The Russia-Ukraine Conflict, Fluctuation of Crude Oil Price and Dynamics of China's stock market

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Abstract. The price of crude oil soared after the outbreak of the Russia-Ukraine conflict. However, China's stock market, by contrast, continues to fall. This paper studies the impact of crude oil price on the dynamic of China's stock market. We build an ARMAX model and an ARMA-GARCH model to analyze whether there are connections between crude oil price and China's stock market. This paper finds that the crude oil futures rate of return is positively correlated with the Shenzhen Component index rate of return and Shanghai Component index rate of return. Also, the crude oil price has a significant impact on the fluctuation of the Shenzhen and Shanghai Stock Exchanges.

Keywords: Chinese stock, Crude Oil, Russia, Ukraine.

1. Introduction

The Russian and Ukraine government had a bad relationship since 2014. In that year, Yanukovych, the president of Ukraine at that time, stopped signing deals with European Union, and tend to strengthen relations with Russia, which causes massive demonstrations. The opposition was keen on joining European Union, and they gradually took the lead. As a result, Yanukovych was out, but the failure of Yanukovych made the Russian government think they had to do something to build a buffer area and protect their strategic interests in the Black Sea in case Ukraine turned all the way west. So, Crimea, a peninsula of great strategic importance, announced a referendum to secede from Ukraine and join Russia. Also, two states of Ukraine, Donetsk, and Lugansk declared their independence. Under the protection of the Russian military, Ukraine's army failed to take back these two states. According to figures released by the Ministry of Regional Economic Development of Ukraine, as of 1 September 2014, 217 assets, including 45 health units, had been destroyed or damaged as a result of the war in the eastern Donetsk Oblast; 51 cultural and sports venues; 81 administrative buildings; There were also 14 trading markets and 132 industrial facilities, with total losses estimated at 4.788 billion hryvnias. The fighting damaged 4,740 residential buildings in the Donetsk oblast and 690 residential buildings in Luhansk oblast, uprooting 710,000 people from their homes. Experts from the Ministry of Regional Economic Development estimate that at least 1.75 billion hryvnias will be needed to repair residential buildings. Restoring the heating, water, and drainage systems at the same time will require at least an additional 70 million hryvnia [1].

Unfortunately, the two states became the trigger for the conflict between Russia and Ukraine in 2022. The Ukraine crisis today is not built in one day. On Dec.17, 2021, NATO has rejected Putin's proposal that NATO ends all military activity in East Europe and not let Ukraine ever join NATO. On Jan.10, 2022, Russia and NATO had a useless conversation, no agreement was reached. On Jan 19, 2022, the US gave Ukraine $200 million in aid, and President Biden made a short speech at the press conference, which was criticized because some people thought his speech leave the door open for Putin to invade. On, Feb 02, 2022, the US Defense Department announced it will send more troops to Europe, and Russia was strongly against it. On Feb 17, 2022, the fight between the two states and Ukraine's government escalated, two sides accused each other of shelling their areas with artillery. On Feb 21, 2022, Putin announced Russia recognizes the independence of two states, the Donetsk People's Republic and the Lugansk People's Republic. NATO countries immediately imposed sanctions against Russia. On Feb 24, 2022, Putin announced that Russian forces will carry out a "special military operation" in the Donbas region, and the conflict escalated to war.

While Russia and Ukraine went to war, the Western countries began to sanction Russia. Sanctions against Russia are common, in 2014, Western countries sanction Russia because of Crimea. However, the sanction this time is unprecedented, including trade, finances, individuals and businesses, and technology. They even kicked Russia out of the SWIFT (Society for Worldwide Interbank Financial Telecommunications). There's one thing to note the sanction has not included crude oil yet, and Russia provides 10% of the global supply of oil. Although the sanctions do not cover crude oil, they spooked the crude oil market and investor confidence all over the world. In Germany, The German investor confidence index published by ZEW plunged from 54.3 in February 2022 to -39.3 in March, near the all-time low of -49.5 reached in March 2020[2]. According to the data from Yahoo Finance, at the beginning of the crisis (Nov 2021), the price was quite stable. However, the market price goes all the way up from 66.18 on Nov 30, 2021, to reach its peak of 123.7 on March 8, 2022. It takes three months for crude oil price rises from 66.18 to 92.81 (Feb 24, 2022). After Feb 24, Russia declared a "special military operation", and it takes only about 12 days that the price to go to its peak.

