

# The Impact of Crude Oil Price Shocks on Bitcoin under the Russian–Ukrainian War

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**Abstract.** Nowadays, the Russian-Ukrainian war has been a hotly topic, and the war has shaken the global economy, especially in the international crude oil market. Also, as a popular financial instrument, the investors like to see Bitcoin as a hedging tool, but the problem of whether cryptocurrencies can hedge the volatility of commodity markets lacks a unified explanation. Therefore, the paper wants to find the relationship between Bitcoin and crude oil during the Russian-Ukrainian war. This paper uses data from Bitcoin, crude oil WTI futures, and crude oil Brent futures, and constructs the VAR model and ARMA-GARCH model based on these data. Ultimately, the article finds that the volatility of the international crude oil market only has little impact on Bitcoin. Thus, the investors do not need to worry about the high crude oil price caused by the war will affect Bitcoin's yield and volatility, so Bitcoin seems like a great hedging instrument against the shock of the international crude oil market.

**Keywords:** The Russia-Ukraine Conflict, Crude Oil Price, Bitcoin.

## 1. Introduction

Cryptocurrencies have continued to evolve for decades, and they have become important hedging, diversifying, and speculating financial instruments. Although the concept of cryptocurrencies was proposed at the end of the 20th century, cryptocurrencies only began to develop violently until Bitcoin was created in 2009. As of June 20, 2022, according to the data on the CoinMarketCap website, the total market value of Bitcoin has exceeded 900 billion dollars, and it has around 43% of the cryptocurrencies' market share. Furthermore, the data on STATISTA website shows that the number of Bitcoin wallet users increased dramatically after 2017, and reached above 81 million around the world in 2022. Thus, as the most mainstream cryptocurrency, the popularity and acceptability of Bitcoin seem to be high. However, unlike traditional fiat currencies, the majority of Bitcoin users see Bitcoin as an investment rather than a medium of exchange, which is totally different from Bitcoin's primal purpose [1]. In fact, the economists still have divergence on the existence of Bitcoin, because some economists think Bitcoin does not have intrinsic value and it could easily form an economic [2], but it seems unlikely to affect investors' interest in Bitcoin. Therefore, now that people like using Bitcoin as a financial instrument, then it is necessary to study its yield and volatility.

On February 24, 2022, Russia launched the war with Ukraine, and the world was shocked by the war. The occurrence of the Russian-Ukrainian war precursor, the trigger is that Ukraine wanted to join NATO regardless of Russia's opposition. Because Ukraine's land abuts Russia, its geographical location is really important to Russia. However, Ukraine has been courting NATO, which makes Russia uneasy. In order to prevent the eastward expansion of NATO, Russia and Ukraine turned from the conflict into war. The war not only hurt many innocent lives but also brought another crisis to the world economy after the COVID-19 pandemic. The war had a negative impact on the world's stock market, and this impact is likely to deepen as the war continues [3]. Global stock markets have suffered a slump since the outbreak of the Russian-Ukrainian war, panic makes the stock market volatile. On February 24, 2022, the Russian stock market once plunged 50%, and European stocks fell collectively at the open. Also, the situation of Russian stock will not be optimistic due to the sanctions imposed by European countries. In addition, the impact of the Russian-Ukrainian war on the commodity market is also significant, which has caused the oil price to soar. Russia is a major energy country, and it mainly produces and exports energy. In 2019, the vast majority of Russia's exports were energy products, with crude oil accounting for 30.3%, refined oil accounting for 16.3%,

and natural gas accounting for 6.46% [4]. Thus, Russia plays an important role in the world's energy market. However, due to the outbreak of the war and the sanctions imposed by European countries on Russia, the supply of oil decreases significantly, which causes oil prices to rise. Based on the data on investing.com website, the spot price of crude oil WTI is 111.2 dollars per bucket as of June 20, 2022. Compared to before the war, the spot price of crude oil WTI was 84.23 dollars per bucket on November 1, 2021, so the crude price of WTI has risen more than 30%. Thus, the outbreak of the war has kept the world's commodity and financial markets volatile, which trend to reduce global GDP growth and push up inflation [5].

