Changes in Bitcoin Prices under the Uncertain Market: An Analysis Based on Time Series Model

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Abstract. Today's society is full of uncertainty, especially during the outbreak of the Russian Ukrainian Conflict, oil prices have changed. This paper uses VAR model and ARMA-GARCHX model to figure out if the high price of oil due to the conflicts between Russia and Ukraine will lead to changes in the price of Bitcoin. Through the use of STATA, it is concluded that in an uncertain market, the price of Bitcoin will be affected by the rise in oil prices. This paper combines the Russian Ukrainian conflict, oil price and Bitcoin price, and uses relevant data to fill in the relevant theories of the impact of the Russian Ukrainian conflict. Therefore, in the process of consumer investment, investors should not only pay attention to the benefits of Bitcoin, but also pay attention to many shortcomings of this emerging virtual currency. Besides, supervisors should improve the stability in the Bitcoin market.

Keywords: Regional conflict, Bitcoin, Time series model.

1. Introduction

In 2014, Russia annexed Crimea, and since then, they've been attacking Ukraine in the east. On February 24, Russia attacked Ukraine without justification this year [1]. The conflict between Russia and Ukraine has had an impact on the availability of energy resources. This has made it difficult to produce energy in many parts of the world, including in countries that use fossil fuels to power their economies [2]. In this article, the author looks at how a political event affecting the crude oil price affects the Bitcoin price.

The stature of this paper is organized as follows: in Part 2, literature review is introduced, which includes relevant research on the causes and impacts of the Russia-Ukraine conflicts and how the Russia-Ukraine conflicts have brought about changes in Bitcoin Prices, concluding with a summary of the literature review. Then it is followed by Part 3, which uses certain data and images as an aid and focuses on the influence of the Russia Ukraine conflict on the oil industry and illustrates the impact of the Russia Ukraine conflict on how it influences the Bitcoin prices. After that, the fourth section will then conduct with a full discussion of the outcomes from the two models, as well as additional analysis on the oil price, volatility of yield, and the index of the oil. The outcomes in empirical analysis are used to show the impact of Bitcoin on risk, and finally to draw conclusions and make predictions and give feasible and innovative suggestions for the future development of the changes of Bitcoin.

2. Literature review

2.1. Geopolitics and Bitcoin

Geopolitics is a type of political geography that deals with the relationships between countries [3]. Geopolitical events include but are not limited to wars, conflicts and tensions between different countries and regions [4, 5]. Meanwhile, Bitcoin is different from traditional currency because it is not controlled by a central bank or financial institution. Instead, Bitcoin is calculated by network nodes [6]. Since Bitcoin was created, people have been concerned about its ability to avoid risks and its potential to hedge risk from geopolitical events [7].

High geopolitical risks are the result of geopolitical events, which often arouse people's panic [8]. Then, these events that happen make people think the future is not going to be as good as they thought it would be. Therefore, the investor's mood will decline when making a successful and effective investment [7]. As a result, people are demand more assets that have hedging capabilities, such as Bitcoin [9]. This growth in demand has led to a surge in Bitcoin prices. The rise in the price of Bitcoin when the world is uncertain. Therefore, when geopolitical events occur in the world, Bitcoin price will increase [10]. Therefore, Bitcoin is like a safe asset that investors can use to avoid risks related to global politics [7]. Anne et al. said that Bitcoin is a good way for risk-averse investors to reduce their chances of losing money if the market happens to go bad [11]. Bouoiyour, Selmi and Wohar decided that Bitcoin is a good choice to use as a safe haven against the risks posed by the 2016 US presidential election [12]. In addition, the rise in global energy costs has prevented miners from achieving balance, which has also reduced the supply of Bitcoin [13].

However, in the rebuttal, Yermack asserted that Bitcoin is useless in effective risk management, and its investors are extremely difficult to hedge the risks [14]. Besides, Baek and Elbeck support that the Bitcoin market have a lot of speculation and that it's not really good for hedging or investing [15].