The crude oil market goes up. However, the SSE Composite Index and Shenzhen Component go straight down. One thing in common, these two indices were quite normal before March, there wasn't dramatically drop at that time but still had some small drop. All of a sudden, for the SSE Composite Index, the price dropped from 3488.83 to the lowest 3063.97 on March 15, 2022. For Shenzhen Component, the price falls from 13488.64 to 11537.24 on March 15, 2022. So, if there's a way can figure out the relation between crude oil price and the Chinese indices it will be easier to predict and understand the Chinese stock.

Many existing literatures focus on researching the contagion effects between crude oil and the Chinese stock market, they indeed considered the external factor that could influence the stock market. The explanatory power of extreme oil returns for synchronous tail events across Chinese stock market sectors is relatively weak in contrast to common domestic factors, but it is never negligible. [3]. According to Xie, China's stock market is highly sensitive to fluctuations in international oil prices. [4]. The correlation structure of the Chinese stock market of crude oil-related companies based on DCCA coefficients reveals a loose structure in an upturn and a relatively compact structure in recession [5]. Another voice thinks that multiple factors lead to the short-term fluctuations of crude oil prices not having a significant impact on the Chinese financial market, while in the long term, fluctuations of crude oil prices will gradually affect the Chinese financial market [6]. Additionally, Wang points out that almost all net spillovers of WTI futures are significantly positive and driven by short-term components, which indices that in their model, the crude oil market is a short-term risk transmitter [7].

Some examples can use, such as the subprime crisis, the 2014 Ukraine Crisis, and Saudi Arabia's price war. However, this time, the 2022 Ukraine crisis has a larger scale, the scale of western sanctions is unparalleled, and Russia's countersanctions are also unprecedented, which brings new data into the study of the relation between crude oil and the Chinese stock market. It's necessary to figure out the influence based on this event. To know the correlation between crude oil prices and the Chinese stock market, and how extreme factors influence the correlation are the key motivation for this paper.

The paper is structured as follows. Section 2 introduces the methodology, Section 3 is dealing with the data analysis, Section 4 is discussion, and Section 5 concludes.

2. Research Design

2.1 Data source

The price of Shenzhen Component index, Shanghai Component index, and Crude oil are collected from Yahoo Finance, one of the best financial websites, which provides many credible and useful financial information all over the world. Information on the US market is more detailed [8]. The data this research collected from Yahoo Finance comes from the ICE Data Services, which was founded in the 1960s, and is famous for providing financial data and analysis services.

This paper chooses a close price to research because the close price is the last price during the regular trading day. A security's close price is the standard benchmark used by investors to track its performance over time.

Data of Shanghai Component index, Shenzhen Component index, and crude oil price are matched in this paper. As the trading days of the Chinese market are different from those of the crude oil market, the confirmed data for different trading days are omitted and the remaining data are renumbered by date. This study will use STATA as the main tool to solve the problems encountered in the research.

2.2 Unit root test

The Unit Root Test tests whether a time series variable is non-stationary or not. Most quantitative analysis of time series is based on the premise that the series is stationary, so the steadiness of data must be checked before starting the research. If any series is not stationary, this paper needs to look for possible ways to improve the results

It is usually assumed that in the Unit Root Test, time series X can be written as:

$$x_t = c_t + \beta x_{t-1} + \sum_{i=1}^{p-1} \emptyset_i \Delta x_{t-i} + \varepsilon_t \quad (1)$$

The null hypothesis of the test is the coefficient $\beta = 1$, showing that the series has a unit root that is not stationary, while the alternative hypothesis is that $\beta < 1$, indicating the series under test is stationary.

Table 1 provides the test result. The result shows that the prices of these three Variables are not performing well in the stationarity test, all of their p-values are above 0.1, which means they are not even significantly stationary under 90% confidence intervals. However, for the Rate of return of these three variables, their p-value indicates that they can be trusted under over 99% confidence intervals. Based on the results, this paper could build the following models with these stationary series.

