BitCoin in China:
Price Discovery and Volatility Transmission

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Abstract: As a digit currency with wide popularity in the world, the market performance of Bitcoin in different countries is worthy of attention. This article analyzes the price discovery and volatility transmission of BitCoin among Chinese and U.S. market and find that Bitcoin price in Chinese market has significant influence on U.S. market, while U.S. market has significant impact on Chinese market through volatility.
Key Words: BitCoin; Price Discovery; Volatility Transmission
JEL Classification: G19

1. Introduction

On the evening of January 18, 2017, the People's bank of China issued an announcement that China's three major currency trading platforms, Okcoin, Huobi.com and BtcChina, have severely broke related rules including moving deposit capital, illegal funding and lack of third party supervision etc. In addition, the central bank once again stressed the non-currency properties of BitCoin, reminding investors of its risk. The announcement lead to a big crash of Bitcoin prices in Chinese market. In few hours, the price of BitCoin decreased by nearly 7%.

BitCoin was born in U.S. after a Japanese mathematician Nakamoto published his famous paper *Bitcoin: A Peer-to-Peer Electronic Cash System*. Due to its special mechanism, BitCoin soon got wide attention in both academy and practice. The most attractive character of BitCoin is its non-centralized issue mechanism, in this mechanism, central bank is no longer needed. These years, BitCoin received increasingly popularity in China. It is reported by Chinese media that nowadays about 30% of the world's BitCoin trades come from China.

The importance of Chinese market and U.S. market makes it meaningful to find out the market connection between those two markets. This paper tries to make a concise research on the price discovery and volatility transmission of BitCoin between the two markets.

The paper is organized as follows. Section 2 is a concise literature review. Section 3 presents empirical results. Section 4 concludes.

2. Literature Review

In extant literature of BitCoin, some scholars are optimistic to BitCoin. Marimon (2003) holds that digital currency is a strong contender to the central bank's currency. Hayek (2007) proposes that the central bank system should be abolished if private issuance of currency and free competition is allowed. Lotz and Vasselin (2013) and Arruñada (2017) believe that digital currency will drive out ordinary currency when its transaction cost is low enough. Woo (2012) and Raskin (2013) believes that BitCoin has value and is optimistic about its prospect.

However, some literatures hold an opposite standpoint. Yermack (2013) notes that Bitcoin is not suitable to be a currency because of the instability of its price. Grinberg (2014) notes that Bitcoin has legal risk. Low and Teo (2016) analyzes the legal risks of holding BitCoin.

In the extant literature of the price discovery and volatility transmission, it is generally believed that the price discovery mechanism of cross-market listed companies can be generally divided into two categories: Home bias Hypothesis and Global Center Hypothesis.Home bias hypothesis believes that the market where the company is located is more likely to have an information advantage, so the stock price there contains more information in other markets, therefore stock in home market plays a role in price discovery in other markets. (Lieberman et. Kim et al., 2000; Phylactic and Korczak, 2005; Pauscual et al, 2006). In global center hypothesis, scholars argue that the market quality is the most important factor in information transmission, so the direction of price discovery comes from high quality markets, especially U.S. markets, to low quality markets, including markets in developed countries. (Werner and Kleidon, 1996; Eun and Sabherwal, 1996; Eun and Sabherwal, 2003; Doidge et.al, 2004)

In studies of price discovery of Chinese listed stocks, Baily (1994) studied the price discovery in China's A and B stock markets. Xu and Fung (2002) examined price discovery and volatility transmission of Chinese stocks listed in both Hong Kong and U.S. markets, which finds that stock price is consistent with home bias hypothesis but volatility is consistent with global center hypothesis.

3. Bitcoin in China: A Concise Review

At present, the number of main BitCoin trading platforms in China is more than 20, among which are OkCoin, Huobi.com, BtcTrade and BtcTrade China. According to main media, about 30% of world's BitCoin trade comes from China.

However, in China the legal status of BitCoin is still unclear. In U.S., several BitCoin trading platforms have already got licenses granted by government, but the Chinese government still holds ambiguous attitude towards BitCoin. For the moment, the Chinese central bank regards BitCoin as a virtual goods and does not include it into regulations of financial assets. This lack of this definition lead to the absence of regulation, which amplifies policy uncertainty in BitCoin markets in China.

In market performance, the price of BitCoin in Chinese market (BtcTrade) is very unstable (See Figure 1), in Figure 2, both Chinese and U.S. markets reached the highest volatility in days from May ,2006 to July ,2006.

