Analysis of the Volatility Characteristics of International Oil Prices - Based on the Perspective of Major Events

Yingying An

School of Economics, Beijing Wuzi University, Beijing 101149, China.

Abstract: The peaks and troughs of previous oil price fluctuations are associated with some major events. In this paper, BP structural breakpoint test is conducted on the spot price of WTI crude oil during the sample period, and it is found that there are four structural breakpoints in the oil price series during the sample period, and then the sample is divided into five stages. By analyzing the five stages, it is found that the fluctuation period of WTI crude oil spot price is gradually shortened, and the amplitude is gradually increased.

Keywords: Oil Price Fluctuations; Major Events; BP Structural Breakpoint

1. Introduction

The major events related to oil contain multiple factors that affect the oil price, and the sudden events will always cause large fluctuations in the oil price. Xun Zhang et al. (2009), based on the structural breakpoint test and the constant return event analysis model, analyzed that the Iranian Revolution, the Gulf War and the Iraq War all had a significant impact on the trend of crude oil prices, and the Iranian Revolution and the Iraq War led to the structural breakpoint of oil prices[1]. Zavadska M et al. (2020) used the data before 2014 and the GARCH, TGARCH and OLS models, and found that supply and demand disruption events (Gulf War and 911 terrorist attacks in the United States) produced high volatility levels and peaks. Volatility during financial crises (the Asian Financial crisis and the 2008/09 global financial crisis) was more persistent[2]. In April 2020, crude oil prices turned negative for the first time in history, an unprecedented event that has prompted academics to study the impact of COVID-19 on oil price volatility. Devpura N et al. (2020) used hourly data for the first half of 2020 to control for multiple indicators of oil price volatility and found that daily increases in COVID-19 cases and deaths increased oil price volatility by 8% to 22%[3]. Tarek B et al. (2023) used the ARMA-Spline-GJR model to accurately assess the volatility of WTI crude oil during the COVID-19 pandemic, and found a strong correlation between the COVID-19 pandemic and historical events since 1986 through NIPALS algorithm and PLS-2 regression[4].

2. Oil price fluctuation stage division

Generally speaking, major events refer to those events that happen suddenly and have a major impact on social security operation or may have a major impact, such as wars, natural disasters, financial crises, epidemics and so on. Based on the research purpose of this paper, the major events in this paper mainly refer to those international major events that cause large fluctuations in oil prices. In different economic environments, events in different periods have different impacts on oil price fluctuations. Therefore, this paper will divide the stages of international oil price fluctuations according to the structural changes of oil prices, and analyze the characteristics of oil price fluctuations in different stages combined with major events.

2.1 Structural breakpoint check

Structural breakpoint test is mainly to determine the time point of structural transformation of time series. The longer the time span of samples used in time series, the greater the possibility of model parameters changing due to major events. After the structural change, the time series before and after the structural change point are regarded as the same trend to analyze, it will not be able to get an accurate conclusion. Identifying and testing the exact time of structural change will help to understand the driving factors of this change and assess the magnitude of the impact of this change (Wang Zhen, 2022)[5]. In this paper, the BP structural breakpoint test method is adopted (Bai and Perron, 2003)[6]. The basic principle is to compute multiple regression models with m breakpoints (or m+1) respectively:

$$
\begin{aligned}
y_t &= z_t^{'}\delta + x_t^{'}\beta_1 + \mu_t, t = 1,2,\cdots,T_1 \\
y_t &= z_t^{'}\delta + x_t^{'}\beta_2 + \mu_t, t = T_1 + 1,\cdots,T_2 \\
&\vdots \\
y_t &= z_t^{'}\delta + x_t^{'}\beta_{m+1} + \mu_t, t = T_m + 1,\cdots,T
\end{aligned} \tag{1}
$$

Where yt is the value of the dependent variable at time t, zt(p×1) and xt(q×1) are covariance vectors, δ and β are corresponding coefficient vectors, μt is the random disturbance term at time t, T is the total sample, the number of breakpoints and the breakpoint date are unknown, and by calculating the residual sum of squares between time series (SSR), The structural change of the horizontal term and the trend term occurs m times at the same time, and the structural break point can be obtained and the confidence test can be carried out by using BIC criterion to analyze the structure of the global minimization of the sum of residual squares.

2.2 Stage division

According to the results of the structural breakpoint test, the WTI spot oil price series during the sample period (January 2, 1986 to October 2, 2023) can be divided into five stages. and the major events in the stages are listed, as shown in Figure 1.