Table 1 ADF-test

Variables	t-statistic	p-value
	Price	
SH	-3.035	0.1483
SZ	-2.944	0.1225
WTI	-2.934	0.1516
	Rate of return	
SH	-7.312	0.0000***
SZ	-7.130	0.0000***
WTI	-6.149	0.0000***

Note: The result is retained to four decimal places

2.3 ARMAX Model Specification

An ARMAX model is a combination of an Autoregressive (AR) process, a Moving Average (MA) process, and an X Distributed Lag (ADL) term.

The notation AR(p) refers to the autoregressive model of order p. It predicts future behavior based on past behavior. It's used for forecasting when there is some correlation between values in a time series and the values that precede and succeed them. The AR(p) model is written as

$$y_t = \emptyset_0 + \sum_{i=1}^{p} \varphi_i y_{t-i} + \varepsilon_t \quad (2)$$

The $\emptyset_0$ is a constant number, the y_t is the value of the series in period t, and ε_t is the error term.

The notation MA(q) refers to the moving average model of order (q). A moving average model is used for forecasting future values. The MA(q) is written as

$$y_t = c_0 + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t \quad (3)$$

The c_0 *is a constant number*, y_t is the present value of the series and $\varepsilon_t$is the error term in period t.

ARMA model is the combination of the AR model and MA model, and to build the ARMAX model, it's necessary to add an X term, illustrated by an Autoregressive Distributed Lag model. The ARMAX model is written as:

$$y_t = \emptyset_0 + \sum_{i=1}^{p} \varphi_i y_{t-i} + \sum_{k=0}^{l} \omega_k x_{t-k} + \varepsilon_t \quad (4)$$

In order to consider the cause of SH and SZ's stock price fluctuation, this paper chooses to build an ARMAX model that includes the impact of its past value as well as the influence of the stock price of WTI. The structure should be

$$y_t = \sum_{i=1}^{p} \varphi_i y_{t-i} + \sum_{k=0}^{l} \omega_k x_{t-k} + c_0 + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_t \quad (5)$$

2.4 ARMA-GARCH Model Specification

Autoregressive conditional heteroskedasticity was developed by Robert F. Engle III in the 1980s. He won the 2003 Nobel Memorial Prize in Economic Science based on that achievement [9]. The ARCH model is used to analyze volatility in time series in order to predict future volatility. The ARCH(p) model is written as

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_p \varepsilon_{t-p}^2 \quad (6)$$

σ_t is the forecast variance in period t. ε_t is the actual variance in period t, and α_0 is constant.

The generalized Autoregressive Conditional Heteroskedasticity model is used when the variance of the error term is heteroskedastic, and it is widely used to predict the volatility of returns on financial assets in time-series analysis. The GARCH (p, q) model is written as

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_p \varepsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_q \sigma_{t-q}^2 \quad (7)$$

3. Empirical Result

3.1 ARMA Identification

In order to build an ARMAX model, the paper finds out the proper AR and MA for SH and SZ stock price data. According to STATA, the partial autocorrelation plot (PACF plot) of SH is shown in Figure 2. The black border is the benchmark to figure out the statistically significant term in the AR model. Figure 2 shows that lags 18 and 19 may cause a significant impact on the current data.

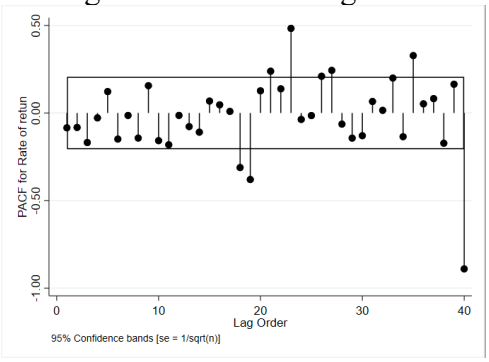

Figure 1 PACF Plot of SH stock rate of return data

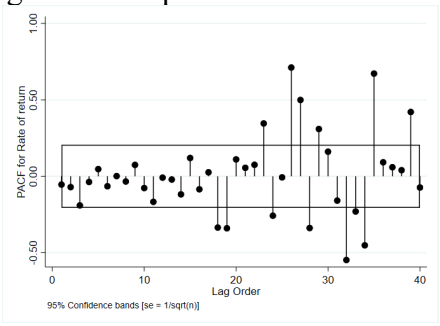

Figure 2 PACF of SZ stock rate of return data

The partial autocorrelation plot (PACF plot) of SH is shown in Figure 1. The black border is the benchmark to figure out the statistically significant term in the AR model. Lags 18 and 19 may cause a significant impact on the current data.

