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The Linkage Effect of the International Crude Oil Market on the Chinese Stock Market

Xia Li[1, a]

[1]School of Management, Shanghai University, Shanghai 200444, China.

[a]lixia_2018@126.com

Abstract

China's oil resources are scarce and highly dependent on the international crude oil market. There are many uncertain factors in the international crude oil market, and the fluctuation of its price will affect the stock price. The stock market is called the "barometer" of a country's macroeconomics. Therefore, studying the dynamic correlation between changes in crude oil prices and China's stock market is an urgent issue. This paper uses the DCC-GARCH model to study their correlation. It was found that the correlation between international crude oil prices and the Shanghai Composite Index changed over time, and the correlation increased significantly during the crisis, and was generally positive. Therefore, the following countermeasures are proposed. First, stock investors should pay close attention to changes in international oil prices and make corresponding countermeasures in advance; second, China should increase oil reserves to deal with the impact of the oil crisis on the domestic economy.

Keywords

Crude oil market, stock market, DCC-GARCH.

1. INTRODUCTION

Crude oil is a basic energy and chemical raw material. It has both the attributes of production factors and consumer goods. It is known as the "blood of modern industry". The rise and development of modern industry cannot be separated from petroleum, which promotes industrial development. In addition, oil can also avoid currency depreciation and inflation risks, and oil has become more and more important. Therefore, oil plays an important role in a country's political, economic, and military fields. In recent years, global oil consumption has increased day by day, making the environment of the international oil market more and more complicated. The uncertainty of the oil market have been increased by political factors in the Middle East, the outbreak of the financial crisis, production control and natural disasters.

Crude oil is a commodity and is often regarded as an investment substitute for virtual capital. Its investors are distributed all over the world. The crude oil market plays an important role in information transmission and price discovery. In the economic and financial fields, stocks are known as the "barometer" of the development of the market economy, that is, under the premise that the market is effective, the stock market plays the role of market economy forecasting. Stock price is also an important information variable in economic and financial research. Therefore, there should be a close correlation between oil prices and the stock market. Therefore, exploring the dynamic correlation between crude oil prices and stock market returns will help regulators improve regulatory efficiency. At the same time, for investors, it is possible to make timely response measures in advance according to changes in crude oil prices to avoid risks.

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This paper selects Brent crude oil prices and Shanghai Stock Exchange Index as the research objects to verify the dynamic correlation between the international crude oil market and the Chinese stock market. This article is divided into five section: section one is the introduction. The research background and significance are mainly written. Section two is a literature review. Section three is the theoretical method. The principle of the DCC-GARCH model is introduced. Section four is the empirical results and analysis. This part takes Brent crude oil prices and Shanghai Composite Index as the research objects, and estimates their correlation by using DCC-GARCH modeling. Section five is the conclusion and countermeasures.

2. LITERATURE REVIEW

Ciner (2001) tested the non-linear correlation between crude oil prices and the US stock market by means of causality testing[1]. Agren (2006) established GARCH-BEKK, analyzed oil futures contracts and the stock market yields of five countries, and found that oil prices had a significant impact on stock prices in most countries[2]. Mohanty (2010) explored the relationship between oil prices in Central and Eastern European countries and the stock returns of oil and gas companies[3]. The study found that there was no significant relationship between 1998 and 2010. Through empirical analysis, it is found that the relationship between oil prices and oil and natural gas companies changes over time. Vo (2011) uses a multivariate stochastic volatility structure to study the relationship between stock volatility and the oil futures market[4]. The study found that these two markets are interrelated, and when the market fluctuates greatly, the dynamic correlation will increase. Aloui (2013) used the Copula method to provide evidence of contagion effects between oil and the transition economies of Central and Eastern Europe (Slovenia, Hungary, Czech Republic, Romania, Poland, and Bulgaria)[5]. Balcilar (2014) used the Markov transform vector error correction model to examine the relationship between US crude oil and stock market prices and found that there was a high volatility before the Great Depression in 1929 and after the OPEC shock in 1973[6]. Du & He (2015) uses Granger causality risk method, value at risk (VaR) risk measurement and a core-based test to detect negative and positive risk spillover effects[7]. The results show that there is a significant risk spillover effect between the considered markets. Ding (2016) studied the causal relationship between WTI and Dubai crude oil yield and five other stock markets (the United States, China, Hong Kong, South Korea, and Japan)[8]. They found that there is Granger causality between the Nikkei and Hang Seng Indexes and WTI returns. Lu (2016) uses a time-varying coefficient vector autoregressive (VAR) model to study the relationship between WTI crude oil and the US S&P 500 stock index[9]. The results of the study found that the causal relationship between oil and the U.S. stock market changes over time and the characteristics are more complex.

