

**AN ANALYSIS OF FACTORS INFLUENCING THE PRICE
OF BITCOIN**

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Fangda Sun
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SIGNATURE PAGE

PROJECT: AN ANALYSIS OF FACTORS INFLUENCING THE PRICE
OF BITCOIN

AUTHOR: Fangda Sun

DATE SUBMITTED: Spring 2019
Department of Economics

Dr. Craig Kerr
Project Committee Chair
Economics

Dr. Carsten Lange
Economics

Dr. Shih-Tang Hwu
Economics

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ABSTRACT

This paper analyzes the various factors that affect Bitcoin's price through the application of the VAR model and a variance decomposition analysis. The results of the analysis show that both the transaction demand and speculative demand have a significant effect on Bitcoin's price. Through a variance decomposition analysis, this paper concludes that the impact of speculative demand on Bitcoin's price is greater than the impact of transaction demand. This indicates that Bitcoin is more inclined to be a speculative commodity.

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Chapter 1

Introduction

The development of the Internet and other communication systems has accelerated the process of electronic currency and virtualization, which has led to changes in market entry methods, market transactions, and payment methods. Bitcoin is an innovative product of the combination of monetary economic theory and modern network information technology.

On November 1, 2008, the founder of Bitcoin published a research report on the P2P¹ electronic money payment system on the Internet using the pseudonym Satoshi Nakamoto. At the beginning of the following year, Bitcoin was created under conditions which were not controlled by various central banks and any financial institutions around the world. Through two market surges in 2013 and 2017, Bitcoin set off a wave of digital currencies in the world financial sector.

Cryptocurrency² is a general term for network money generated by complex math-

¹Peer-to-peer (P2P) computing or networking is a distributed application architecture that partitions tasks or workloads between peers. Peers are equally privileged, equipotent participants in the application. They are said to form a peer-to-peer network of nodes.

²Cryptocurrency (or crypto currency) is described as a digital asset designed to work as a medium of

ematical algorithms based on cryptography and modern network P2P technology. It is a special electronic and digital virtual currency. The number of cryptocurrencies available over the internet as of the 19th of August, 2018 is over 1600 and growing. A new cryptocurrency can be created at any time. By market capitalization, Bitcoin is currently (December 15, 2018) the largest Blockchain³ network, followed by Ripple, Ethereum and Tether. The market capitalization of Bitcoin once exceeded 300 billion at the end of 2017, however, the current market value has shrunk by approximately 60 billion. The dramatic volatility of Bitcoin's price makes it a significant investment value and a speculative opportunity. At the same time, it raises many questions that need to be studied and explored. Presently, many researchers and policymakers, including Ben Bernanke, the former chairman of the Federal Reserve, have published articles and comments on Bitcoin.

This paper builds a relevant model based on the outstanding achievements of predecessors, seeking to explain the impact of Bitcoin's supply, transaction demand, speculative demand, and macroeconomic development on Bitcoin's price. Through the analysis of these factors affecting Bitcoin's price, the decision mechanism of Bitcoin's price is discussed to reveal more clearly that Bitcoin tends to be a speculative commodity in the current market.

exchange that uses strong cryptography to secure financial transactions, control the creation of additional units, and verify the transfer of assets in Narayanan et al. (2016).

³In Economist (2015), the authors define the Blockchain (originally block chain) as a growing list of records, called blocks, which are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data.

Chapter 2

Literature Review

Buchholz et al. (2012) find that the main driver of Bitcoin's price is the supply and demand relationship of Bitcoin in the digital currency market. In general, the demand for Bitcoin is mainly determined by its value as a medium of exchange (i.e. the value of future exchanges). Therefore, as long as people use Bitcoin as a medium of exchange, the intrinsic value of Bitcoin will not disappear.

Baur, Hong and Lee (2018) argue that Bitcoin is similar to gold, with limited supply and increased supply through mining, decentralization, and independence from central banks or government regimes. Barro (1979) makes an early investigation from the relationship between the dollar and the price of gold, mainly studying the level and conditions of fluctuations of the currency and price levels under the gold standard. The author concludes that under the political system at the time, the price level is seriously affected by the positive monetary policy. At the same time, the government's monetary policy is determined under the gold standard according to the basic situation of the gold itself. Based on this, Barro (1979) concludes that gold and the gold standard of banking stocks have a great influence on the price level and the US dollar at that time.

