

# Research on the Digital Currency Price Synergy Based on VAR Model: Evidence from Bitcoin and Ethereum

Junqi Wang<sup>1,\*</sup>, Xuecheng Wang<sup>2</sup>

<sup>1</sup>North China University of Technology

<sup>2</sup>North China University of Technology

\*Corresponding author. Email: 205125502@qq.com, wxc@outlook.com.

## ABSTRACT

Based on the VAR model, we use Bitcoin prices as well as the Ethereum price daily data between December 2019 and January 2022 for dynamic identification, and the empirical analysis results show that the Bitcoin price is the granger reason of Ethereum prices, but Ethereum price is not the Bitcoin prices granger reason, namely in the long run the Bitcoin price fluctuation can affect the Ethereum price fluctuations, But Ethereum price fluctuations do not affect bitcoin price fluctuations. Meanwhile, according to the impulse response diagram, when the Bitcoin price is impacted by one unit, the Ethereum price will fluctuate greatly and approach 0 in the 11th phase. Based on the above research conclusions, this paper will put forward corresponding policy suggestions.

**Keywords:** Bitcoin price, Ethereum price, VAR model, COVID-19.

## 1. INTRODUCTION

As technology continues to advance and the digital economy continues to grow, currencies are gradually becoming virtualized and digitalized. Blockchain-based native tokens Bitcoin and Ethereum are private digital currencies based on commercial credit and issued by the private sector. According to data in CoinMarketCap, there will be more than 6,200 types of private digital currencies worldwide by 2021. Both are also known as crypto-digital currencies as they are currencies generated and used within a blockchain system. The outbreak of COVID-19 as a sudden global public health emergency facilitated a significant increase in demand for contactless payments, thus driving the further development of digital currencies.

A great deal of research has been done by scholars on cryptographic digital currencies such as Bitcoin and Ethereum. Among them, Yueh-Min Niu (2017) used cointegration and Granger causality tests to learn that there is no long-run smooth relationship between bitcoin prices and the prices of traditional investment instruments, but in the short run Bitcoin prices are influenced by the Dow Jones index, the RMB-USD exchange rate, and the federal funds rate, which can be used as an investment alternative. Jiahong Li et al. (2021) Using three GARCH family models, found that the GJR-GARCH-t model fits best and there is a

leverage effect between bitcoin and major assets in the Chinese financial market. Also, by calculating VaR, CVaR and information shock curves, we find that the VaR and CVaR values calculated based on Cornish-Fisher method are more reasonable for estimating Bitcoin risk. Linfeng Du (2021) uses a time-varying parametric vector auto-regressive model (TVP-VAR) to dynamically identify the time-varying relationships among the Bitcoin market, the RMB exchange rate, and the stock market. The results of the empirical analysis show that even though China conducted a large-scale closure and retirement of the Bitcoin market in 2017, it still had a significant impact on China's stock market. Meanwhile, with the acceleration of RMB exchange rate reform, the impact of the Bitcoin market on the RMB exchange rate market has been strengthening. However, the impact of the Bitcoin market on the above two markets shows significant differentiation. Ren Wang (2018) and others studied whether there is a bubble in the price volatility of Ethereum, a digital currency based on blockchain technology, based on the GSADF method, and the results of the empirical analysis showed that the price of Ethereum had a cyclical bubble several times between 2015 and 2017, and the longest-lasting cyclical bubble lasted 72 days. As a result, investors can take advantage of its high volatility characteristics to make rational investments and rationalize their allocations. Xuemei Xu (2021) analyzes the phenomenon, prospect,

and countermeasures of global digital currency competition, and the results show that legal digital currencies are expected to replace private digital currencies in the continuous development of the future, driving sovereign currency competition into the digital dimension. Therefore, China should grasp the general trend of the times, continue to steadily promote the digital renminbi research and development trials, while strengthening bilateral and multilateral legal digital currency cooperation, jointly exploring the transnational use and rule governance of legal digital currency, continuously enhancing the awareness of international monetary competition, and carrying forward the spirit of struggle. Figure 1 shows the analysis results of relevant studies.

