

An Empirical Analysis of Bitcoin's Currency Function

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Abstract. With various kinds of virtual currencies pouring into people's life, bitcoin, a typical virtual currency, exerts leavening influence on economic development and central currency policy. In this article, we select bitcoin's related data source and explore bitcoin's substitution effect on real currency. The empirical results indicate that although the substitution rate of bitcoin has long-run equilibrium relationship with broad money multiplier, it doesn't cause a significant change of broad money multiplier. Thus, a clear conclusion can be drawn that bitcoin has not set out on its career as a currency yet.

Key word: bitcoin; money multiplier; currency function

1. Introduction

Bitcoin is an online communication protocol that facilitates the use of a virtual currency, including electronic payments. Since its inception in 2009 by an anonymous group of developers (Nakamoto 2008), Bitcoin has served approximately 62.5 million transactions between 109 million accounts. As of November 2016, the daily transaction volume was approximately 5,700,000 bitcoins—roughly \$4 billion at market exchange rates—and the total market value of all bitcoins in circulation was \$11.9 billion (Blockchain.info 2016).

Bitcoin is of interest to economists as a virtual currency with potential to disrupt existing payment systems and perhaps even monetary systems. Even at their current early stage, such virtual currencies provide a variety of insights about market design and the behavior of buyers and sellers.

2. Literature Review

Unlike most currencies, bitcoin (Bitcoin, BTC) is produced by a particular algorithm and a large number of calculations, whose issuance doesn't rely on a specific monetary institution. The attitudes of different countries are not the same.

Germany stressed that bitcoin should not be used as a legal means of payment. The Japanese government cleared the official definition that bitcoin, the Internet virtual currency, was not a currency at a cabinet meeting in 2014. The U.S. government did not specify whether bitcoin had the legal currency status. (Zhang Chen 2014). People's Bank of China and other five ministries thought that bitcoin did not have the legal compensation, coerciveness and other monetary attribute, and therefore wasn't the real sense of legal currency.

In conclusion, although countries' attitude to bitcoin was different, overall, all authorities did not identified bitcoin as a legitimate currency (Pang Bo (2013), Lee Chong (2015)), providing a basis for the study that whether bitcoin has currency functions.

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Past research about bitcoin has predominantly focused on market price, economic utility and other aspects of the bitcoin. Yermark(2013) shows that there is almost no correlation between the price of bitcoin and conventional exchange rates. Moreover, the volatility of bitcoin prices is an order of magnitude higher than the volatility observed in conventional nominal exchange rates. So he concludes that “bitcoin behaves more like a speculative investment than a currency.” J B Smith (2015) comes to the conclusion that the raise of economic freedom brings about the decline of the value of bitcoin, and then put forward the idea of the using bitcoin during the emergency recession.

Adjusting money supply is one of the main approaches that government implement monetary policy. Furthermore money multiplier is an important factor that affects money supply. In theory, the emergence and development of bitcoin have a significant impact on the money supply. This impact is mainly achieved by weakening the Central Bank's control of base currency, enhancing the endogenesis of money multiplier, and then increasing the difficulty of the Central Bank to control money supply (Peng Guangyao (2015)).

Bitcoin has several similarities with electronic money. Meanwhile research about electronic money’s effect on money multiplier is comprehensive. Solomon (1997) believes that when researching electronic currency’s impact on money supply, the issuance number of electronic currency should be included into the total amount of currency so as to increase money multiplier significantly. Hawkins Berk(2002) believes that influencing the base currency and monetary multiplier, the development of electronic money has a significant impact on the Central Bank. From the perspective of electronic currency’s impact on money demand, Berentsen (1998) discusses whether the execution of Central Bank’s monetary policy and electronic currency influence money multiplier and monetary transmission mechanism. Fogelstrom and Owen (2004) conclude that electronic currency will influence money multiplier and basic currency and prohibit Central Bank from controlling monetary policy. As a result, Central Bank is obliged to focus on this problem when conducting currency policy. Hu Haiou, Jia Dekui (2003) points out that the electronic money will reduce the public demand for Central Bank base currency, enhance the endogenesis of money multiplier, weaken the effects of monetary policy, and even make it ineffective. Zhou Guangyou (2007) considers that the rapid development of electronic money has an obvious substitution effect on cash and demand deposit, and amplifies the effect of money multiplier.

In order to explore currency function of bitcoin in China, we try to put bitcoin into the framework of the money supply decision theory in this paper, and attempt to research the impact of the bitcoin’s development on the money multiplier so as to clear bitcoin’s currency function.