2.2. Influencing factors of oil price

Meanwhile, the oil market is affected by the overall of the economy in different countries. and are also affected by geopolitical risks [16]. Besides, historically, the sharp change of oil price is usually caused by the impact of business cycle, economic and geopolitical uncertainty, and the convergence of technological change on oil supply and demand. It is well known that the War between Arab and Israeli in 1973, the September 11 terrorist attacks and other terrorist attacks around the world have greatly pushed up oil prices and led to structural disruption of macroeconomic and financial indicators. However, there is not much research on how geopolitical factors can affect oil prices [2]. Noguera-Santaella investigated the connection between armed conflict and domestic conflict and how that affects oil prices. He studied how events like the American Civil War, the Arab Spring, and other events have affected oil prices in the past [17]. According to research, geopolitical events (including wars and natural disasters) had a small but positive impact on oil prices before 2000, but they will have a more moderate impact in the future. At the same time, according to the study of Appiah-Otoo, the study found that the war between Russia and Ukraine has caused oil prices to go up, with the biggest impacts in the middle and upper ranges of oil prices. Additional, Russia is a major oil and gas producer, so it is important for countries in Europe to have access to these resources [2].

2.3. Oil and Bitcoin

A new study shows that Bitcoin has helped to reduce global uncertainty, which has made people interested in Bitcoin as an investment and a way to protect themselves from high levels of uncertainty [18]. As for Bitcoin's role in hedging energy risks, Bouri, Jalkh, Molnár and Roubaud evaluated Bitcoin's role to diversify your portfolio, or to use it as a haven in case of market volatility [19]. Besides, experts believe that as a hedge, the Bitcoin can be used to against fluctuations in the energy commodity index, but it is not a good option for buying non-energy commodities. As a store of value and a hedge against economic volatility, it seems that Bitcoin has more obvious influence than gold in its ability to resist the decline and fluctuation of oil price [20].

There is little literature on whether Bitcoin can hedge against changes in oil prices in geopolitical risks, VAR model and ARMA-GARCHX model was used in this article to investigate the impact of international crude oil price volatility caused by the Russia-Ukraine conflicts on the volatility of Bitcoin.

3. Research Design

3.1. Data source

The study extracted daily closing stock prices of WTI, Brent and the petroleum and petrochemical index from August 16, 2021, to November 24, 2022, from the Choice financial terminal. With the updated edited data, Stata was used to analyze the data and construct models for further exploration.

3.2. Unit Root test

Testing whether the data are stable is the firstly step before proceeding. Based on the ADF test conducted in Stata, the p-values in Table 1 for WTI and Brent in the price are high, which means that it is not significant. However, the p-values in Table 1 for WTI and Brent in the yield all equal 0, which is considered statistically significant. Due to these findings, evidence is enough to reject that the variable has a unit root. In other words, the model built on the data is feasible and the data are stationary.

Table 1. ADF test

Variables	t-statistic	p-value
Price		
Petroleum industry	-2.845	0.1808
WTI	-1.513	0.8245
Brent	-1.585	0.7983
Yield		
Petroleum industry	-11.612	0.0000***
WTI	-13.297	0.0000***
Brent	-13.028	0.0000***

3.3. VAR model

There has been a lot of new literature exploring how this technique can be used in different areas of economics since Sims introduced the VAR model, such as the energy and environment [21]. The VAR model can be employed to capture the relationship between multiple variables while avoiding the challenge of model construction based on rigorous economic theory [22].

To find out the optimal lag order for a VAR model, the LR statistic and other information criterion of each lag should be assessed. An asterisk sign (*) appears after the data to signify the desired lag order.

Table 2. VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	2137.24				2.4e-11	-15.9271	-15.911*	-15.8869*
1	2146.7	18.921	9	0.026	2.4e-11*	-15.9306*	-15.866	-15.7698
2	2151.62	9.8587	9	0.382	2.5e-11	-15.9002	-15.7872	-15.6188
3	2154.14	5.0397	9	0.831	2.6e-11	-15.8518	-15.6904	-15.4499
4	2156.16	4.0308	9	0.909	2.8e-11	-15.7997	-15.5898	-15.2771
5	2160.85	9.3753	9	0.403	2.9e-11	-15.7675	-15.5092	-15.1244
6	2169.03	16.362	9	0.060	2.9e-11	-15.7614	-15.4546	-14.9977
7	2172.8	7.5491	9	0.580	3.0e-11	-15.7224	-15.3672	-14.8381
8	2181.08	16.554	9	0.056	3.0e-11	-15.717	-15.3134	-14.7121
9	2188.84	15.525	9	0.077	3.0e-11	-15.7078	-15.2557	-14.5823
10	2195.2	12.724	9	0.176	3.1e-11	-15.6881	-15.1876	-14.442
11	2200.4	10.385	9	0.320	3.2e-11	-15.6597	-15.1107	-14.293
12	2212.15	23.511*	9	0.005	3.1e-11	-15.6802	-15.0829	-14.1929

