RESEARCH ON THE INFLUENCE FACTORS OF BITCOIN PRICE: THE INTERNAL AND MACRO FACTORS

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ABSTRACT

This dissertation analyzes the impact of external macro and internal factors on the price of Bitcoin. Employing data from January 1, 2020 to February 28, 2023, this dissertation starts with the system operation of cryptocurrency represented by Bitcoin and uses the Granger causality test of the time series VAR model, impulse response, and variance decomposition to analyze the factors affecting Bitcoin prices. Empirical tests have shown that the price of Bitcoin is affected by both the external macro factors and internal operation mechanism, and there are significant changes in the influencing factors before and after the issuance of the China mining ban in May 2021.

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CHAPTER 1

INTRODUCTION

Research Background

Bitcoin is a decentralized cryptocurrency that integrates existing computer network technologies such as encrypted computing, consensus mechanism, point-to-point transmission, and distributed data storage. On this basis, it uses proof of work (Pow) to overcome Byzantine problems of the decentralization system. Since the appearance of Bitcoin, blockchain technology has been widely recognized as its underlying technology. Despite that the Bitcoin market and the global cryptocurrency market have recently suffered setbacks, blockchain technology and applications continue to expand, from the initial operation of cryptocurrencies to the Internet of Things, social communications, file storage, supply chain finance, e-commerce, logistics tracking, identity verification, securities transactions, equity crowd-funding, smart contracts, and other fields. Bitcoin market has experienced a period of steady rise, outbreak and then decline in prices, and its high volatility raises a concern. At the beginning of 2021, a bitcoin was worth $40,000, but in the following six months, it quickly fell from a high position of $60,000 to $33,000, and its price has fluctuated greatly since the slump occurs. As a result, the Chinese regulatory authorities have adopted a new sanction policy to completely prohibit illegal cryptocurrency transactions and mining behaviors within the borders.

Research Topics

From May 18, 2021, the three associations issued an announcement to remind of preventing the risk of virtual currency trading speculation. Immediately, the Inner

Mongolia Development and Reform Commission issued the "Eight Measures of the Inner Mongolia Autonomous Region Development and Reform Commission on Resolutely Combating and Punishing Virtual Currency "Mining" Behaviors" on May 26. The contents include putting mining-related companies and personnel onto the dishonest list and sending all those involved in mining activities or providing convenience for them to the discipline inspection and supervision agencies. Subsequently, the Financial Stability and Development Committee of the State Council held its fifty-first meeting, stating that it would crack down on Bitcoin mining and trading. In the global Bitcoin mining network, Chinese miners have always occupied a dominant position. According to multiple authoritative data, basically two years ago, the computing power owned by Chinese mining pools accounted for 65% of the computing power of the entire Bitcoin network.

As a brand-new digital asset, cryptocurrency has no physical currency form, and its value base is completely different from traditional financial assets, but it has gained certain market recognition and attracted the attention of many scholars for its advantages of anonymity, low transaction cost and fast speed. Since the entire cryptocurrency market is in the stage of exploration and development, and there are a large number of "bubbles", resulting in sharp price fluctuations. The risks faced by relevant market participants increase and may lead to risk contagion. Therefore, the study on influencing factors of cryptocurrency is particularly important. Through the research on changes in the macro environment and the internal mechanism of cryptocurrencies, the research and theoretical results of cryptocurrencies can be enriched.

This paper hopes to analyze the determinants of Bitcoin price, its internal influencing factors, and the external macro environment, observe what factors have a major impact on the price of the currency after China's "coin mining" ban is issued, and give constructive suggestions on the prevention and control of the risks of Bitcoin in the financial field. This paper will conduct an in-depth analysis of the determinants of the currency price through econometric methods such as VAR model impulse response analysis and variance decomposition.

CHAPTER 2

THEORY ON BITCOIN & LITERATURE REVIEW

Theoretical Analysis of Bitcoin

The operating mechanism of Bitcoin

Bitcoin mining (Mining) is the only way to issue new Bitcoins. The process of mining activities is as follows: (1) Each miner node uses the content of the latest block in the local blockchain as an input value to calculate its hash solution; (2) Bitcoin miners screen the transaction information forwarded or released by other nodes and delete the transaction information included in the blockchain, with insufficient balance or other errors. The transaction collected is continuously broadcast at the same time. (3) Randomly generate a set of strings and combine the strings with the obtained hash value and the entered transaction information as input and output a new hash value; (4) Detect whether this new hash value is less than the current difficulty threshold. If the new hash value is less than the current difficulty threshold, the mining is successful, and a new block is generated. Broadcast is made to the whole network. If the hash value result is greater than the threshold value, recalculate from step 3; (5) Other nodes receive this newly born block and verify whether its hash value meets the requirements. If enough miner nodes prove that the block is uniquely valid, other nodes will receive the block and add it to the local block chain. Miners who successfully mine a new block will receive a certain amount of bitcoin rewards, and the bitcoin system will generate a new block in about ten minutes on average; (6) If other miner nodes successfully dig out a legal new block, the remaining nodes will add this block to the local and start mining from step one.

In order to effectively control the production speed of the new block, the Bitcoin system constantly adjusts the difficulty threshold of the hash algorithm based on the total computing power of the entire internet. The larger the computing power of the entire internet is, the smaller the threshold is and the higher the difficulty is. When the time interval between a new block being mined is less than 10 minutes, the system will automatically increase the difficulty of the hash algorithm of the next block; when the time interval between a new block being mined is greater than 10 minutes, the system will reduce the difficulty of the next hash algorithm. Finally, a new zone is generated every 10 minutes on average. That is to say, the average computing power put into production in a period is directly proportional to the difficulty of mining. The higher the computing power of the entire network is, the greater the difficulty of mining is. Miners participate in the whole network competition with their own computing power, and mine according to the probability determined by the ratio of their computing power to the whole network computing power. If they successfully calculate the hash value of the previous block first, they will publish it to the internet. If the hash value calculated is recognized by the entire node network, then it can be counted as successful mining. If someone mines ahead of time within ten minutes, the previous calculation will be invalidated, and a new block can be recreated. The working method of paying computing power to solve the hash problem used by Bitcoin mining is also called Pow (proof-of-work). This mining method is accompanied by extremely high-power consumption. Power consumption is proportional to Bitcoin price which represents the miners' costs.

Determination of bitcoin price

1. Currency attributes of Bitcoin

The function of currency is reflected in the changes in commodity transactions from ancient times to the present. The currency has the function of a value measure and a method of circulation at the earliest. Before the commodity enters the market circulation, its value is measured at the currency level first, and the function of value scale of the currency is performed; after the commodity enters the market circulation, the currency is the medium of its transaction, and the function of the circulation means of the currency is performed. These are the two basic functions of the currency. Currency, as a general representative of social wealth, can be used as a store of value when it ceases to circulate, thereby performing the function of a means of storage. With the development of the commodity economy, credit sales transactions began to appear. At this time, currency no longer performed the function of a means of circulation but was used to pay off debts on the agreed delivery date, which performed the function of a means of payment.

As a means of value exchange, its medium has also undergone a series of evolution, including the era of commodity currency in which salt, shells, stones, etc. are used as mediums, the era of metal currency in which gold, silver, copper, and other precious metals are used as mediums, and the era of gold standard in which paper currency replaced precious metals such as gold and silver. Until now it is the era of credit currency all over the world. The currency circulation speed is faster, the currency circulation cost is lower, and the total amount of currency can better meet the requirements of economic activities. Existing research has discussed the changes in the

form of currency in the future. It should have a faster circulation speed, a more flexible total amount of circulation, and a more extensive usage scenario. Bitcoin, which integrates distributed storage database technology, P2P communication protocol, consensus algorithm, encryption algorithm and other technologies with blockchain technology as the underlying technology, just fits these requirements.

Bitcoin is an entirely new currency that goes beyond the definition of currency ever before. It is different from other sovereign currencies in that it has no fixed issuer. The creation of Bitcoin does not rely on credit but maintains a total circulation flow with a controllable issuance speed in the market. This point is similar to the feature of gold, but not exactly the same as the feature of gold. According to the discussion of the scope of the money supply and demand theory, on the supply side, Bitcoin has a constant issuance speed: starting from 2009, a block is mined every ten minutes and 50 Bitcoins are created, and then the issuance is halved every four years. 18 million bitcoins have been mined until 2019, and the final total number of bitcoins issued will be 21 million. On the demand side, people hold Bitcoin because of the convenience of its global transactions, the immutability of account book, and the fairness of decentralization, which makes the price of Bitcoin soar from 0.003 dollar to a maximum of 18,674 dollar. With an advantage of a stable total amount similar to gold, and at the same time a more flexible usage scenario than traditional currencies, Bitcoin is destined to become an alternative to satisfy investors' daily asset allocation.

In sum, Bitcoin is an electronic asset with currency attributes. We next discuss Bitcoin from two aspects: the research scope of traditional currency and the unique mining behavior of Bitcoin.

2. Liquidity preference theory

The discussion of the currency attribute of Bitcoin is based on Keynes' liquidity preference theory. Keynes published “The General Theory of Employment, Interest, and Money” in 1936. The book explains the value storage function of currency. Whether it is put in a pocket or locked in a bank safe, people will not worry about its corruption like storing food, and it can still be used even if it is taken out after ten years. Currencies have the strongest liquidity when used for transactions, unlike other assets such as bonds and stocks, which must be converted into money before they can be exchanged for goods and services. Keynes and his schools emphasized the status of monetary liquidity, so his monetary theory is also called liquidity preference theory.