3. Data

In general, Chinese broad money multiplier m_2 stables at 4.2 times. However, because of the impact of the financial crisis, money multiplier reaches the minimum 3.71 in the third quarter of 2011. Meanwhile, money multiplier rises slightly in 2015, and reaches the highest 5.04 times in the fourth quarter of 2015. Since bitcoin appeared in 2009, its online trading volume has showed an exponential growth. Bitcoin's quarterly turnover increases from about 400000 in the fourth quarter of 2011 to 340.4 billion in the fourth quarter of 2015. The related data are shown in Figure 1.

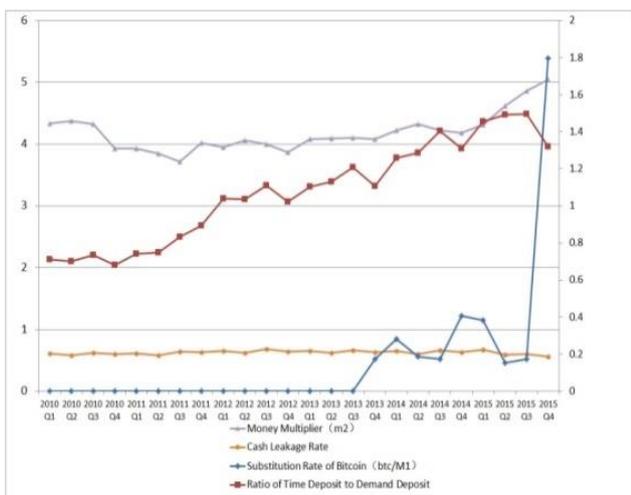


Fig. 1: Variables' trend of change

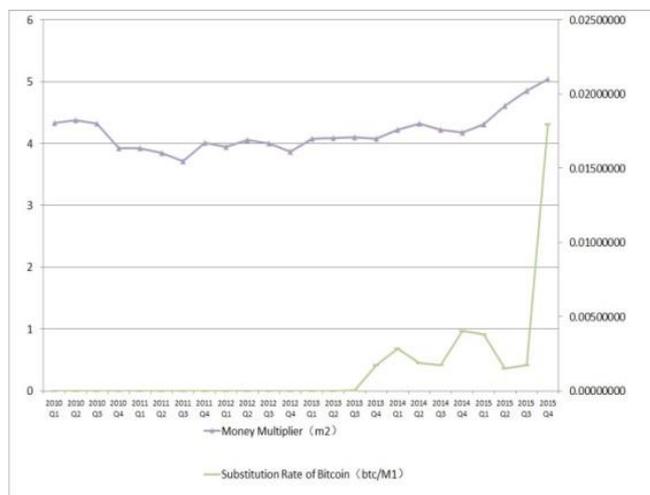


Fig. 2: Bitcoin and money mutipiler's trend of change

Substitution rate of bitcoin, from 0 in 2010 to 1.8% in 2016, shows the same growth rate trend with bitcoin's trading volume. What's more, cash leakage rate stables within the scope of 18% and 23%. Ratio of time deposit to demand deposit rises from 0.71 to 1.49, and shows the same change tendency with broad money multiplier m2. The related data are shown in Figure 2.

It can be seen that the substitution of bitcoin for cash and demand deposit is not very obvious. The corresponding relationship between bitcoin and money multiplier also needs further discussion. In order to reveal their relationship, we try to establish a linear regression model between bitcoin and money multiplier.

Table 1: Computation of money multiplier

Period	Bitcoin's Trading Volume (million)	Substitution Rate of Bitcoin(btc/M1)	Cash leakage rate	Ratio of Time Deposit to Demand Deposit	Money Multiplier (m2)
2010 Q1	0	0.00000000	0.2053	71.22%	4.3329831
2010 Q2	0	0.00000000	0.1929	70.08%	4.3761142
2010 Q3	0	0.00000000	0.2072	73.60%	4.3259099
2010 Q4	0	0.00000000	0.2010	68.12%	3.9235232
2011 Q1	0	0.00000000	0.2025	74.01%	3.9281393
2011 Q2	0	0.00000000	0.1932	74.79%	3.8464082
2011 Q3	0	0.00000000	0.2143	83.26%	3.7141802
2011 Q4	0.4038	0.00000003	0.2122	89.40%	4.0169382
2012 Q1	0.792	0.00000007	0.2171	104.01%	3.9452225
2012 Q2	2.215	0.00000017	0.2069	103.45%	4.0569789
2012 Q3	5.97	0.00000044	0.2290	110.95%	3.9986811
2012 Q4	4.33	0.00000029	0.2152	102.16%	3.8656698
2013 Q1	65.77	0.00000513	0.2171	110.38%	4.0781826
2013 Q2	65.77	0.00000460	0.2084	112.90%	4.0868360
2013 Q3	387	0.00002568	0.2208	120.80%	4.0964987
2013 Q4	29110	0.00175168	0.2101	110.59%	4.0831148
2014 Q1	39300	0.00283215	0.2166	125.86%	4.2206814
2014 Q2	29030	0.00186991	0.2002	128.67%	4.3199543
2014 Q3	28600	0.00175158	0.2193	140.41%	4.2177242
2014 Q4	72400	0.00405337	0.2094	131.11%	4.1781456
2015 Q1	56700	0.00383390	0.2251	145.36%	4.3085567
2015 Q2	25380	0.00152842	0.1970	149.35%	4.6137556
2015 Q3	30310	0.00174808	0.2011	149.45%	4.8565145