Table 2 reveals that lags 12, 1, and 0 all have that sign. Because the sign in FPE and AIC are in Lag 1, and the sign in HQIC and SBIC are in Lag 0, which is unrealistic Lag and its cannot an optimal lag order. Besides, the figure in FPE and AIC in Lag 11 reaches the top, and then it is declined. As a result, lag 12 is the better option to start with.

3.4. ARMA-GARCHX Model

The ARMA-GARCHX model can evaluate both the return and volatility of the WTI and Brent. This model is broken down into two sections in this paper: ARMA and GARCHX.

3.5. ARMA

$$y_t = \emptyset_0 + \sum_{i=1}^{p} \emptyset_i \, y_{t-i} + a_i - \sum_{i=1}^{q} \beta_i \, a_{t-i} \quad (1)$$

The general expression of this ARMA model is displayed in equation (1). The AR(p) is represented by the component $\emptyset 0 + \sum_{i=1}^{p} \emptyset_i \, y_{t-i}$, whereas the rest of the equation is MA(q). AR(p) estimates future value applying past WTI and Brent stock returns from August 16, 2021, to November 24, 2022, whilst MA(q) forecasts using an error term.

Specifically, in this paper, the AR model uses the historical returns of BTI and Brent oil price over the period from six months before the start of Russia Ukraine conflict to the present, while the MA model uses an error term to forecast the future.

3.6. GARCHX

Then comes another section GARCH. GARCH is derived from ARCH fundamentally, and both treat volatility as a variance to be modelled [23]. In this paper, GARCH (1,1) was considered, where the first 1 denotes one autoregressive lag and the second 1 denotes one moving average lag. The reasons for selecting GARCH (1,1) are as follows: it has fewer parameters than ARCH(p); it fits many time series well, it is sufficient to identify the volatility clustering in the data, and it only requires one lag for analysis. As a result, the model GARCH (1,1) was picked.

However, in order to better simulate and predict the volatility of oil prices, research usually adds exogenous regression variables to the volatility model, so as to increase the fitting ability of the volatility model. GARCHX model also came into being, which will help improve the explanatory power of volatility. This is the formula of this model:

$$\sigma_t^2 = \alpha_{0,1} + \alpha_1 \varepsilon_{t-1}^2 + \gamma_1 \sigma_{t-1}^2 + \pi x_{t-1} \quad (2)$$

In the equation, term $\alpha_1 \varepsilon_{t-1}^2$ is ARCH part and $\gamma_1 \sigma_{t-1}^2 1$ represents GARCH part, and the additional term πx_{t-1} represents confirmed cases that acted as an extra explanatory variable in the model. In this model, the author introduces the index of oil.

After that, this paper construct ARMA-GARCHX models of the returns and volatilities of the stocks of WTI and Brent oil price simultaneously. This paper uses the time points of log yield of crude oil as dummy variables and add them to the model for calculation. As a result, this paper can assess the correlation between the Russia Ukraine conflict and these returns and volatilities of the stocks of oil price companies.

4. Empirical Results and Analysis

4.1. Order of VAR Model

Following the specification of the VAR model's order, it is crucial to examine whether the VAR model is stable. The impulse-response function will not center to zero if this VAR model is non-stationary, which may indicate that Russia Ukraine conflict have long lasting effects on the oil price. After that, the model's applicability was determined by carrying out the unit root test and sketching a unit circle with the roots. All the roots are clearly within the circle in Fig. 1, implying that there is no need to reevaluate the lag order and that triradiate VAR (12) is a stable model.