Keynes believes that there are three main motivations for the public to hold currency. One is transaction motivation, which generally refers to the motivation of individuals and companies to hold currency to purchase goods. The currency demand for transaction motivation mainly depends on income, and the transaction motivation of Bitcoin mainly depends on Bitcoin's economies of scale, transaction costs, and transaction speed. The second one is the cautious motivation, also known as the precautionary motivation, which refers to the motivation to hold a part of currency to prevent unexpected expenditures. This part of the motivation in the Bitcoin system also depends on the transaction cost, transaction speed, and Bitcoin's economies of scale. The third one is speculative motivation, which refers to the motivation to hold a part of currency to seize favorable opportunities to buy securities or other financial products. The bitcoin demand for speculative motivation mainly depends on the global

comprehensive interest rate and is inversely proportional to the global comprehensive interest rate. The higher the global comprehensive interest rate is, the more people are inclined to sell Bitcoin and hold financial assets denominated in other traditional currencies.

It can be concluded in terms of the exposition above that the interest rate is inversely proportional to the speculative demand for money. Keynesians believe that interest rates should be controlled before controlling currency demand. Therefore, the Keynesians suggested that the government can control the interest rate by controlling the currency supply and should implement interest rate regulation when necessary. His specific suggestion on monetary policy is that when the economy is depressed, an expansionary monetary policy should be adopted to increase the money supply so as to lower interest rates to stimulate economic recovery; when the economy is advancing at a high speed, a tight monetary policy should be adopted to reduce the money supply so as to raise interest rates to inhibit excessive economic growth. The adoption of monetary policy should be based on economic trends and discretionary approaches.

3. Attributes of the mining market

Traditional microeconomics defines the market as an organizational form or institutional arrangement in which buyers and sellers interact with each other to determine the transaction price and transaction quantity. It can be a tangible trading place for buying and selling items, such as vegetable markets, department stores, etc., or it can be a contact point that using modern communication tools to trade items, such as the stock market and foreign exchange market. The cryptocurrency mining market is a virtual market without specific locations and traders. Participants in mining are called miners.

Unlike miners in the real sense, cryptocurrency miners do not pay actual physical labor, but instead paying the computing power of their integrated processors. The mining process is not aimed at limited ore resources, but at inexhaustible cryptocurrency blocks.

In the cryptocurrency mining market, miners produce almost indiscriminate computing power and receive token rewards with the same value. In the long run, the mining market is more inclined to a perfectly competitive market. The economic definition of a perfectly competitive market is a market that does not contain any monopoly factors. There are a large number of buyers and sellers in the market, the goods provided by each manufacturer are completely homogeneous, all resources are in full liquidity, and market information is complete. However, in the short term, cryptocurrency miners have to confront with different electricity costs, different mining equipment, different mining software and incomplete market information, so the research of this paper temporarily classifies the Bitcoin mining market as a monopoly competitive market. The economic definition of a monopolistic competition market is a market organization in which many manufacturers produce and sell the same kind of product with differences and same product price. It is easy to enter and exit the market, and the manufacturers in the market can obtain short-term excess profit.

The Theory of Herding

Herding behavior refers to the behavior of investors in the market who are influenced by some other investors and blindly follow the crowd. Some scholars also call it "the crowd effect" or "herding effect". In recent years, the continuous development of behavioral finance theory has increasingly challenged the traditional efficient market hypothesis. Herding behavior is a typical phenomenon that cannot be explained by the

rational hypothesis. The connotation of herd behavior is the abnormal market behavior caused by the herd mentality and follow-up mentality of market participants. Keynes (1934) was the first to clarify the problem of "herding effect" in financial market. He pointed out that one of the reasons for the huge fluctuations in the stock market for a period is the group behavior generated by irrational emotions. In securities markets with herding behavior, market ups and downs are expanded, the price mechanism is chaotic, and the market efficiency is reduced. A deep understanding of irrational behaviors such as herding behavior can help us explain real-world economic phenomena.

Expectation theory also explains many phenomena in life that deviates from rational choices. It is a descriptive theory that specifically explains human behavior in making choices under uncertain conditions. Anticipation is a kind of mental calculation activity, and anticipation itself shows certain rationality. But for future events, it is impossible for people to calculate a definite risk probability as assumed by neoclassical theory; at the same time, people's expectations for the future do not have any definite connection with current events. Therefore, there is a certain degree of uncertainty and instability in expectations, and it has a subjective preference, that is, expectations are closely related to specific conditions and specific personal behavior preferences. With the uncertainty of the future, different people will have different expectations. In a sense, the economic process is the process of human economic behavior, and expectations, as a characteristic and prerequisite of the activity of economic parties, undoubtedly dominate their explicit economic behavior. This kind of economic behavior based on uncertainty has an irrational color.

At the same time, we also emphasize the consensus theory. Whether it is investment in cryptocurrency or other types of financial assets, it is essentially the result of a consensus. For market investors, some of them got some conclusions and enlightenment through reading a lot of books and analyzing past transactions experience. They applied the enlightenment to current financial assets. Compared with other investors, they can predict price changes in advance, and these people are often the first to smell the consensus and place the bet. When other investors in the market realize and make corresponding changes, the market consensus is reached, and the price tends to rise or fall. Therefore, based on consensus factors, we can explain the mutual influence of asset price fluctuations as well.

We believe that the expectation theory, consensus theory and herding effect that exist in other stock markets also exist in the cryptocurrency market and have been more effectively verified in the cryptocurrency market. In this thesis, we explain the possible influence between different cryptocurrencies with a psychological factor, that is, the herding effect. Like the stock market, when a certain industry is favored by everyone, such as the new energy industry, the consumer industry, etc., at this time, it may be a company with a small market capitalization in the industry as the first one to rise sharply. The reason may be a company with a small market capitalization needs a small amount of funds for a sharp rise and is more likely to be influenced by market funds. In this case, many investors will tend to be on the safe side and do not want to be affected by large funds. Retail investors will tend to buy stocks with a large market capitalization in the industry, then these stocks will also have a large increase in a few days or a period after the rise of small market value stocks, but this increase and lag time cannot be effectively

predicted. It is common to see this situation. Generally speaking, in financial investment activities, there will be a herding effect. Due to changes in other asset prices or relatively large changes in the price of Bitcoin itself, investors at this time believe that funds will flow in substantially to those currencies due to psychological effects and inner expectations. The price of such currencies will also experience similar rises and falls.

Therefore, the financial theory applied in the investment of other financial assets can be applied even more effectively in the cryptocurrency market. Due to the particularity of the creation of cryptocurrency, it is not anchored to any base currency, and its essence is independently generated and will exist for a long time. Virtual currencies such as Bitcoin have no clear fundamental value, and their price fluctuations can be completely determined by public expectations and strictly follow the supply and demand relationship in the market. When there is good news in the market, such as further regulation or liberalization and increase in the value of physical applications, consumers believe that their prices will show an upward trend out of expectations and consensus effects; under the herding effect, a large amount of funds blindly chase this scarce product, and this will make price rise spirally. Conversely, bad news such as tightening regulatory policies will lead to a sharp decrease in prices.

Literature Review & Hypothesis Development

Regarding the factors affecting the price of Bitcoin, many Chinese scholars have conducted analyses from different angles, including macro factors, such as the U.S. dollar index, gold price trends, stock indexes, etc. Deng Wei (2017) proposes that Bitcoin is a perfect financial speculation object, speculative factors are the main reason for the Bitcoin price bubble, and the lack of supervision is an important reason for the

continuous expansion of the Bitcoin price bubble. In addition, the overestimation of the value of Bitcoin is due to excessive exaggeration on the advantages of Bitcoin and market manipulation are also possible factors for the long-term existence of the Bitcoin price bubble. Niu (2017) argues that the price fluctuations of Bitcoin are affected by the prices of other investment tools. Through the cointegration relationship test, it is found that there is no long-term stable relationship between the price of Bitcoin and the price of traditional investment tools, but in the short term, the price of Bitcoin is still positively affected by the stock index and exchange rate and negatively affected by interest rates.

Yan (2018) explored factors that affect fluctuations in Bitcoin prices. She theoretically analyzed the impact of national policies and their own demand on its price fluctuations and empirically analyzed the impact of exchange rates and investment tools, including gold and stocks, on its price. She established a VAR model on Bitcoin price, gold price, stock price index, and exchange rate and did cointegration test, Granger causality test, impulse response analysis and variance decomposition, aiming to explore whether there is a short-term or long-term correlation or causality. She also tried to figure out the size of contribution of the three variables and Bitcoin itself to its price fluctuations. The results show that there is no long-term co-integration relationship among the variables, and three variables have significant short-term lag effects on Bitcoin prices and the influencing time is long. Gan (2021) divided the determinants of Bitcoin price into three groups: internal factors, macroeconomic factors, and emotional sentiment factors. She selected the sample interval period from February 2013 to February 2021 and used the AR-GARCH model and VAR model to analyze the volatility rate of Bitcoin and influencing factors of price. The study found shows that macroeconomic factors (US

dollar index) have the greatest impact on the short-term price of Bitcoin. The long-term price of Bitcoin is mainly affected by internal factors (transaction cost).

Digital currency represented by Bitcoin has achieved rapid development during the past ten years, and the correlation between prices of Bitcoin and other types of assets has significantly increased. Zhu et al. (2017) pointed out that by June 28, 2021, Bitcoin still accounted for 47.17% of the total cryptocurrency market. Bitcoin is a speculative asset. They compared the impact of various economic factors on the price of Bitcoin through the VEC model, and found that among the Consumer index, the price of the US dollar and the financial market environment have the greatest impacts on the price of Bitcoin. Selmi (2018) explores the linkage between Bitcoin, gold, and crude oil prices from the perspective of quantile regression, and the results indicated that gold and Bitcoin can be used as safe haven hedging assets for crude oil. The range of the increase of the prices of gold and Bitcoin will be enlarged as Crude oil prices fluctuate violently, that is, Bitcoin can be used as a safe-haven asset to a certain extent. Gillaizeau (2019) used volatility measurement and dynamic forecasting methods and found that there is an interaction between Bitcoin and the US dollar. Shahzad (2019) conducted a regression test on the relationship between Bitcoin, gold, commodities, and the stock market based on time series, and found that in the case of high stock market fluctuations, both Bitcoin and gold price will rise to a certain extent. Wang, Chen, & Zhao (2020) examined the relationship between Bitcoin and the stock market (S&P500, NASDAQ, and Dow Jones Industrial Average). The result showed that the effect of Bitcoin on the stock market is weaker than that of the stock market on Bitcoin, while S&P500 stock growth has a comparatively strong influence on Bitcoin. Zheng (2021) use the SVAR model and find

that the price of Bitcoin is positively affected by the exchange rate of the euro against the US dollar and the Nasdaq index return, and negatively affected by gold price and the federal interest rate. The variance decomposition results of Bitcoin price show that the impact of various indicators on the price of Bitcoin is gradually increasing, and the price of gold has the greatest impact on the price of Bitcoin.