The cryptocurrency market also suffered huge volatility during the Russian-Ukrainian war. Based on Yahoo finance website, the spot price of Bitcoin is 20599.54 dollars as of June 20, 2022, but the spot price of Bitcoin before the Russian-Ukrainian war was much higher than the present price. According to the same data of Bitcoin, the spot price of Bitcoin was 61004.41 dollars on November 1, 2021, so the price of Bitcoin has dropped more than 66% during this period. Then, it is hard to not link the reasons for the drop in Bitcoin price to the Russian-Ukrainian war. Furthermore, because the Russian-Ukrainian war has a serious impact on the oil market, it is necessary to study the correlation between oil and Bitcoin during the war. However, there is very little research about this area in the previous literature, so it is difficult to find the answer from the previous research. In order to add more research to this area, this paper wants to find that whether the volatility in the Bitcoin market is caused by the crude oil market during the Russian-Ukrainian war. Thus, the paper uses the VAR model and ARMA-GARCH model to investigate whether the changes in crude oil prices have an impact on Bitcoin's yields and volatility respectively. Because Bitcoin is an important and popular financial instrument for investors, so this study will be helpful for Bitcoin users.

The paper has 5 following sections totally, section 2 is the literature review, which shows the Bitcoin concepts from other economical scholars. Section 3 is the method, this part will present the model selections and the process of building models, including the VAR model and ARMA-GARCH model. The rest sections of the paper contain the result section, discussion section, and conclusion section.

## 2. Literature review

This paper provides an overview of some existing works of literature on Bitcoin. First, since Bitcoin has become a popular financial instrument, and is generally recognized by investors, so many economists have studied how Bitcoin price is formed. The price of Bitcoin is generally affected by the money supply, price level, investor interest, and government policies [6]. The formation of the Bitcoin extreme price is likely to be caused by demand shocks [7]. The long-term fundamentals may also affect Bitcoin's price [8]. In addition, the Bitcoin price is only affected by the stock market, oil, and exchange rate in the short run, it will not be affected in long run [9].

Second, as Bitcoin prompts the development of the entire cryptocurrency market, economists have different views on cryptocurrency with in-depth research. Some economical scholars believe that cryptocurrencies can help investors diversify the risk of the asset portfolio because cryptocurrencies have less correlation with other traditional commodities [10]. This opinion has been upheld by many economists since cryptocurrencies and gold have a similar feature, both can hedge the risk posed by extreme financial markets [11]. However, other economical scholars do not fully agree with the above opinions. The hedging feature of cryptocurrencies may not work in all financial markets, especially in undeveloped financial markets [12]. In addition, under the impact of cryptocurrency policy uncertainty, Bitcoin may have negative performance, and it cannot hedge risk [13].

### 3. Method

#### 3.1 Data sources

In order to check whether Bitcoin and crude oil are related, the construction of models in this paper is based on 3 time-series data, including the prices of WTI futures, Brent futures, and Bitcoin. Both data of WTI futures and Brent futures were downloaded from the investing.com website, and the investing.com website is one of the top three global finance websites in the world, so the two crude oil data are credible. Also, the data of Bitcoin was downloaded from the Yahoo finance website, and the Yahoo finance website is also trusted. The three data used in this paper are intercepted from three months before the Russian-Ukrainian war to the present (November 24, 2021, to May 27, 2022), because this paper wants to study whether the changes in crude oil prices caused by the war have an impact on the price of Bitcoin, so it is necessary to intercept the data before the war and the data after the war. Finally, the cleaned dataset contains 3 variables (the prices of WTI futures, Brent futures, and Bitcoin) and 133 observations (133 trading days). In addition, the yield of an asset refers to the logarithm of the yield in the following section.

