influence of price limit, volatility and open interest of nearby contracts reduce after the regular margin increases. Default risks are controlled by regular margin from the perspective of open interest and price volatility. We take three-month series as contracts with potential market risks. The price limit system dominates the positive effect on volatility when margins of these contracts raise. And the risk margin adjustments contribute more to higher open interest in this case, which means market risks are not well controlled.

The huge demand from the robust economy and the improvement of regulation have made China's futures market grown up rapidly in the past decade. The industry's increasing demand has brought large trading volume to China's futures market. But there is still room for regulation improvement. Since the static margin adjustment reacts sluggishly to price and open interest information, it is necessary to mark to market during trading day and improve the frequency of risk assessment and clearing. However, further solution in the future may be turning the static methodology into a dynamic one, so as to be more sensitive to extreme fluctuations and defuse the accumulation risks. In fact, many exchanges in emerging countries have adopted the dynamic margin setting method. Although China's futures market started very late, it has grown up quickly and become more influential. More attention should be paid to the market risk management, especially the effect of margin requirement.

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Appendix Impulse Response Figures of Six Futures

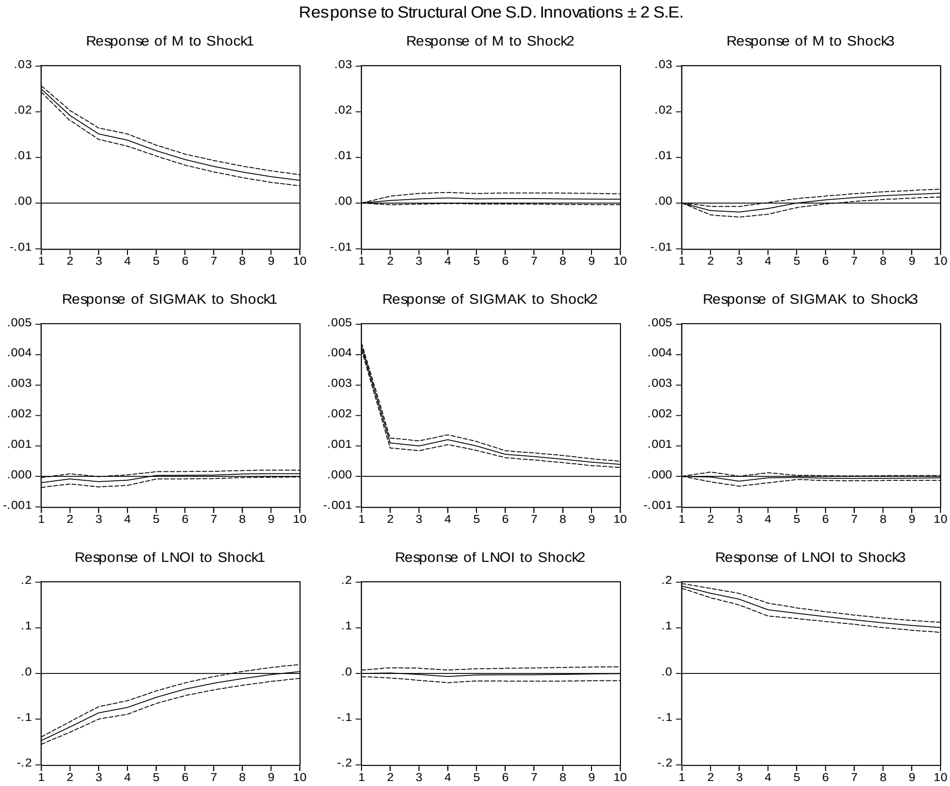

Figure 1 Impulse Response of Aluminium (AL) for Regular Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