Ciaian, Rajcaniova and Kancs (2016) draw on the Barro (1979) model under the gold standard to an econometrically estimable model for Bitcoin's price and conclude that the impact of Bitcoin supply and demand on its price increases over time. In the short term, speculative factors also have a certain impact on Bitcoin's price, while macroeconomic factors have no effect on Bitcoin's price.

On the basis of Ciaian, Rajcaniova and Kancs (2016), this paper updates the sample time interval from July 1, 2015, to January 31, 2019,⁴ to test their results about the impact of Bitcoin supply and demand on Bitcoin's price. This is to verify if there is any relationship between macroeconomic factors and Bitcoin's price.

Since the speculative demand data for Bitcoin cannot be directly obtained, a proxy variable, *Investors' attention to Bitcoin*, is applied to characterize speculative demand on Bitcoin. This section adopts the practice of Kristoufek (2013), which uses *Google Trends (weekly)* as a measure of investors' attention in their research. Kristoufek (2013) studies the relationship between Bitcoin's price and Google Trends. This study shows that not only are the search queries and the prices connected but also a pronounced asymmetry exists between the effect of an increased interest in the currency while being above or below its trend value. The following utilizes the daily data and measures the Investors' Attention to Bitcoin with the daily search volume of the word "*Bitcoin*" on Wikipedia.

In addition to affecting the supply and demand factors of traditional commodities, the degree of development of macroeconomic finance will also affect the behavior of Bitcoin investors, thus affecting the price of Bitcoin. Van Wijk (2013) uses several financial factors including several stock exchange indices, exchange rates, and oil prices to analyze how economic performance and economic growth would influence the value of Bitcoin

⁴Although Bitcoin was produced in 2009, Bitcoin's price began to fluctuate significantly from 2011 onwards. After browsing the data, I find the statistically significant data of Bitcoin is after 2015 since the previous data transaction volume is too small.

based on the ECM model. Van Wijk (2013) concludes that the value of the Dow Jones, the euro-dollar exchange rate, and the WTI oil price have a significant effect on the value of the Bitcoin in the long run. The value of the Dow Jones Index also significantly affects the value of the Bitcoin in the short run. This paper adopts the method of Van Wijk (2013) and selects the S&P 500 Index as a variable to represent the macroeconomic and financial factors since the S&P 500 Index has a wider sampling area, stronger representativeness, higher precision, and better continuity compared to the Dow Jones Index.

Chapter 3

Factors Influencing the Price of Bitcoin

3.1 Market Supply and Demand Factors

To analyze the impact of supply and demand factors on Bitcoin's price, Ciaian, Rajcaniova and Kancs (2016) derive an econometrically estimable model for Bitcoin's price from Barro (1979) model. Ciaian, Rajcaniova and Kancs (2016) develop the equilibrium equation of Bitcoin's price, which is shown below:

$$P^B = \frac{PG}{VB} \quad (3.1)$$

where P^B is Bitcoin's price, P is the general price level of goods and services, G is the size of the Bitcoin economy, V is the velocity of Bitcoin, and B represents the total stock of Bitcoins in circulation.

This paper divides the demand for Bitcoin into the transaction and speculative demand based on its demand motive. In Dimand (2016), the authors divide the demand for liquidity into three types according to their motives based on the money demand theory of John Maynard Keynes: transaction motive demand, precautionary motive demand, and speculative motive demand. The precautionary demand is defined as unusual costs

for use of social unexpected problems. However, this paper treats the precautionary demand as a reasonable “leakage” of transactions demand and speculative demand since the unexpected problems are nothing but transaction and speculative motives. Therefore, this paper does not consider Bitcoin’s precautionary demand and only focuses on its transaction and speculative demand, as represented in the following formula:

$$M^D = M_1^D + M_2^D \quad (3.2)$$

where M_1^D represents transaction demand and M_2^D represents speculative demand. The Baumol–Tobin model⁵ considers the transaction demand of liquidity related to its transaction volume and the transaction cost. In Baumol (1952) and Tobin (1956), the authors conclude that the greater the transaction volume and the transaction cost of liquidity, the greater the transaction demand of liquidity. Therefore, according to the studies of Baumol (1952) and Tobin (1956) and the Bitcoin price model derived by Ciaian, Rajcaniova and Kancs (2016), the transaction demand for Bitcoin is represented as:

$$M_1^D = M_1^D(P, G, \text{transaction volume}, \text{transaction cost}) \quad (3.3)$$

