

The Russian-Ukraine Conflict, Crude Oil Price Fluctuation and Dynamic Changes in Stock Market: Evidence from the U.S and China

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Abstract. Political struggle is an important factor affecting the pattern of the international oil trade. The escalation of collisions between Russia and Ukraine, and the economic sanctions that the United States and European countries implemented against Russia had a significant impact on Russian oil exports. In this context, it is crucial to study how Chinese and American stock markets react to the burnt of international crude oil prices, in order to understand the phenomenon of risk contagion between markets and prevent risks. This paper selects the settlement prices of the Dow Jones index, S&P 500 index, Nasdaq index, Shanghai index, Shenzhen index, and international crude oil futures prices from three months before the Russian-Ukraine Conflict to the end of May 2022 to illustrate the tolerance to the volatility of two markets, using VAR and ARMA-GARCH model. The empirical results indicated that crude oil price fluctuation has a stronger impact on the US stock market than on the Chinese stock market, and specific stocks act differently during this “black swan incident”.

Keywords: Russian-Ukraine Conflict; stock price; crude oil price; volatility.

1. Introduction

Energy is an important material basis for promoting economic development and social progress. Among them, as an extremely important non-renewable energy, oil occupies a major position in the global energy market and is an important strategic material related to national security. On February 24, 2022, Russia began military action against Ukraine, and the Russia-Ukraine conflict broke out in full force. As the situation between Russia and Ukraine continues to deteriorate, the United States, Europe, and other Western countries have launched energy, economic, financial, and other sanctions against Russia, which has strongly affected The export of Russian crude oil, resulting in increased uncertainty of global crude oil supply and price. In the long term, this will affect the course of the global economic recovery and affect energy supplies. When the price of oil fluctuates, the stock market, which is closely linked to the real economy, reacts accordingly. At present, it is thought that the change in crude oil price is one of the important elements of stock price fluctuation.

The process of world economic integration is constantly advancing, and the linkage between various financial markets is becoming closer and closer. The price fluctuation behavior of the market contains a lot of information, which spreads very quickly among financial markets. When the information in the market changes, financial products can quickly adjust their prices according to the changes. Consequently, it is urgent and necessary to analyze the relationship between them, especially under the current situation of economic instability. From the perspective of the government, it is helpful to make better policies and prevent financial risks; From the perspective of regulatory authorities, we can better understand the situation of information transmission, to effectively resist the impact of oil prices, formulate policies and maintain the stability of the financial market; For investors, it can help investors establish an effective portfolio and reduce losses.

Li Sufang, Xie Chi, and Zhu Xi'an reckoned that there is a co-integration relation between international oil prices and the stock price of various industries in China. The Bayes quantile panel

co-integration model and Gibbs sampling algorithm are constructed by using the panel data model. [1]. Meng Yan and Zhang Ran have built an autoregressive model to analyze the connection between oil price and macroeconomic conditions, and have a conclusion that the higher the oil price is, the higher the hidden risks becomes in the stock market [2]. Jin Hongfei and Jin Luo studied the relation between stock price and crude oil price through VAR model and GARCH model and concluded that there was no wave spillover in the direction between the oil market and the Chinese stock market, indicating that there was no information transfer between the two markets, while there was information transfer between American stock market and oil market. So stable oil prices help stabilize the U.S. stock market [3] [4]. Qi Qianmin and Zhu Hongliang believed there was a co-integration correlation between oil price and the Chinese stock index, but neither of them played a dominant role, and the influence of changes was mainly explained by their reasons. There are three possible reasons for this: the weakness of China's oil pricing system, China's coal-dominated energy consumption, and the immaturity of China's stock market [5]. Wang Fangming explicated that the influence of the volatility in crude oil prices could explain some of the changes in the return rate of stocks by using the SVAR model [6]. Duan Yinying and Wang Huizhen studied the spillover effect of international oil price and emerging market index, then draw a conclusion that the WTI return series has an important guiding effect on the emerging market stock market, but WTI return is not affected by the emerging market stock market. And emerging stock markets as a whole have a high correlation with the WTI index by the VAR-BEKK-GARCH model [7]. Zhang Chen conducted stationarity test, co-integration test, Granger causality test, and other methods, and believed that although there was a relationship between A-share price and oil price according to the test result, it was a result of statistical significance and could not be used as definitive evidence. Therefore, the oil price is mainly affected by international supply and demand, and the price of China's A-share market cannot be used as a factor affecting the international oil price. It also suggests that China should strive to improve the stock market price mechanism [8]. Chen Shimin and Hao Yuzhu concluded that the mining industry and transportation storage industry was positively guiding the change in Chinese crude oil futures price, but the impact was small. However, China's crude oil futures and agriculture, forestry, hydropower, and gas industry have no statistical significance of guidance [9].

