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Bitcoin Volatility and Currency Acceptance:
A Time-Series Approach

By

Francis Rocco

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of the requirements for
Honors in the Department of Economics

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ABSTRACT

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Virtual currencies emerged in 2009 as alternatives to traditional methods of payment, offering faster transaction speeds and increased privacy. The prime example of these currencies is Bitcoin. Prior literature in the past five years has generally predicted that bitcoin would fail to supplant an existing widely traded currency, but the volatility of the currency has been decreasing since then. I test Dowd and Greenaway's (1993) currency acceptance model using recent data on Bitcoin, including Bitcoin volatility. This paper will show whether Bitcoin's ability to act as a store of value and its level of price volatility affect the number of people that will accept it as a currency. Confidence in existing currencies may be weakening, and thus, analyzing the relationship between volatility and currency acceptance is significant in understanding the future behavior of currencies. I will employ a time-series vector autoregression to determine the effects of the number of vendors that accept Bitcoin, the volatility of the Bitcoin, the volatility of the dollar, and the volatility of the Euro on both Bitcoin volatility and the number of vendors that accept Bitcoin. I will also run Newey-West regressions to determine the effects of each volatility on the number of vendors.

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1 Introduction

In the past few decades, major technological advancements have begun to streamline the purchasing process for millions of consumers. With the advent of credit cards, online shopping, and mobile wallet services, it has become increasingly simple to make purchases of all sizes. More recently in 2009, a new type of currency emerged—one that could exist solely on the internet and yet maintain the requirements to serve just as a physical currency would. The prime example of this type of currency is Bitcoin, the first *cryptocurrency* in the world. Despite being the first of its kind, Bitcoin offers many unique characteristics that govern how it transacts, such as the ability to conduct transactions anonymously, maintain security, and perhaps most importantly, its status as a decentralized currency. No single entity has sole command over Bitcoin and its only constraints are the proofing mechanisms that exist to limit its supply. This characteristic offers security for those concerned with inflation expectations.

Bitcoin's inception occurred on October 31, 2008 when Satoshi Nakamoto (a widely speculated pseudonym for a small group of people) published *Bitcoin: A Peer-to-Peer Electronic Cash System* detailing the construction and implementation of a peer-to-peer electronic cash system (Nakamoto, 2008). Transactions within the system could be verified, authenticated, and protected through coding software. These characteristics also provided a mechanism to prevent multiple instances of the same transaction and, ultimately, fraudulent transactions.

Given Bitcoin's relatively short time in circulation thus far, people may be more or less likely to accept it as a currency. Dowd and Greenaway (1993) developed a currency acceptance model that incorporates switching costs and network effects (which will be defined later), and then predicts a critical mass of users that must be reached in order for the economy to switch to the new currency. By applying that model to recent data regarding Bitcoin, this paper will

attempt to show whether Bitcoin's ability to act as a store of value and its level of price volatility affect the number of people that will accept it as a currency.

2 Bitcoin History and Terminology

It is necessary to define some terminology regarding Bitcoin's operation as follows: a *block* is a cluster of transactions that occur within a ten-minute period. Further, there is a master register of verified Bitcoin transactions, and certain participants in the Bitcoin transaction network (known as *miners*) are chosen to verify each of the blocks. The master register is known as a *blockchain* which is readily available online, but the anonymity arises in the difficulty of determining the identity of a specific user by their transactions. When a miner successfully verifies a block the fastest, his or her solution is sent out to the network. Once the network verifies that the solution is correct (by majority rule), the miner receives some bitcoins as payment. The difficulty of this process increases every two weeks to ensure a fair competition between all of the miners. Additionally, given the required ten-minute period for blocks to form, it is generally suggested to wait through six rounds of verification before concluding that a transaction was properly added to the blockchain, which can be much faster than a typical electronic payment[1] (Segendorf, 2014).

On January 3, 2009, the first block, known thereafter as the *Genesis Block* or *Block 0*, was mined. On January 9, 2009, the first version of the Bitcoin interface was released ("Abridged", 2013). The generation system for each unit possessed the capability to create 21 million total bitcoins into the year 2040. There are currently around 16 million bitcoins in circulation. On October 5, 2009, the New Liberty Standard published an official exchange rate of $1.00 equivalent to 1,309.03 BTC. Then, on February 6, 2010, the Bitcoin Market was

[1] Compared to normal debit or credit card systems that can take a few days to process transactions.

established as the first official currency exchange for bitcoins. Thus, in the span of a little more than a year, Bitcoin became an official currency with the capability of conversion between preexisting currencies ("Abridged", 2013).

