Analysis of the Dynamic Characteristics of Bitcoin and Ethereum

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Abstract

Represented by two digital currencies, Bitcoin and Ethereum, the dynamic characteristics of the currency value of digital currencies are analyzed. First, we conduct a horizontal analysis of the relationship between these two digital currencies through co-integration and Granger causality test. Secondly, the Sup ADF and GSADF test methods are used to longitudinally analyze the bubbles of the three digital currencies. The results show that there are Granger causality and price bubbles in Bitcoin and Ethereum. Through analysis, it is found that the high volatility of currency value is not only related to the relationship between digital currencies but also related to factors such as digital currency market fluctuations and regulatory policies.

Keywords- *Bitcoin; Ethereum; price bubble; Granger causality test*

1. INTRODUCTION

In recent years, as people's interest in digital currencies has increased, a large amount of capital has flowed into the digital currency market, and the types and currency values of digital currencies have undergone tremendous changes. The existing digital currency types have increased to nearly 2,000, and the main digital currencies are Bitcoin and Ethereum. The circulating market value of these two digital currencies ranks among the top two in the world, occupying more than 40% of the digital currency market share.

Since Bitcoin started trading in 2010, its trading price and market value have shown a rapid upward trend. In November 2013 alone, the value of Bitcoin rose from $2.432 billion to $13.615 billion. As of January 1, 2020, the value of Bitcoin has reached $65.372 billion. Ethereum was issued at an ICO (Initial Coin Offering) in July 2014 at a price of approximately $0.3, and its value reached $100 million in August 2015. As of January 1, 2020, its value rose $14.241 billion. The currency value of the digital currency fluctuates greatly, and many risks behind the digital currency are exposed during this sharp rise and fall, including systemic financial risks, legal risks, and transaction risks. Lei Jie and Luo Liangwen (2018) [1] pointed out that these risks will harm the interests of small and medium investors and affect the stability of the national central bank's monetary policy. Zhang Lijing (2019) [2] pointed out that Bitcoin's large market volatility may have a spreading effect on other risky assets around the world. Large fluctuations in the Bitcoin market may be transmitted to risky assets such as stocks and commodities. Therefore, it is of great significance to study the dynamic characteristics of digital currency value.

The violent fluctuations in the value of digital currencies have aroused the attention of scholars. The sharp rise of digital currencies in 2016 and 2017 has further triggered research on the relationship between digital currency prices and macroeconomic factors. Bouri E. et al (2017) [3] found that before 2013, positive stock returns led to increased volatility of Bitcoin. After 2013, negative stock returns led to increased volatility in Bitcoin. Masiak C. et al (2018) [4] conducted a vector auto-regression and Granger causality test on the relationship between Bitcoin, Ethereum, and ICO, and found that there is a negative relationship between ICO and Bitcoin and Ethereum, and ICO The impact on Ethereum is even greater.

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Based on existing research findings, most studies on the relationship between digital currencies focus on the relationship between digital currencies and stocks, currencies of different countries, news and media sentiments, etc. Most of the research on digital currency bubbles is limited to one type of digital currency. Both aspects seldom involve the relationship between multiple digital currencies and the dynamic characteristics of currency values. Therefore, based on the relationship between multiple digital currencies, this paper conducts a horizontal analysis of the dynamic characteristics of the currency value of the digital currency, and conducts a vertical analysis of the dynamic characteristics of the currency value of the digital currency through the discussion of different digital currency bubbles, and obtains the high volatility and speculation of the currency value of the digital currency. Factors, regulatory policies, and other digital currency factors are related, and it is proposed to strengthen the supervision of the digital currency market and formulate relevant laws and regulations, and other measures.

2. Variable Description and Empirical Test

2.1. Data and descriptive statistics

This paper selects Bitcoin (BTC) and Ethereum (ETH) from Wind, denominated in U.S. dollars. Since the first transaction of Ethereum occurred in August 2015, the sample interval of this paper is set from August 31, 2015, to April 5, 2020, including 240 weeks of currency value data.