Based on this, this paper puts forward hypothesis 1 (H1): The price of Bitcoin will be affected by the macroeconomic environment, among which the fluctuations of the US dollar index, gold price, international energy index and stock market will have a certain impact on the price of Bitcoin.

Ding Dong (2018) pointed out that, first, the core of Bitcoin's operating mechanism lies in the behavior of mining. As a major innovation in the history of currency development, a series of innovative ideas and methods used in the design of Bitcoin are worth learning. The innovation includes the challenges to the current credit notes, the exploration of the world's unified currency, and the application of blockchain technology.

Secondly, due to the decentralization of Bitcoin, illegal transactions cannot be supervised, and the superior limit of the total amount will cause people to collect Bitcoin instead of using Bitcoin for various payment behaviors. With a series of reasons such as competition from various other digital currencies with the same effect, Bitcoin will not be able to perform the basic functions of currency well in the future, nor will it become the next generation of currency. Finally, the supply of Bitcoin will be affected by the mining cost of Bitcoin and the attitudes of governments towards bitcoin mining; the demand for bitcoin can be divided into speculative demand, transaction demand, and prudent

demand. In addition, the demand for bitcoin will also be affected by the government's policy on bitcoin transactions. The price of Bitcoin is determined when supply and demand reach equilibrium. In addition, given the two attributes of Bitcoin—currency and mining behavior, we propose that Bitcoin price is positively related to the interest level in the international market and Bitcoin computing power. Based on this, this paper puts forward hypothesis 2 (H2): The price of Bitcoin will be affected by the internal operation mechanism, among which the trading volume, transaction cost, miner computing power and speculative demand of bitcoin will have a certain impact on the price of bitcoin.

In addition, the 2017 China Bitcoin trading ban after the promulgation of the bitcoin trading market brought a large impact on bitcoin price. Given that, we expect that the recent Chinese mining ban issued in 2021 will also change the environment of the Bitcoin exchange market. As a result, this paper puts forward hypothesis 3 (H3): The factors and their impacts on the price of Bitcoin will change after the issuance of China mining ban in May 2021. Combined with past literature research, many scholars have studied the external macro influencing factors, such as the stock market, gold price and other cryptocurrencies, on the influencing factors of bitcoin price and the internal factors related to the operation mechanism of bitcoin, such as the computing power or energy of bitcoin. However, there is little literature that combines the two categories of factors to analyze the strength of the impact. Prior to this paper, there is much domestic literature focusing on China’s ban on Bitcoin transactions in China in 2017 or the development of Bitcoin in the previous years. Therefore, the time range selected in this paper is updated. This paper hopes to observe the difference between macro and internal influencing factors after China bans mining after 2021.

CHAPTER 3

INTRODUCTION OF MODEL

Data Source

This paper selects data from January 1, 2020 to February 28, 2023. Following previous studies and the operational theory of bitcoin, we selected the dollar index, the international gold price, the stock market (S&P500), and the price of crude oil as the macroeconomic factors. Bitcoin transaction volume, transaction cost, bitcoin computing power and speculative demand (one-year Treasury bond yield) were selected to measure the internal factors of Bitcoin. Bitcoin transaction data and mining statistics are from Block Chain and bitcoin research institutions BlockChain.info, CoinDesk, investing.com and BTC.com. Stock market data is from the RESSET financial database. The international gold price is obtained from the London Bullion Market Association (LBMA) official website. LMBA is the world's most authoritative independent precious metals association and provides the most representative data.

1. Dependent variable:

Bitcoin price (P): It is expressed by the exchange rate of bitcoin against the US dollar, which reflects the fluctuation of the price of bitcoin.

2. Independent variable:

1) US dollar index (DO): It is a variable that comprehensively reflects the supply and demand of the US dollar in the international foreign exchange market and is used to measure the change degree of the US dollar against a basket of currencies. Here it is used to reflect the price of goods bought with Bitcoin.

2) Gold price (G): Gold is an excellent safe-haven asset, and even though it is no longer a currency, it still has value. Due to its scarcity and good physical properties, it is also used as a stable means of storing value.

3) Stock market (S): The S&P 500 index represents the stock market index.

4) International energy price (PE): This paper uses the OPEC crude oil price as an alternative variable. The OPEC crude oil price is a common crude oil export price used by the 12 OPEC members. It provides a good indication of the overall global energy supply and demand.

5) Bitcoin trading volume (V): It is the daily trading volume of Bitcoin, which is used to reflect the change of demand in the Bitcoin market.

6) Bitcoin transaction cost (CT): It indicates the resistance factor of Bitcoin in the transaction process, which can be directly expressed by Bitcoin transaction fees. Bitcoin transaction fee is the “handling fee” charged by miner nodes to verify and record transaction information.

7) Bitcoin computing power (Q): Refers to the Bitcoin hash rate, which is the number of times hash puzzles are calculated per second, directly reflecting the computing power of the entire network.

8) One-year dollar Treasury bond yield (R): It reflects the comprehensive interest rate level in the international market. It is used to measure speculative demand for bitcoin. Referring to the variable selection by Lou Xiao (2019), we also use this variable to measure the speculative demand for bitcoin.

Although we use daily data, cryptocurrency transactions can still be traded on cryptocurrency exchanges during weekends and holidays, but stock market is closed for weekends and holidays. We discard the dates where U.S. stock trading did not occur.

Model Introduction

Our time series model analysis is shown below:

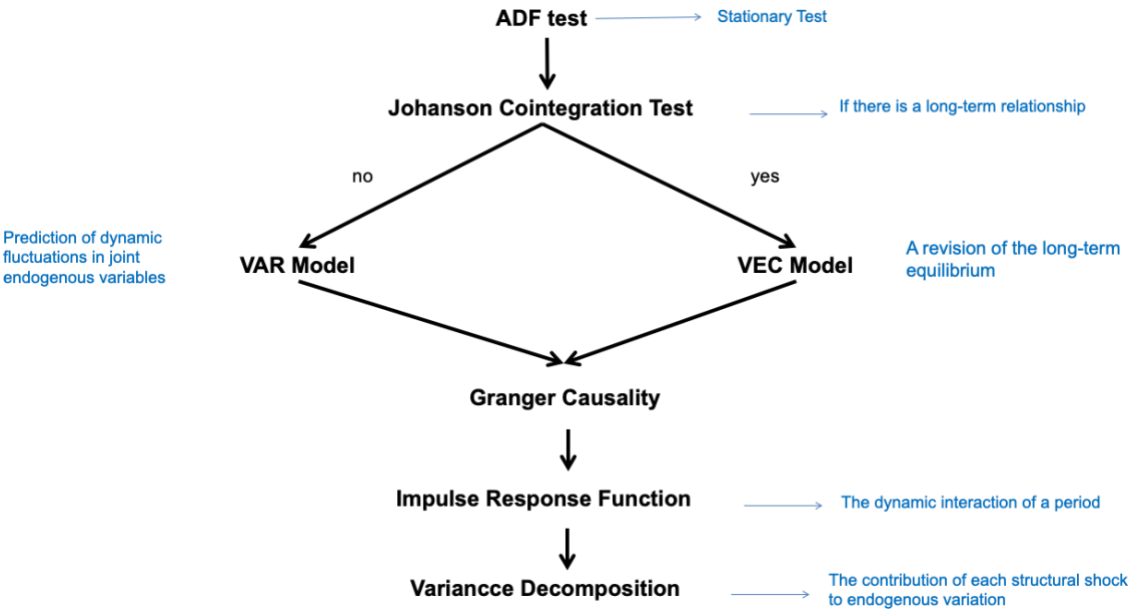

Figure 1. VAR/VECM model regression process

1. Stationary (ADF) test

The stationarity of sequence is the premise of regression analysis. Among the stationarity test methods, there are mainly autocorrelation test, unit root test and non-parametric test. The unit root test is an effective method to test the stationarity in modern time series analysis at present. Therefore, in this paper, Augmented Dickey-Fuller test (ADF), which has been widely used in empirical financial analysis in recent years, is used to test the stationarity of the original sequence.

The principle of ADF is to add lag term of dependent variable to the independent variables to reduce the autocorrelation of residuals of the regression equation. (Dickey and Fuller, 1981) Its specific model is as follows:

Case 1: No intercept and trend terms: $\Delta y_t = \varrho x_{t-1} + \sum_{i=1}^{m} \varphi_i \Delta x_{t-1} + \varepsilon_t$

Case 2: The existence of the intercept term: $\Delta y_t = c + \varrho x_{t-1} + \sum_{i=1}^{m} \varphi_i \Delta x_{t-1} + \varepsilon_t$

Case 3: Whether intercept terms and trend terms exist: $\Delta y_t = c + \gamma t + \varrho x_{t-1} + \sum_{i=1}^{m} \varphi_i \Delta x_{t-1} + \varepsilon_t$

Case one means there is no intercept term and trend term; In case two, c is the intercept term; In case three, c is the intercept term and γt is the trend term.