Many academics have speculated why exactly the currency came into existence, and one of the more accepted conjectures relates to the global financial crisis that occurred in the year prior. Some have suggested there is rising uncertainty in paper currencies such as the dollar (Luther, 2015 and Richter et al., 2015). However, no government or central bank controls the supply of bitcoins, so Bitcoin may be insulated from political instability. With that characteristic, Bitcoin could prove more attractive to countries that experience higher instability. Still, its volatility will likely arise as a point of contention on that matter.

As a currency, Bitcoin has proven to be quite volatile. Figure 1 illustrates the exchange rate between one bitcoin and one United States dollar from February 19, 2013 to February 19, 2017.

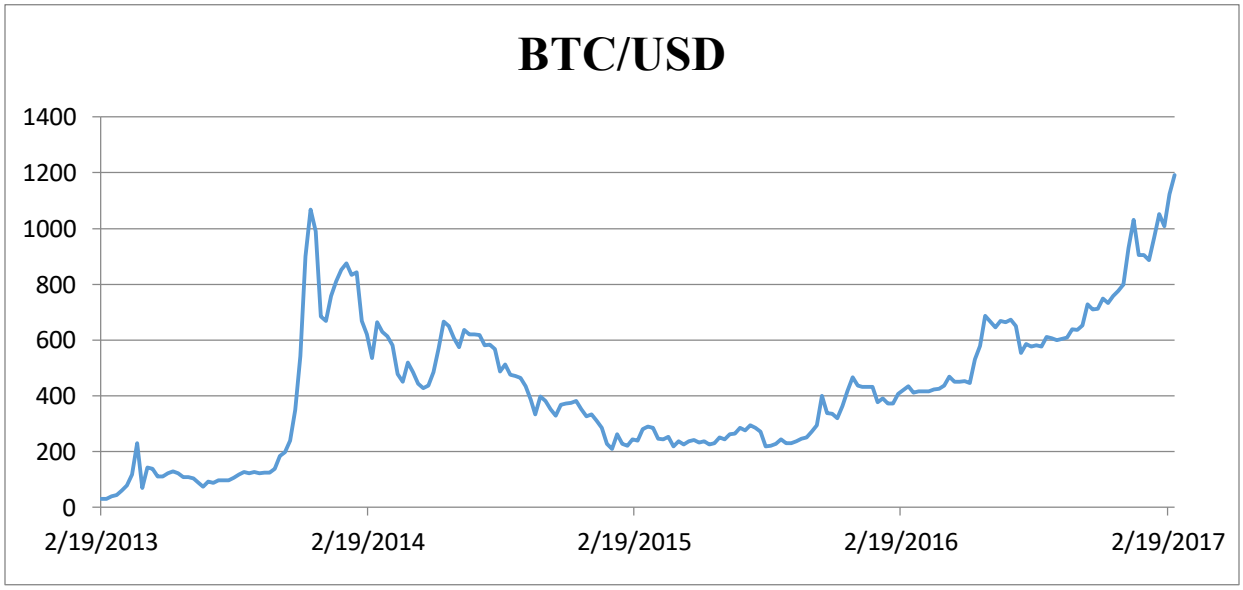

Figure 1

Clearly, there has been a wide range in the exchange rate in only four years. Though there have been approximately 203 million transactions using bitcoins since 2009[2], the currency is still relatively young and the network of acceptance is not particularly large (some sources suggest more than 100,000 vendors as of February 2015[3]). Since Bitcoin is still relatively new, there is uncertainty in its performance and it is still quite sensitive to many shocks to the market. Thus, the volatility of Bitcoin is higher than most established currencies. Presumably, this volatility affects Bitcoin's capability of acting as a reliable store of value. In order to gain any degree of acceptance, it is essential to provide some level of stability in terms of the value of the currency. One important sense of value is the exchange rate. A lot of volatility in the exchange rate exposes the Bitcoin holder to more risk. This risk is exactly like the concept of portfolio risk, wherein holding different currencies is parallel to diversifying a portfolio. Different currency exchange rates may perform differently over time, and if a small number of currencies are held, the result will be similar to under-diversifying a portfolio. Additionally, the volatility of the dollar likely influences the volatility of Bitcoin to some extent, given that the dollar's exchange rate is influenced by supply and demand and Bitcoin's is as well. More uncertainty in the dollar may cause people to be willing to accept another currency, which "diversifies" the currency exchange risk. Ultimately, it would be interesting to see if a higher volatility of the dollar induces greater use of Bitcoin.