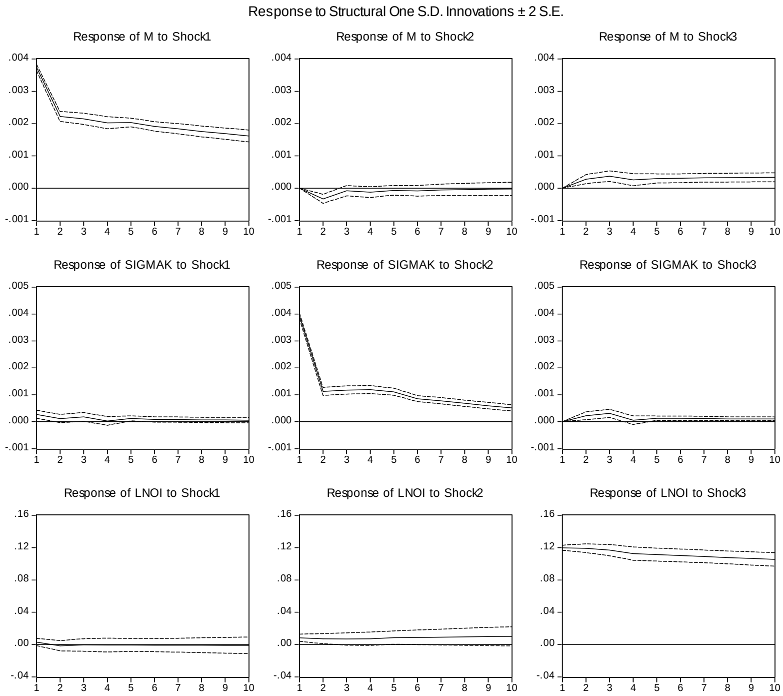

Figure 2 Impulse Response of Aluminium (AL) for Risk Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

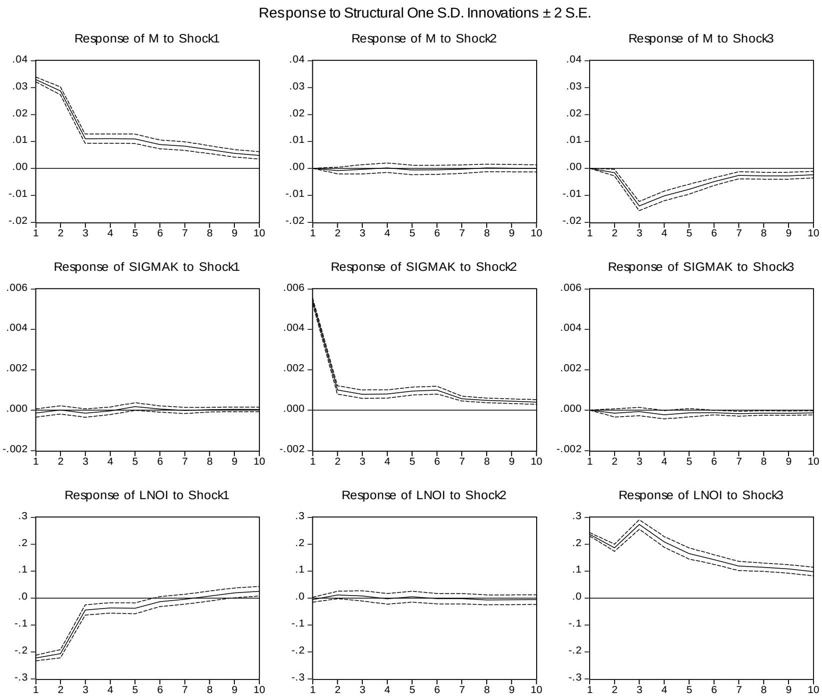

Figure 3 Impulse Response of Copper (CU) for Regular Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