Du and He believed that under different economic and financial environments, the spillovers between the energy and equity markets are usually not invariable, and the intensity of the spillover effect should also vary with the degree of market volatility in different periods [10]. B. Azizz and W.Hassan showed that due to the positive correlation between crude oil price and earnings per share, it can be considered that rising oil price in the market will lead to rising stock yield, while the decrease in oil price will lead to declining stock yield [11]. The research results of Dutta A. show that energy stock returns have a high sensitivity to crude oil volatility. In addition, the impact of volatility is much greater than the spot price of WTI crude oil [12]. Nadal, szklo, and Lucena studied the stock market using DCC-GARCH volatility model. The research shows the fluctuation of oil prices caused by demand shock is positively correlated with the return rate of the stock market during financial market volatility (2007-2008 middle) and recovery (2009-2013) [13]. K.Mokni studied the dynamic response of stock markets by a two-stage method using the stock price and oil price data of oil-related countries. The outcomes manifest that the specific demand price of crude oil positively affects the yield of export inventory but negatively affects the export countries(except the Chinese market) [14].

Under the background of the conflict between Russia and Ukraine, this paper takes the relationship between the international crude oil futures price and Chinese stock markets and the US stock market as the research object. This paper selects the WTI, SSEC, SZI, S&P500, and NASDAQ to conduct research. The whole chapter is divided into five parts. The first part is the introduction, which describes the research background, research significance, and literature review. The second part is the research design, including data sources, model introduction, and setting. The third part is the empirical results and analysis. The fourth part is the discussion, and the fifth part is the conclusion of the article.

2. Experimental design

2.1 Data Sources

The economic data (Dow Jones Index, S&P 500 Index, Nasdaq Index, Shanghai Index, Shenzhen Index, and international crude oil futures prices) used in this article are all downloaded from the website cn.investing.com. The settlement price was selected from 3 months before the start of the Russian-Ukrainian conflict to the end of May this year. In all the model analyses involved in this article, all data are logarithmic, for example, the stock price data refers to the logarithm of the price, and the settlement price of international crude oil futures refers to the logarithm of the price, etc.

2.2 ADF-test

The first step in building a model is to test the stationarity of each variable. As shown in Table 1, the ADF test shows that the p-values of the return series of the following six prices are all less than 0.05, indicating the stationarity of the series. Therefore, all six economic indicators covered in this paper are eligible introduction variables in the VAR model because they are all stationary.

Table 1. ADF-test.

Variables	t-statistic	p-value
	Yield	
DJI	-8.341	0.0000***
S&P 500	-8.63	0.0000***
NASDAQ	-9.480	0.0000***
SH index	-7.894	0.0000***
SZ index	-9.910	0.0000***
Crude oil	-10.598	0.0000***

2.3 Model Introduction: VAR

Sometimes people care about the prediction of multiple economic variables at the same time. Therefore, this part builds a VAR model to meet this need.