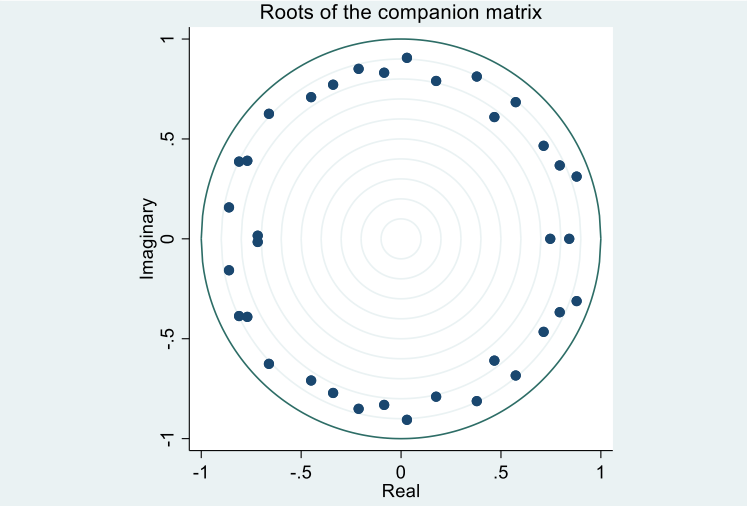


Figure 1. Unit circle test Photo credit: Original

4.2. Impulse Response

From the estimation results of the impulse response, when the Russia Ukraine conflict made oil more expensive, the cryptocurrency market became volatile. Specifically, when t=0, WTI crude oil yield increases by 1%, and its impact will be quickly reflected in the cryptocurrency market in the current period. The impact on Bitcoin yield during t=1 is about 0.3%. Then there will be shocks in the near future. Similarly, the change of Brent crude oil yield during t=0 has an impact on the special currency yield. However, it is difficult to judge the net effect or cumulative effect only from the impulse response diagram. Therefore, this paper further calculates the cumulative response function. As shown in Figure 3, the cumulative impact function shows how Bitcoin and Ethereum's returns change as a result of changes of the crude oil in the next 30 periods. The net impact of a unit changes in WTI yield on the future 30 Bitcoin returns is 10%. Similarly, the cumulative impact of Brent's yield change on the yield of special currency is about 2.5%.

WTI Brent

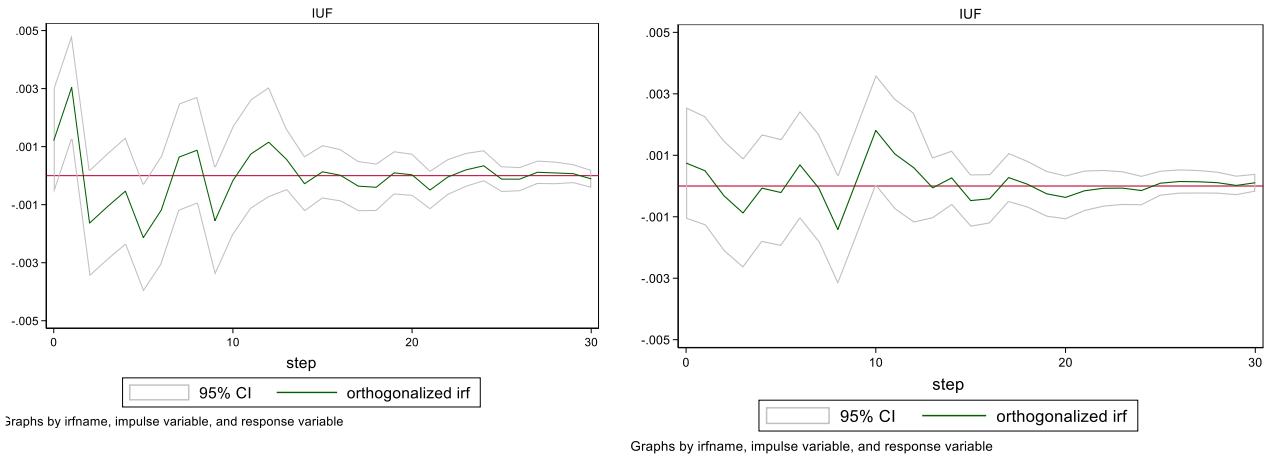


Figure 2. Impulse response Photo credit: Original

Oil prices changed a lot because of these geopolitical events. These made it hard to predict how much oil we would need, which created lots of anxiety [7]. As a result, investors are less likely to hold oil related assets. Therefore, this has also made other assets more valuable (such as Bitcoin), which may avoid risks related to large fluctuations in oil prices (ibid). Besides, Bitcoin price has a positive impact on geopolitical risks, which indicates that Bitcoin is a tool that can be used to see how the world is doing, and it can help you understand the global political environment better. Therefore, in the turbulent geopolitical conflict, Bitcoin may be a form of risk hedging.