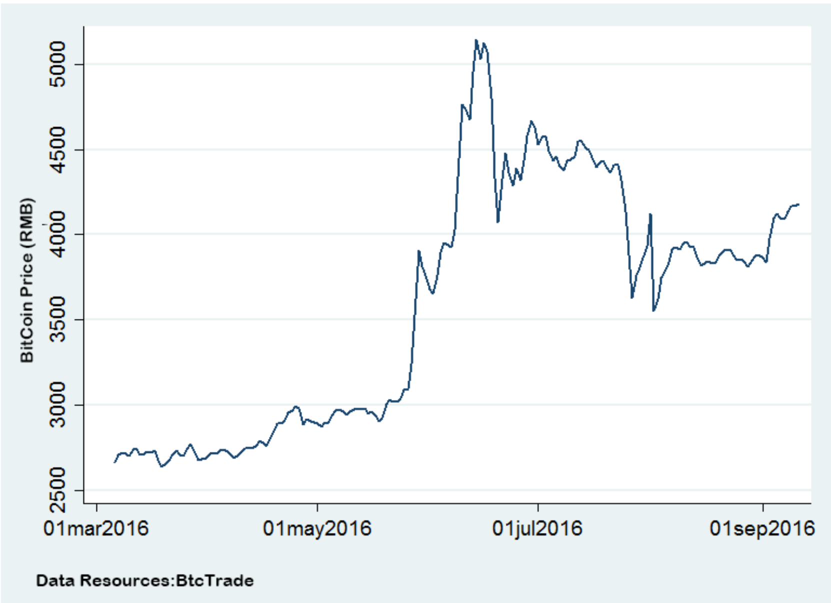

Figure 1 BitCoin Price of Chinese Market （From: BtcTrade）

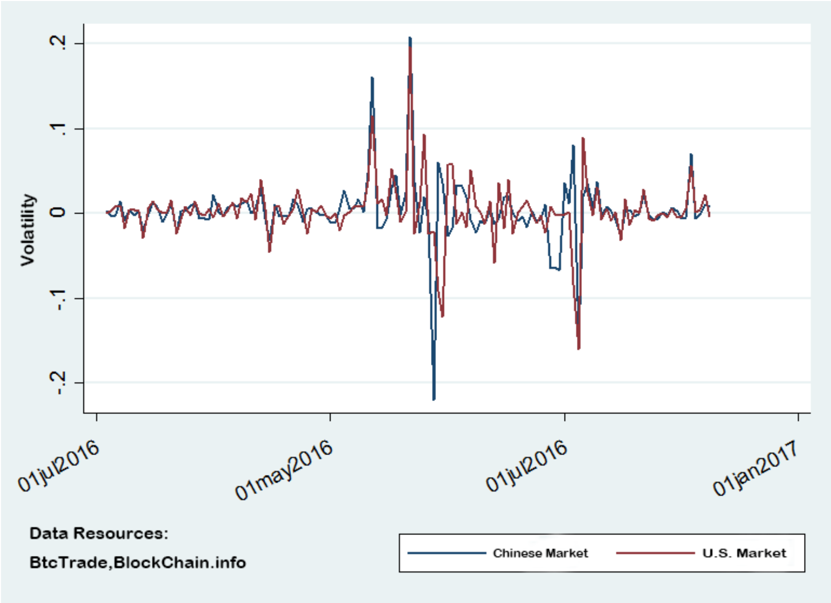

Figure 2 Volatility of BitCoin prices in Chinese and U.S. Markets

4. Data and Empirical Framework

4.1. Data

Data used in this paper dates from May 8 ,2015 to Sep 30,2016, where BitCoin price(BitCoin(China)) data in Chinese market, are obtained from one of the main platform BtcTrade, BitCoin price data in U.S. market(BitCoin(USA)*) are obtained from BlockChain.info, Exchange rate data are obtained from Chinese CSMAR database.

BitCoin(USA) is the product of BitCoin(USA)* and Exchange, representing the market value of U.S market dominated in RMB.

Table 1 shows the summary statistics.

Table 1 Summary Statistics

Variable	Mean	Std. Err	Min	Median	Max
BitCoin(China)	3571.00	722.50	2674.00	3761.00	5146.00
BitCoin(USA)*	538.50	101.70	408.90	570.10	762.40
Exchange	6.58	0.08	6.46	6.57	6.70
BitCoin(USA)	3543.33	8.136	2641.494	3745.557	5108.08

4.2. Empirical Framework

Based on the Granger (1969) method, this paper use recursive Granger test and Rolling Granger test used in to test price discovery in Chinese and U.S. markets, a similar research is Chen. et al (2009) analyzing stock price discovery for Chinese listed companies. The basic form of Granger test is:

$$y_t = \gamma + \sum_s \alpha_s y_{t-s} + \sum_s \beta_s z_{t-s} + \varepsilon_t$$
$$z_t = \eta + \sum_s \chi_s z_{t-s} + \sum_s \delta_s y_{t-s} + v_t$$

Where y_t, z_t stand for testing variables, ε_t and v_t represent disturbance.