We define a VAR model of order p, namely VAR (p), as:

$$Y_t = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_p Y_{t-p} + \varepsilon_t \quad (1)$$

This is a two-variable (VAR) model:

$$Y_t = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \gamma_{11} \\ \beta_{21} & \gamma_{21} \end{pmatrix} Y_{t-1} + \cdots + \begin{pmatrix} \beta_{1p} & \gamma_{1p} \\ \beta_{2p} & \gamma_{2p} \end{pmatrix} Y_{t-p} + \varepsilon_t \quad (2)$$

Defining the corresponding coefficient matrix as $\Gamma_0, \Gamma_1, \cdots, \Gamma_t$, we can get:

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \cdots + \Gamma_p y_{t-p} + \varepsilon_t \quad (3)$$

The VAR model characterizes the regression of each time series on all-time series lags, so we can put the returns of five stocks together and predict a whole system by generating a six-variable VAR model based on this model.

2.4 Model Introduction: ARMA-GARCH

This section builds an ARMA-GARCH model that simultaneously predicts rate of returns and volatility for the Dow, S&P 500, NASDAQ, Shanghai, and Shenzhen indices. This model takes the price fluctuation of international crude oil futures caused by the Russian-Ukraine Conflict as an

exogenous variable. The model results are supposed to show the degree to which the returns and volatility of each stock are affected by fluctuations in crude oil prices.

In order to achieve this, the autoregressive part of σ_t^2 is added to the original ARCH model, which means σ_t^2 is still a function of $\{\sigma_{t-1}^2, \dots, \sigma_{t-p}^2\}$.

The model GARCH (p,q) is shown below:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \dots + \gamma_p \sigma_{t-p}^2 \quad (4)$$

Assume that the generation process of the disturbance term is defined as:

$$\varepsilon_t = v_t \sqrt{\alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma_1 \sigma_{t-1}^2} \quad (5)$$

Intuitively, because σ_{t-1}^2 contains $\{\varepsilon_{t-2}^2, \dots, \varepsilon_{t-p-1}^2\}$, it can be assumed that GARCH (1, 1) is equal to an infinite-order ARCH model. Therefore, a higher-order ARCH (p) model, after introducing σ_{t-1}^2 as an explanatory variable, can be reduced to GARCH (1, 1).

3. Empirical result

3.1 VAR

It can be seen from Table 2 that LR reaches the minimum at lag=12. Therefore, the order of the VAR model is determined as 12. Before estimating the parameters, the stationarity of the parameters needs to be tested.

The model is set as follows (k>1):

$$\text{VAR}(k): Y_t = C + AY_{t-1} + U_t \quad (6)$$

Before running the VAR model, it is necessary to check whether the VAR system is a stationary process, that is, if all eigenvalues are inside the unit element, it is a stationary process. The test results can be seen in Figure 1, all the black points fall within the unit circle, which proves that the VAR system is stationary.

Table 2. VAR model identification.

Lag	LL	LR	df	p
0	2113.81			
1	2137.38	47.144	36	0.101
2	2156.9	39.041	36	0.335
3	2185.72	57.637	36	0.012
4	2204.13	36.826	36	0.43
5	2242.22	76.175	36	0
6	2263.79	43.134	36	0.193
7	2297.54	67.507	36	0.001
8	2332.36	69.65	36	0.001
9	2376.41	88.095	36	0
10	2408.47	64.115	36	0.003
11	2465.77	114.59	36	0
12	2507.6	83.661*	36	0