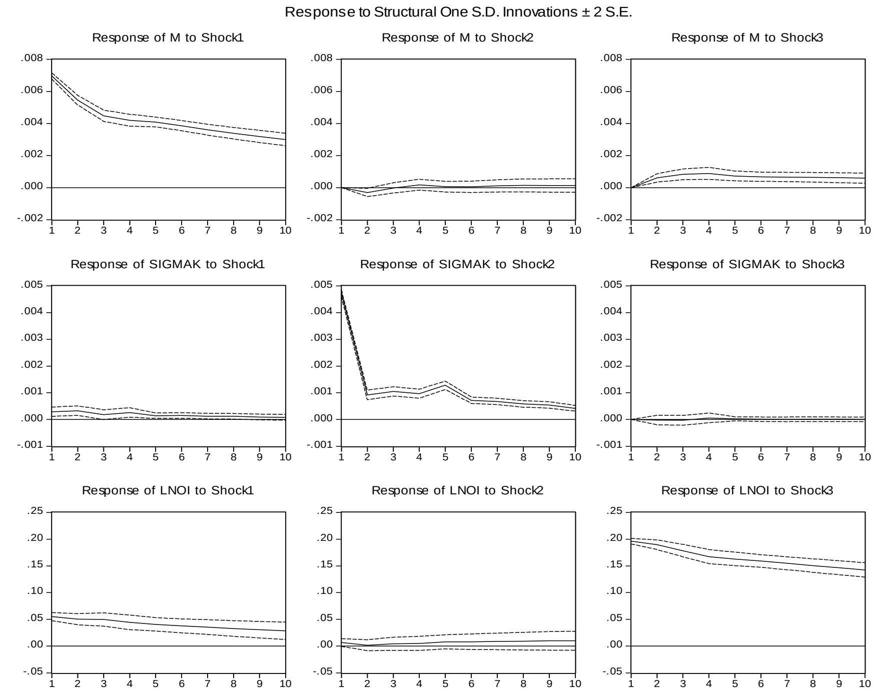

Figure 4 Impulse Response Of Copper (CU) for Risk Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

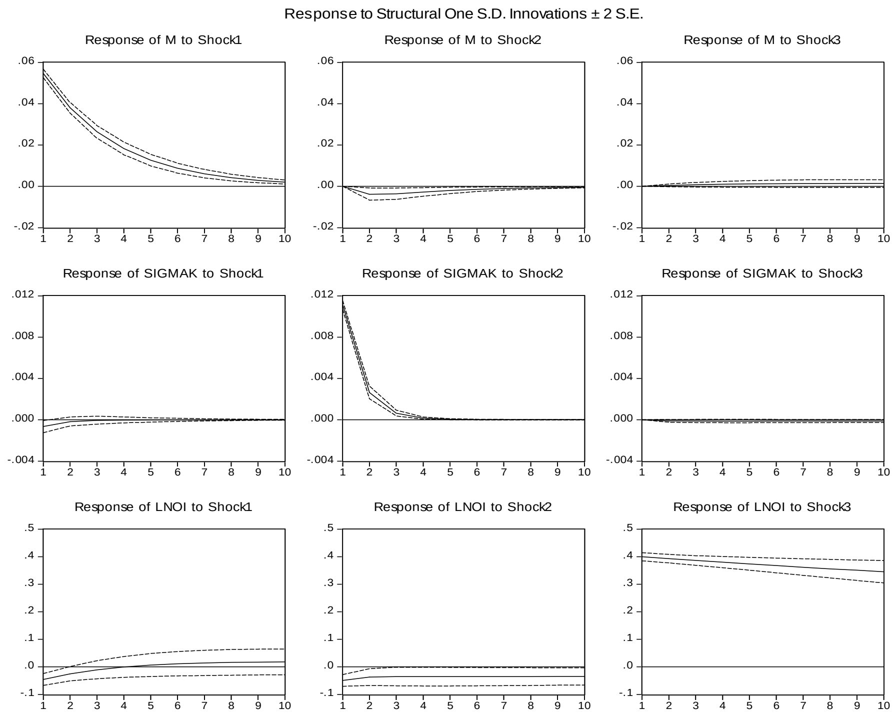

Figure 5 Impulse Response of Fuel Oil (FU) for Regular Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