If the sequence Y fails to reject the null hypothesis after ADF test, the sequence needs to be differentiated again and finally put into the ADF model for test to determine whether it is stable. If the time series is stationary after d difference, it is said that the sequence is stationary of order d, that is, the I(d) process.

2. test of cointegration

When the original time series is unstable, the VAR model or VEC model cannot be directly constructed. Toda and Phillip pointed out that the same order difference stationarity appeared in the stationarity test, which means that there may be a long-term cointegration relationship between variables. Therefore, the co-integration (Johansen) test is used to determine if there is a long-term relationship.

For the P-order VAR model, it can be defined as:

$$Y_t = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_n Y_{t-n} + HX_t + \epsilon_t$$

C represents the n×1 constant vector, Φi(i=1,2,,,,,p) represents the n×n autoregressive coefficient matrix, and εt represents the n×1 dimensional vector.

3. VAR model

Regardless of VAR or VEC model, we need to first determine the lag order q. Akaike information criterion, Bayesian information criterion and Hannan-Quinn information criterion are adopted. Lutkepohl found that the lag lengths selected by

these criteria had the following relationship: q(SC) ≤q(HQ) ≤q(AIC). If q(SC) =q(HQ)=q(AIC), the optimal order of lag can be confirmed. Otherwise, the corresponding residual autocorrelation will need to be analyzed by running Ljung and Box's Portmanteau autocorrelation tests to determine the optimal lag length. In principle, we prefer q(SC) because there are fewer unknown parameters to estimate.

If the variables are not co-integrated, Toda and Phillips suggest that the use of stationary differential data series for Granger causality test of the VAR model has a higher effect than the horizontal data series directly applied to a limited sample. Therefore, the VAR model is estimated as:

$$\boldsymbol{Y_t = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_n Y_{t-n} + \epsilon_t}$$

Where Yt is the N×1 order time series vector, containing explanatory variables; Φi is the matrix of coefficients; C is a constant vector; εt is a k-dimensional vector.

4. VEC model

If the variables are co-integrated, the VEC-based model is used. The VEC model is a limited VAR model for non-stationary sequences with known cointegration.

Compared with VAR model, ECTt-1 with coefficient δ is added to VEC model. ECTt-1 is called an error correction term, and it contains information about the long-term relationship between the cointegration variables, which can be obtained from Johanson's test. δ indicates that the deviation from the long-term equilibrium and the dependent variable is gradually corrected through a series of local short-term adjustments:

$$\boldsymbol{Y_t = C + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_n Y_{t-n} + \epsilon_t + \delta ECT_{t-1}}$$

Where Yt is the time series vector of order N×1, Φiis the coefficient matrix, C is the constant vector, εt is the K-dimensional vector.

5. Granger causality test

The concept of Granger causality has been widely developed and applied after the pioneering research of Granger(1969) and Sims(1972). In essence, "Granger causality" tests whether the lag of one variable has a marginal predictive effect on another variable. Granger causality test studies the causal relationship between the change of one variable and the change of another variable in the lag period. It is expressed in the equation that the variable in the lag period enters the equation of the explained variable as an explanatory variable. Those who can achieve the above effects are regarded as having Grange causality. The following equation represents the binary P-order VAR model:

$$\begin{pmatrix} y_t \\ x_t \end{pmatrix} = \begin{pmatrix} a_0 \\ c_0 \end{pmatrix} + \begin{pmatrix} a_1 & b_1 \\ c_1 & d_1 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \end{pmatrix} + \begin{pmatrix} a_2 & b_2 \\ c_2 & d_2 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ x_{t-2} \end{pmatrix} + \cdots + \begin{pmatrix} a_p & b_p \\ c_p & d_p \end{pmatrix} \begin{pmatrix} y_{t-p} \\ x_{t-p} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{pmatrix}$$

If and only if bi=0 (i=1, 2,... p), x does not Granger cause y, which is equivalent to that x is exogenous to y; By the same token, if and only if ci=0 (i=1,2... p), y cannot Granger cause y, which is equivalent to that y is exogenous to x.

Granger solves the causal relationship between two variables x and y. In other words, it is cause and being caused. However, it should be noted that this causation is not

causation in the usual sense, but only reflects the sequence in statistical time. The core idea of Granger test is that for economic variables X and Y, if the change of X causes the change of Y, the change of X should occur before the change of Y. The empirical results of Granger causality test do not reveal whether changes in a given variable have positive or negative effects on other variables, or how long such effects will last. This information is provided by checking the impulse response (IR) function of VAR.

6. Impulse response function

This analysis investigates how variables in the VAR or VEC model respond to some external change over time. In a VAR or VEC model, a single criterion shock to the I-th variable directly affects not only the I-th variable itself, but also all other variables. IR is sensitive to the ranking of endogenous variables in the model. To avoid sorting problems, the generalized impulse response (GIR) method of Pesaran and Shin (1998) is applied.

Consider a p-order vector autoregressive (VAR) model:

$Yt = C + \Phi 1 Yt{-}1 + \Phi 2 Yt{-}2 + \cdots + \Phi n Yt{-}n + HXt + \epsilon t$

Where Y is a K-dimensional vector composed of endogenous variables, Φi is a coefficient matrix, C is a constant vector, and ϵt is a K-dimensional vector. With appropriate changes, the above model can be expressed as:

$$Y_t = C + \sum_{s=0}^{\infty} (\psi_s p)(P^{-1}\epsilon_{t-s}) = C + \sum_{s=0}^{\infty} (\psi_s p)(\epsilon_{t-s})$$

ψ is the coefficient matrix and C is the constant vector. P is a non-singular matrix, and ϵt is a vector white noise. The impulse response function of the model shows how shocks to one endogenous variable affect other endogenous variables.

7. Variance decomposition

Variance decomposition is to analyze the contribution of each structural impact to the change of endogenous variables (usually measured by variance) to further evaluate the importance of different structural impacts. Thus, the variance decomposition gives information about the relative importance of each random disturbance that affects the variables in the model. Here are the basic concepts:

$$y_{it} = \sum_{j=1}^{k} (a_{ij}^{(0)} \epsilon_{jt-1} + a_{ij}^{(1)} \epsilon_{jt-2} + a_{ij}^{(2)} \epsilon_{jt-3} + a_{ij}^{(3)} \epsilon_{jt-4} + \cdots)$$

It shows that the contents of each parenthesis are the sum of the effects of the JTH perturbation term i from infinity to the current time point.

CHAPTER 4

EMPIRICAL ANALYSIS RESULTS

Descriptive Statistics

First, we analyze the determinants of bitcoin price after China's mining ban based on a sample of daily observations from June 1, 2021 to February 28, 2023, a total of 9 variables and 638 time-series observations. The descriptive statistics of the sample are shown in Table 1 below.

Table 1. Descriptive statistics (after China's mining ban)

	LN(CT) transaction cost	LN(DO) US dollar index	LN(G) Gold price	LN(P) Bitcoin price	LN(PE) energy price	LN(Q) Computing power	LN(R) Treasury yield	LN(S) Stock market	LN(V) Trading volume
Mean	0.65	4.61	7.50	10.35	4.48	5.24	-0.16	8.34	4.92
Median	0.61	4.60	7.50	10.42	4.44	5.29	0.57	8.35	4.94
Maximum	2.39	4.74	7.62	11.12	4.85	5.85	1.62	8.48	6.77
Minimum	-0.50	4.50	7.40	9.67	4.19	4.42	-3.15	8.18	-1.35
Std. Dev.	0.53	0.06	0.04	0.41	0.17	0.30	1.66	0.07	1.08
Skewness	0.64	0.17	-0.03	-0.05	0.29	-0.60	-0.49	-0.19	-1.74
Kurtosis	3.62	1.81	3.02	1.66	1.89	2.78	1.60	2.01	8.86
Jarque-Bera	37.74	27.92	0.06	32.88	28.57	26.80	53.69	20.58	849.02
Probability	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00
Sum	286.84	2022.43	3292.68	4545.49	1968.83	2299.62	-72.29	3663.37	2159.52
Sum Sq. Dev.	121.67	1.77	0.78	73.38	12.09	40.20	1208.61	2.29	508.97
Observations	439	439	439	439	439	439	439	439	439

It can be seen from descriptive statistics that the skewness of bitcoin transaction cost, US dollar index and energy price is greater than zero, while the skewness of other variables is less than zero. That skewness is greater than zero means that their peak probability density is located on the left side of the mean, that is, the arithmetic mean is greater than the median. Bitcoin transaction costs and Bitcoin volume have kurtosis value that is greater than standard kurtosis 3, meaning that their probability density has the feature of "sharp peak and thick tail", that is, there is a large number of intermediate data and a small number of extreme data. The international gold price has negative skewness

and shows relatively flat probability density, which is due to the fact that gold price, as a huge economic indicator, is less affected by various short-term shock factors. The negative bias of bitcoin price, bitcoin computing power, and one-year U.S. Treasury bond yield have relatively flat probability density because the changes of these three factors depend on constructive inputs and tend to lag.

Stability Test

For time series analysis, the data need to be tested for stationarity first. For stationary time series data, regression can be carried out directly, while for non-stationary time series data, the data need to be processed. Time trend should be removed before the empirical analysis can be carried out. Usually, differential processing is used to make the data stable or co-integration analysis is used to study the long-term equilibrium relationship of variables of the same order. If non-stationary data is directly used for regression, the regression result is likely to be false regression. Therefore, the first step of empirical analysis is to do unit root test. If the data has no unit root, we consider the data to be stationary; otherwise, we consider the original sequence to be non-stationary.

The stationarity test needs to be carried out from case 3 to case 1 mentioned before. If the null hypothesis is rejected in the process, the sequence is stable, and the stationarity test ends. If the null hypothesis cannot be rejected in all three cases, the sequence is unstable and further differential processing is required.