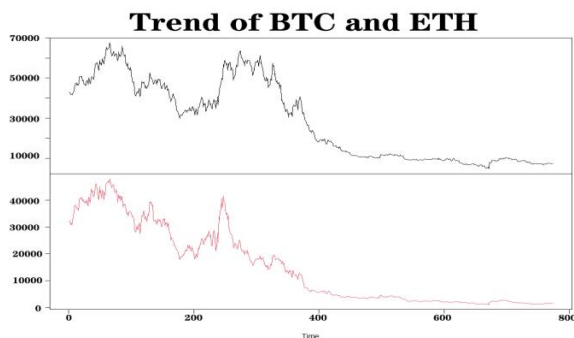


Figure 1. Trend of Bitcoin and Ethereum price

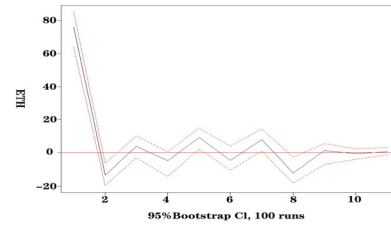
According to research, the price of Bitcoin and Ethereum is mainly affected by supply factors and demand factors and macro environmental factors. The risk increases sharply when the market is in crisis. However, few articles have studied the correlation between the two price fluctuations. In this paper, we will explore the correlation between Bitcoin and Ethereum using VAR model in the context of COVID-19 epidemic.

## 2. REPRESENTATIONAL ANALYSIS AND DESCRIPTIVE STATISTICS.

### 2.1. Characterization analysis

Figure 2 shows the trend of daily data of Bitcoin price and Ethereum price from December 2019 to January 2022.

Orthogonal Impulses Response from BTC



Orthogonal Impulse Responses from ETH

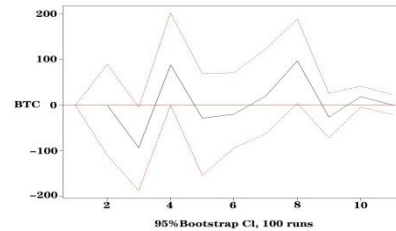


Figure 2. Impulse response analysis

Overall, Bitcoin and Ethereum prices moved in roughly the same direction under the combined influence of multiple complex factors, and Bitcoin price changes preceded Ethereum price changes, with Bitcoin price changes greater than Ethereum price changes. By stages, the crypto-digital currency was suppressed by the sell-off at the beginning of 2019 and then the price rebounded and had a small upward trend, then the impact of the COVID-19 at the beginning of 2020 caused the price of both to plummet until the end of March, after which the crypto-digital currency as a whole was on an upward trend all the way up to the beginning of the 2021, when the crypto-digital currency price hit a new high. However, in the April 2021, the digital currency market fell sharply due to policies such as the increase in capital gains tax rates by the US President to alleviate income inequality and the gradual tighten of domestic regulation, with various popular coins generally falling by about 20%, and a significant retracement followed.

### 2.2. Descriptive statistics

The table1 shows the descriptive statistics of Bitcoin as well as Ether prices.

Table 1.VAR model parameter estimation results

Variables	Bitcoin Price	Ethereum Price	Bitcoin price first order differential values
Sample size	774	774	773
Minimum value	4826.00	107.90	-7311.50
Maximum value	67527.90	4808.38	7542.80

Average	28582.40	1513.64	55.03
Median	23605.70	637.43	29.15
Standard deviation	19687.96	1442.82	1382.20
Skewness	0.32	0.69	-0.01
Kurtosis	-1.49	-0.97	5.62

**TABLE 2.** Unit root test results for the original series of variables and their first-order difference series

Variable	ADF Inspection	PP Inspection	KPSS test (LEVEL)	KPSS test (TREND)	Conclusion
BTC	-2.1941 (0.50)	-9.2740 (0.59)	9.2620 (0.01)	0.6715 (0.01)	Unstable
ETH	-2.1153 (0.53)	-11.5020 (0.49)	9.9073 (0.01)	1.6265 (0.01)	Unstable
dBTC	-7.8692 (0.01)	-844.410 (0.01)	0.1126 (0.1)	0.0864 (0.1)	Smooth and stable
dETH	-8.5244 (0.01)	-887.770 (0.01)	0.0653 (0.1)	0.0593 (0.1)	Smooth and stable

From the table, we know that the difference between the maximum and minimum values of the two digital cryptocurrencies is large and the standard deviation is large, which indicates that the price fluctuations of the two digital cryptocurrencies are more dramatic during this period.