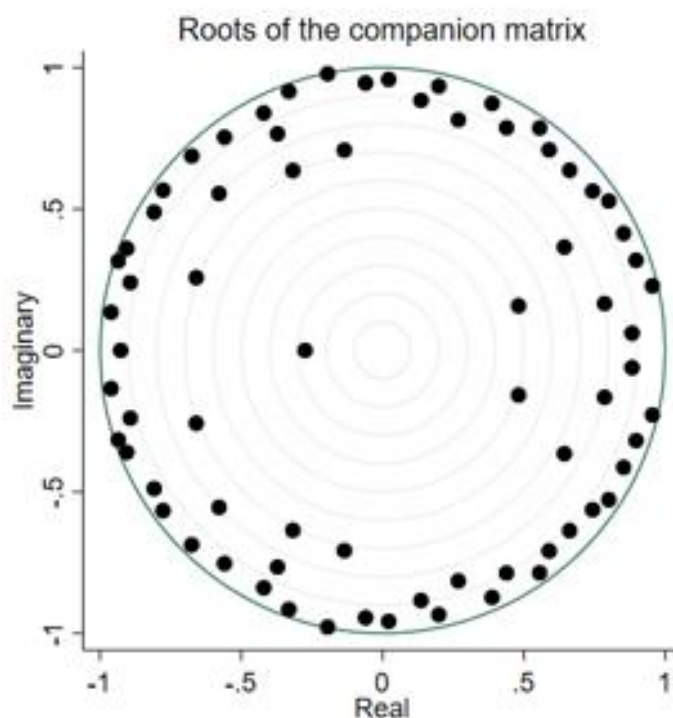


Figure 1. VAR stability.

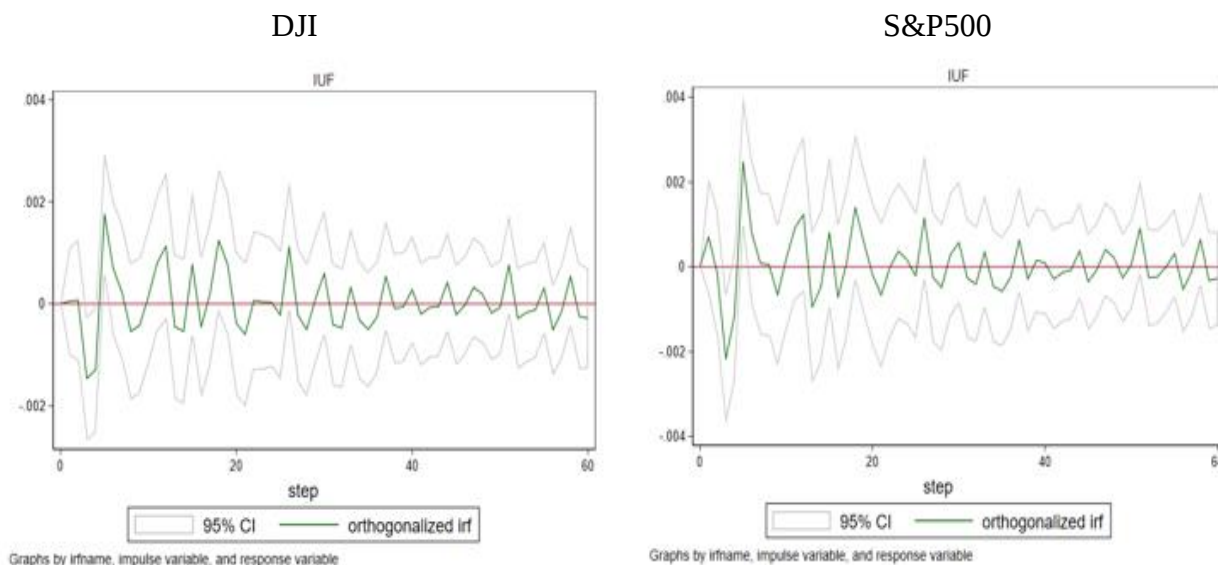
3.2 Impose and response

This part takes the stock returns of five stocks as the response variable and the international crude oil futures price as the impulse variable. The five impulse response graphs are presented in Figure 2.

Judging from the yields of the Dow Jones Index and S&P 500, the increase in the price of crude oil in $t=0$ futures will cause the Dow Jones Index and S&P 500 yields to fluctuate violently in the future, and the effect will last for a long time, and the amplitude of “The decay” is also slower.