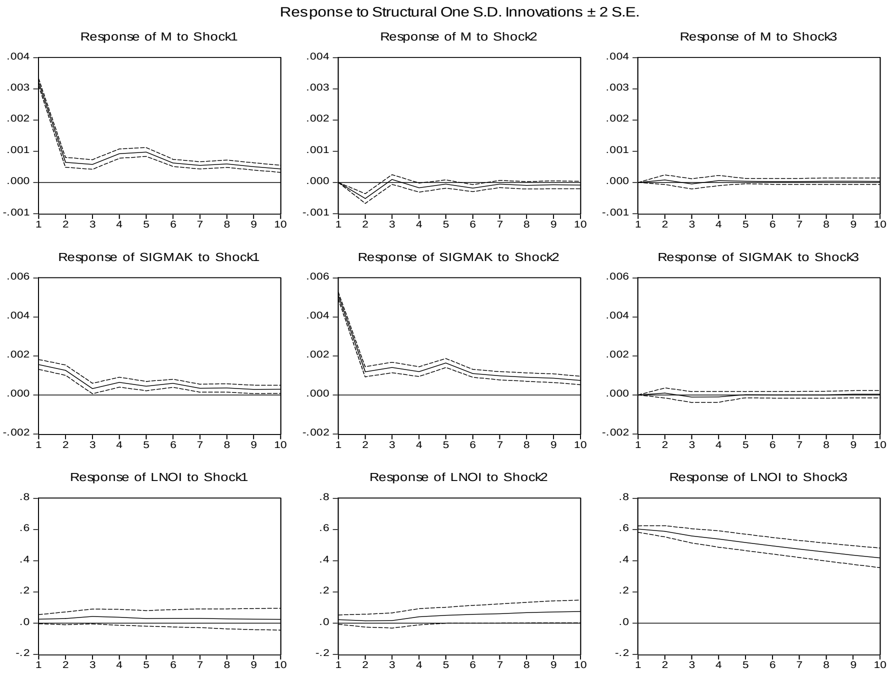

Figure 6 Impulse Response of Fuel Oil (FU) for Risk Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

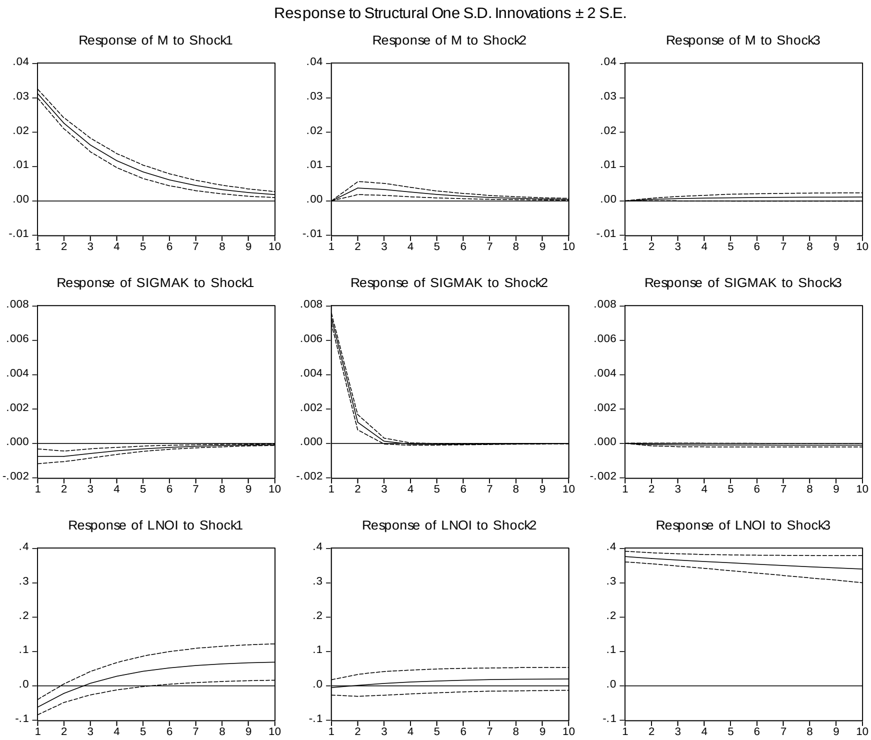

Figure 7 Impulse Response of Steel Rebar (RB) for Regular Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