### 3. EMPIRICAL STUDIES

#### 3.1 Data sources and model construction

The data selected for the article are from the daily readings of cryptocurrencies Bitcoin and Ethereum from December of the 2019 to January of the 2022 in the Yingwei Financial Intelligence Quotes App. The previous analysis shows that there is a dynamic correlation between Bitcoin price and Ethereum price. In order to accurately analyze their internal connection, this article explores the dynamic relationship between the price fluctuations of both by constructing a VAR model. Let the Bitcoin price be BTC and the Ethereum price be ETH, the model results are as follows.

$$\begin{aligned}
 BTC_t &= C + \Phi_1 BTC_{t-1} + \Phi_2 BTC_{t-2} + \dots + \Phi_i BTC_{t-i} \\
 &+ \theta_1 ETH_{t-1} + \theta_2 ETH_{t-2} + \dots + \theta_j ETH_{t-j} + \omega_1(1) \\
 ETH_t &= \vartheta + \Phi_1 BTC_{t-1} + \Phi_2 BTC_{t-2} + \dots + \Phi_i BTC_{t-i} \\
 &+ \theta_1 ETH_{t-1} + \theta_2 ETH_{t-2} + \dots + \theta_j ETH_{t-j} + \omega_2(2)
 \end{aligned}$$

In this model denotes the time, and denotes the lag term coefficient of Bitcoin, and denotes the lag term coefficient of Ethereum, and denotes the constant,

and  $\omega$  denotes the error term of the equation. R is used to construct a VAR model with Bitcoin price of BTC and Ethereum price of ETH.

**TABLE 3.** Parameter estimation results

Variables	BTC <sub>t</sub>	ETH <sub>t</sub>
BTC <sub>t-1</sub>	-0.0462	-0.0085*
ETH <sub>t-1</sub>	-0.0070	-0.0196
BTC <sub>t-2</sub>	0.0764	0.0028
ETH <sub>t-2</sub>	-1.3500.	-0.0128
BTC <sub>t-3</sub>	-0.0622	-0.0068.
ETH <sub>t-3</sub>	1.1934.	0.0632
BTC <sub>t-4</sub>	0.0876	0.0067
ETH <sub>t-4</sub>	-0.2466	0.0056
BTC <sub>t-5</sub>	0.0408	0.0042
ETH <sub>t-5</sub>	-0.3736	-0.1237*
BTC <sub>t-6</sub>	0.0089	-0.0024
ETH <sub>t-6</sub>	0.3918	0.1338*
BTC <sub>t-7</sub>	-0.1284*	-0.0144***
ETH <sub>t-7</sub>	1.2485	0.1312*
p-value	0.1765	0.0000

#### 3.2 Unit root test and selection of lag order

VAR model time series regression is applicable to trend smooth process, otherwise pseudo-regression phenomenon will occur, so the Bitcoin price as well as Ethereum price time series is tested for unit root, that is,

to test whether there is unit root in the characteristic equation of the series, this study selected ADF test and PP test as well as KPSS method to test the smoothness of the series, the test results are listed in the following table2.

The test results show that the original variables all have unit roots, the same as the series is not smooth, while after the first-order difference, none of the first-order difference variables have unit roots, so the series of variables after the first-order difference is smooth, and the original variables are consistent with the first-order single integer characteristics. VAR model can be established to explore the dynamic relationship between the price fluctuations of the two. And the lag term of the model is determined by the AIC criterion as 5.

**3.3VAR model regression results**

The parameter estimation results of the VAR (5) model are presented in the following table3. Based on the parameter estimation results, it is clear that some of the variables in the model may have multicollinearity and the significance level of the regression coefficients is not high, but the analysis of the model does not focus on the regression coefficients. From the overall regression results, there is a certain correlation between the two variable masses.

**3.4Granger causality test**

From the results of Granger causality test, we can know that in the original hypothesis that Bitcoin price is not the Granger cause of Ethereum price, the P-value of the test result is 0.0456, less than 0.05, so the original hypothesis can be rejected at the 5% level and the alternative hypothesis that Bitcoin price is the Granger cause of Bitcoin price is accepted. is much greater than 0.05, so the original hypothesis that the Ether price is not the Granger cause of the Bitcoin price cannot be rejected at the 5% level again.

Granger causality test is done between Bitcoin price and Ethereum price to explore whether there is a short-term lead-after relationship between them. The results of the test are presented in the following table 4.

**TABLE4.**Granger causality test results

Original hypothesis	Lagging order	F-Test	p	Conclusion
BTC is not ETH Granger's cause	5	3.5047	0.0456	Rejection
ETH is not BTC Granger's cause	5	1.5956	0.6716	No Rejection

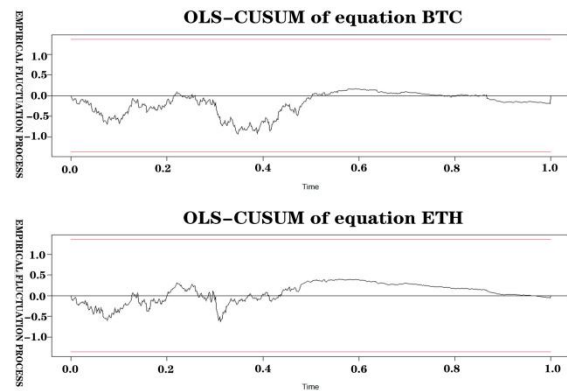
**3.5Impulse Response Analysis**

Since Ethereum price is not the Granger causality of Bitcoin price, this paper only needs to analyze the magnitude of Ethereum price fluctuation when a unit shock is given to Bitcoin price, and the response of Ethereum price to its own shock, and the results of impulse response analysis are as follows.