As far as the Nasdaq Index and the Shanghai Index are concerned, the increase in futures crude oil prices during the $t=0$ period will also cause fluctuations in the yields of the Nasdaq Index and the Shanghai Index, but as time goes on, the amplitude gradually increases around the $t=30$ period. Decrease until it disappears.

For the Shenzhen Index, the strike of rising crude oil prices on the Shenzhen Index yield is not significant in an economic sense.



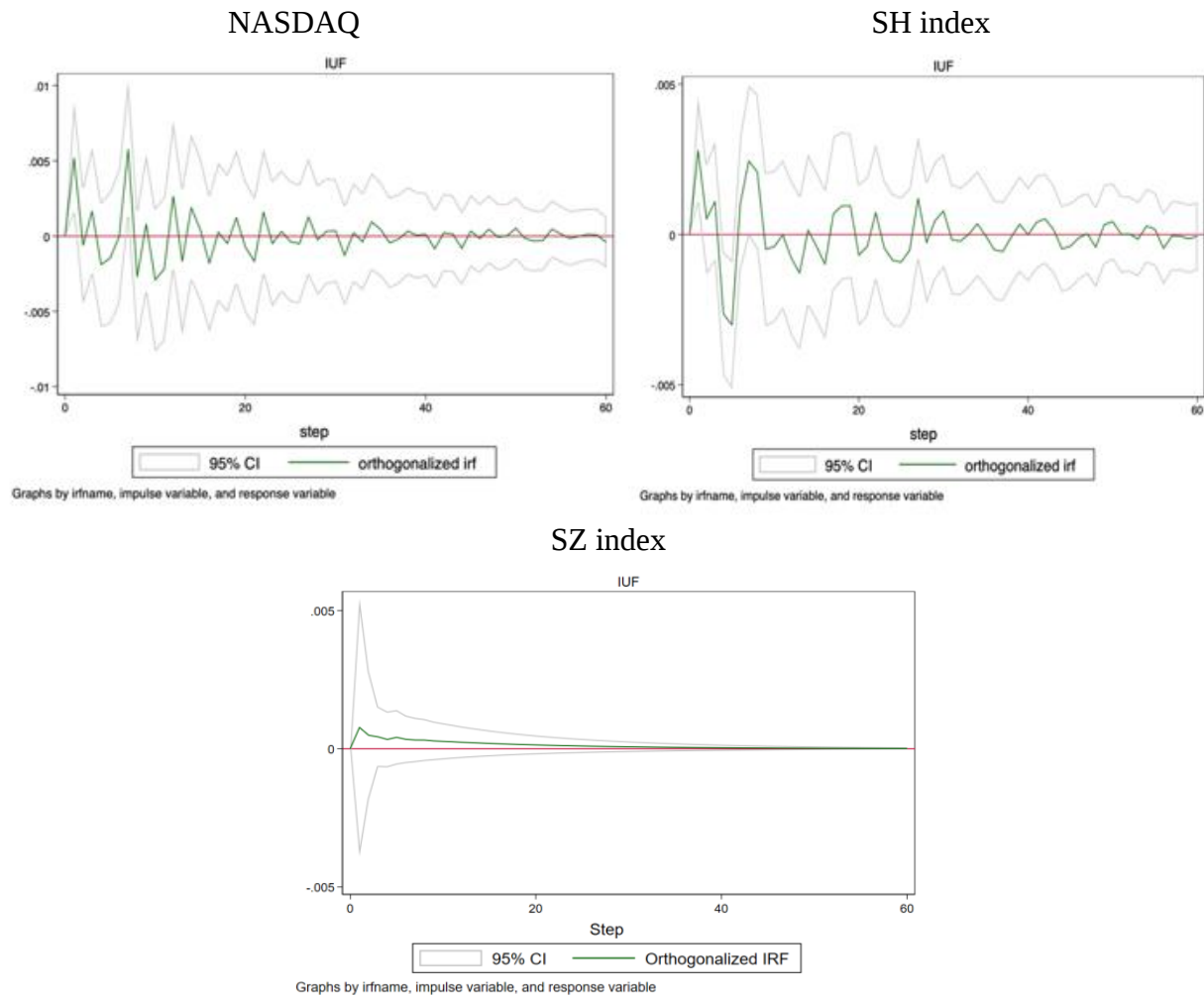
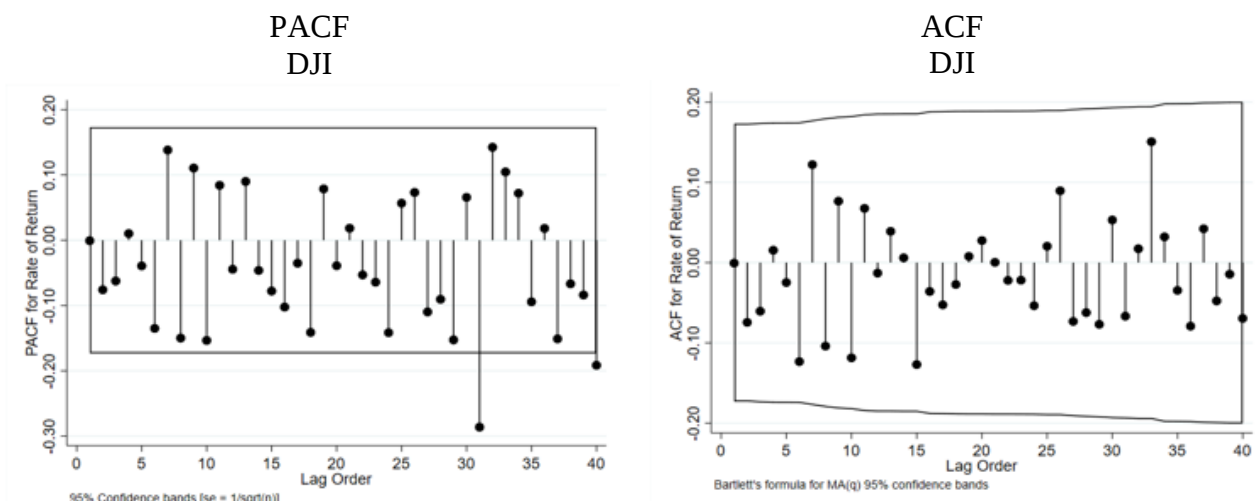