3. METHODOLOGY

Engel proposed the ARCH model, which makes the second assumption of time series variables in traditional econometrics—the problem of homoscedasticity is well resolved. The ARCH model can be used to study volatility. The core idea of ARCH is: the variance of the random interference term μ at time t is related to the error square of the interference term before time t. But the ARCH model requires a lot of lag periods to get a better fitting effect. In this way, many parameters need to be estimated when using this model, which leads to a decrease in accuracy. In order to improve accuracy, Bollerslev proposed the GARCH model. That is, the generalized autoregressive conditional heteroscedasticity model can better predict the volatility of the rate of return. The core idea of the GARCH model is to replace the lag value of the square of many random interference terms with the lag value of the variance of one or two random interference terms. The basic expression of GARCH(q,p) model is:

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$$y_t = x_t{}^T\beta + \mu_t, \mu_t \sim (0, \sigma_t^2) \quad (1)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1\mu_{t-1}^2 + \gamma\sigma_{t-1}^2 \quad (2)$$

In practical applications, people pay more attention to the correlation between the volatility of assets, but the GARCH model can only describe a single asset volatility. Later, scholars proposed the CCC-GARCH model, in which the correlation coefficient of the return rates between different assets is constant. However, Engel believes that the correlation coefficient between variables changes with time. In 2002, he proposed a dynamic conditional correlation model which is called DCC-GARCH model. DCC-GARCH model can accurately reveal that the correlation between financial asset variables changes with time. Assuming that the vector r_t composed of crude oil yield and stock yield sequence obeys a conditional normal distribution, that is, $r_t|I_{t-1} \sim N(0, H_t)$, where I_{t-1} is the information set that can be collected at time t; H_t is the conditional covariance matrix, which satisfies: $H_t = D_t R_t D_t$, and $D_t = [diag(\sqrt{h_{it}})]$; h_{it} is estimated by univariate GARCH, which is the conditional variance, and the form is as follows:

$$h_{it} = \omega_i + \sum_{k=1}^{p} \alpha_{ik}\varepsilon_{i,t-k}^2 + \sum_{l=1}^{q} \beta_{il}h_{i,t-l} \quad (3)$$

R_t is time-varying correlation matrix:

$$R_t = \left[diag(Q_t)^{\frac{-1}{2}}\right] Q_t \left[diag(Q_t)^{\frac{-1}{2}}\right] \quad (4)$$

Q_t is symmetric positive definite correlation matrix:

$$Q_t = (1 - a - b)s + a(z_{t-1}z_{t-1}') + bQ_{t-1} \quad (5)$$

$z_t = D_t^{-1}r_t$ is standardized residuals, s is unconditional correlation matrix of z_t; a, b is non-negative parameters, satisfies $a + b < 1$. So:

$$R_t = \rho_{ij,t} = q_{ij,t}/\sqrt{q_{it,t}q_{jj,t}}, \ i,j = 1,2,\cdots,k \quad (6)$$

4. EMPIRICAL RESULTS

The international oil price selected in this paper is Brent Spot Price FOB, which is the spot price of European Brent crude oil. Brent crude oil is a kind of light, low-sulfur crude oil. Currently, more than 65% of global crude oil spot prices are priced according to the Brent system. Crude oil price data comes from U.S Energy Information Administration. The sample uses 15-year weekly data as the research benchmark, and selects the Shanghai Composite Index return data from January 3, 2003 to March 30, 2018. Both the crude oil price and the yield of the Shanghai Composite Index are calculated based on the weekly yield. The descriptive statistics and tests of the main variables are as follows:

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Table 1. Descriptive statistics and testing of main variables

Measured variable	Stock market return	P value	Oil market return	P value
Maximum	0.150		0.200	
Minimum	-0.138		-0.179	
Standard Deviation	0.035		0.041	
Mean	0.002		0.001	
JB	145.954	0.0010	168.577	0.0010
LQ1	31.014	0.0011	46.026	0.0000
LQ5	14.076	0.0151	33.808	0.0000
LQ1^2	16.153	0.0001	42.821	0.0000
LQ5^2	88.304	0.0000	128.051	0.0000
PP	-26.115	0.0010	-22.405	0.0010
ADF	-13.520	0.0010	-13.459	0.0010

Use MATLAB R2014a to estimate the correlation coefficient. Table 3 shows the values of a and b in the DCC-GARCH model in the third section. It can be found that it is significantly positive, indicating that the use of the DCC model is reasonable.