According to the impulse response diagram, the perturbation of Bitcoin price on Ethereum price reaches the maximum in the first period, and then the fluctuation decreases and reaches the minimum in the sixth period. The perturbation of Ethereum price on itself reaches its maximum in the first period, and then the fluctuation decreases and starts to approach 0 around the 11th period.

**3.6Stability check**

The CUSUM test using recursive least squares was used to determine the stability of the model, and the results of the test are shown in Figure 3



**Figure 3.** The results of the smoothness test

From the above figure, it can be seen that the cumulative sum of residuals of Bitcoin price and Ethereum price are within the critical line, which can be considered that the residuals of the current model are in a stable state.

**4. CONCLUSIONS**

The results of the empirical analysis show that Bitcoin price is the Granger cause of Ethereum price, but Ethereum price is not the Granger cause of Bitcoin price, and there is a one-way Granger causality between the two, so overall, the movement of Bitcoin price can drive the movement of Ethereum price.

This may be due to the fact that Bitcoin, the number one digital currency in cryptocurrency in terms of market capitalization, was born during the financial crisis in 2008 and is by far one of the largest crypto digital currencies in terms of volume as well as

influence. Its value is backed by its decentralized blockchain technology features, and it uses "distributed ledger" to record every transaction and encryption technology to record transaction data as a blockchain, which greatly increases the security of the transaction process and improves customer trust as the transaction data and user information are difficult to be tampered with. So movements in the price of Bitcoin may affect movements in other crypto-digital currencies. But because Bitcoin is the first true crypto-digital currency. As the leading crypto-digital currency its price fluctuation is influenced by many objective factors, so in the short term the price movement of Ethereum cannot affect the fluctuation of Bitcoin price.

The outbreak of the COVID-19 has had a significant impact on the landscape of the world economy while driving the digitization of the global economy, which has led to an increasing demand and risk for the reality of digital currencies. Crypto-digital currencies, represented by Bitcoin and Ether, were similar to traditional financial instruments at the beginning of this epidemic in that their prices were on a plummeting trend, but the difference is that crypto-digital currencies were the first to pull back and catch up to their all-time highs compared to other financial instruments. The reason for this phenomenon could be that some of their unique characteristics made them more attractive to investors during the crisis. Firstly, they are not regulated by any jurisdiction or the financial system and can be traded without government borrowing, which in a way makes them decentralized. Secondly, they are issued in limited numbers, which makes the benefit of the limited nature of crypto-digital currencies obvious in the context of the proliferation of fiat currencies due to the epidemic where countries are using loose monetary policies to recover their economies instead. Finally, crypto-digital currencies have a hedging function for investors in the event of a crisis in the financial markets. Therefore, in the context of the COVID-19 crypto-digital currencies represented by Bitcoin and Ethereum are popular among investors. In conclusion, this paper explores the correlation between the prices of Bitcoin and Ethereum, the representatives of crypto digital currencies, by establishing a VAR model. The empirical analysis show that the price change of Bitcoin may affect the fluctuation of Ether price, so investors can choose to invest in crypto digital currencies reasonably based on this feature.

## ACKNOWLEDGMENTS

This work was financially supported by Beijing Social Science Fund (21JJC021)

## REFERENCES

[1] Niu Yuemin. Influencing factors of bitcoin price formation mechanism[J]. Times

Finance,2017(27):220-221.

- [2] Li Jiahong, Li Ping. A study of the relationship between bitcoin and major assets in Chinese financial markets during the COVID-19 epidemic[J]. Management Review,2021,33(11):286-297.DOI:10.14120/j.cnki.cn11-5057/f.2021.11.002.
- [3] Du Linfeng. Does the Bitcoin market still have an impact on our exchange rate and stock market? -- An empirical study based on TVP-VAR model[J]. North China Finance,2021(11):20-31.
- [4] Wang Ren, He Qinya. Is there a bubble in the price of digital currency Ether? -- An empirical study based on GSADF method[J]. Finance and Economics,2018(10):9-16.DOI:10.19622/j.cnki.cn36-1005/f.2018.10.002.
- [5] Xu Xuemei. The current situation, prospect and countermeasures of global digital currency competition[J]. Modern Business,2021(34):72-75.DOI:10.14097/j.cnki.5392/2021.34.021.