From the perspective of speculative demand, the demand for Bitcoin is for an investment or speculative tool. Many investment options can be chosen by investors, but the investors should generate searching costs when determining the target of the investment. The decision-making preferences of new investors tend to be distorted under the influence of social attention (such as the news media’s attention to Bitcoin), which are driven by heat-driven investment behavior because they reduce the search cost of potential investment opportunity information. Under the attention of the news media, the investment target is likely to become the first choice of new investors. As an emerging product, investors’ attention to Bitcoin and related reports from the news media has

⁵The Baumol–Tobin model is an economic model of the transactions demand for money as developed independently by Baumol (1952) and Tobin (1956).

positively affected investors' perception of Bitcoin. On the other hand, if society pays too much attention to Bitcoin, it will likely trigger "herd behavior".⁶ Therefore, I use a proxy variable, *Investors' Attention to Bitcoin*, to characterize speculative demand on Bitcoin, the higher the level of investors' attention to Bitcoin, the less the cost of Bitcoin to be recognized as an investment target, and the greater the speculative demand for Bitcoin. This paper adopts the practice of Kristoufek (2013), using the volume of the word "Bitcoin" views on Wikipedia (*views on Wikipedia*) to represent *Investors' Attention to Bitcoin*. Therefore, the speculative demand for Bitcoin can be represented as:

$$M_2^D = M_2^D(\text{views on Wikipedia}) \quad (3.4)$$

3.2 Macroeconomic and Financial Factors

There are other factors that affect the behavior of Bitcoin investors, thus affecting Bitcoin's price. Van Wijk (2013) emphasizes the degree of macroeconomic development (measured by macroeconomic and financial indicators such as exchange rates and oil prices) on the decision-making role of Bitcoin's price. The authors conclude that good macroeconomic and financial developments may facilitate the use of Bitcoin in trading sessions, which may have a positive impact on Bitcoin demand. On the other hand, the stock exchange index may be negatively correlated with Bitcoin's price. The decline in stock price means that investors are selling their stock holdings and would have a large amount of money spilling out of the stock market. This would lead to the devaluation of their associates but may stimulate Bitcoin's price to rise because investors may choose Bitcoin as an alternative investment.

⁶Herd behavior is the behavior of individuals in a group acting collectively without centralized direction. Economically speaking, investors inexplicably follow the crowd and buy the winners.

Chapter 4

Data

4.1 Selection of Variables

According to the models and theories in the previous chapter, this paper selects the following variables among the factors affecting Bitcoin's price: Bitcoin market price in USD represents Bitcoin's price, P^B . Total number of Bitcoins represents the total stock of Bitcoin in circulation, B. Bitcoin estimated transaction volume⁷ represents the size of Bitcoin, G. Bitcoin cost per transaction represents the transaction cost of Bitcoin. The trade weighted U.S. Dollar Index⁸ represents the global price level, P. The volume of the word "*Bitcoin*" views on Wikipedia represents the speculative demand factors, and the

⁷Bitcoin estimated transaction volume is similar to the total output volume with the addition of an algorithm which attempts to remove change from the total value. This may be a more accurate reflection of the true transaction volume.

⁸In the older U.S. Dollar Index, a significant weight is given to the euro, because of most U.S. Trade in 1973 was with European countries. As U. S. trade expanded over time, the weights in that index went unchanged and became out of date. To more accurately reflect the strength of the dollar relative to other world currencies, the Federal Reserve created the trade-weighted US Dollar Index, which includes a bigger collection of currencies than the US dollar index.

S&P 500 Index represents the macro-financial factors.

4.2 Source of Data

The time series daily data is collected from 07/01/2015-01/31/2019 for all variables of this study. The data of variable *Bitcoin's price, number of Bitcoins, transaction volume, transaction cost* is from www.blockchain.com/charts, the data of variable *USD*, *S&P 500* is from fred.stlouisfed.org, and the data of variable *views on Wikipedia* is from tools.wmflabs.org-g/pageviews.