#### 3.2 ADF-test

This paper uses time-series data, so it is important to check the stationarity of the data before budding the models. Otherwise, if the date is not stationary, the results reflected by the model are inaccurate and unreasonable. Thus, the paper uses the ADF test to check the stationarity of the prices and yield of Bitcoin, WTI futures, and Brent futures. Based on the ADF-test, the null hypothesis is that the data is not stationary, and the alternative hypothesis is that the data is stationary. Also, the p-value is the basis for judging which hypothesis is supported, there is evidence against the null hypothesis if the p-value is less than 0.05, otherwise.

**Table 1.** ADF-test.

| Price   |        |           |
|---------|--------|-----------|
| Bitcoin | -2.598 | 0.2807    |
| WTI     | -3.392 | 0.0524    |
| Brent   | -3.117 | 0.1022    |
| Yield   |        |           |
| Bitcoin | -7.415 | 0.0000*** |
| WTI     | -9.023 | 0.0000*** |
| Brent   | -8.876 | 0.0000*** |

Based on Table 1, the Bitcoin prices, WTI futures prices, and Brent prices are not stationary, because all the p-values are greater than 0.05, so there is no evidence to show that they are stationary. However, the Bitcoin yields, WTI futures yields, and Brent yields are stationary, all of them have a p-value which is less than 0.05. Therefore, in the following model-building section, it is necessary to use Bitcoin yields, WTI futures yields, and Brent yields as variables.

#### 3.3 Model construction: VAR

The first model constructed in this paper is the VAR model, it is a vector autoregressive model composed of multiple time-series variables. This model is mainly used for prediction based on multiple variables simultaneously, and it also detects dynamic dependencies between variables over time. Thus, it seems a good choice to use the VAR model to test the impact of crude oil prices on BTC yields, and the model should be 3 meta-model.

The VAR model specification is shown below:

$$y_t = \begin{pmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \gamma_{11} & \alpha_{11} \\ \beta_{21} & \gamma_{21} & \alpha_{21} \\ \beta_{31} & \gamma_{31} & \alpha_{31} \end{pmatrix} y_{t-1} + \cdots + \begin{pmatrix} \beta_{1k} & \gamma_{1k} & \alpha_{1k} \\ \beta_{2k} & \gamma_{2k} & \alpha_{2k} \\ \beta_{3k} & \gamma_{3k} & \alpha_{3k} \end{pmatrix} y_{t-k} + \epsilon_t \quad (1)$$

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \cdots + \Gamma_k y_{t-k} + \epsilon_t \quad (2)$$

Equation (1) and Equation (2) have the same meaning, and both are the equation of the VAR model. The only difference between the two equations is the formula expression, each coefficient is matrix form in Equation (1), but equation (2) uses  $\Gamma$  to represent the coefficient matrix. From the Equation (1) and Equation (2),  $y_t = \{y_{1t}, y_{2t}, y_{3t}\}$  is a vector that contains three time-series variables, including the yields of Bitcoin, WTI futures, and Brent futures. Also,  $\epsilon_t = \{\epsilon_{1t}, \epsilon_{2t}, \epsilon_{3t}\}$  is a vector of error terms, and  $k$  represents the time lag.

The following part is the impulse response function, which implies how much the other variables will change under the change of one unit disturbance of a certain variable over time. Thus, this model shows the positive or negative impact of crude oil price shock on Bitcoin yields. In this model, the WTI futures yield and Brent futures yield are impulse variables, and the Bitcoin yield is the response variable. The impulse response function is won below:

$$\frac{\partial y_{t+s}}{\partial \epsilon_t} = \psi_s \quad (3)$$

Equation (3) represents that when the error term  $\epsilon_t$  of a variable  $y$  increase one unit, how the value of another variable  $y$  will be affected at  $(t + s)$  period, under other variables and error terms remain fixed. In addition, in this model, WTI yield and Brent yield are impulse variables and Bitcoin is the response variable.

### 3.4 Model construction: ARMA-GARCH

The second model constructed in this paper is the ARMA-GARCH model, and it can predict the yield and volatility in financial models. Thus, this model can measure the volatility of Bitcoin under the crude oil price shock, and the WTI futures yields and Brent futures yields are exogenous variables. In theory, the ARMA-GARCH model can be decomposed into 2 parts, such as the ARMA model and the GARCH model.