Noting that Granger test is only applicable to a sequence of stationary variables or variables with cointegration relationships. Therefore, to use Granger test, we first perform the trace test of Johansen (1991) and the Maximum Eigenvalue Test.

To analyze the direction of the volatility transmission of BitCoin, the M-GARCH (1,1) model under the BEKK setting is used (Bollerslev et. al., 1988; Engle and Kroner, 1995). The horizontal equation is:

$$\Delta X_t = \prod X_t + \sum_s \Gamma_s \Delta X_{t-s} + \varepsilon_t$$

where $X_t = (BitCoin(China), BitCoin(USA))^{\mathrm{T}}$ is a 2×1 column vector, and matrices $\prod$, Γ_s are in the size of 2×2. The variance-covariance matrix of perturbance ε_t is assumed to be:

$$Var\begin{pmatrix}\varepsilon_{1,t}\\ \varepsilon_{2,t}\end{pmatrix} = \begin{pmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t}\end{pmatrix} = \begin{pmatrix} c_{11} & c_{12} \\ 0 & c_{22}\end{pmatrix}^{\mathrm{T}} \begin{pmatrix} c_{11} & c_{12} \\ 0 & c_{22}\end{pmatrix}$$
$$+ \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22}\end{pmatrix}^{\mathrm{T}} \begin{pmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon^2_{2,t-1}\end{pmatrix} \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22}\end{pmatrix}$$
$$+ \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22}\end{pmatrix}^{\mathrm{T}} \begin{pmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1}\end{pmatrix} \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22}\end{pmatrix}$$

Where a_{12} reflect the volatility transmission from $BitCoin(USA)$ to $BitCoin(China)$, b_{12} reflects the dependence of the conditional volatility of $BitCoin(USA)$ on $BitCoin(China)$, a_{12} and b_{12} can be interpreted in a similar way.

5. Empirical Result

5.1. Johansen Test

Since Granger test requires that the variables must be stationary or have a cointegration relationship, we first need to perform Johansen tests on BitCoin (China), and BitCoin (USA) , the results are shown in Table 2.

Table 2 Johansen Test Results

Variable	Max Likelihood	Eigenvalue	Trace statistic	5% Critical value
BitCoin(China) BitCoin(USA)	-1618.00	0.36	2.34*	3.76

It can be seen from Table 2 that BitCoin (China) has a cointegration relationship with BitCoin (USA), so Granger test can be used in this case to study the price discovery among Chinese and U.S markets.

In addition, this paper uses Johansen (1991) to test the cointegration relationship between BitCoin (China) and BitCoin (USA), in which the 10% confidence values obtained by Osterwald-Lenum (1992) are normalized to 1. The results are shown in Figure 3, where the top graph shows Z-Representation, and the bottom graph shows R-Representation. As can be seen in Figure 3 that in the long run the trace statistics of two variables are significantly higher than 1, indicating that there is a long-term cointegration relationship between BitCoin (China) and BitCoin (USA).

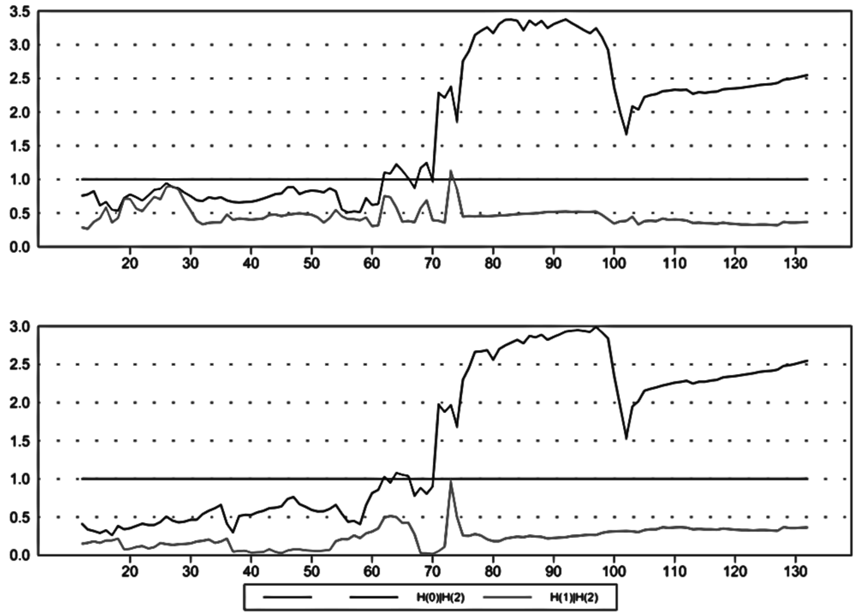

Figure 3 Recursive Trace Test Results

Table 3 reports the results of the full-sample Granger test. It can be seen from table 3 that BitCoin (China) is the Granger's causality of BitCoin (USA) and BitCoin (USA) at lags from 1 to 10, which shows the robustness of the result that Chinese Bitcoin market has a price discovery function to the U.S. market.