4. Variables Selection

As for currency function, bitcoins mainly substitute cash and demand deposit to facilitate the process of transaction. Meanwhile, since bitcoin mainly has influence on cash and demand deposit, the emergence of bitcoin theoretically affects money multiplier and monetary policy further. In order to explore the degree to which bitcoin affects money multiplier, we select the substitution rate of bitcoin as the main variable. Furthermore, we choose cash leakage rate and ratio of time deposit to demand deposit as control variables in order to find the variables' comprehensive influence on money multiplier.

(1) Substitution rate of bitcoin (BTC/(M1*V1)). Substitution rate of bitcoin means the ratio of bitcoin trading volume to narrow money trading volume. From the perspective of bitcoin's current situation, bitcoin mainly substitutes demand deposit in circulation. With the further development of bitcoin, the rate will definitely rise. As a result, the height of the substitution rate of bitcoin not only represents bitcoin's development degree of one country but also has great impact on money multiplier. When the number of bitcoin used for currency function increases, broad money M2 will decrease, followed by the decrease of money multiplier.

(2) Ratio of time deposit to demand deposit. The main function of commercial bank is collecting deposits and offering loans. Since depositors of demand deposits are more inclined to withdraw ahead of schedule than depositors of time deposits, commercial banks prefer to select time deposits for loan services in order to comply with the request of risk management. Theoretically time deposit reserve rate is lower than demand deposit reserve rate. Therefore, the increase of ratio of time deposit to demand deposit results in the increase of money multiplier.

(3) Cash leakage rate. Cash leakage refers to the process in which clients withdraw cash to make cash flow out of the banking system. Cash leakage rate is defined as the ratio of cash leakage to total deposits. The increase of cash leakage rate implies that supposing that the number of total deposits is unchanged, the increasing number of bank deposits results in the decrease in the derived capacity of bank deposits and the decrease in money multiplier. In short, cash leakage rate is negatively correlated with the number of money multiplier.

5. Empirical Analysis and Results

5.1. Empirical Analysis

1) Data stationary test

Firstly, we use ADF unit root test for data stationary test to find out whether there is a cointegration relationship between m_2 and v_1 , v_2 , v_3 .

Variables are defined as follows:

Symbol	Variable
m_2	Broad Money Multiplier
v_1	Substitution Rate of Bitcoin
v_2	Demand Deposit
v_3	Cash Leakage Rate

① The I and T mean Constant and Trend term, P means Lag coefficient according to AIC principle, N means the counterpart-lack in the equation.

② Δ means One Order Difference, $\Delta\Delta$ means Two Order Difference.

Table 2: Stability Test Results

Variable	Test condition (I, T, P)	ADF Statistic	The critical value of the level 0.05	Stability
m_2	(I, N, 5)	0.392940	-2.998064	Not stable
Δm_2	(I, N, 5)	-3.818873	-3.004861	Stable
v_1	(I, N, 5)	2.711261	-3.040391	Not stable
Δv_1	(I, T, 5)	-3.381376	-3.710482	Not stable
$\Delta\Delta v_1$	(I, T, 5)	-2.506208	-1.964417	Stable
v_2	(I, T, 5)	-1.193816	-3.040390	Not stable
Δv_2	(I, N, 5)	-2.997206	-3.065584	Not stable
$\Delta\Delta v_2$	(I, N, 5)	-5.775026	-3.029969	Stable
v_3	(I, N, 5)	-2.039216	-3.029969	Not stable
Δv_3	(I, T, 5)	-5.697296	-3.658446	Stable

As shown in Table 2, the time series m_2 , v_1 , v_2 , v_3 are all not stable. m_2 , v_2 are integrated of order one, while v_1 and v_3 are integrated of order two.