Figure 2. Impulse and response.

3.3 ARMA

The first thing to do to set up ARMA is to determine the order of the AR and MA model through PACF and ACF. This part analyzed the situation of the five stocks separately: according to Figure 2, the AR order of the Dow Jones, S&P 500, NASDAQ, Shanghai Index, and Shenzhen Index returns are 31, 31, 1, 5, 1, respectively, while the MA order is None, None, 1, None, 1.

The next step is to analyze the tolerance or reaction of each stock to the volatility of crude oil prices, using ARMA-GARCH model.



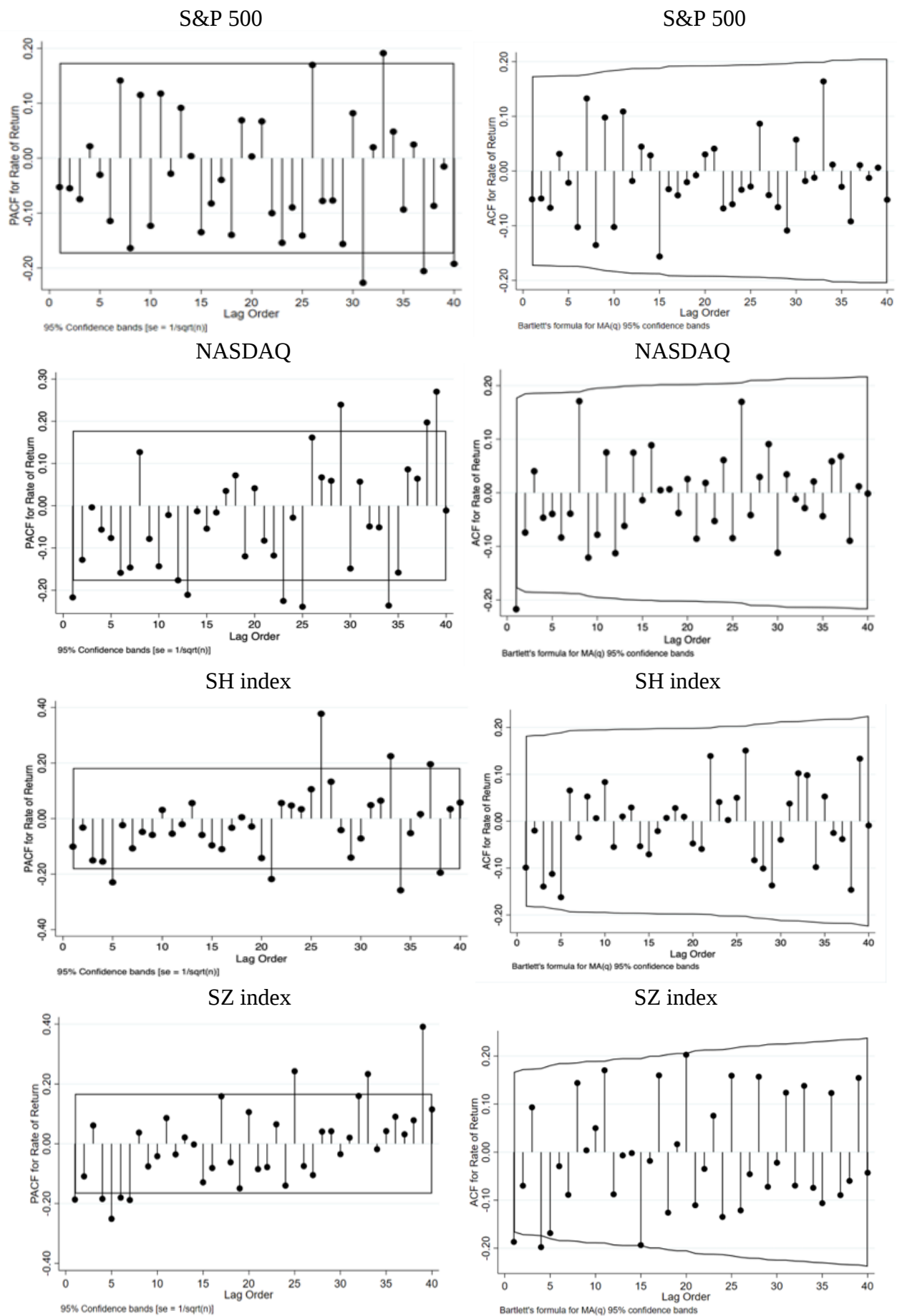


Figure 3. ARMA identification.

3.4 ARMA-GARCH

Table 3 shows the estimated results of the variance equation.

Judging from the estimation results of ARMA-GARCH, the increase in crude oil futures prices has no significant impact on the daily fluctuations of the Dow Jones index yield, S&P 500 yield, or Shanghai index yield.

It has a significant positive impression on the daily volatility of the NASDAQ index return and the Shenzhen Index return.

If we pay attention to the two Chinese indices: the rise in oil prices did not lead to fluctuations in the yields of the Shanghai index yield, but it caused the yields of the Shenzhen Index to fluctuate. This shows that the Shanghai index is larger and more able to withstand the impact of external risks. The same reason also explains why the NASDAQ is more volatile than the DJI and S&P500 because as a small-cap stock index, compares to the other two indicators, NASDAQ does not significantly reflect the resilience of the market to shocks.