Meanwhile, BitCoin(USA) is not the Granger's causality of BitCoin(China), which means the US market's price discovery for Chinese market is not obvious.

5.2. Price Discovery

Table 4 reports the results of recursive and rolling Granger test. Panel A of Table 4 shows the probability that the Wald statistics in testing price discovery from Chinese market to the U.S. market (China to U.S) and U.S. market to the Chinese market (U.S to China). Table 5 shows the probability of the Wald statistic of China to U.S is larger (or smaller) than Wald statistic of U.S to China. As shown in the table, the probability that the Wald statistics of China to U.S is larger than that of U.S to China is far higher than the opposite case in both recursive and rolling estimation. These result shows that Chinese market plays an important role in price discovery, which is consistent with literatures on home bias hypothesis (Lieberman et. Kim et al., 2000; Phylactic and Korczak, 2005; Pauscual et al, 2006).

5.3. Volatility Transmission

After analyzing the price discovery of Bitcoin between Chinese and U.S. markets, this paper analyzes the volatility transmission in the two markets. Using BEKK model with ECM as horizontal equation. The estimation results are shown in Table 6.

In Table 6, a_{12} and b_{12} are both significant, while b_{21} and a_{21} are not significant. The results show that the direction of volatility transmission is different from price discovery, which holds the global center hypothesis.

6. Conclusion

Although the use of Bitcoin is now not popular enough to have huge impact on the real economy, as a digit currency constructed on Block Chain technique, the birth of Bitcoin provides us with a lot of useful ideas of Internet financial development.

This paper found that, in price discovery, Chinese market has greater impact on U.S. market, which is consistent with home bias hypothesis, while volatility transmission is more likely to be originated from U.S. market to Chinese market, which supports global center hypothesis. These results show similarity with stock price analyzed in Xu and Fung (2002).

Table 3 Results of Granger's Causality Test: Chinese and U.S. markets

	BitCoin(USA)->BitCoin(China)		BitCoin(China)->BitCoin(USA)	
Lags	Chi-square	p-value	Chi-square	p-value
1	0.61	0.44	26.21***	0.00
2	0.00	0.96	74.09***	0.00
3	0.01	0.92	68.05***	0.00
4	0.03	0.85	48.88***	0.00
5	0.22	0.64	34.18***	0.00
6	0.18	0.67	22.72***	0.00
7	0.03	0.87	20.50***	0.00
8	0.19	0.67	21.18***	0.00
9	0.73	0.39	21.41***	0.00
10	1.14	0.29	21.64***	0.00

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4 Probability of significance in Granger's Test

Number of Observations	10	20	30	60	90
Panel A: Recursive Estimation					
C->U	0.36	0.28	0.78	0.72	1.00
U->C	0.26	0.12	0.77	0.7	1.00
Panel B: Rolling Estimation					
C->U	0.79	0.86	0.95	0.99	0.99
U->C	0.75	0.82	0.9	0.97	0.99

Notes: numbers in Table 4 represent the probability that the Wald statistics are significant.

Table 5 Comparison of Wald statistics in Granger's Test

Number of Observations	10	20	30	60	90
Panel A: Recursive Estimation					
C->U is larger	0.91	0.93	0.99	0.99	0.99
U->C is larger	0.09	0.07	0.01	0.01	0.01
Panel B: Rolling Estimation					
C->U is larger	0.61	0.63	0.64	0.67	0.62
U->C is larger	0.39	0.37	0.36	0.33	0.38

Notes: numbers in Table 5 represent the probability that the Wald statistics of price in Chinese market are larger (or smaller) than that in U.S. market.

Table 6 BEKK Model Estimation Results: Chinese market and U.S. market

Parameters	Estimate	s.e.	T-Stat.	p-Value
c_{11}	0.020***	0.01	4.32	0.00
c_{21}	0.011***	0.00	3.21	0.00
c_{22}	0.002	0.01	0.00	1.00
a_{11}	0.231***	0.07	3.36	0.00
a_{12}	0.104*	0.05	1.98	0.05
a_{21}	0.046	0.08	0.55	0.58
a_{22}	0.173***	0.06	2.93	0.00
b_{11}	0.916***	0.04	24.10	0.00
b_{12}	-0.051**	0.02	-2.49	0.01
b_{21}	0.003	0.02	0.03	0.98
b_{22}	0.997***	0.01	92.21	0.00

Notes: *** p<0.01, ** p<0.05, * p<0.1

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