4.3 Statistical Description of Data

Descriptive statistics for each variable are as follows⁹ :

Table 4.1: Statistical Description of Sample Data

	mean	std. dev.	coef. var.	min	max
Bitcoin's price	3500.63	3813.67	108.94%	213.2	19289.8
number of Bitcoins**	1.62	0.09	5.37%	1.43	1.75
transaction volume*	244.68	106.89	43.65%	42.55	767.41
transaction cost	31.23	33.16	106.15%	3.443	161.686
USD	90.78	2.54	2.8%	84.63	96.87
views on Wikipedia*	22.73	31.57	138.9%	6.63	344.69
S&P 500	2379.49	297.20	12.49%	1829.08	2930.75

First, by observing the statistical description of Bitcoin's price which is the dependent

⁹“*”: divided by thousands, “**”: divided by millions.

variable, the maximum value of Bitcoin's price is \$19289.8, which is 90.48 times greater than the minimum value of \$213.2. This indicates that the price span of Bitcoin is huge, and may cause a significant economic bubble.

Second, I observe the fluctuations of the variables by comparing their coefficient of variation¹⁰. The coefficient of variation of Bitcoin's price is 108.94%, which is 38.9 times greater than the coefficient of variation of the US Dollar Index, which is 2.8%. This indicates that the price fluctuation of Bitcoin is much higher than the US Dollar, and it hence does not have the stability for being a currency. The coefficient of variation of Bitcoin's price is even 38.9 times higher than the coefficient of variation of S&P 500 Index, which is 12.49%, indicating that the volatility of Bitcoin's price is even higher than the stock which is an investment tool.

The volatility of Bitcoin's price is represented in Figure 4.1. It can be preliminarily concluded that the volatility of Bitcoin's price is greater than the S&P 500. Therefore, Bitcoin should be considered as a speculative commodity. Furthermore, this paper analyzes the factors affecting the price of Bitcoin to further validate this inference.

In the perspective of market size, Bitcoin has not reached the level that can affect dollar and stock prices. Therefore, from a theoretical point of view, the impact of Bitcoin's price on the US dollar and stock price are limited. However, either the US dollar or stock prices unilaterally impact the price of Bitcoin. Therefore, this project's model will consider the US Dollar Index and the S&P 500 Index as exogenous variables of Bitcoin's price.

Furthermore, as seen in Table 4.1, the coefficient of variations of the transaction cost and Bitcoin's price are almost the same, 106.15% and 108.94%, respectively. This indi-

¹⁰The coefficient of variation is defined as the ratio of the standard deviation to the mean. It shows the extent of variability in relation to the mean of the population.