Table 2. Stationarity test (after China's mining ban)

Variable	T-Statistic	Critical Value			Conclusion
		1%	5%	10%	
LNCT	-2.245	-3.441	-2.866	-2.569	Unstable
DLNCT	-16.472	-3.441	-2.866	-2.569	Stable
LNDO	0.219	-3.441	-2.866	-2.569	Unstable
DLNDO	-20.627	-3.441	-2.866	-2.569	Stable
LNG	-2.220	-3.441	-2.866	-2.569	Unstable
DLNG	-21.691	-3.441	-2.866	-2.569	Stable
LNP	-1.286	-3.441	-2.866	-2.569	Unstable
DLNP	-20.366	-3.441	-2.866	-2.569	Stable
LNPE	-1.413	-3.441	-2.866	-2.569	Unstable
DLNPE	-18.515	-3.441	-2.866	-2.569	Stable
LNQ	-1.850	-3.441	-2.866	-2.569	Unstable
DLNQ	-16.087	-3.441	-2.866	-2.569	Stable
LNR	-1.446	-3.441	-2.866	-2.569	Unstable
DLNR	-18.868	-3.441	-2.866	-2.569	Stable
LNS	-1.905	-3.441	-2.866	-2.569	Unstable
DLNS	-20.804	-3.441	-2.866	-2.569	Stable
LNV	-1.766	-3.441	-2.866	-2.569	Unstable
DLNV	-25.937	-3.441	-2.866	-2.569	Stable

Note: LN is logarithm. D is the first-order difference. If you take the first-order difference sequence of the natural logarithm, you will get the rate of change, which still has economic significance.

ADF test results showed that the null hypothesis is not rejected in any of the nine time series at the significance level of 1%, meaning that the original sequences are non-stationary. However, the null hypothesis of unit root is rejected at the significance level of 1% for the first-order difference value of all nine variables. Therefore, the first-order difference values of all variables are stationary, and they are first-order unintegrated, which meets the conditions for the following co-integration test.

Determination of Model Order

The determination of the optimal lag order is very important for the establishment of the model. If the lag order is too large, on the one hand, it will lead to the reduction of the sample size; on the other hand, it will lead to too many variables in the model and too

many parameters to be estimated. Too little lag order will lead to the omission of information. The traditional econometric analysis process determines the order of VAR model by observing the information index AIC and BIC. This paper mainly uses AIC as the information index. Akaike information criterion (AIC) is an indicator to evaluate the complexity of the econometric model and compare the suitability of the "fitting" of the econometric model. It was created and improved by Japanese statistician Koji Akaike. Akaike information Criterion is based on the concept of information entropy.

We use Eviews for order analysis, create the VAR model after establishing the data set, select the maximum lag order p of 8, and observe the indicators in turn.

Table 3. Optimal order of lag (after China's mining ban)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	2084.977	NA	4.41e-16	-9.815496	-9.729381	-9.781469
1	7018.432	9633.649	4.80e-26	-32.75854	-31.89740*	-32.41828*
2	7128.589	210.4182*	4.18e-26*	-32.89640*	-31.26023	-32.24990
3	7196.525	126.8788	4.45e-26	-32.83464	-30.42344	-31.88189
4	7258.450	113.0165	4.88e-26	-32.74445	-29.55822	-31.48546
5	7320.713	110.9827	5.36e-26	-32.65585	-28.69459	-31.09063
6	7377.337	98.52342	6.04e-26	-32.54060	-27.80431	-30.66914
7	7431.565	92.04747	6.91e-26	-32.41402	-26.90270	-30.23632
8	7470.351	64.18438	8.53e-26	-32.21443	-25.92808	-29.73049

According to the principle saying that the minority is subordinate to the majority, the optimal lag order of the model is determined to be 2, which is expressed as VAR (2).

Co-integration Test

VAR or VECM model can be constructed on the premise that data are stable, and the model will produce pseudo (false) regression when the data sequence is not stable. The purpose of co-integration test is to check whether the causal relationship reflected in the regression equation contained in the model contains false regression, that is, to test whether there is a stable relationship between variables.

Therefore, the causality test of non-stationary sequences is called the co-integration test. Co-integration test is often used to investigate whether there is a long-term stable definite co-integration relationship in non-stationary time series.

Table 4. Unrestricted Cointegration Rank Test (Trace) (after China's mining ban)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.135183	204.5326	197.3709	0.0210
At most 1 *	0.092903	141.6446	159.5297	0.3066
At most 2	0.079231	99.42442	125.6154	0.6199
At most 3	0.056496	63.68214	95.75366	0.8929
At most 4	0.032866	38.50101	69.81889	0.9668
At most 5	0.028482	24.03106	47.85613	0.9418
At most 6	0.017916	11.51924	29.79707	0.9473
At most 7	0.007284	3.691430	15.49471	0.9268
At most 8	0.001214	0.526013	3.841466	0.4683

Table 5. Unrestricted Cointegration Rank Test (Maximum Eigenvalue) (after China's mining ban)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.135183	62.88801	58.43354	0.0172
At most 1 *	0.092903	42.22015	52.36261	0.3657
At most 2	0.079231	35.74227	46.23142	0.4135
At most 3	0.056496	25.18113	40.07757	0.7561
At most 4	0.032866	14.46995	33.87687	0.9836
At most 5	0.028482	12.51182	27.58434	0.9102
At most 6	0.017916	7.827812	21.13162	0.9139
At most 7	0.007284	3.165417	14.26460	0.9351
At most 8	0.001214	0.526013	3.841466	0.4683

Through the above analysis, it can be found that all variables are first-order unintegrated and have the same trend component, so the prerequisite for co-integration test is satisfied. We Use Eviews for co-integration test and two outputs are obtained.

The first output is based on trace statistics test results, and the second output is based on the largest feature root test results. It can be seen from the results of the two co-integration tests that the null hypothesis is accepted at the significance level of 5%, that is, there are one co-integration relationships between variables. Therefore, the error correction model should be selected.

Stability Test of the Model

The stationary condition of VECM model is the same as that of univariate autoregressive model, which makes the root of the determinant corresponding to the characteristic root polynomial within the unit circle. We Use the feature root graph analyzed in Eviews to yield the following graph. Unit roots all fall in a circle, so the model is stable.

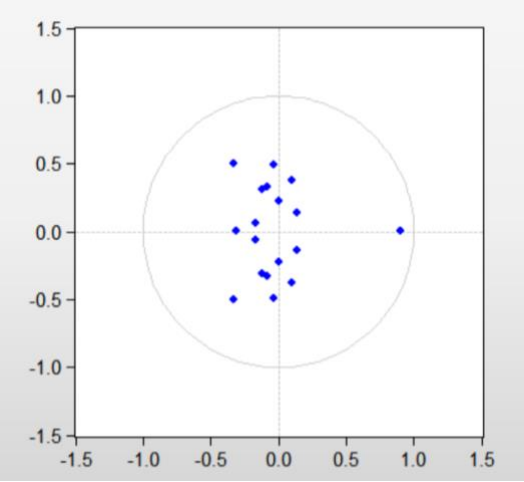

Figure 2. Model stationarity test (after China's mining ban)

Granger Causality Test

If a random variable is helpful to the prediction of another random quantity, the former is said to be the Granger causality of the latter. Granger test must first prove that random variables are stationary sequences, and stationarity is the premise of Granger test.

It has been proved above that the sequence of variable sets is stationary, so Granger test can be carried out. Run the Granger test of VAR model with a lag of 2 orders on Eviews, and the following table is obtained.

Table 6. Granger causality test (after China's mining ban)

Dependent variable: D(DLNP)			
Excluded	Chi-sq	df	Prob.
D(LNCT) transaction cost	14.94202	2	0.0006
D(LNDO) US dollar index	4.753908	2	0.0928
D(LNG) gold price	2.062846	2	0.3565
D(LNPE) energy price	0.463527	2	0.7931
D(LNQ) computing power	3.503084	2	0.1735
D(LNR) treasury yield	0.697820	2	0.7055
D(LNS) stock market	1.286834	2	0.5255
D(LNV) trading volumn	1.575423	2	0.4549

From the Granger causality test, it can be seen that there is a unidirectional causality between bitcoin transaction cost and bitcoin price at the significance level of 1%. There is a unidirectional causality between the US dollar index and bitcoin price at the 10% significance level. However, Granger causality can only represent the data level, bitcoin transaction costs and US dollar index have an explanatory effect on bitcoin price. Therefore, it can be preliminarily concluded that both the internal factors of bitcoin and the external macro market have a certain impact on bitcoin.

Impulse Response Function

The whole system when an error term changes, or the system is affected by certain impulse This is the impulse response function. Since this paper mainly studies the influence of macro and internal factors on the price of bitcoin, it mainly considers the influence of the disturbance of the error term of each variable on the price of Bitcoin.