ARMA model can predict Bitcoin's future yields based on Bitcoin's past yields and disturbances, and the ARMA (p, q) model specification is shown below:

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + \alpha_t - \sum_{i=1}^q \theta_i \alpha_{t-i} \quad (4)$$

In Equation (4),  $\alpha_t$  is white noise series and  $x_{t-i}$  is Bitcoin yields in  $(t - i)$ Th period. Also,  $p$  and  $q$  are non-negative integral orders of the AR and MA model respectively. Then, ARMA (p, q) model is constituted by AR (p) and MA (q) models.

In addition, the GARCH (p, q) model is used to predict the future volatility of Bitcoin, and the model specification is shown below:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \cdots + \alpha_p \epsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_q \sigma_{t-q}^2 \quad (5)$$

For Equation (5), the setup of the GARCH (p, q) model is based on the ARCH(p) model, and  $\alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \cdots + \alpha_p \epsilon_{t-p}^2$  is the equation of the ARCH(p) model, so GARCH is made up of the ARCH

model and the autoregression of  $\sigma_t^2$ . Also, the ARCH (p) model with high orders can be simplified as GARCH (1, 1).

Based on GARCH (1, 1), the model also adds other exogenous variables, such as WTI futures yields and Brent futures yields. The model specification is shown below:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \gamma_1 x_t + \gamma_2 x_{t-1} + \gamma_3 x_{t-2} \quad (6)$$

Based on Equation (6), it can examine the relationship between Bitcoin's volatility and crude oil price, and  $x_t$  represents the futures yield of WTI or Brent at time t.

## 4. Result

### 4.1 The result of the VAR model

The paper uses information criteria to find the order of the VAR model, including FPE, AIC, HQIC, and SBIC, they are good ways to select an optimal model. Then, the summary table of information criteria is shown below:

**Table 2.** VAR model identification.

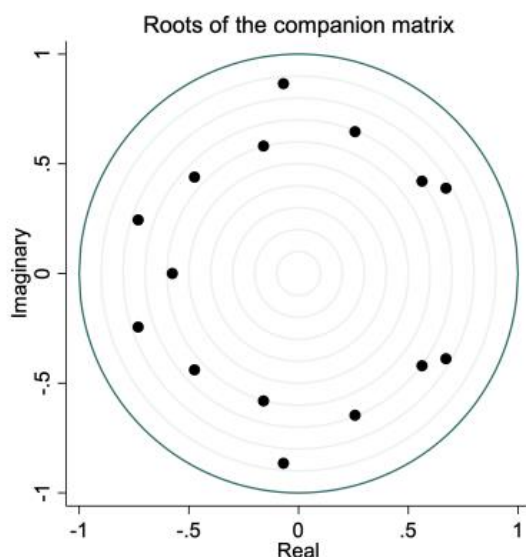
| Lag | LL       | LR       | df | p      | FPE      | AIC       | HQIC      | SBIC      |
|-----|----------|----------|----|--------|----------|-----------|-----------|-----------|
| 0   | 714.3810 |          |    |        | 1.4e-09  | -11.8564  | -11.8281  | -11.7867  |
| 1   | 769.8840 | 111.0100 | 9  | 0.0000 | 6.6e-10  | -12.6314  | -12.5182* | -12.3527* |
| 2   | 781.6680 | 23.5690  | 9  | 0.0050 | 6.3e-10  | -12.6778  | -12.4797  | -12.1900  |
| 3   | 790.3600 | 17.3820  | 9  | 0.0430 | 6.3e-10  | -12.6727  | -12.3897  | -11.9758  |
| 4   | 797.7260 | 14.7320  | 9  | 0.0990 | 6.5e-10  | -12.6454  | -12.2775  | -11.7359  |
| 5   | 808.9830 | 22.5140  | 9  | 0.0070 | 6.3e-10* | -12.6830* | -12.2302  | -11.5680  |
| 6   | 817.9560 | 17.9470* | 9  | 0.0360 | 6.3e-10  | -12.6826  | -12.1449  | -11.3585  |
| 7   | 823.2650 | 10.6180  | 9  | 0.3030 | 6.7e-10  | -12.6211  | -11.9985  | -11.0880  |
| 8   | 831.6760 | 16.8210  | 9  | 0.0520 | 6.8e-10  | -12.6113  | -11.9038  | -10.8691  |
| 9   | 836.2930 | 9.2334   | 9  | 0.4160 | 7.4e-10  | -12.5382  | -11.7458  | -10.5870  |
| 10  | 840.8730 | 9.1605   | 9  | 0.4230 | 8.0e-10  | -12.4645  | -11.5872  | -10.3042  |
| 11  | 845.7730 | 9.8013   | 9  | 0.3670 | 8.7e-10  | -12.3962  | -11.4340  | -10.0269  |
| 12  | 848.9970 | 6.4464   | 9  | 0.6950 | 9.7e-10  | -12.2999  | -11.2528  | -9.7215   |