Table 2. Parameters of DCC model

Measured variable	Coefficient of Brent and Shanghai Composite Index	P value
lambda1	.0178984	0.030
lambda2	.9657924	0.000

The picture below shows the correlation coefficient between Brent crude oil and the Shanghai Composite Index:

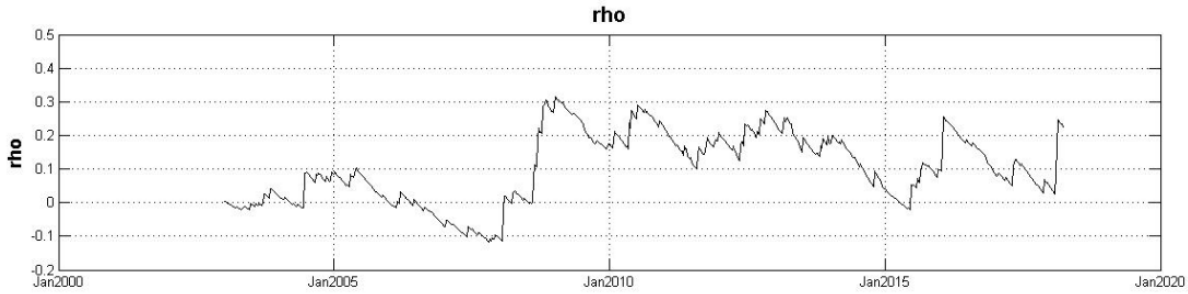

Fig 1. Correlation coefficient between Brent crude oil and Shanghai Composite Index

According to the image, it can be seen that the correlation coefficient of Brent crude oil and the Shanghai Composite Index are highly consistent. The correlation coefficient fluctuated around a relatively low positive correlation level from 2003 to 2006. After that, before the outbreak of the financial crisis in 2007, the correlation coefficient between the two had a low negative correlation. This shows that the correlation between oil and stock returns was weak before the financial crisis. After that, the spreading subprime mortgage crisis caused the economy to continue to decline, the demand for oil decreased, and the price of crude oil dropped suddenly in a short period of time. In September 2008, Lehman Brothers declared bankruptcy

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as a symbol of the peak of the financial crisis. The DCC of crude oil and stock returns began to rise significantly, and the correlation coefficient reached its peak on November 14, 2008. As the economy continues to recover, the correlation coefficient begins to decrease. During the European debt crisis in 2012, the correlation coefficient increased slightly. From the end of 2014 to 2016, the price of crude oil fell from more than $100 to about $40 per barrel. At the same time, starting in June 2015, a stock market crash broke out in the Chinese stock market, and stock prices continued to fall. The correlation coefficient between oil and stock returns increased to an extreme value again at the beginning of 2016. The results of the DCC model show that there is an obvious relationship between changes in international crude oil prices and the rate of return in my country's stock market that changes over time. On the whole, there is a positive correlation between crude oil prices and Chinese stock market yield.

5. CONCLUSION

Use the DCC-GARCH model to establish the time-varying relationship between crude oil prices and stock index returns, and use its dynamic correlation coefficients to judge the impact of oil price changes on stock returns. Through empirical analysis of data from 2003 to 2018, it is found that the correlation coefficient between crude oil prices and stock index returns are as follows: (1) The dynamic correlation coefficients change with time and are "time-varying". (2) Before the crisis, the risk spillover effect and the correlation were low, and the price change of Brent crude oil had less impact on the domestic stock market. (3) During economic turmoil or financial crises, such as the financial crisis from 2008 to 2009, its relevance has increased, and the risk of oil price changes on stock index returns has also increased. With the increasing degree of financial and economic globalization, changes in international crude oil prices will have greater risk spillover effects on the stock market.

Therefore, the following countermeasures are proposed:(1) The international crude oil market is more sensitive to changes in the overall economic situation than the domestic stock market, especially during the crisis, and will be transmitted to the Chinese stock market through multiple channels. Therefore, domestic stock market investors should pay close attention to changes in international crude oil prices. (2) China is a net oil importer with huge imports and a high dependence on international crude oil. China should increase its oil reserves and stabilize the domestic stock market during the turbulent period of the international crude oil market.

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