Certainly, this is not the first instance of the introduction of a new international currency. Prior to its introduction and shortly thereafter, the Euro was expected to displace the dollar to some degree, and there was debate as to whether the Euro would replace the dollar as the currency of choice for international transactions (Frisch, 2003). This paper will also highlight

[2] "Total Number of Transactions." Blockchain.info. Blockchain, n.d. Web. 13 Feb. 2017.
[3] Cuthbertson, Anthony. "Bitcoin Now Accepted by 100,000 Merchants Worldwide." International Business Times UK. N.p., 04 Feb. 2015. Web. 20 May 2017.

some of the arguments within that literature, compare the results to Bitcoin, and incorporate the Euro's volatility as it is another widely accepted international currency.

3 Literature Review

Since its inception, a small but robust literature regarding the acceptance of Bitcoin has been developed. Luther (2013) begins by attributing the emergence of electronic currencies to increased efficiency in processing transactions and sustaining lower maintenance costs. He acknowledges cryptocurrencies as emergent solutions to this uncertainty and highlights Bitcoin as the primary example. He recognizes that there are several benefits to Bitcoin, such as the anonymous nature of transactions, and describes the transactions as "effectively irreversible" and similar to those conducted with cash. In contrast to credit and debit cards, Bitcoin bears no possibility for a chargeback—once a transaction is completed, the buyer cannot request to reverse it in the future. However, he argues that, due to network effects and switching costs, widespread acceptance of a cryptocurrency such as Bitcoin is not realistic.

To defend his assertion, Luther (2013) employs the previously mentioned model of currency acceptance by Dowd and Greenaway (1993). The model operates under the assumption that the value of attributed to a given currency depends somewhat on the amount of agents that are willing to transact with it. Luther describes the "socially optimal" opportunity to switch as when "the cost of switching is less than the net gain in utility from switching" (Luther, 2013).

The expected utility that an agent receives from switching currencies depends largely on whether the agent expects that other agents will switch as well. If only one agent switches, then the agent does not receive benefits within the network and only receives the net present value of the new currency. Luther then lists statistics about the first three years of Bitcoin's performance, which details the small network of Bitcoin users and the total transactions (the majority of which

are less than one Bitcoin). These factors account for the model's ability to predict a lack of widespread acceptance. Luther describes another scenario in which an agent's decision to switch only depends on whether the currency was accepted historically rather than solely on whether other agents will switch, but yields a similar conclusion: no one will choose to act first and thus no one will switch. Ultimately, Luther concludes that, without any period of monetary instability of support from the government, Bitcoin is unlikely to gain widespread acceptance. Still, he concedes that the failure does not imply that existing cryptocurrencies are inferior, and a successful transition requires great effort against network effects and switching costs.

Richter, Kraus, and Bouncken (2015) also begin by focusing on the causes for the emergence of virtual currencies, namely, the loss of trust in the banking sector, the fear of losing capital, lower interest rates recently, and the vast public uncertainty in the value in existing currencies. They assert that virtual currencies offer a perspective on a new type of banking system wherein many of those issues are alleviated. They describe in detail the five central challenges posed by Guo and Chow (2008): the security threat of using the internet, the danger of a virtual monetary system collapse, the impacts of real-world monetary systems on virtual ones, money laundering, tax evasion, online criminals, and the value fluctuation of virtual money. Richter, et al. then detail virtual currency systems that have already been accepted in some form, which are closed virtual currency schemes (such as currency in online video games) and virtual currency systems with differing directions of cash flow. They focus on the last of these for their high relevance to the public and emphasize the similar notion that the smaller network is a large downfall for virtual currency users. However, they concede that the field and the currencies are still quite young. Ultimately, they conclude that virtual currencies will

continue to progress and gain more acceptance, perhaps even more so with an "official, central authority in the lead," such as a newly created, singular World Bank.

