Empirical Analysis of the Impact of International Crude Oil Price Fluctuation on China's Stock Market

Yicheng Chen*
Nanjing University of Science and Technology, No. 200 Xiaolingwei, Xuanwu District, Nanjing City, Jiangsu Province, China

*Corresponding author. Email: yicheng0920@outlook.com

Abstract. The price of oil, known as "black gold", has always attracted the attention of countries around the world. It is already a consensus that international oil prices affect economic operations, and naturally will affect the stock market which is regarded as a barometer of economic operations. The purpose of writing this article is to reveal the impact of international crude oil price fluctuations on China's stock market. In order to solve this problem, the author of this paper selected two sets of time series of Brent crude oil spot price and Shanghai Stock Index, and used Eviews software to perform various econometric tests such as cointegration test, Granger causality test, impulse response function, and decomposition of variance. It is found that there is a long-term stable cointegration relationship between the international oil price and the Shanghai Stock Index, and that the international oil price is the Granger cause of the Shanghai Stock Index. Furthermore, the former has a positive dynamic impact on the latter as a whole. It reached its maximum by the middle of the third month, and then slowly decreased to stabilize. Compared with the results of other similar studies, this article draws more accurate conclusions thanks to the latest, more realistic data without much artificial processing. The conclusions of this paper can help stock investors and economic decision makers to make more effective decisions.

Keywords: international oil prices, the Shanghai composite index, VAR model.

1. Introduction
With the rapid development of industrialization and the increasingly close global economic relations due to economic globalization, the impact of oil and its price fluctuations will spread to the whole world. The impact of the three oil crises in the history of the world on Western developed countries is obvious. As a matter of fact, the United States, Britain, Europe, Japan and other countries were affected by the oil crisis and their economies were in recession, inflation was severe, and industrial development was hampered. For our country, China has developed from a net exporter of crude oil to a net importer of crude oil, and its crude oil imports have increased year after year. The dependence on imported crude oil has become stronger and stronger, and the impact of international oil price shocks on China has become increasingly significant. Therefore, it is particularly important to understand the impact of international oil prices on the stock market.

Stock market behavior research is the most representative of financial market research topics. Studying the impact of international oil price fluctuations on Chinese stock markets will help in-depth
research on the impact of international oil price fluctuations on financial markets. Most of the existing researches are earlier and have certain limitations in advancing with the times. In addition, there are few literatures that directly study the impact of international oil prices on China's stock market. Time span is long, select the latest data, strive to be comprehensive and accurate, and make a small contribution to the theoretical research of this problem.

Research on the impact of international oil prices on the stock market is conducive to revealing the impact of international oil prices on China's stock market, clarifying the relationship between the two, and better grasping and responding to the impact of international oil price fluctuations in the practice of economic operations, and for policymakers Economic participants provide clearer decision-making references.

2. Empirical analysis

2.1. Model description
The model background on which this paper's empirical analysis relies is VAR. This article has only two variables, so this article uses a two-variable VAR model. Based on the VAR model, this paper uses the unit root test, co-integration test, Granger causality test, impulse response function test, and variance decomposition to analyze. The lag period is automatically selected by Eviews software according to SIC.

2.2. Variable selection and data source
Brent crude is a light, low-sulfur crude produced in the Brent and Ninian oil fields in the North Sea and is widely traded in the futures, OTC swaps, forward and spot cash markets. Now more than 65% of the world's commodity crude oil relies on the Brent system as a benchmark for pricing, and it is the crude oil consumed by most countries and regions around the world. And Brent crude oil price statistics are more comprehensive. Therefore, this article selects Brent crude oil to represent the international oil price, represented by OP. The time span is from December 1990 to January 2020, and the data frequency is monthly data, with a total of 350 data. Data downloaded from the US Energy Information Administration.