2) Co-integration Test

After finishing data stationary test, we use Johansen co-integration test to figure out whether long-term integration relationship exists among m_2 , v_1 , v_2 , v_3 .

a) Johansen Test

Lag period is defined according to VAR model.

** Significant beyond the 5% level (two-sided tests).

Table 3: Johansen test results

Hypothesized		Trace	Prob.**
No. of CE(s)	Eigenvalue	Statistic	
None **	0.734637	59.60555	0.0027
At most 1 **	0.579104	31.74575	0.0294
At most 2	0.398545	13.57300	0.0954
At most 3	0.128840	2.896522	0.0888

As shown above, under the 5% level, there are at most two co-integrating vectors between m_2 and v_1 , v_2 , v_3 .

b) Regression Analysis

According to co-integration test, there is long-term integration relationship exists among m_2 , v_1 , v_2 , v_3 . Furthermore, we defined m_2 as dependent variable and v_1 , v_2 , v_3 as the independents variables and establish a regression equation as follows.

*** Significant beyond the 1% level (two-sided tests).

Table 4: Regression Analysis Results

Variable	Coefficient	t-Statistic	Prob.
V1	24.31659	1.80696	0.0858
V2	0.58996***	3.33138	0.0033
V3	-13.75491***	-3.11804	0.0054
C	6.38310***	7.36743	0.0000

As shown in Table 4, the variable v_1 is not significant. The result indicated that there is no significant relationship between m_2 and v_1 .

5.2. Empirical Analysis Results

According to above, the empirical tests show that although long-term integration relationship does exist among m_2 , v_1 , v_2 , v_3 , according to the regression analysis, the variable v_1 is not significant. It can be concluded that there is no noticeable relationship between substitution rate of bitcoin(v_1) and broad money multiplier (m_2).

6. Conclusion

According the research above, we draw the conclusion that the change of the substitution rate of bitcoin does not cause the change of broad money multiplier (m_2), which proves that the bitcoin has not yet reached the extent to impact money multiplier or even monetary policy in China. In short, bitcoin hasn't implemented currency function.

Bitcoin's development in the future is affected by various factors, such as the government's attitude, people's cognitive level and whether bitcoin can seek transformation and so on. Still, bitcoin's developing foreground is worth looking forward to. In the future, we will study the decentralization characteristic of Bitcoin, deconstruct the economic mechanism of bitcoin and try to reveal the financial investment and speculation function.

7. Acknowledgment

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8. References

- [1] Berentsen, Aleksander. Monetary Policy Implications of Digital Money [J]. Mpra Paper, 1998, 51(1): 89–118.
- [2] Berk J M. CENTRAL BANKING AND FINANCIAL INNOVATION1 [J]. Psl Quarterly Review, 2002, 55(Sep): 263-297.
- [3] Owen A L, Fogelstrom C. Monetary policy implications of electronic currency: an empirical analysis [J]. Applied Economics Letters, 2005, 12(7): 419-423.
- [4] Smith J B. An Analysis of Bitcoin Exchange Rates [J]. Social Science Electronic Publishing, 2015.

- [5] Solomon E H. Virtual money: understanding the power and risks of money's high-speed journey into electronic space[J]. 1997.
- [6] Yermack D. Is Bitcoin a Real Currency? [J]. Ssrn Electronic Journal, 2013.
- [7] Hu Haiou, Jia Dekui. The Capacity of Electronic Currency to Rise the Challenge on Monetary Policy [J]. FOREIGN ECONOMICS AND MANAGEMENT, 2003, 25(4): 26-30.
- [8] Lee Chong. Will Bitcoin Become a Real Currency? [J]. Contemporary Economic Research, 2015(4): 60-65.
- [9] Pang Bo. Can Bitcoin Replace the Traditional Currency? [J]. Practical Electronics, 2013(16): 270-270.
- [10] Peng Guangyao. The Enlightenment on the Differences between Bitcoin and RMB. [J]. Times Finance, 2015(14): 76-76.
- [11] Zhang Chen. Reality of Risk of Bitcoin and China's Legal Regulation Measures. [J]. Journal of Chongqing University of Posts and Telecommunications (Social Science Edition), 2014(5): 27-31.
- [12] Zhou Guangyou. An Empirical Study on the Impact of Money Multiplication of Electronic Money Development. [J]. THE JOURNAL OF QUANTITATIVE & TECHNICAL ECONOMICS, 2007, 24(5): 98-107.