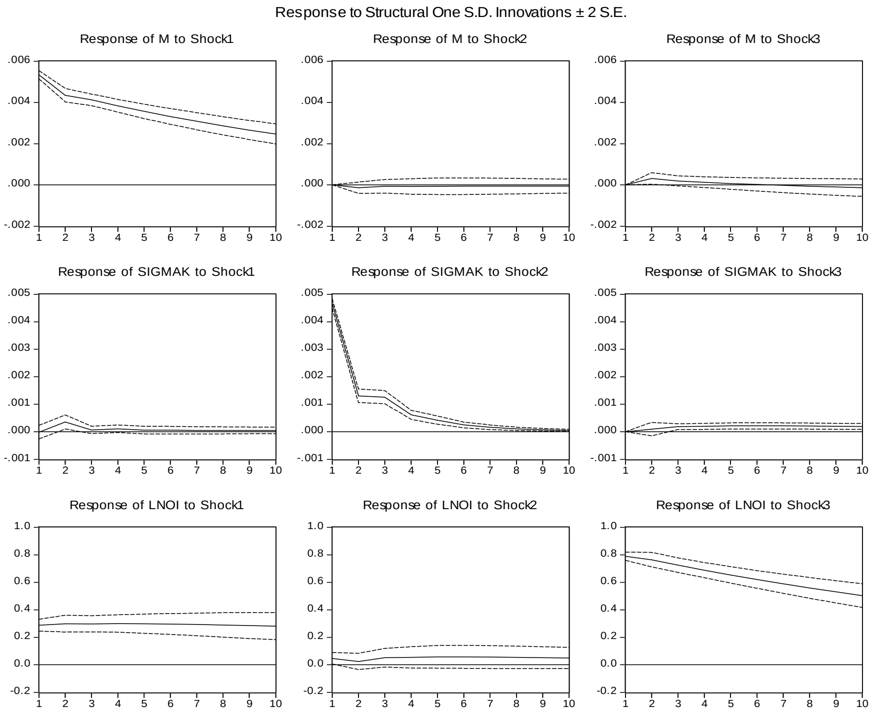

Figure 8　Impulse Response of Steel Rebar (RB) for Risk Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