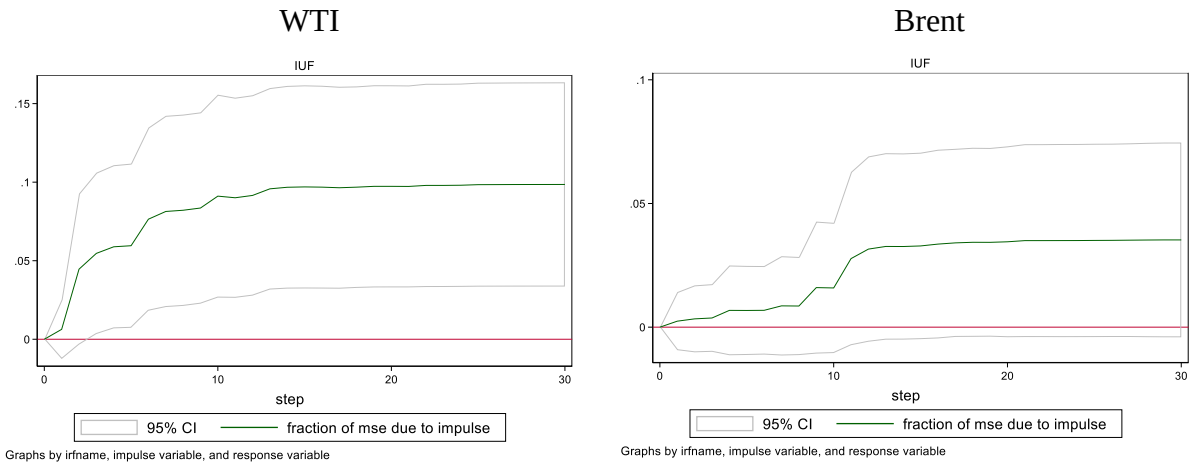


Figure 3. Cumulative response Photo credit: Original

4.3. ARMA Specification

In this section of the article, it is first necessary to order the first log-return series using the PACF and ACF pairs, the results of which are shown below.

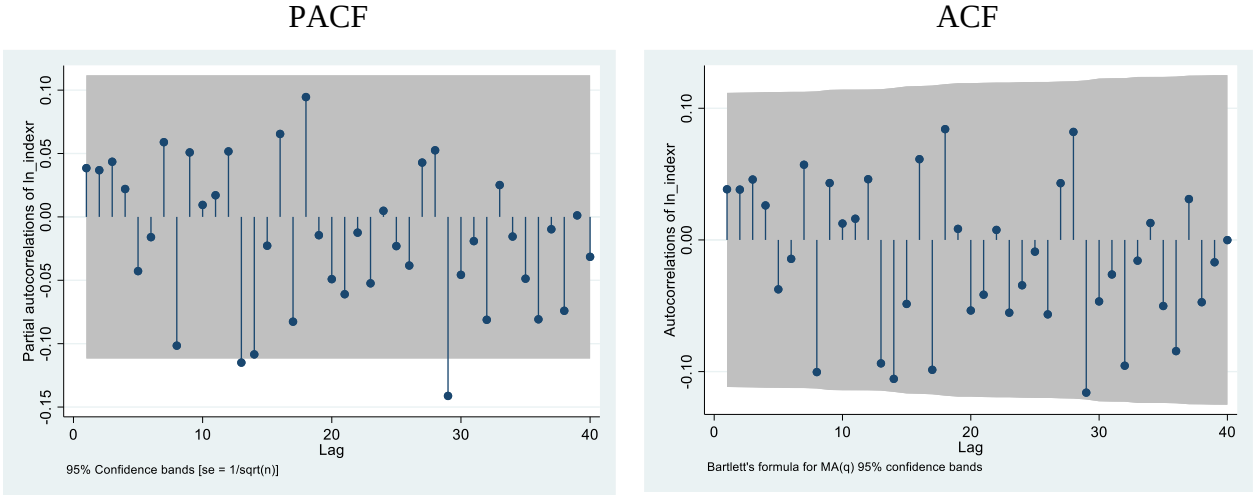


Figure 4. PACF and ACF Photo credit: Original

Regarding to the order of the stock return in logarithm, PACF and ACF can be helpful to derive the lag orders for AR(p) and MA(q). In the Fig. 4, the first part beyond the critical values is 12 for PACF plots, but in ACF, there is no plot that is beyond the critical values. Therefore, the result shows that AR(p) have order 12 and value of p is equal to 12.