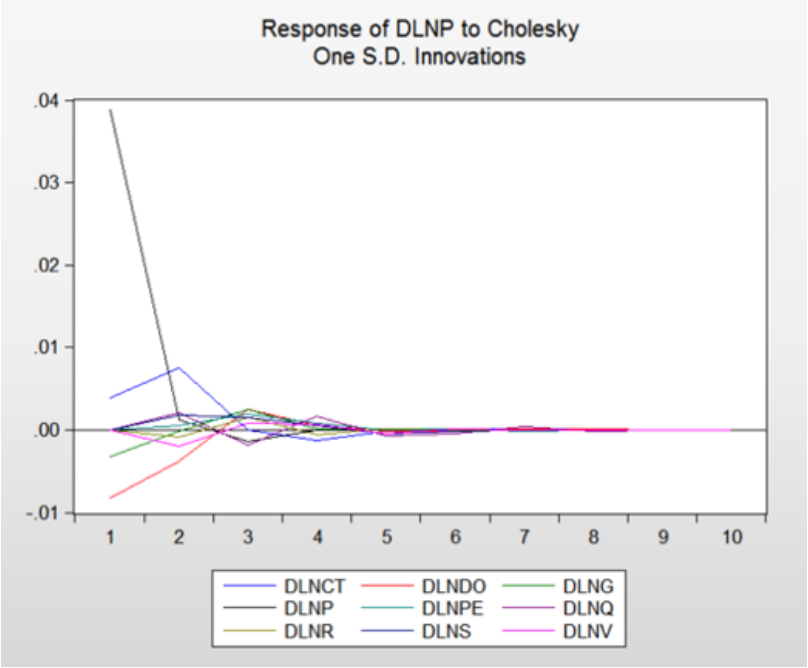

Figure 3. Impulse response diagram (before China's mining ban)

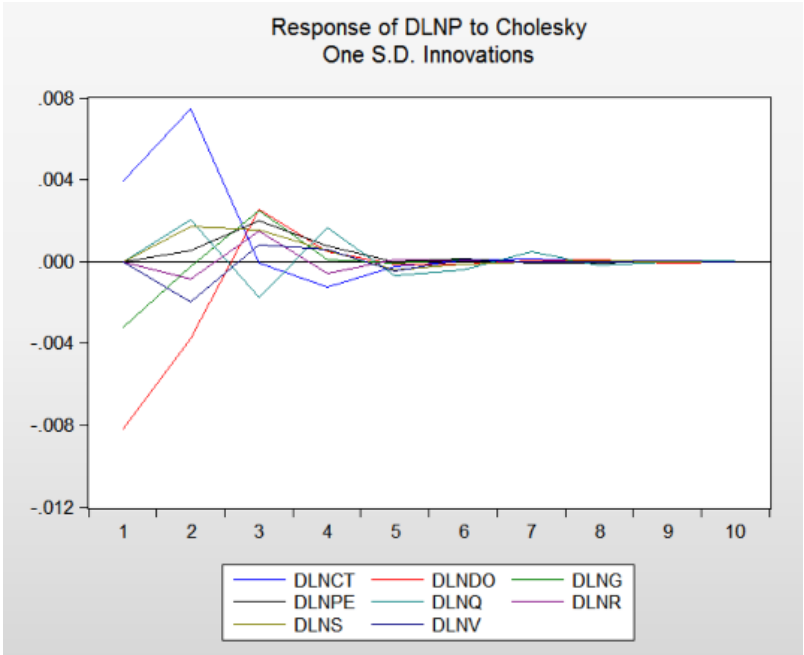

Figure 4. Impulse response diagram (after China's mining ban)

When the bitcoin price is hit by one standard deviation of its own occurrence, the impact reaches its maximum at a lag of one period and then begins to level off. This shows that the price of bitcoin has an obvious positive promotion effect on itself, and it is the most affected at the beginning. When the transaction cost of bitcoin receives a one-standard deviation shock, the impact on the price of bitcoin reaches the maximum at the second lag, and it is the largest positive impact among all variables. Subsequently, a negative effect occurs after a lag of three periods. When the US dollar index receives a one-standard deviation shock, the impact on the price of Bitcoin reaches the maximum negative impact after lagging one period, and the positive impact appears after lagging three periods. In addition, the initial impact of international gold price on bitcoin price is also negative. The remaining variables have small fluctuations in the bitcoin price between lags 1-5 periods. All variables tend to be stable after five periods.

Variance Decomposition

Variance decomposition is used to describe the interpretation degree of other variables when the dependent variable changes. This paper only considers the interpretation degree of other independent variables and their own changes when the bitcoin price is taken as the dependent variable. The results are shown in the following table:

Table 7. Variance decomposition (after China's mining ban)

Period	Bitcoin price	US dollar index	Gold price	Stock market	Energy price	Trading volume	Transaction Cost	Computing Power	Treasury yield
1	94.17471	4.208677	0.631780	0.000000	0.000000	0.000000	0.984833	0.000000	0.000000
2	89.57995	4.840450	0.603303	0.180894	0.018050	0.227359	4.253281	0.251616	0.045097
3	88.28411	5.147944	0.952192	0.320251	0.244741	0.262596	4.186891	0.429509	0.171768
4	87.96031	5.142732	0.949418	0.337475	0.280358	0.283870	4.264354	0.589447	0.192034
5	87.91154	5.140714	0.949269	0.346964	0.280209	0.295859	4.264720	0.618230	0.192490
6	87.89924	5.140858	0.949603	0.348087	0.281290	0.296227	4.264222	0.627860	0.192612
7	87.88686	5.140370	0.949516	0.348042	0.281813	0.296211	4.264552	0.640049	0.192590
8	87.88487	5.140580	0.949502	0.348047	0.282064	0.296205	4.264495	0.641605	0.192628
9	87.88449	5.140728	0.949498	0.348047	0.282228	0.296225	4.264546	0.641603	0.192637
10	87.88433	5.140719	0.949498	0.348049	0.282231	0.296243	4.264553	0.641735	0.192637
11	87.88424	5.140720	0.949499	0.348049	0.282234	0.296244	4.264548	0.641832	0.192638
12	87.88422	5.140720	0.949499	0.348049	0.282236	0.296244	4.264548	0.641848	0.192638
13	87.88422	5.140720	0.949499	0.348049	0.282236	0.296244	4.264548	0.641848	0.192638
14	87.88421	5.140720	0.949499	0.348049	0.282236	0.296244	4.264547	0.641852	0.192638
15	87.88421	5.140720	0.949499	0.348049	0.282236	0.296244	4.264547	0.641853	0.192638

Table 7 shows the variance decomposition of bitcoin value. After a lag of 15 periods, the variance results do not change significantly. According to the analysis of the results, the explanation degree of bitcoin price to itself accounts for 87.88%. The US dollar index has the largest impact on bitcoin price at 5.14%. Secondly, the impact of bitcoin transaction cost on bitcoin price accounted for 4.26%. The influence of international gold price on bitcoin price ranked third, accounting for 0.95%. The influence of bitcoin computing power on bitcoin price ranked fourth, accounting for 0.64%. The stock market (S&P500), bitcoin trading volume and energy price have similar impacts on bitcoin price, accounting for 0.35%, 0.30% and 0.28% respectively. Speculative demand for bitcoin (one-year Treasury yield) only accounted for 0.19% of the impact on the price of bitcoin.

Discussion

Herding effect refers to a herd behavior in which investors, influenced by other factors, blindly follow other investors in the market. In financial theory, "herd behavior" is usually used to explain phenomena that cannot be explained by rational hypotheses, as a supplement to empirical finance, and to demonstrate the role of psychological factors in financial asset transactions on the other hand. Anticipation itself is a kind of mental calculation activity, and there is still a certain lag and implementation success between anticipation and actions. It is usually used together with the "herding effect" as a theoretical explanation for market diseconomies behavior in financial investment activities. This paper uses herding effect and expectation theory to explain that "Bitcoin price explains 87.88% of itself." Due to the specialty of the generation of cryptocurrency, it is not anchored to any base currency, and its essence is independently generated and long-term existence. Virtual currencies such as Bitcoin have no clear fundamental value and essentially have no physical value. Their price fluctuations can be entirely determined by public expectations and strictly follow the supply and demand relationship in the market. When there is good news in the market, out of expectations and the herd effect, when the price of Bitcoin shows an upward trend a large amount of money blindly chases Bitcoin, which will positively promote the price to rise further. Conversely, bad news will bring about a sharp drop in prices.

From the empirical results, we can see that there are many influencing factors of bitcoin price, and it is more likely to cause short-term fluctuations. Among them, the factors that have a significant impact on the price of bitcoin are the US dollar index and

bitcoin transaction cost. Expanding the scope of variables, macro influencing factors include US dollar index, stock market, energy market and international gold price, and these four influencing factors account for about 6.71% of the impact on bitcoin price. Internal influencing factors include bitcoin trading volume, computing power, speculative demand (one-year US Treasury yield) and transaction costs, which account for about 5.39% of the impact on bitcoin price. The gap between macro and internal influence is about 1.32%, with the macro market having a greater impact on the price of bitcoin. This is consistent with the conclusion proposed by Gan (2021) that macroeconomic factors have the greatest impact on the short-term price of Bitcoin.

Internal explanatory factors: The bitcoin transaction fee is paid to miners based on the size of the transaction data, rather than the number of bitcoins traded. As blocks are mined periodically, users effectively bid against the available block space. With the mining ban in China, miners can discover block space much less quickly, and the daily supply of block space is smaller. Demand remains the same or increases, so transaction costs rise. Therefore, the cost of bitcoin transactions has a significant relationship on the bitcoin price. In addition, on the explanation of computing power, Lou Xiao (2019) used data from 2016 to 2018 to study and found that there was a two-way causal relationship between bitcoin computing power and bitcoin price. However, according to our empirical results, computing power is not a significant variable. That may be because of a mining ban in China, which previously accounted for 75 per cent of the world's bitcoin computing power.

CHAPTER 5

ANALYSIS OF THE REGRESSION RESULTS BEFORE THE PROMULGATION OF CHINA'S MINING BAN

To better explain the impact of the promulgation of the Chinese ban, we conduct the same empirical analysis on the data before the ban from January 1, 2020 to May 31, 2021.

Descriptive Statistical Analysis

The descriptive statistics of the currency price model are shown in the table below.