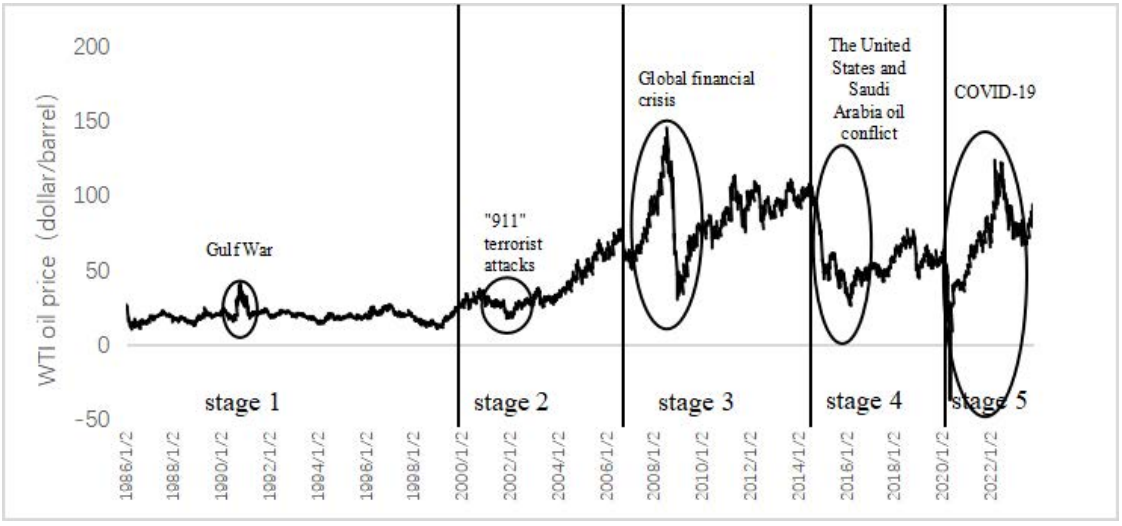

Figure 1 : Stage division and corresponding major events.

2.3 Volatility characteristics

(1986.1-1999.8) The oil price was in a stable stage. The mean value is 18.95 and the coefficient of variation is the smallest, indicating that the outliers are the least, but the amplitude (30.82) is still large, and the relative amplitude (amplitude/mean) is as high as 162.65%, because the Gulf War also occurred during this period, which made the oil price fluctuate and caused the third oil crisis in the world. The relative degree of volatility per unit time, that is, the intensity of the volatility, is only 4.71%, and in the long run, the trend of oil prices during this period has not changed.

(1999.8-2006.9) The oil price was in the rising stage. After the end of the Asian financial crisis, the volatility of oil prices was accompanied by the comprehensive and sustained growth of the global economy and continued to rise. But with the 9/11 terrorist attacks, oil prices fell sharply. The coefficient of variation (39.61%) is the largest, indicating that there are more outliers, and the amplitude (59.55) and relative amplitude (157.29%) are large. Because the oil price rose during this stage, the difference between the increase and the average value is large, but the volatility intensity per unit time (8.9%) is small, and the volatility is generally in line with the upward trend.

(2006.9-2014.9) Oil prices were in a period of sharp fluctuations. The mean value of oil price is 86.05, and the standard deviation and coefficient of variation are too large, indicating that there are more outliers in this stage. For example, the oil price in this stage peaked at 145.31 and soon fell to 30.28, resulting in an amplitude of 115.03. The existence of outliers in this stage mainly stems from the impact of the

global financial crisis on oil price volatility. The relative amplitude (133.68%) and volatility intensity (6.62%) are both low because of the rapid recovery in oil prices following the end of the international financial crisis.

(2014.9-2020.1) The fluctuation of oil price was in a relatively stable stage. The mean value of oil price is 54.36, the standard deviation and coefficient of variation are small, and there are few transaction values. At the end of 2014, the oil conflict between the United States and Saudi Arabia broke out, resulting in large amplitude and volatility of oil prices, but on the whole, the degree of deviation from the mean is small, and the oil price is relatively stable after falling.

(2020.1-2023.10) The fluctuation of oil price is in the stage of drastic fluctuation. The COVID-19 pandemic is having a major impact around the world. During this period, the average oil price was 69.39, but the standard deviation and coefficient of variation were large, and there were many outliers, resulting in negative oil price for the first time in history. The volatility intensity per unit time (24.7%) and relative amplitude (231.47%) are the highest in the five stages, and the fifth stage is the most volatile.

4. Conclusion

The fluctuation of the world oil price shows the trend that the change period is gradually shortened and the amplitude is gradually increased. The relationship between supply and demand is the fundamental factor affecting the fluctuation of international oil price. By intensifying the contradiction between oil supply and demand, major events make fundamental changes in the fundamentals of supply and demand, and then cause oil price fluctuations.

References

[1] Xun Zhang, Lean Yu, Jianqiang Li, Shouyang Wang. Impacts of major emergencies on crude oil prices [J]. Systems Engineering Theory and Practice,2009,29(03):10-15.

[2] Zavadska M,Morales L,Coughlan J. Brent crude oil prices volatility during major crises[J]. Finance Research Letters,2020,32.

[3] Devpura N , Narayan P K .Hourly oil price volatility: The role of COVID-19[J]. 2020.DOI:10.46557/001c.13683.

[4] Tarek B,Khaled G,Emilios G, et al. Crude oil prices in times of crisis: The role of Covid-19 and historical events[J]. International Review of Financial Analysis,2024,91.

[5] Wang Zhen, Wang Kai. Impact of war on structural changes of crude oil prices [J]. China Energy,202,44(03):6-13+18.

[6] Bai J,Perron P. Computation and analysis of multiple structural change models[J]. Journal Of Applied Econometrics, 2003,18:1-22.

About the author:

Yingying An (1997-), female, Han, Heze City, Shandong Province, postgraduate, financial metrology.