4.4. ARMA-GARCH Estimation Results

This paper is working on ARMA-GARCHX model to see how the volatility of a special currency changes when there is a conflict between Russia and Ukraine.

The results in Table 3 show that after the mean equation controls the autocorrelation, the ARCH and GARCH terms in the variance equations in columns (1) and (2) are still significant at least at the 5% level. It shows that there is significant conditional heteroscedasticity in bitcoin returns, and GARCH modeling can be conducted. From the estimation results of external explanatory variables, the volatility of Bitcoin is not affected by the yield of WTI and Brent crude oil.

Table 3. ARMA-GARCHX estimation results

	(1)			(2)		
	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Mean Equation						
AR, L13	-0.0436535	0.0584423	0.455	-0.0428586	0.0567308	0.450
Constant	0.0001759	0.0009458	0.852	0.0002997	0.0009124	0.743
Variance Equation						
WTI	-2.032679	9.10941	0.823			
Brent				-6.363032	8.954082	0.477
ARCH, L1	0.1797536	0.0808497	0.026	0.1804038	0.0782465	0.021
GARCH, L1	0.6699041	0.1535232	0.000	0.6894348	0.1355325	0.000
Constant	-10.01811	0.6885995	0.000	-10.20383	0.6699379	0.000

5. Discussion

In comparison to other studies, this paper focuses on the conflicts between Russia and Ukraine, and how this has affected the price of oil. The volatility of the Bitcoin has also been affected by this. However, in the existing literatures, there are documents indicate that the geopolitical crisis may affect the oil price. And then, Bitcoin may be a way to hedge the risk of rising oil prices. However, this paper studies and describes the specific event of the Russian Ukrainian conflict, and further proves that in the background of the current Russian Ukrainian conflict, the increase in oil prices causes the money market to fluctuate more frequently. At the same time, Bitcoin can indeed hedge this geopolitical risk. However, one similarity between us in analyzing price and yield volatility is that many authors adopted methodology or related transformations such as VAR model, GARCH(X) model, TGARCH model, EGARCH model, or others in their research to determine movements of price and yield.

Investors' aversion to high risks in uncertain periods chose to turn to more beneficial assets in the whole recovery process of financial markets. Bitcoin is strong during downturns because they make other investments less risky. The stock market grows when the economy is doing well and stays stable, while Bitcoin will be beneficial when the market is in a rough spot [21]. However, Bitcoin as an emerging virtual currency, has a small market, a poor structure and little supervision. If the government makes any changes to how Bitcoin is regulated, that will have a big impact on how people invest in Bitcoin. Therefore, supervisor should add its transparency, increase the liquidity and effective price, so that investors can reduce their uncertainty about the company's risks. This will help to improve the stability of the market. All in all, while investors are investing in Bitcoin to reduce their risks in an uncertain society, they should also pay more attention to some defects of Bitcoin.

6. Conclusion

Today's society is full of uncertainty. Therefore, the goal of this study is to examine the impact of the international crude oil price fluctuation caused by the uncertainty society on the volatility of the Bitcoin, with an emphasis on the conflict between Russia and Ukraine. VAR and ARMA-GARCH models are introduced for this purpose, with the VAR model exploring impulse response and the ARMA-GARCH model assessing the price of WTI and Brent, conditional variances, and the probability of the significant. The study leads to a conclusion after conducting empirical investigation.

Finally, this article demonstrates that the rise in international crude oil prices triggered by the conflicts between Russia and Ukraine have led to fluctuations in the cryptocurrency market. At the same time, the change of crude oil yield has an impact on the yield of special currency. In the turbulent geopolitical conflict, Bitcoin may be a form of hedging risks. However, from the estimation results of external explanatory variables, the changes of WTI and Brent crude oil yield have no significant impact on the volatility of the special currency. Therefore, in today's unstable social form, investors

can buy Bitcoin to hedge the risks associated with the conflicts between Russian and Ukrainian. However, they cannot ignore the drawbacks of Bitcoin.