It can be seen from Figure 1 that the currency value of Bitcoin and Ethereum has shown a steady growth trend from 2015 to 2016. In 2017, the currency value of both digital currencies rose rapidly and reached their highest point around January 2018. Just as Masiak C. & Block J (2018) [4] studied the relationship between digital currency and ICO, there is a causal relationship between the fluctuation of digital currency prices and ICO projects. Therefore, the popularity of ICO projects has caused funds to continue to flow into the digital currency market, which has triggered the continuous increase in the value of Bitcoin and Ethereum. In October 2017, the Chicago Mercantile Exchange launched the Bitcoin futures contract, which once again stimulated people's enthusiasm for digital currency, causing the value of the digital currency to rise further and reach its peak [5]. With the tightening of regulations in various countries and the entry of investment institutions, the prices of the two digital currencies began to fall and reached an inflection point around January 2019. The rise in the price of digital currency this time is related to the cyclicality of digital currency prices on the one hand, and on the other hand to economic shocks, lack of investment channels for investors to maintain value, and the use of digital currency as a safe-haven asset. Since then, the currency value of Ethereum is generally stable, but the currency value of Bitcoin fluctuates greatly. Especially in February 2020, with the rapid spread of new crown pneumonia, people are pessimistic about the economy, leading to a sharp drop in the value of Bitcoin [6]. From the perspective of the relationship between these two digital currencies, the number of fluctuations and the amplitude of fluctuations of Bitcoin is greater than those of Ethereum. However, Ethereum in 2016 and 2017 generally followed Bitcoin's skyrocketing and soaring, plummeting and falling, which shows that there may be a correlation between the value of these two digital currencies.

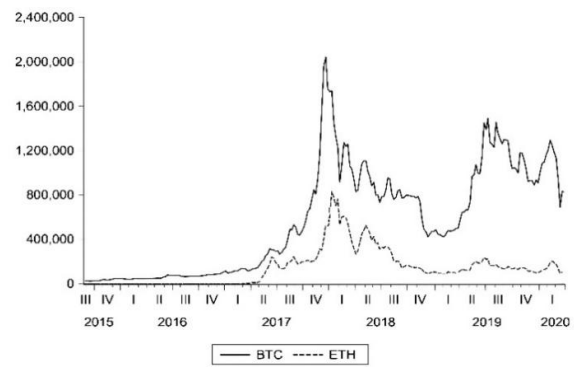

Figure 1. Bitcoin and Ethereum currency value chart

From the results of the descriptive statistics on the prices of the three digital currencies in Table 1, it can be seen that the currency values of these two digital currencies fluctuate greatly. If the sample obeys a normal distribution, its skewness should be 0, kurtosis is 3, and the Bella statistic is relatively close to 0. Therefore, the price series of Bitcoin presents the characteristics of a low peak to the right, and the price series of Ethereum presents a rightward deviation. The characteristic of spikes. The Bella statistic of these two digital currencies is greater than 0, which means that their sample data does not obey a normal distribution. It can be seen that the currency value of Bitcoin and Ethereum fluctuates greatly during the sample period, and there may be price bubbles.

TABLE I. Descriptive statistical results of two digital currencies

Variable	Standard Deviation	Skewness	Kurtosis	Bella Statistics
BTC	4853.18	0.5159	2.3042	15.4873
ETH	1622.40	1.7304	6.2765	227.137

2.2. Horizontal analysis of the dynamic characteristics of digital currency value

To conduct a horizontal analysis of the dynamic characteristics of the currency value of digital currencies,

the Granger causality test is used to explore the relationship between digital currencies [7]. This paper first uses the ADF test to test the stationarity of Bitcoin (BTC) and Ethereum (ETH), and the results show that the time series of these two digital currencies are first-order single integers. Further EG co-integration test shows that Bitcoin and Ethereum have a long-term stable equilibrium relationship at the 5% confidence level. Finally, the Granger causality test is performed, and the results are shown in Table 2.

TABLE II. GRANGER CAUSALITY TEST OF BITCOIN AND ETHEREUM

Null Hypothesis	Lag order	F-statistic	P-value	Test Result
The reason why DETH is not a Granger of DBTC	2	9.5671	0.0001	Reject
The reason why DBTC is not a Granger of DETH	2	6.2730	0.0022	Reject

It can be seen from Table 2 that there is Granger causality between Bitcoin and Ethereum. This shows that the prediction effect of one of the digital currencies through the past information of Bitcoin and Ethereum is better than the prediction effect of using the past information of the digital currency alone. It means that the currency value fluctuations of these two digital currencies can be predicted through the past currency value information of Bitcoin and Ethereum.

2.3. Longitudinal analysis of the dynamic characteristics of digital currency value

To better verify the relationship between the two digital currencies, this paper conducts a longitudinal analysis of the dynamic characteristics of the currency value of the digital currency through a bubble test and explores the specific reasons for the bubble. The Sup ADF test and GSADF test are used to longitudinally analyze the dynamic characteristics of Bitcoin and Ethereum currency values [8]. According to the minimum effective window determination method proposed by Phillips et al (2015) [9], the selected minimum sample window width is 4, and the corresponding Sup ADF and GSADF test statistics and corresponding critical values are obtained through 1000 Monte Carlo simulation experiments.