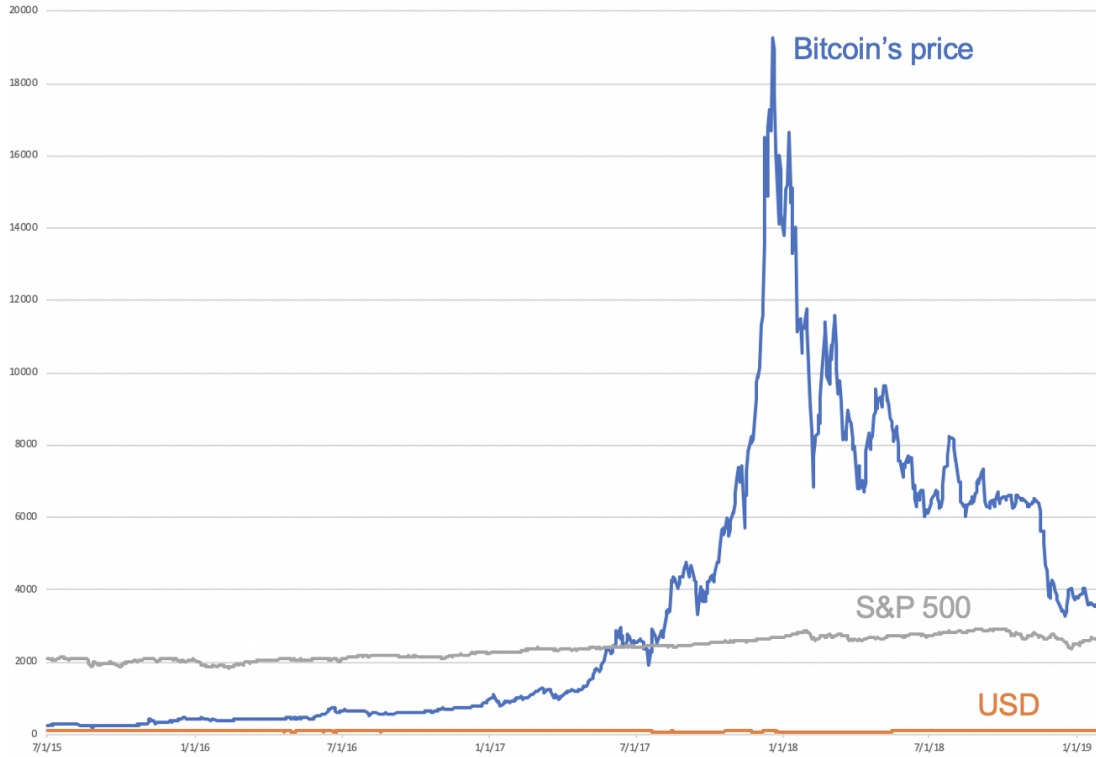


Figure 4.1: Comparison of Bitcoin's price with the U.S. Dollar Index and the S&P 500 Index

cates that there may be a close relationship between Bitcoin's price and transaction cost. As Figure 4.2 demonstrates, trends of Bitcoin's price and its transaction cost are similar, indicating that the transaction cost may be a fixed ratio of Bitcoin's price, satisfying *Bitcoin's price* = α *transaction cost*, where α is a constant between 0 to 1. Therefore, there should be a clear linear relationship between the price of Bitcoin and its cost. In order to decrease the noise of the model and avoid multicollinearity, the variable *transaction cost* is not considered in the following model.

Finally, as seen in Figure 4.3, it can be intuitively concluded that the growth rate of the total number of Bitcoins is slowing down to 0, which is consistent with the theoretical assumption, indicating that Bitcoin's supply is almost constant. Therefore, the variable

number of Bitcoins is considered as an exogenous variable in what follows.