As China's financial center, Shanghai has a more developed and perfect capital market. The Shanghai Stock Exchange was established earlier, and its listed companies are also larger. It has more types of listed securities and a larger total market value than Shenzhen Stock Exchange, and more market capitalization. So this article takes the Shanghai Stock Exchange as the representative of the Chinese stock market. The Shanghai Stock Index (000001), also called the Shanghai Stock Exchange Composite Index, is the earliest issued stock index. It is a weighted comprehensive stock price index based on all stocks listed on the Shanghai Stock Exchange. Therefore, this article selects the Shanghai Stock Index (000001) to represent the Chinese stock market, represented by SZ. The time span is from December 1990 to January 2020. The data frequency is monthly data, with a total of 350 data. Data downloaded from Sohu Securities. In addition, D (OP) and D (SZ) represent the first-order difference of the two time series of international oil price and Shanghai Stock Index respectively.
2.3. Historical comparison of fluctuations in international oil prices and Shanghai stock index

Comparing the historical trends of international oil prices and the Shanghai Stock Exchange Index, we can find that from 2000 to 2006, international oil prices rose while the Shanghai Stock Exchange Index fell; from 2014 to 2015, international oil prices fell and the Shanghai Stock Exchange Index rose. In these two time periods, the trends of international oil prices and the Shanghai Stock Exchange Index are opposite. In addition, from 2010 to 2014, international oil prices operated at a high level, while the battlefield index operated at a low level. The above three time periods confirm a research conclusion of many scholars, that is, a traditional view that has dominated for a long time: "the rise in international oil prices inhibits economic growth". In some other time periods, such as from 2006 to 2008 and after 2016, international oil prices and the Shanghai Stock Exchange Index showed the same increase and decrease. The above empirical observations show that the impact of international oil prices on the Shanghai Stock Exchange Index is not constant, nor is it a simple positive and negative correlation, but it changes over time. The following specifically analyzes the relationship between the two from the perspective of empirical quantification.

2.4. Unit root stationarity test
The first step of the empirical analysis is to test the unit root stability of the two sets of time series of international oil prices and the Shanghai Stock Exchange Index and make it operate smoothly. The ADF test is used here. If there is a unit root, the sequence is a non-stationary time series. If there is no unit
The null hypothesis is that there is a unit root for each sequence. The software automatically selects the lag time as 1 according to the SIC information criteria. The following table shows the unit root test results:

**Table 1. Unit root test of international oil prices and Shanghai Stock Index.**

| Series   | OP value | D(OP) value | SZ value | D(SZ) value |
|----------|----------|-------------|----------|-------------|
| P value  | 0.2860   | 1.487e-24   | 0.2424   | 8.045e-20   |
| Conclusion | p>0.05, unstable | p<0.05, stable | p>0.05, unstable | p<0.05, stable |

The above table shows that the original international oil price series is a non-stationary time series, and the first-order difference of the international oil price series D (OP) is a stable time series, so the international oil price time series is a first-order single integer series. Similarly, the original Shanghai Stock Index series is also a non-stationary time series. The first-order difference of the Shanghai Stock Index series D (SZ) is a stable time series, and the Shanghai Stock Index is also a first-order single integer order. Therefore, the next co-integration test can be carried out.

### 2.5. Cointegration test

Feature root trace test, as one of the methods of cointegration test, is a joint saliency test with higher reliability. Therefore, feature root trace test is used directly here.

**Table 2. Cointegration test.**

| Hypothesized No. of CE(s) | Trace Statistic | Critical Value | P value | Conclusion |
|---------------------------|-----------------|----------------|---------|------------|
| None *                    | 16.69283        | 15.49471       | 0.0329  | Refuse     |
| At most 1                 | 2.660679        | 3.841466       | 0.1029  | can not Refuse |

From the above results, we can see that the international oil price and the Shanghai Stock Exchange Index have a long-term stable co-integration relationship, that is, they have a stable long-term equilibrium relationship.

### 2.6. Granger causality test

This test determines whether one time series has a predictive relationship to the other. Although Granger causality is not equal to actual causality, it also has certain reference value. Because in economics, the Granger causality in the statistical sense is also meaningful and can still play a role in economic forecasting. The Granger causality test requires that the sequence is a stable time series, so the international oil price and Shanghai Stock Index series after the first-order difference are used to perform the Granger causality test. Confidence was chosen as 0.05 and the lag time was 2.