References

[1] Lewtak K, Kanecki K, Tyszko P, et al. Hospitalizations of Ukrainian Migrants and Refugees in Poland in the Time of the Russia-Ukraine Conflict[J]. International Journal of Environmental Research and Public Health, 2022, 19(20): 13350.

[2] Nerlinger M, Utz S. The impact of the Russia-Ukraine conflict on energy firms: A capital market perspective[J]. Finance Research Letters, 2022, 50: 103243.

[3] Tuathail G Ó. Understanding critical geopolitics: Geopolitics and risk society[J]. The Journal of Strategic Studies, 1999, 22(2-3): 107-124.

[4] Caldara D, Iacoviello M . Measuring Geopolitical Risk[J]. American Economic Review, 2022, 112.

[5] Clance M W, Gupta R, Wohar M E. Geopolitical risks and recessions in a panel of advanced economies: evidence from over a century of data[J]. Applied Economics Letters, 2019, 26.

[6] Murphy E V, Murphy M M, Seitzinger M V. Bitcoin: questions, answers, and analysis of legal issues[C]. Library of Congress, Congressional Research Service, 2015.

[7] Su C W, Qin M, Tao R, et al. Can Bitcoin hedge the risks of geopolitical events? [J]. Technological Forecasting and Social Change, 2020, 159: 120182.

[8] Violet C, Blunden B. The Emotional Construal of War: Anger, Fear, and Other Negative Emotions[J]. Peace & Conflict Journal of Peace Psychology, 2008, 14(2):123-150.

[9] Karalevicius V. Using sentiment analysis to predict interday Bitcoin price movements[J]. Journal of Risk Finance, 2018, 19(1):56-75.

[10] Mamun M A, Uddin G S, Suleman M T, et al. Geopolitical risk, uncertainty and Bitcoin investment[J]. Physica A: Statistical Mechanics and its Applications, 2019, 540(1):123107.

[11] Anne, Haubo, Dyhrberg. Bitcoin, gold and the dollar – A GARCH volatility analysis[J]. Finance Research Letters, 2016.

[12] Bouoiyour J, Selmi R, Wohar M. Safe havens in the face of Presidential election uncertainty: A comparison between Bitcoin, oil and precious metals[J]. Post-Print, 2019.

[13] D Das, A Dutta. Bitcoin's energy consumption: Is it the Achilles heel to miner's revenue? [J]. Economics Letters, 2020, 186.

[14] Yermack D. Is Bitcoin a real currency? An economic appraisal. Handbook of digital currency[J]. Elsevier, 2015: 31-43.

[15] Baek C, Elbeck M. Bitcoins as an investment or speculative vehicle? A first look[J]. Applied Economics Letters, 2015, 22(1-3):30-34.

[16] Ozcelebi O, Tokmakcioglu K. Assessment of the asymmetric impacts of the geopolitical risk on oil market dynamics[J]. International Journal of Finance & Economics, 2022, 27(1): 275-289.

[17] Noguera-Santaella J. Geopolitics and the oil price[J]. Economic Modelling, 2016, 52: 301-309.

[18] Eb A, Rg B, Akt C, et al. Does Bitcoin hedge global uncertainty? Evidence from wavelet-based quantile-in-quantile regressions - ScienceDirect[J]. Finance Research Letters, 2017, 23:87-95.

[19] Bouri E, Jalkh N, Peter Molnár, et al. Bitcoin for energy commodities before and after the December 2013 crash: diversifier, hedge or safe haven? [J]. Post-Print, 2017.

[20] Selmi R, Mensi W, Hammoudeh S, et al. Is Bitcoin a hedge, a safe haven or a diversifier for oil price movements? A comparison with gold[J]. Energy Economics, 2018, 74: 787-801.

[21] Sims C A. Macroeconomics and reality[J]. Econometrica: journal of the Econometric Society, 1980: 1-48.

[22] Freeman, John, R, et al. Vector Autoregression and the Study of Politics. [J]. American Journal of Political Science, 1989.

[23] Engle R. GARCH 101; The Use of ARCH/GARCH Models in Applied Econometrics[J]. The Journal of Economic Perspectives, 2001.