Table 8. Descriptive Statistical Analysis (before China's mining ban)

	LN(CT) Transaction cost	LN(DO) US Dollar index	LN(G) gold price	LN(P) Bitcoin price	LN(PE) Energy price	LN(Q) Computing power	LNR treasury bond yield	LN(S) Stock market	LN(V) Transaction volume
Mean	1.30	4.55	7.48	9.69	3.80	4.85	-1.88	8.13	4.59
Median	1.29	4.54	7.49	9.34	3.82	4.83	-2.06	8.13	4.93
Maximum	4.14	4.63	7.64	11.06	4.26	5.29	0.45	8.35	6.91
Minimum	-1.27	4.49	7.30	8.48	2.50	4.50	-3.19	7.71	0.00
Std. Dev.	1.31	0.04	0.07	0.75	0.37	0.16	0.93	0.13	2.03
Skewness	0.02	0.37	-0.47	0.62	-1.24	0.19	1.44	-0.47	-1.20
Kurtosis	1.89	1.81	2.59	1.85	4.36	2.33	4.41	2.91	3.35
Jarque-Bera	18.15	29.16	15.37	42.00	117.71	8.92	152.27	13.04	88.08
Probability	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Sum	458.61	1609.72	2649.43	3431.35	1344.40	1718.29	-666.16	2879.301	1623.99
Sum Sq. Dev.	609.5203	0.48	1.76	196.06	48.21	9.10	305.96	6.32	1452.10
Observations	354	354	354	354	354	354	354	354	354

It can be seen from the descriptive statistics that Bitcoin currency price, Bitcoin transaction cost, US dollar index, Bitcoin computing power, and treasury bond yield all have skewness greater than zero, and the skewness of other variables is less than zero. These four indicators show that the right tail is longer than the left tail, and the right tail of the curve is extended due to a small number of large sample values. Energy prices, Treasury yields, and Bitcoin volume are greater than the standard kurtosis value of 3. A

kurtosis greater than 3 means that their probability densities have the characteristics of "sharp peaks and thick tails", that is, there are a large number of intermediate value data and a small amount of extreme value data. Bitcoin transaction costs, the U.S. dollar index, and Bitcoin prices are relatively flat and positively biased, showing high similarity.

Stability Test

Table 9. Stationarity test (before China's mining ban)

Variable	T-Statistic	Critical Value			Conclusion
		1%	5%	10%	
LNCT	-1.351	-3.449	-2.870	-2.571	Unstable
DLNCT	-6.999	-3.449	-2.870	-2.571	Stable
LNDO	-1.469	-3.449	-2.870	-2.571	Unstable
DLNDO	-16.479	-3.449	-2.870	-2.571	Stable
LNG	-1.129	-3.449	-2.870	-2.571	Unstable
DLNG	-18.289	-3.449	-2.870	-2.571	Stable
LNP	-0.598	-3.449	-2.870	-2.571	Unstable
DLNP	-21.861	-3.449	-2.870	-2.571	Stable
LNPE	-1.240	-3.449	-2.870	-2.571	Unstable
DLNPE	-19.410	-3.449	-2.870	-2.571	Stable
LNQ	-1.347	-3.449	-2.870	-2.571	Unstable
DLNQ	-7.613	-3.449	-2.870	-2.571	Stable
LNR	-0.323	-3.449	-2.870	-2.571	Unstable
DLNR	-15.483	-3.449	-2.870	-2.571	Stable
LNS	-1.803	-3.449	-2.870	-2.571	Unstable
DLNS	-5.033	-3.449	-2.870	-2.571	Stable
LNV	-3.633	-3.449	-2.870	-2.571	Unstable
DLNV	-13.908	-3.449	-2.870	-2.571	Stable

NOTE: LN is the logarithm taken. d is the first-order difference which takes the first-order difference series for the natural logarithm and what obtained will be the rate of change, still retaining the economic meaning.

The results of the ADF test show that none of the nine sequence data rejects the null hypothesis at 1% significance level, so the original sequence data is non-stationary. However, the first-order difference values of each variable reject the null hypothesis, so the first-order difference values of each variable are all stationary data, and they are all first-order integrated, which satisfy the following conditions for the cointegration test.

Model Ordering

Table 10. Optimal lag order (before China's mining ban)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	4515.653	NA	1.81e-23	-26.82531	-26.72307*	-26.78456
1	4723.103	402.5524	8.53e-24	-27.57799	-26.55555	-27.17042*
2	4825.065	192.3926	7.53e-24	-27.70277	-25.76013	-26.92838
3	4916.912	168.3859	7.08e-24	-27.76733	-24.90450	-26.62613
4	5030.494	202.1487	5.86e-24	-27.96127	-24.17824	-26.45325
5	5131.646	174.6075	5.24e-24*	-28.08122*	-23.37800	-26.20639
6	5199.894	114.1534	5.71e-24	-28.00532	-22.38190	-25.76367
7	5260.275	97.75951	6.56e-24	-27.88259	-21.33897	-25.27412
8	5332.759	113.4720*	7.05e-24	-27.83190	-20.36808	-24.85661

According to the principle that the minority obeys the majority, the optimal lag order of the model is determined to be 5, expressed as VAR(5).

Cointegration Test

Table 11. Unrestricted Cointegration Rank Test (Trace) (before China's mining ban)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.346239	675.8656	197.3709	0.0001
At most 1 *	0.301891	531.3611	159.5297	0.0000
At most 2 *	0.278814	409.1716	125.6154	0.0000
At most 3 *	0.209087	298.0400	95.75366	0.0000
At most 4 *	0.170685	218.2872	69.81889	0.0000
At most 5 *	0.161008	154.6546	47.85613	0.0000
At most 6 *	0.124480	94.96610	29.79707	0.0000
At most 7 *	0.088073	49.76731	15.49471	0.0000
At most 8	1.052737	18.42079	3.841466	0.9784

Trace test indicates 8 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 12. Unrestricted Cointegration Rank Test (Maximum Eigenvalue) (before China's mining ban)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.346239	144.5046	58.43354	0.0000
At most 1 *	0.301891	122.1894	52.36261	0.0000
At most 2 *	0.278814	111.1316	46.23142	0.0000
At most 3 *	0.209087	79.75283	40.07757	0.0000
At most 4 *	0.170685	63.63261	33.87687	0.0000
At most 5 *	0.161008	59.68847	27.58434	0.0000
At most 6 *	0.124480	45.19879	21.13162	0.0000
At most 7 *	0.088073	31.34652	14.26460	0.0000
At most 8	1.052737	18.42079	3.841466	0.9784

Max-eigenvalue test indicates 8 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

From the results of the two cointegration tests, it can be seen that the null hypothesis is accepted at a significance level of 5%, that is, there are 8 cointegration relationships among the variables. Therefore, an error correction model should be selected. (VECM model results are placed in the appendix)

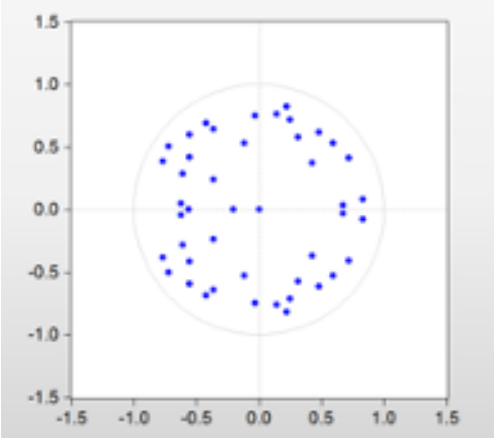

Figure 5. Model Stationarity Test (before China's mining ban)

The unit roots all fall within the circle, so the model is stationary.

Granger Causality Test

The Granger test must first prove that the random variable is a stationary sequence. Stationarity is the premise of the Granger test. It has been proved that the sequence of the variable group is stationary, so the Granger test can be performed. We run the Granger test of the VAR model with lag 5 on EViews and get the following table.

Table 13. Granger causality test (before China's mining ban)

Dependent variable: D(DLNP)

Excluded	Chi-sq	df	Prob.
D(DLNCT)	10.55495	5	0.0610
D(DLNDO)	4.214440	5	0.5190
D(DLNG)	1.745832	5	0.8831
D(DLNPE)	11.50306	5	0.0423
D(DLNQ)	6.651802	5	0.2479
D(DLNR)	25.51154	5	0.0001
D(DLNS)	16.09511	5	0.0066
D(DLNV)	1.277750	5	0.9372
All	108.8355	40	0.0000

From the Granger causality test, it can be seen that there is a one-way causal relationship between the S&P500 (stock market) and the one-year U.S. Treasury bond yield (speculative demand) and the price of Bitcoin at a significance level of 1%. There is a one-way causal relationship between energy prices and bitcoin prices at a significance level of 5%.

There is a one-way causal relationship between the transaction cost of Bitcoin and the price of Bitcoin at the 10% significance level. In terms of data, S&P500, one-year U.S. Treasury yield, energy prices, and Bitcoin transaction costs can explain the price of Bitcoin. The one-year U.S. Treasury yield is used to explain the speculative demand for

Bitcoin. Therefore, it can be preliminarily concluded that both internal factors of Bitcoin and macro market influencing factors can explain Bitcoin.

Impulse Response Function

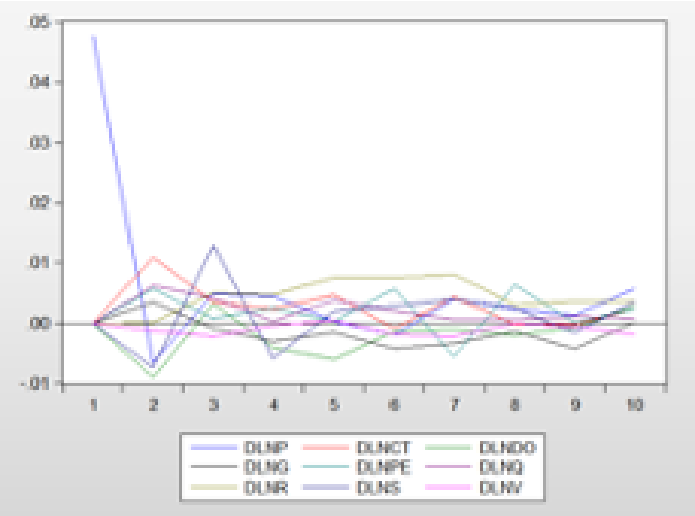

Figure 6. Impulse response function (before China's mining ban)

We can see that the influence of 4 macro variables and 4 internal variables on the price of Bitcoin returns to a stable level after 10 periods. When the price of Bitcoin is impacted by one standard deviation of itself, the impact reaches its maximum in the first period of lag, negative in the second period, positive in the third period, and then begins to stabilize. This shows that Bitcoin price has an obvious positive effect on itself, and it is most affected at the beginning.