**Table 3. Granger causality test.**

| Null Hypothesis                                | F-Statistic | P value | Conclusion |
|-------------------------------------------------|-------------|---------|------------|
| D(SZ) does not Granger Cause D(OP)              | 1.42930     | 0.2409  | P>0.05, Can not Refuse |
| D(OP) does not Granger Cause D(SZ)              | 6.10727     | 0.0025  | P<0.05, Refuse |

According to the results in the table above, the Shanghai Stock Index cannot be considered as the Granger cause of international oil prices, but the international oil price can be considered as the Granger cause of the Shanghai Stock Index, that is, changes in international oil prices will affect the changes in the Shanghai Stock Index to some extent. Oil prices have a predictive effect on the Shanghai Stock Index. A test with an appropriately increased lag also showed the same result.
2.7. Impulse response function

Both the impulse response function and the variance decomposition require the VAR system to be stable. Therefore, the unit root test is used to verify the stability of the VAR system, and then the impulse response function analysis and variance decomposition analysis are performed.

Figure 3. Unit root test of VAR system.

Figure 4. Impulse response function curve.

Figure 3 is the result of checking the stability of the VAR system using the AR unit root method. It can be seen that the AR roots of the VAR system constructed with the original sequence are located in the unit circle, that is, the VAR system is stable, so the following impulse response analysis and variance decomposition analysis can be performed with the two original time series.

Figure 4 is a graph of the impulse response function of Shanghai Stock Index to international oil prices. The vertical axis measures the magnitude of the impact of the Shanghai Stock Index on international oil price shocks, and the horizontal axis represents the time after a shock. It can be seen from the graph that the impact of a standard deviation of international oil prices has a positive impact on the Shanghai Stock Exchange Index as a whole. The impact began to appear and became larger about half a month later, reaching the maximum in the middle of the third month. After that, it slowly decreases and stabilizes.

2.8. Variance decomposition

Table 4. Variance decomposition results.

| Period | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|--------|---|---|---|---|---|---|---|---|---|----|
| Contrib | 0.053 | 0.623 | 1.036 | 1.27 | 1.401 | 1.460 | 1.479 | 1.474 | 1.454 | 1.425 |
Table 4 is a table of the variance decomposition results of the international oil price against the Shanghai Stock Index. It can be seen from the table that the contribution of international oil prices to the variance of the Shanghai Stock Index unit gradually increased from 0.053% in the first period, to a maximum of 1.479% in the seventh period, and then gradually decreased and stabilized. The tenth issue still has a contribution of 1.425%.

3. Summary
Based on the monthly data of Brent crude oil spot price and Shanghai Stock Index from December 1990 to January 2020, this paper studies the impact of international oil prices on China's stock market and draws the following conclusions: First, both international oil prices and Shanghai Stock Index are first-order single-integrated time series. There is a co-integration relationship between the two, that is, international oil prices and the Shanghai Stock Exchange Index are not independent of each other, but have a long-term equilibrium relationship; Second, the Granger causality test shows that international oil prices are The Granger reason for the Shanghai Stock Index, which means that changes in international oil prices have some predictive effect on changes in the Shanghai Stock Index; Third, the impulse response function curve reveals that the global oil price has a positive dynamic impact on the Shanghai Stock Index as a whole. It started and gradually increased after half a month, and reached its peak in the middle of the third month, and then slowly decreased to stabilize; Fourth, the variance decomposition revealed the contribution of international oil prices to the fluctuation of the Shanghai Stock Exchange Index from the perspective of the contribution rate of unit variance change. This contribution gradually increased over time, reaching a maximum of 1.479% in the seventh period, and then slowly decreased. At this point, the quantitative analysis of the impact of international oil prices on the Shanghai Stock Index has ended.

Acknowledgement
This research is supported by data from the U.S. Energy Information Administration and Sohu Securities websites.

References
[1] K. Larsson, M. Nossman, Jumps and Stochastic Volatility in Oil Prices: Time Series Evidence, J. Energy Economics. 33 (2011) 504-514.
[2] Y. H. Lee, Kaneko, Takashi, Oil Sensitivity and Its Asymmetric Impact on the Stock Market, J. Energy. 36(2011)168-174.
[3] A. Fayyad, K. Daly, The Impact of Oil Price Shocks on Stock Market Returns: Comparing GCC Countries with the UK and USA, J. Emerg Mark Rev. 12(2011)61-78.
[4] Syed A. Basher, Perry Sadorsky, Oil price risk and emerging stock markets, J. Global Finance Journal. 2 (2006).
[5] Information on https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rbrte&f=m
[6] Information on http://q.stock.sohu.com/zs/000001/lshq.shtml