Given their increasing popularity, virtual currencies have also begun to attract speculation regarding a proper form of regulation. Jeans (2014) focuses on the legal decisions and policies existing for Bitcoin today and how they may affect how virtual currencies operate in the future. With preexisting laws, he asserts that it is feasible to prevent cyber-crime, exercise taxation, and provide consumer fraud protection for transactions made using Bitcoin. Jeans writes that Bitcoin has been recognized by the IRS, and users may be subject to taxes related to capital gains. Ultimately, classifying Bitcoin and other virtual currencies as property causes ambiguity as to how they should be taxed. In addition, Jeans classifies Bitcoin as "hypervolatile" due to large spikes and drops in value from speculation over regulation. He notes that the relatively smaller volume of bitcoins in existence would cause relatively smaller events to have a larger impact on the value, which could devalue real-world currencies as well. Finally, he writes that the anonymity of transactions with Bitcoin still provides room for illegal activity, and thus regulation and possible rejection of virtual currencies is still possible by the government. On this issue, Jeans classifies Germany as a strong proponent, China and Russia as fierce opponents, and Canada, India, and the European Union as wavering back and forth over their final stance.

Though it is a virtual currency, Bitcoin can also provide beneficial services that may not be immediately apparent. Luther and Olson (2014) begin by equating money to memory (as was originally done by Kocherlakota (1998a; 1998b; 2002b)), and imply that it is a publicly updated record of all transactions based on public record-keeping abilities. They analyze Bitcoin's ability to act as a medium of exchange, describing its strengths in having "quasi-anonymous" transactions. The supply of Bitcoin is also predictable and not subject to shocks in the monetary

supply, but maintains disadvantages by having a predetermined supply and purchasing power fluctuations in response to changes in demand. Luther and Olson argue that transactions costs are still significant since it takes ten minutes to process a transaction block, while also highlighting the small user base and the lack of vendors that accept Bitcoin as a form of payment. Still, they concede that regardless of network effects, Bitcoin has garnered some acceptance. They mention that from May 2012 to May 2014, market capitalization increased from $100 million to $6.2 billion and they find that Bitcoin Gold app downloads were larger in countries with troubled banking systems.

Not all countries are inclined to immediately accept virtual currencies, and many governments have even demonstrated significant reluctance toward them. Hendrickson, Hogan, and Luther (2015) detail certain governments, such as China, that have banned the use of virtual currencies due to the rapid growth of its network. They analyze whether a government can actually prevent Bitcoin transactions or inadvertently push use directly into illegal markets. They highlight Bitcoin's presence in over fifty gambling websites that transact with the currency and the sale of drugs on the Silk Road in exchange for Bitcoin as well. They define a "Bitcoin Equilibrium" in which "Bitcoin, but not currency, is accepted in exchange," and a "coexistence equilibrium" that provides a basis for both Bitcoin and currency to be accepted for exchange. They conclude that even if every private agent is willing to accept Bitcoin, as long as the government does not accept it, it can still remove Bitcoin from circulation and restore a preexisting currency without repercussion. Outside of Bitcoin being held exclusively by the government, many transactions are still out of reach for government policy. Hendrickson, et al. find that there is a requirement for the government to be a certain size, depending on the amount of agents that are willing to accept the traditional currency, in order to prevent Bitcoin's

circulation. They attribute the lack of uniform Bitcoin acceptance among different communities and governments to that finding, and they expect that preference for Bitcoin is higher in countries with greater levels of technology and internet access. They also suggest this preference holds in countries where inflationary central bank policies render the traditional currency a lesser substitute.

Moore and Christin (2013) argue that Bitcoin's main advantages lie in its decentralized nature, requirement of proving procedures to keep the supply of Bitcoins limited, and status as an alternative to those who fear hyperinflation of the dollar due to excessive deflation by the Federal Reserve. Given the privacy in Bitcoin transactions, one may speculate that theft and piracy may arise as relevant issues. They focus on instances of Bitcoin theft, such as in March 2012 when over 43,000 Bitcoins were stolen from the Bitcoinica trading platform, and in September 2012 when over $250,000 worth was stolen from the Bitfloor currency exchange. Moore and Christin (2013) also highlight that the Bitcoin exchange rate has still fluctuated regardless of the known hacks and theft aside from two instances in 2011 and 2012. They discuss the existence of third parties that intermediate exchanges between physical and virtual currency, online wallets, investment services, and other related services. Using data from bitcoincharts.com, they construct a model that employs average daily transaction volume, whether a security breach occurred, and the AML/CFT compliance by financial regulators. Ultimately, they show that popular exchanges have a higher likelihood for a security breach, and they find that exchanges that process more transactions are not as prone to closure. Additionally, they analyze the months in which the exchanges were operational, count the number of possible days the exchange could have been hacked, and conclude that transaction volume is positively correlated with the chances of a breach occurring. They also highlight the proof-of-work

mechanics for Bitcoin transaction verification and the associated economic costs of performing such services. Finally, they consider the possibility of Bitcoin users that have an increasing preference for transaction anonymity, which could cause them to use an exchange service with a higher risk.