The autocorrelation plot of SZ is shown in Figure 2. The black border is the benchmark to figure out the statistically significant term in MA model. Unfortunately, there's no lag that may cause a significant impact on the current data because no lags go out of the benchmark.

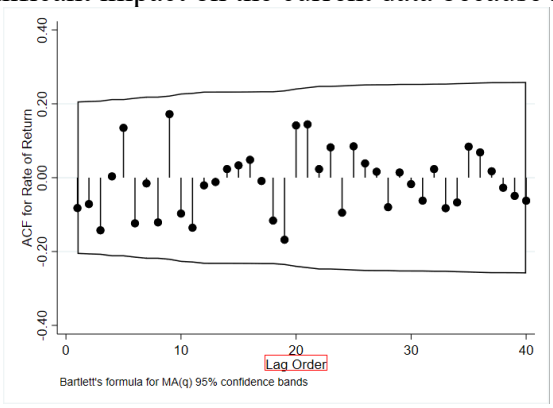

Figure 3 ACF of SH stock rate of return data

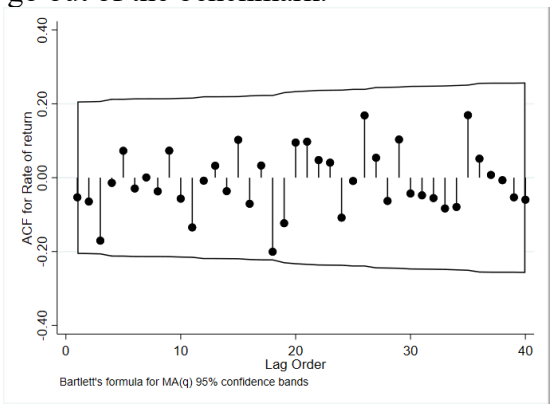

Figure 4 ACF of SZ stock rate of return data

The MA part of the series are determined by the autocorrelation plot (ACF plot). The autocorrelation plot of SH and SZ is shown in Figure 3. The black border is the benchmark to figure out the statistically significant term in MA model. There's no lag that may cause a significant impact on the current data because no lags go out of the benchmark.

3.2 ARMAX result

Table 2 ARMAX model test results. As can be seen from the estimation results in Column (2), the current crude oil futures rate of return is positively correlated with the Shenzhen Component index rate of return, and negatively correlated with the lagging crude oil futures rate of return, with coefficients of 0.0798 and -0.0918 respectively, both significant at the level of 5%.

Column (3) and the Yield of Shanghai Composite Index have similar estimation results. And an important feature is that the negative coefficient is larger than the positive coefficient in absolute terms, which explains the relationship between the rise in futures oil prices and the short-term decline in The Chinese stock market from a dynamic perspective.

Table 2 ARMAX model

Variables	SZ index			SH index		
	(1)	(2)	(3)	(4)	(5)	(6)
			WTI			
T=0	-0.0099	0.0798**	0.0775*	-0.0069	0.0797**	0.0786**
	(0.0103)	(0.0397)	(0.0039)	(0.0086)	(0.0307)	(0.0331)
T=-1		-0.0918**	-0.1734***		-0.0885***	-0.1110**
		(0.0406)	(0.0595)		(0.0297)	(0.0487)
T=-2			0.0851**			0.0239
			(0.0349)			(0.0275)
			AR			
T=-18	-0.1537	-0.1721	-0.2009	-0.2424**	-0.2834**	-0.2842**
	(0.1134)	(0.1242)	(0.1309)	(0.1219)	(0.1349)	(0.1424)
Constant	0.0418	0.0507	0.0457	0.0297	0.0374	0.0363
	(0.0470)	(0.0449)	(0.0430)	(0.0394)	(0.0355)	(0.0363)

Note: The numbers in brackets are standard error, and all model estimates in this paper are reserved to four decimal places