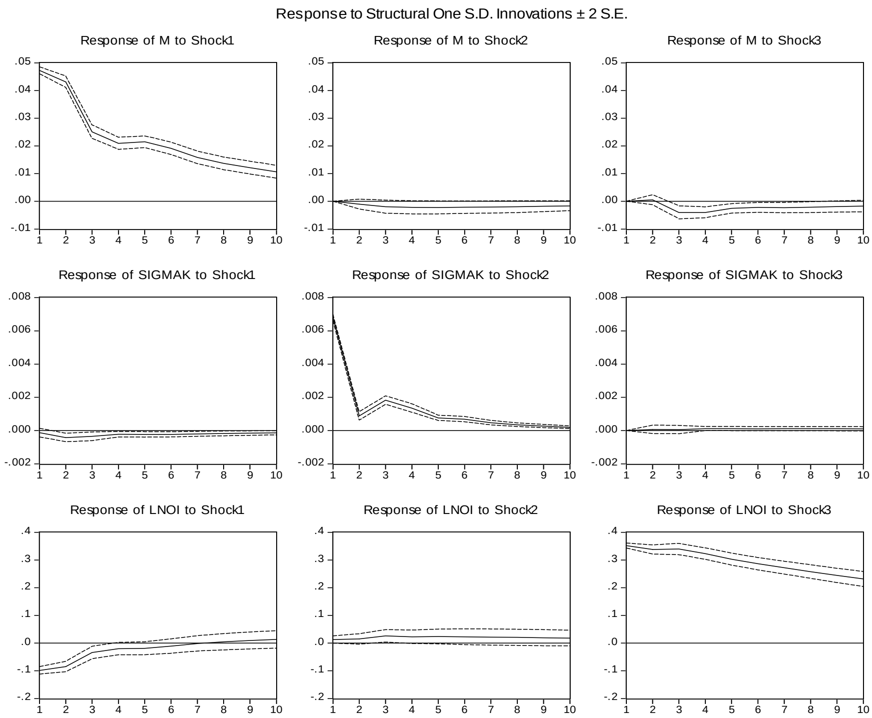

Figure 9　Impulse Response of Rubber (RU) for Regular Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

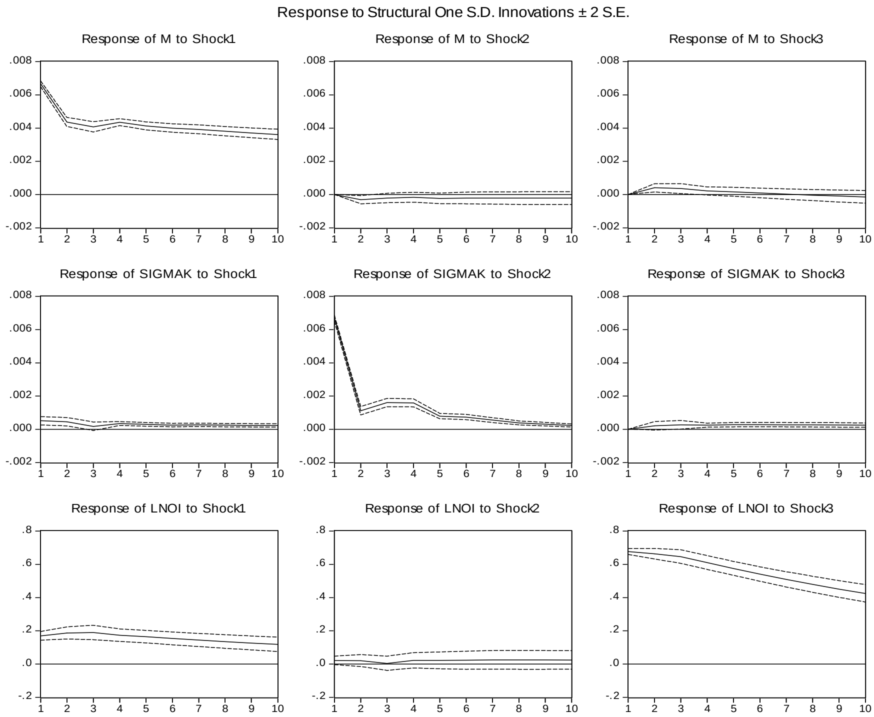

Figure 10 Impulse Response of Rubber (RU) for Risk Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