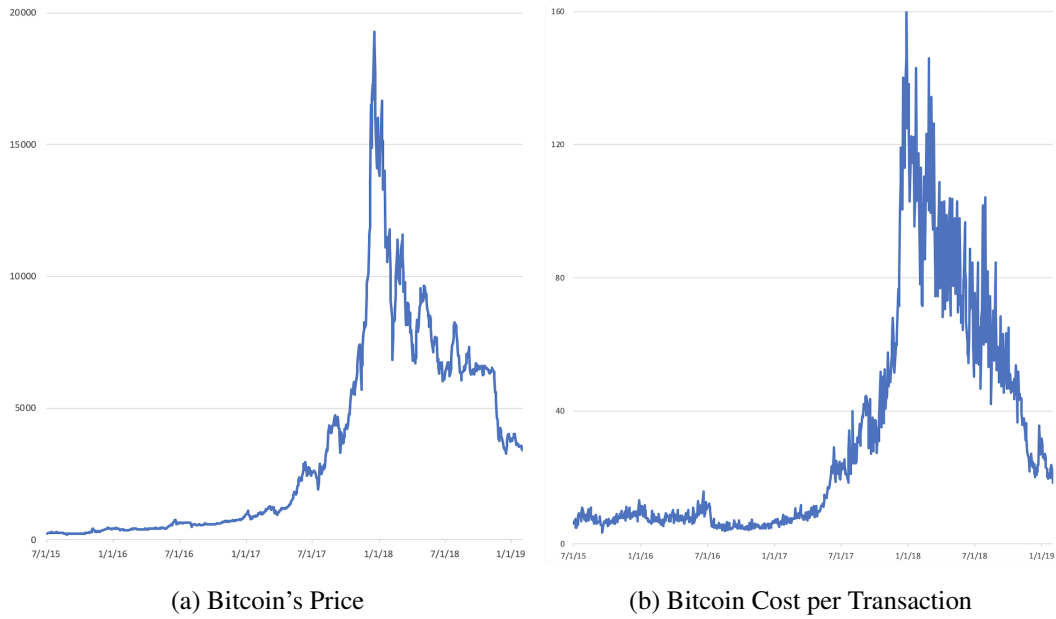


Figure 4.2: Bitcoin's Price and Bitcoin Cost per Transaction

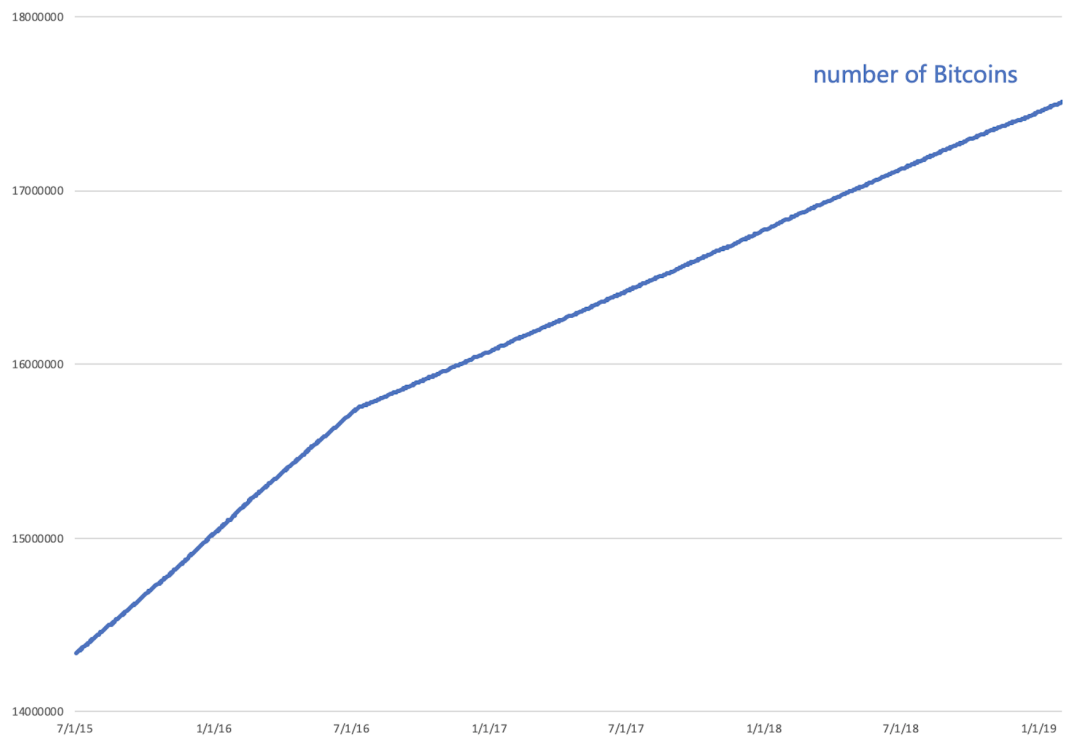


Figure 4.3: Total Number of Bitcoins

Chapter 5

Analysis

5.1 Analysis Method

The variables selected in Chapter 3 interact with each other and endogenous variables may appear on both the left and right sides of the equation. Therefore, this paper uses the vector autoregressive (VAR) model to analyze the causality between endogenous time series. The core idea of the VAR model is to directly consider the relationship between time series of economic variables without considering the economic theory and to avoid the structural modeling methods need to model only each endogenous variable in the system after all endogenous variables. The VAR model is often used to predict the correlation of time series systems and to study the dynamic effects of random disturbances on variable systems.

According to Lütkepohl (2005), in econometrics and other applications of multivariate time series analysis, a variance decomposition or forecast error variance decomposition (FEVD) is used to aid in the interpretation of a vector autoregression (VAR) model once it has been fitted. Based on the VAR model. The variance decomposition indicates

the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables.