3.3 ARMA-GARCH estimation

Table 3 ARMA-GARCH model, variance equation

Variables	SZ			SH		
	(1)	(2)	(3)	(4)	(5)	(6)
WTI, T=0	3.6256***	-7.6940	-4.8600	3.2246**	-3.5253	-4.1830
	(1.2846)	（9.9812)	（5.4938)	（1.4715)	(6.065)	（7.4196)
WTI, T=-1		11.5250	8.0231		7.0865	5.009
		（8.7446)	（10.4302)		(6.0755)	（10.9076)
WTI, T=-2			0.5661			2.5938
			（7.2322)			（6.0672)
Constant	-25.1648	-27.4473***	-25.2354***	-24.0358***	-24.70709***	-24.6839***
	（5.8472)	（7.7158)	（6.0354)	（6.5625)	(5.6947)	（6.4915)

The results of column (1) and Column (6) show that the current futures crude oil price also has a significant impact on the fluctuation of Shenzhen and Shanghai stock Exchanges. This result is in line with reality. There is a huge decline in both Shanghai and Shenzhen indexes. This decline may cause by the panic of investors. When researchers look at the stock market, it's necessary for them to also take a look at the futures market.

4. Discussion

According to the result, there's a connection between Crude Oil price and Chinese stock indices. When experiencing such external impact, what can government do? What policy can the government make?

The OECD's latest simulations suggest that, under a given scenario, global GDP growth could be more than 1 percentage point lower in the year following the start of the conflict and global inflation could be nearly 2.5 percentage points higher [10]. Price shocks also bear the greatest burden on the vulnerable in advanced economies and on the general population of developing countries, especially the least developed countries, because these poor people and their families spend a higher proportion of their food and fuel costs. Rising prices have also made the global macroeconomic situation more uncertain and volatile, with many countries either raising interest rates or preparing to do so, putting their economies in danger of contracting. For developing countries, historically high debt burdens, the ongoing impact of COVID-19, and commodity price shocks will significantly increase the risk of a balance of payments deterioration, exchange rate depreciation, and debt crises [11].

Should there be tax breaks for manufacturing to reduce costs and avoid pushing up domestic prices?

This could be one solution to reduce investor panic. What should consider is will manufacturing costs increase. Crude oil not only turns into gasoline but also becomes the raw materials needed for manufacturing. As a result, with the increase in the price of crude oil, the manufacturing cost will also increase. In that case, to reduce cost, and reduce panic, it is appropriate to carry out the tax breaks.

Should oil reserves be used to supply the market in the short term? The question is, does China lack Crude Oil? Although Russia suffered from the most severe sanctions in history, China and Russia's strategic partnership remains strong. Additionally, China and Russia used sign the crude oil contract, which indices China imports crude oil from Russia. However, Russia's crude oil cannot fulfill the demand of China, China has to import from other countries at a high price, which may cause an increase in manufacturing costs. Even though China has to pay more money for crude oil in a short period, is it worth dipping into China's oil reserves? This requires more research to find out.

Further research can be done based on the following points: first, more data can be added to this research such as the crude oil price, Shenzhen Component index, Shanghai Component index during the Ukraine crisis in 2014, or the oil crisis. Second, when having a GARCH model, the ARMAX

model can be improved with the same GARCH model to be more precise in the analysis of stock price or rate of return.

5. Conclusion

Russia and Ukraine's conflict changes the world. During this period the price of crude oil price increased like a skyrocket, while the price of Shenzhen Component index and Shanghai Component index go downhill. This paper researches the fluctuation of international crude oil prices and the dynamic change of the Chinese stock index, based on the background of the Russia and Ukraine conflict. This paper focuses on the stock rate of return based on the situation of the Ukraine crisis and does further research on their volatility.

This paper finds that SH and SZ stock's rates of return are influenced by the past. Also, according to the ACF plot, no lags will cause a significant impact, as a result, MA in the ARMAX test is discarded, while the PACF test shows that in both Shenzhen and Shanghai, their lags of 18 may have a significant impact on the current data, so AR is still using.

The ARMAX model finds that the current crude oil futures rate of return is positively correlated with the Shenzhen Component index rate of return and Shanghai Component index rate of return.

The ARMA-GARCH model finds that based on the chosen time series, the crude oil price will influence the fluctuation of Shenzhen and Shanghai stock exchanges.

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