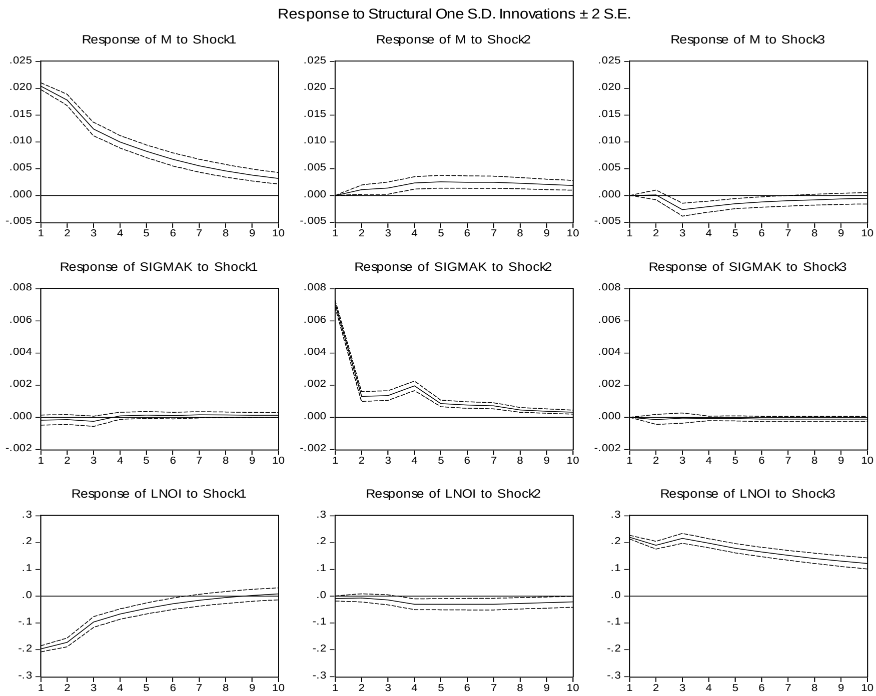

Figure 11 Impulse Response of Zinc (ZN) for Regular Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.

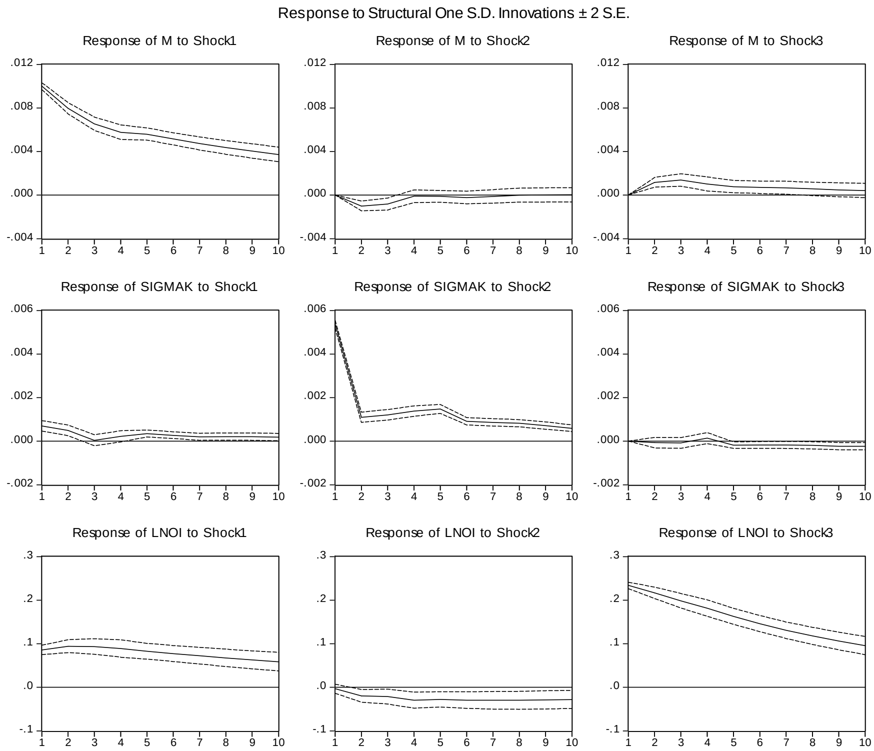

Figure 12 Impulse Response of Zinc (ZN) for Risk Margin Change, Open Interest and Volatility

Notes: The graphs at column 1, row 2 and row 3 show the impulse responses of σ (volatility) and *lnoi* (open interest) to a one-standard-deviation positive margin increase shock, respectively. The solid lines illustrate the mean responses and dotted ones show one-standard-error lower and upper bounds.