TABLE III. SADF AND GSADF TEST RESULTS OF BITCOIN

Test statistics	Finite sample critical value		
	90%	95%	99%
Sup ADF test	12.7115	1.1760	1.4620	2.0067
GSADF test	12.7115	1.9513	2.2091	2.7063

TABLE IV. SADF AND GSADF TEST RESULTS OF ETHEREUM

Test statistics	Finite sample critical value		
	90%	95%	99%
Sup ADF test	20.1433	1.1351	1.4067	1.7126
GSADF test	20.1433	1.9567	2.2440	2.78136

It can be seen from Table 3 and Table 4 that the Sup ADF and GSADF statistics of Bitcoin and Ethereum are both greater than their critical value at 99%, indicating that the currency values of these two digital currencies have price bubbles. At the same time, by comparing the critical values of Sup ADF and GSADF at 90%, 95%, and 99%, it is found that the GSADF test is more sensitive than the Sup ADF test when continuous foaming occurs. To further discover the timing of the occurrence and bursting of the two digital currency bubbles, it can be estimated by comparing the GSADF statistical value series and the 95% critical value series.

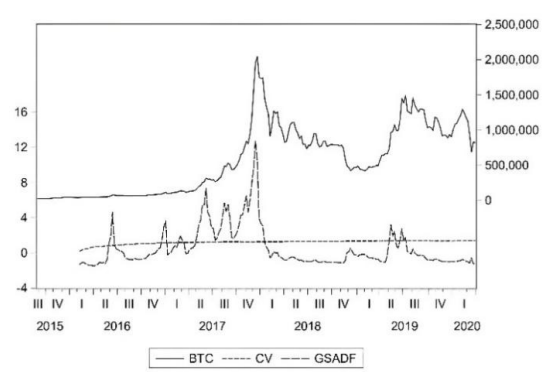

Figure 2. The bubble period of Bitcoin value

By analyzing Figure 2, it can be found that the Bitcoin bubble is concentrated in 2016, 2017 and 2019. According to statistics, China's annual Bitcoin transaction volume reached 4.5 trillion yuan in 2016, accounting for more than 90% of the global Bitcoin market transaction volume. In 2016, with China's continuous strengthening of foreign exchange controls and the sharp depreciation of the renminbi, many Chinese investors are looking for new ways to export funds. Due to the anonymity and investment properties of Bitcoin, many Chinese investors bought Bitcoin in large quantities, resulting in a bubble.

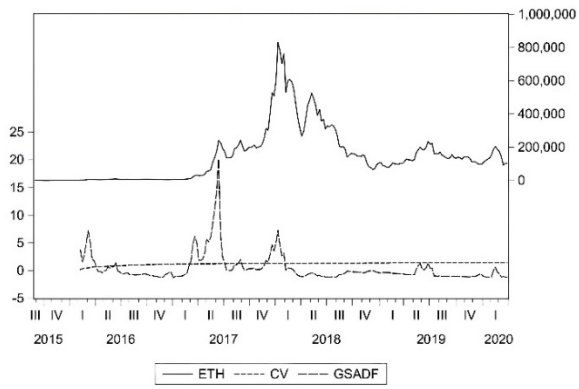

Figure 3. The bubble period of Ethereum value

By analyzing Figure 3, it can be found that the price bubbles of Ethereum mainly appeared in 2016, 2017 and 2019. The price bubble of Ethereum in 2016 is not only related to my country's foreign exchange control, but also closely related to the DAO, a crowdfunding project based on the Ethereum blockchain platform. The DAO raised 11.5 million Ethereum in May 2016, which was valued at 149 million yuan at the time. On June 17, 2016, the DAO was hacked and Ethereum with a market value of $50 million was transferred, causing the price of Ethereum to plummet. The ICO project raises digital currency by issuing the project's own tokens, so that Ethereum has a specific application channel.

From the comparison of Figure 2 and Figure 3, we can see that both Bitcoin and Ethereum have price bubbles. From the perspective of the interrelationship between the two, although the number, size, and duration of bubbles are different, Bitcoin and Ethereum have caused multiple bubbles in 2017 due to the influence of ICO projects. This shows that both are greatly affected by the digital currency market and speculative factors. Besides, with the entry of regulatory agencies, the bubble of the two digital currencies burst, which illustrates the importance of regulatory policies in the digital currency market. As far as a single digital currency is concerned, Bitcoin's price bubble has appeared many times and lasted for a long time. This is because Bitcoin's anonymity makes it a new investment method and hedging product, which is vulnerable to speculative factors. At the same time, as the "leader" in the digital currency market, the soaring price of Bitcoin will also drive dramatic changes in the price of Ethereum.