But if we analyze the economic situation of China and the United States, we found that in the current market, crude oil is the basic energy for the development of the US economy. Therefore, when crude oil rises, the prices of many products in the United States will rise, which is not conducive to the export of American products and may cause a deficit in US trade. When the U.S. trade deficit, is likely to cause the dollar to depreciate. Moreover, if crude oil rises sharply, it will also affect the development of listed companies in the US machinery and automobile industries, causing stocks in these industries to fall.

However, the brunt of crude oil price fluctuations in China is relatively small. To illustrate, China's energy supply is dominated by coal, while oil and natural gas account for less than 30% of total energy consumption, which makes the strike of rising oil prices on China's inflation and economic performance easier to control. But objectively speaking, the soaring oil and gas prices on the international market has greatly increased the cost of imports, thus pushing up China's industrial and agricultural production costs and eventually passing pressure on the consumer side, thus forming the driving force of inflation. At the same time, since oil costs account for about 40% of China's road freight costs, rising oil prices are bound to have a strike on the road freight industry.

Table 3. ARMA-GARCH estimation results.

Variables	(1)	(2)	(3)	(4)	(5)
	DJI	S&P 500	NASDAQ	SH index	SZ index
Crude oil	9.6732 (37.0547)	1.3710 (1.7545)	5.9146*** (0.0476)	2.1474 (37.0547)	24.7758*** (6.4617)
ARCH (-1)	0.1415 (0.0964)	0.0506 (0.0539)	0.1141 (0.0250)	0.4343 (0.1956)	0.5655** (0.1910)
GARCH (-1)	0.7977*** (0.1289)	-0.9259*** (0.1360)	-0.9411*** (0.0301)	-0.1522*** (0.1173)	0.4325*** (0.0743)
Constant	-0.0006 (0.0008)	-0.0012 (0.0013)	-0.0000 (0.0030)	0.0004 (0.0015)	-0.0003 (0.0004)

4. Discussion

It is reported that the increase in crude oil prices led to longer-term future shocks in the returns of the S&P 500 Index, Dow Jones index, NASDAQ Index, and Shanghai Stock Indices. Meanwhile, the impact on the Shenzhen index was not significant. By comparing with the current literature, unlike the findings of Jin Hongfei and Jin Luo (2010) using VAR and GARCH models, this paper uses the

same model to determine that Chinese stock market returns can be predicted by changes in oil prices using the Shanghai Stock Indices [3][4].

The difference between the VAR and GARCH models is that the same model can predict the Chinese stock market returns by using Shanghai Stock Indices. Also, in contrast to the research of Li Sufang, Xie Chi, and Zhu Xi 'an the economic impact of international oil prices should be clearly shown in the stock market in the short and long term, nonetheless, our results only reflect the long-term findings [1].

This study can be used both as an aid to check the validity of the preceding research literature and as a valuable reference for subsequent researchers in the context of the Russia-Ukraine conflict. Through modeling and data analysis, this study can better reflect the economic conditions resulting from the war and allow investors to make the appropriate judgments.

5. Conclusion

The gradual deterioration of the situation in Russia and Ukraine has had a significant impact on the global economic outlook. These included the US and China, two representative countries of developed and developing economies.

This article focused on the dynamics of the Russian-Ukrainian conflict on international crude oil prices and the relationship within the US and Chinese stock markets, using international crude oil futures prices, the Shanghai Stock Index, the Shenzhen Stock Index, the Dow Jones index, the S&P 500 Index, and the NASDAQ Index as research objects.

The increase in crude oil prices has resulted in longer-term future shocks in the returns of the NASDAQ Index, S&P 500 Index, Dow Jones index, and Shanghai Stock Indices. The impact on the Shenzhen index was not significant. As a result, it was concluded that the increase in futures crude oil prices due to the Russia-Ukraine conflict have a stronger influence on the US stock market than on the Chinese stock market.

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