5.2 VAR Model and Variance Decomposition Analysis

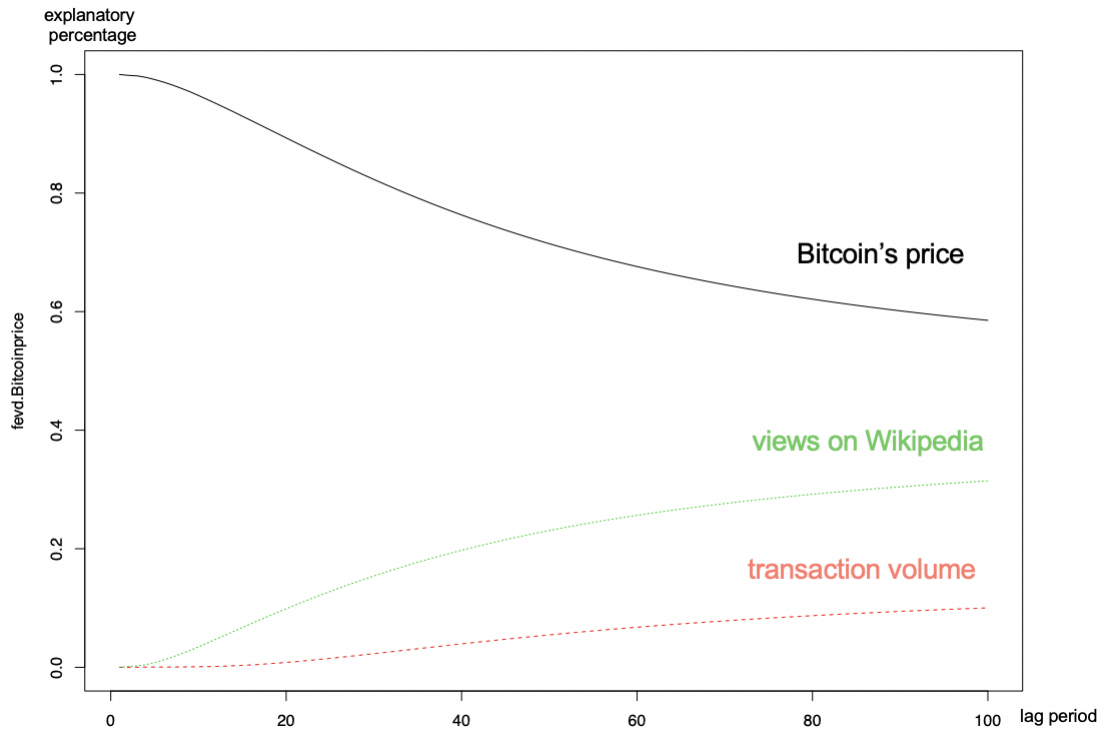


Figure 5.1: Variance Decomposition of Bitcoin's Price

According to the assumptions in Section 4.3, the following variables: *Bitcoin's price*, *transaction volume*, and *views on Wikipedia* are considered as endogenous variables in this paper, the other variables: *number of Bitcoins*, *USD*, and *S&P 500* are considered as exogenous variables. Based on this, this paper applies a p -th order VAR model, denoted

as VAR(p), is

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + C D_{t-1} + e_t \quad (5.1)$$

Y_t is a $K \times 1$ vector of endogenous variables and e_t assigns a spherical disturbance term of the same dimension. The coefficient matrices A_1, \dots, A_p are of dimension $K \times K$. p is the lag-order for the estimated VAR-process, which is determined by the Akaike Information Criterion (AIC) ¹¹ in R¹² automatically. For the VAR-process of this paper, the lag-order p is 6. C is a coefficient matrix of exogenous variables and D_t is a $K \times 1$ vector of exogenous variables.

Based on the VAR model, this paper applies a variance decomposition analysis for Bitcoin's price. Figure 5.1 represents the variance decomposition of Bitcoin's price. The factors explaining the Bitcoin's price gradually increase over time. The explanatory ability of the variable *views on Wikipedia*, which represents the speculative demand, and the variable *transaction volume*, which represents the transactional demand, reaching the maximum 31.44% and 10.03% in the lag period 100. That is to say, in the lag period 100, the 31.44% change of Bitcoin's price is caused by investors' attention, and 10.03% is caused by the transaction volume.

¹¹The Akaike information criterion (AIC) is an estimator of the relative quality of statistical models for a given set of data, and it is used as a common approach for lag-order selection of the VAR model in Lütkepohl (2005)

¹²R is a programming language and software environment for statistical computing and graphics supported by the R Foundation for Statistical Computing. The R language is widely used among statisticians and data miners for developing statistical software and data analysis.

Chapter 6

Conclusion and Discussion

From the results of the variance decomposition analysis of Bitcoin's price, this paper concludes that Bitcoin's price is mainly affected by the demand factors, especially speculative demand. The impact of speculative demand on Bitcoin's price is greater than the impact of transaction demand on it, indicating that Bitcoin is more likely to be a speculative commodity.

As a speculative commodity, Bitcoin's usage may take one of many paths. One possibility is that Bitcoin becomes a legal and compliant investment product globally. In order to achieve this, the investment environment, relevant laws, and regulations of Bitcoin must be improved. This path is affected by the degree to which Bitcoin is perceived as a valuable investment. With the recognition of the value of Bitcoin, investors recognize Bitcoin as a hedge for the stock market.

Another path for Bitcoin is that it may continue to evolve toward becoming a legitimate currency. To attain this objective, Bitcoin must overcome the fundamental problem of its current stability, although the stability of the currency is in contradiction with the constant supply of Bitcoin. As a speculative commodity, Bitcoin's price fluctuates

greatly, which makes it hard to satisfy the stability requirement for currency.

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