3. Conclusion

Bitcoin and Ethereum, as the world's mainstream digital currencies, occupy a large share of the digital currency market. Based on the currency value data of the two digital currencies from August 31, 2015, to April 5, 2020, through horizontal analysis of the dynamic characteristics of their currency values, it is found that there is an agreement between Bitcoin and Ethereum. Integrating Granger causality, that is, the correlation between digital currencies will have a great impact on the fluctuation of the currency value of the digital currency, so the fluctuation of the currency value can be predicted by the mutual relationship between the two currencies. Further, a longitudinal analysis of the dynamic characteristics of the currency value of the two digital currencies found that both digital currencies have price bubbles, and the longest duration of the two digital currency bubbles is from 2017 to 2018, indicating that the currency value of the digital currency has Larger volatility and instability.

Through horizontal and vertical analysis of the dynamic characteristics of the currency value of the digital currency, it is concluded that the currency value of the digital currency has high volatility and complexity. This can help establish an objective understanding of the value of the digital currency, provide theoretical support for investors when investing in digital currency, and also have reference value for the future development of the digital currency market. Specific suggestions: First, when investors invest in digital currencies, they should recognize the relationship between digital currencies, and use the past information of digital currencies to predict the digital currencies before making investment decisions to avoid unnecessary losses. Regulators should also pay attention to the important position of Bitcoin in the digital currency market, so they should focus on monitoring Bitcoin's price fluctuations [10]. At the same time, investors should recognize the high risk and complexity of the digital currency market and avoid blindly following the trend. Second, regulatory agencies can use regulatory policies to influence the currency fluctuations of digital currencies and guide the healthy development of the digital currency market. On the one hand, the anonymity and globalization of digital currency make it more difficult to control digital currency. Therefore, regulators can closely monitor the accounts that are frequently traded on the trading platform recently based on the open and transparent characteristics of the blockchain. As a currency with the attributes of investment products, although digital currency cannot be accepted and recognized by people in the short term, it will still be active in the world as an investment asset, and its investment value is undeniable. On the other hand, central banks of various countries should speed up the research on their legal digital currencies, and use national credit as the guarantee to not only meet people's liquidity needs, but also effectively control currency flows and reduce the impact of digital currency speculation. Third, Bitcoin and Ethereum, as digital assets without actual value, are prone to price bubbles. It is recommended that my country accelerate the study of asset digitization based on real assets such as land property rights and gold, so as to achieve the purpose of preventing the violent fluctuation of digital currency and alleviating investment risks.

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REFERENCES

[1] Lei Jie, Luo Liangwen. Bitcoin risk and its supervision system construction. Finance and Accounting Monthly, 2018, (11):166~171.

[2] Zhang Lijing. Bitcoin: a window to observe market risk appetite. China Securities Journal, 2019-06-18(A09).

[3] Bouri E, Azzi G, Dyhrberg A H.On the Return-volatility Relationship in the Bitcoin Market around the Price Crash of 2013. Economics the Open-Access Open-Assessment e-Journal, 2016, 11:1~16.

[4] Maciak C, Block J H, et al. The Triangle of ICOs, Bitcoin and Ethereum: A Time Series Analysis. SSRN Electronic Journal, 2018.

[5] Sifat I M, Mohamad A, Shariff M S B M. Lead-Lag Relationship between Bitcoin and Ethereum: Evidence from Hourly and Daily Data [J].Research in International Business and Finance, 2019, 50: 306-321.

[6] Chen, C., Liu, L., & Zhao, N. (2020). Fear sentiment, uncertainty, and bitcoin price dynamics: The case of COVID-19. Emerging Markets Finance and Trade, 56(10), 2298-2309.

[7] Dastgir, S., Demir, E., Downing, G., Gozgor, G., & Lau, C. K. M. (2019). The causal relationship between Bitcoin attention and Bitcoin returns Evidence from the Copula-based Granger causality test. Finance Research Letters, 28, 160-164.

[8] Corbet, S., Lucey, B., & Yarovaya, L. (2018). Datestamping the Bitcoin and Ethereum bubbles. Finance Research Letters, 26, 81-88.

[9] Phillips P C B, Shi S, Yu J. Testing for Multiple Bubbles: Historical Episodes of Exuberance and Collapse in the S&P 500. International Economic Review, 2015, 56(4): 1043~1078.

[10] Prayogo, G. (2018). Bitcoin, regulation and the importance of national legal reform. Asian Journal of Law and Jurisprudence, 1(1), 1-9.