As Table 2 shown, it is clear to see that FPE and AIC achieve a minimum value when the lag equals 5, and HQIC and SBIC achieve a minimum value when the lag equals 5. If the model is to predict future outcomes, then AIC is a better way to find the optimal model [14]. Based on the above information, this paper decides to order the VAR model according to AIC, so the order of the VAR model is set to 5.

After the order of the model is determined, it is also necessary to check the stationarity of the model. Based on Equation (2), given matrices  $\Gamma_1, \dots, \Gamma_k$ , the stationary of the VAR (k) model is testable. The companion matrix is:

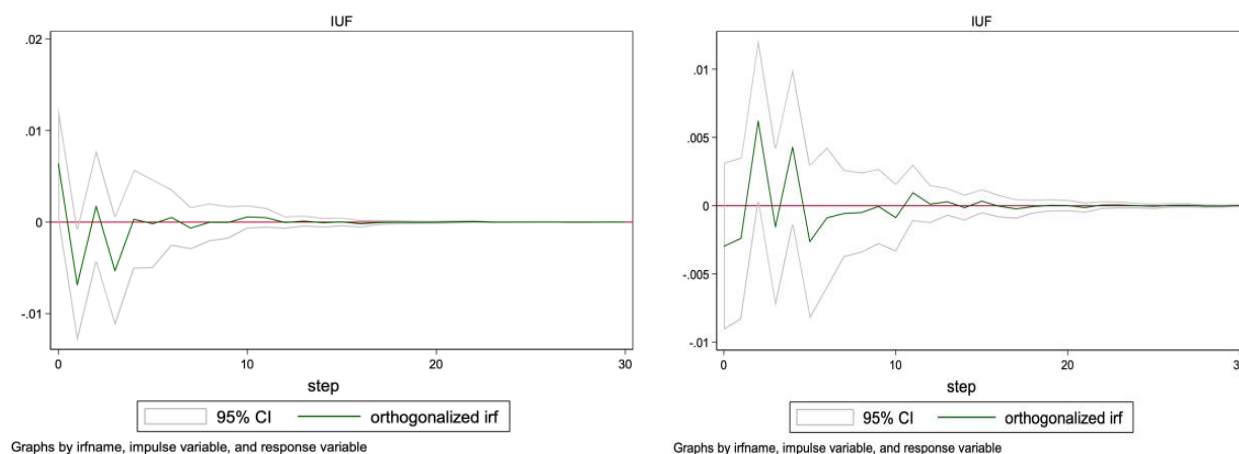
$$\Gamma(pk \times pk) = \begin{pmatrix} \Gamma_1 & \Gamma_2 & \Gamma_3 & \cdots & \Gamma_p \\ I_p & 0 & 0 & \cdots & 0 \\ 0 & I_p & 0 & \cdots & 0 \\ \vdots & \vdots & & \ddots & \vdots \\ 0 & 0 & I_p & \cdots & 0 \end{pmatrix} \quad (7)$$

If the roots of the companion matrix are inside the unit circle, then the VAR (k) model is stationary. According to Figure 1 below, all the points are inside the unit circle, so the VAR (5) model is stationary.