When the Bitcoin transaction cost is impacted by one standard deviation, the impact reaches its maximum in the second period of lag, and then the impact weakens and begins to level off. When the S&P500 (stock market) is impacted by one standard deviation, the impact on the bitcoin price is negative when it lags for one period, and it

has the largest positive impact when it is lagged for two periods, and then becomes negative again. The U.S. dollar index has the largest negative impact when lagging two periods. The effects of other variables are relatively similar, which is closer to the results of the Granger causality test, and all effects are relatively short-term.

Variance Decomposition

Table 14. Variance decomposition (before China's mining ban)

Period	S.E.	DLNP	DLNCT	DLNDO	DLNG	DLNPE	DLNQ	DLNR	DLNS	DLNV
1	0.047526	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.051385	87.18847	4.408018	3.168854	0.461088	1.245802	1.441798	0.000415	2.029881	0.055678
3	0.053852	80.16342	4.437929	3.246202	0.443649	1.154630	1.891441	0.853155	7.589402	0.220170
4	0.054905	77.81256	4.455134	3.650259	0.740166	1.316922	1.821555	1.548897	8.438393	0.216111
5	0.056128	74.46384	4.936395	4.652582	0.778915	1.263013	2.205091	3.284864	8.200931	0.214365
…	…	…	…	…	…	…	…	…	…	…
35	0.069242	56.42651	5.550722	3.537274	2.221387	4.040814	2.068462	16.75332	7.952836	1.448672
36	0.069559	56.15066	5.556837	3.506439	2.226390	4.023500	2.068857	17.04647	7.944807	1.476042
37	0.069874	55.87536	5.575409	3.477195	2.229919	4.012815	2.070121	17.33069	7.926112	1.502372
38	0.070186	55.61057	5.579834	3.447882	2.235551	3.993242	2.070034	17.61817	7.913721	1.530994
39	0.070498	55.34535	5.591046	3.419820	2.240352	3.982047	2.071462	17.89272	7.901962	1.555242
40	0.070812	55.08269	5.604189	3.391394	2.244756	3.964329	2.072071	18.17256	7.885512	1.582502

The number of lags we choose is 40. Because after the 40th order, the 9 variables tend to be stable. From the table, we can see that the influence of Bitcoin price on itself accounts for 55.08%. The one-year U.S. Treasury yield (speculative demand) has the largest impact on Bitcoin at 18.17%. The second is that S&P500 (stock market) has an impact of 7.89% on the price of Bitcoin. Bitcoin's transaction cost has the third most impact on the price of Bitcoin, accounting for 5.60%. Energy prices and the U.S. dollar index have relatively close influences on Bitcoin prices, 3.96% and 3.39% respectively. The impact of the international gold price and bitcoin computing power on the bitcoin price is also relatively close, 2.24% and 2.07% respectively. The trading volume of Bitcoin has the least impact on the price of Bitcoin, accounting for only 1.58%.

Discussion

First of all, before the promulgation of China's Bitcoin mining ban, both macro market factors and internal factors had a greater impact on the price of Bitcoin. The degree of explanation of the eight influencing factors decreased from 44.92% to 12.12%. It can be seen that after the promulgation of China's ban on mining, the impact on the price of Bitcoin has changed significantly. Secondly, before the promulgation of the ban, internal factors were the main influencing factors, while after the promulgation of the ban, the external macro market has a greater impact on the price of Bitcoin. We guess that this change may be due to the fact that China is the largest transaction party and mining party in Bitcoin transactions, and the Chinese government is the ultimate guarantee of credit. Therefore, once China issues a more stringent ban, a large number of funds are no longer willing to regard Bitcoin as a "safe haven asset." A large amount of funds have flowed out of the virtual currency market, and the speculative demand attribute of Bitcoin has been greatly reduced. Then the one-year U.S. Treasury bond yield, that is, the speculative demand defined in this thesis, is no longer significant.

Table 15. The results of variance decomposition are compared before and after China's mining ban

Period	Bitcoin price	US dollar index	Gold price	Stock market	Energy price	Trading volume	Transaction Cost	Computing Power	Treasury yield
Before	55.08%	3.39%	2.24%	7.885512	3.964329	1.582502	5.604189	2.072071	18.17256
After	87.88%	5.14%	0.94%	0.348049	0.282236	0.296244	4.264547	0.641853	0.192638

In addition, before the ban, the impact of the US dollar on Bitcoin was small, which may be because China was the largest trading party before, but after the ban, the impact of the US dollar index became significantly larger, which may be because a large number of traders have withdrawn from the Chinses market, and the Chinese market is no longer the main trading market for Bitcoin. Many bitcoin transactions began to anchor the United States. Therefore, the U.S. dollar index's influence on it has increased. The impact of the international gold price and the stock market on it has been significantly reduced after the ban, which may be because gold and stocks have trading alternatives to Bitcoin. Affected by the ban, the currency and transaction attributes of Bitcoin were reduced, and a large amount of funds flowed to the gold and stock markets in one direction. Therefore, the impact of the above two variables on the price of Bitcoin is no longer significant.

The transaction cost of Bitcoin is a significant variable before and after the ban, and the difference between the two variance decomposition results is not large. It shows that the impact of Bitcoin transaction costs on the price of Bitcoin is relatively stable and has not been significantly affected by the promulgation of China's mining ban. This may be because the size of Bitcoin transaction fees is at the discretion of the participants in the transaction. When users send bitcoins, they can set the transaction fee according to their demands. A large transaction fee can get confirmation faster, while a small transaction fee may take a long time to get confirmed.

According to the design of Bitcoin network, the transaction fee is determined by the data size of the transaction and the congestion level of the current node. If a node is

processing many transactions, the transaction fees required for transactions submitted on that node will increase accordingly. Therefore, transaction fees for Bitcoin transactions are based on the supply and demand of the network. Even with the ban in China, there will always be bitcoin transactions in the cryptocurrency market, so bitcoin transaction costs will always be a significant variable.

CHAPTER 6

CONCLUSION AND SUGGESTIONS

Conclusion

This thesis studies the factors affecting the price of Bitcoin before and after China's mining ban in May 2021 and selects 4 macro factors and 4 internal factors for comparison. After analyzing the determinants of the Bitcoin price, firstly, it has been shown that the Bitcoin price will be significantly affected by the macro and internal factors in the short term. Therefore, the stable development of the macroeconomic environment is of great significance to the stability of the Bitcoin price. In addition, before and after the promulgation of the ban, the comprehensive explanation of the eight explanatory variables for the price of Bitcoin decreased significantly. The core of this thesis is to discuss the impact of four macro market factors and four internal factors on the price of Bitcoin, and after the promulgation of the mining ban in China, the degree of explanation of these eight factors has declined significantly.

However, in fact, there are many factors that affect the price of Bitcoin, especially the Chinese government's policy has a greater impact on it. Based on the research results of this thesis, more variables can be considered in the development of follow-up research, especially the impact of policies. From the perspective of the impact of the macro market, before the ban, the stock market (S&P500) had a significant impact on the price of Bitcoin, while the international gold price, US dollar index and energy prices had relatively weak influence on the price of Bitcoin. After the promulgation of the ban, the U.S. dollar index has a significant impact on the price of Bitcoin, while the impact on

international gold prices is relatively weak. The impact of the stock market (S&P500) and energy prices on the price of Bitcoin is not obvious.

From the perspective of the impact of the internal operating mechanism, before the ban, the speculative demand for Bitcoin (the yield of one-year U.S. Treasury bonds) had a significant impact on the price of Bitcoin, and the impact of Bitcoin transaction costs on the price of Bitcoin was strong, while Bitcoin computing power and transaction volume had small impact on Bitcoin prices. After the promulgation of the ban, Bitcoin transaction fees still have a significant impact on Bitcoin prices, computing power has a weaker impact on Bitcoin, and trading volume and Bitcoin speculative demand (yield of 1-year U.S. Treasury bonds) have not obvious impacts on Bitcoin prices. Among them, the speculative demand for Bitcoin is also the indicator with most obvious changes.

Suggestion

Bitcoin's decentralized mode of operation does not establish an internal stable coin price mechanism, and there is no external institution like central bank to implement control measures, resulting in the natural instability of Bitcoin price. This paper puts forward the following policy suggestions.

1. continue to crack down on money laundering using digital currencies in accordance with the law.

The extensiveness, convenience and secrecy of the bitcoin trading market make it easy for speculative capital to enter and exit the market. There is no mechanism to prevent bubbles in the bitcoin market, and the bursting of bubbles has a broad and direct impact on the global financial market. Therefore, the government needs to take regulatory measures to combat money laundering.

2. focus on blockchain technology change

Although Bitcoin has many disadvantages, its underlying blockchain technology has broad application prospects. Blockchain technology is a distributed ledger system. Every participant is a bookkeeper, and every legal account book change will be broadcast and verified among bookkeepers. This book has the advantages of immutability and fast access. The upgraded version of blockchain technology also includes programmable smart contracts. Users can program the transactions that occur in the account within their own authority, so that the transactions are automatically carried out when the conditions are triggered, and several users can also sign a consensus agreement to realize multi-party automatic transactions. Users of the blockchain can conduct instant transactions that break through geographical restrictions without mutual trust. It can effectively simplify the business processes of financial industries such as exchanges and banks and improve financial efficiency. Blockchain also has many exploratory applications in other real economy industries, including transportation, logistics, energy, medical care, software development, etc.

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