**Figure 1.** VAR stability.

Then, impulse response graphs can examine how crude oil price shocks affect Bitcoin yields, including short-run effects and long-run effects. Figure 2 contains two impulse response graphs, the impulse variable of the left graph is the WTI futures yields, the impulse variable of the right graph is the Brent futures yields, and the response variables are Bitcoin yields for both graphs. Thus, Figure 2 presents the correlation between WTI futures yields and Bitcoin yields and the correlation between Brent futures yields and Bitcoin yields respectively.



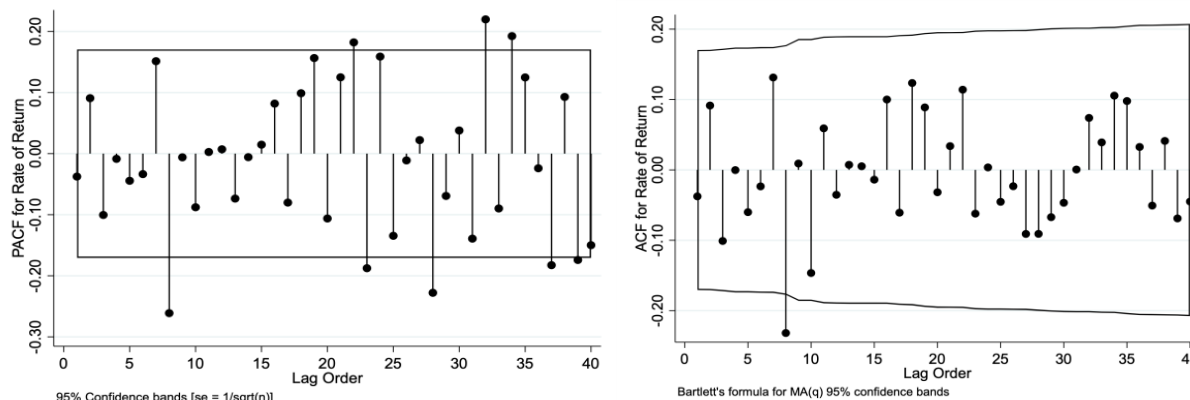
**Figure 2.** Impulse and response.

Therefore, based on Figure 2, the rise in crude oil prices due to the Russian-Ukrainian war

Seems to have a limited impact on Bitcoin yield. Specifically, the Bitcoin yield will shocks in the next 4 periods when the WTI futures yield increases by 1%, but the maximum amplitude is only about 0.05% and the shock gradually disappears after the 4th period. In addition, the Bitcoin yield will shock in the next 5 periods if the Brent futures yield increases by 1%, and the maximum amplitude is around 6%, but the shock gradually disappears after the 5th period.

## 4.2 The result of the ARMA-GARCH model

The orders of the AR (p) model and MA (q) should be founded first, and the paper applies PACF and ACF to order AR and MA models respectively.



**Figure 3.** PACF and ACF for ARMA identification.

The paper uses PACF to order the AR model, by comparing the partial autocorrelations with the boundary of a certain region, it can show that the partial correlation is zero. Because the autocorrelation of the first lag is significant, so the order of the AR model should be 8 according to the left graph of Figure 3. Also, the paper uses ACF to order the MA model, by comparing the complete autocorrelations with the boundary of the certain region, the orders of the MA model should be 8 according to the right graph in Figure 3. After that, combining the above information, the ARMA (8, 8) is constructed.

Table 3 is the summary table of the ARMA-GARCH model. Based on the estimated results of the variance function, the increase in international crude oil prices will not lead to an increase in the daily volatility of Bitcoin.

**Table 3.** ARMA-GARCH estimation results.

| Variables  | (1)                     | (2)                     | (3)                     | (4)                    | (5)                    | (6)                    |
|------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|------------------------|
| WTI        |                         |                         |                         |                        |                        |                        |
| T=0        | -16.5043***<br>(5.0478) | -17.8515***<br>(4.6863) | -15.7641***<br>(5.8321) |                        |                        |                        |
| T=-1       |                         | 8.8014<br>(9.1924)      | 2.7106<br>(7.2841)      |                        |                        |                        |
| T=-2       |                         |                         | 4.1298<br>(8.2583)      |                        |                        |                        |
| Brent      |                         |                         |                         |                        |                        |                        |
| T=0        |                         |                         |                         | -13.8127**<br>(6.5156) | -3.3661<br>(2.2634)    | -1.1924<br>(6.1744)    |
| T=-1       |                         |                         |                         |                        | -4.7103*<br>(2.6404)   | -6.3067<br>(7.2125)    |
| T=-2       |                         |                         |                         |                        |                        | 10.4741<br>(13.2058)   |
| GARCH      |                         |                         |                         |                        |                        |                        |
| ARCH (-1)  | 0.0582<br>(0.1035)      | 0.0595<br>(0.0839)      | 0.0687<br>(0.1047)      | 0.0343<br>(0.0846)     | -0.0348<br>(0.0420)    | -0.0097<br>(0.0580)    |
| GARCH (-1) | 0.2699<br>(0.2225)      | 0.3126<br>(0.1838)      | 0.3255<br>(0.2835)      | 0.4639<br>(0.3241)     | -0.3311<br>(0.7099)    | 0.5240<br>(0.5501)     |
| Constant   | -7.0842***<br>(0.3495)  | -7.2583***<br>(0.3609)  | -7.2407***<br>(0.4909)  | -7.3187***<br>(0.6481) | -6.2394***<br>(0.4929) | -7.3255***<br>(1.2528) |

## 5. Discussion

This article studies whether the shock of international crude oil prices will affect the yield and volatility of Bitcoin under the Russian-Ukrainian war. From the results of the VAR model and ARMA-GARCH model, it can be found that the impact of rising crude oil prices on Bitcoin is limited. The Bitcoin yield will only be affected to a small extent in the short-run and will not be affected in the long-run, the volatility of Bitcoin will not be greater. These results seem reasonable because many economical scholars also have similar research results. Based on the literature review section, the price of Bitcoin is mainly determined by investors' interest, related government policies, and inflation [6], and the demand and supply of Bitcoin are also important factors that affect bitcoin price [7]. However, few economists mention that the shock of traditional commodity prices will affect Bitcoin, the main reason is that the cryptocurrencies are less correlated with the traditional commodities [10]. Therefore, crude oil is a popular commodity, and its price shock hardly affects Bitcoin.

Now, the Russian-Ukrainian war is still going on, the war has had a huge impact on the crude oil market and the price of crude oil has risen sharply, which shocks the entire world's financial market. Because the investors like to use Bitcoin as a haven when the market is volatile, the result of this paper is important to the investors. Bitcoin users can dispel concerns about the impact of crude oil market volatility on Bitcoin, so Bitcoin seems like a great financial instrument to hedge the risk of the crude oil market under the Russian-Ukrainian war.

However, this article only discusses that the shock of crude oil does not have a direct impact on Bitcoin, but the article does not reflect the indirect impact. For example, higher crude oil prices will lead to higher inflation [15], but this paper does not examine whether the increase in inflation rate is the reason for the decline in Bitcoin price during the Russian-Ukrainian war period. Therefore, in future research, it is necessary to study whether the shock in the crude oil market has an indirect effect on Bitcoin.

## 6. Conclusion

In conclusion, the occurrence of the Russian-Ukrainian war was unexpected, which brings a great impact on the global commodity market, among which the most affected is the international crude oil market. Thus, it is necessary to study what financial instruments can effectively help investors to hedge the volatility of the international crude oil market.

This paper examines the connection between Bitcoin and crude oil under the Russian-Ukrainian war, and the paper uses the VAR model and ARMA-GARCH model to analyze the impact of crude oil price shock on the yield and volatility of Bitcoin. From the results, the paper finds that the increase in crude oil price only has limited impact on Bitcoin's yield and volatility, and this minimal impact only exists in the short run.

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