Until this point, the primary consideration for countries that might adopt Bitcoin have been primarily those that are fully developed. Clegg (2014) focuses on the possibility of countries that are still developing and how Bitcoin's characteristics could transform their economies given its infrastructure. He discusses how the currency's decentralized nature protects against rapid inflation and volatility, providing the example of Zimbabwe's extreme hyperinflation in 2008 which caused a switch to the dollar, a currency with much greater stability. He describes Bitcoin as "isolated from political volatility" which also protects from corruption within a government, which is more common among developing countries. He emphasizes Bitcoin's limited and predetermined supply as a major advantage over countries that are able to simply print more money and redistribute wealth while simultaneously causing inflation. Clegg proceeds by mentioning Bitcoin's distributed consensus model, i.e., the requirement of 51 percent of the Bitcoin miners to agree on any major changes to the system. He argues that it would be detrimental to each miner to attempt to devalue the currency in an attempt to gain greater control over it, and thus the currency is far less susceptible to that kind of attack. Then, he cites Kenya as a country that has widespread use of M-Pesa, a mobile money management service, and demonstrates that households with access to M-Pesa could better recover from negative shocks such as job loss or yearly harvest issues. He also emphasizes that M-Pesa is at a disadvantage to Bitcoin since it requires a user to travel to a retail store to process transactions frequently; Bitcoin, however, can simply be managed online, and offers more

privacy. Clegg then discusses another advantage in that current Bitcoin users have a direct interest to attract new users because it encourages more vendors to accept it and increases the network size. He mentions how the comparatively low transaction fees and the inclusion of lesser developed regions to increase the network size also favor Bitcoin over other mobile services. Finally, he concedes that having access to the Internet is one of the largest barriers to these countries, as clearly it is quite difficult to transact with Bitcoin without having reasonably widespread Internet access.

It is also worth considering a previous major shift in currency to evaluate the transition and the performance shortly thereafter. Mundell (1998) describes the history of the Euro, its introduction on January 1, 1999, and the transition to a single currency and entity from the European Monetary Union. He argues that this transition will be even more powerful than the 1944 Bretton Woods transition and the removal of gold from backing the dollar in 1971 since the United States and its currency remained in power both times. He highlights the criteria for any country to convert to the Euro, and specifically mentions how the debt to GDP ratio needs to be less than 60 percent. Mundell then asserts that any given currency's stability is influenced by both the range that its market dominates and its store of value, and questions whether the Euro will be able to attain the same characteristics as other major world currencies such as the United States dollar. He argues that, regardless of the most accepted currency, there is always a second-most accepted currency that will replace the existing one, should political ramifications render the former obsolete. He highlights size and stability of the second currency as the primary contributing factors, and asserts that a steadily growing international debt will render the world unable to rely solely on the dollar. However, he concedes that the transition period poses a great threat to the stability of the new currency, so the new currency must remain stable in order to

replace the old one. Mundell continues by emphasizing the importance of the Japanese Yen alongside the dollar and the euro, stating that Asia's economic performance rivals that of the rest of the world and that the exchange rates among the three should be monitored closely. In regard to the transition specifically, he argues that countries wishing to diversify reserves with the new currency may experiences issues until the European Central Bank establishes a reputation. He concludes that the introduction of the Euro will give the world an alternative to the dollar that provides stability and more power in constructing a future international monetary system.

In considering the Euro's performance thus far, it may seem surprising that it has not displaced the dollar to a larger extent. Frisch (2003) discusses this topic, and begins by detailing the history of the Euro and its introduction to society, defining its criteria for price stability, and contrasting the components of the European Central Bank's monetary strategy with that of the Federal Reserve. He proceeds through the three fundamental characteristics of money, highlighting that the dollar remained a dominant international currency (and therefore medium of exchange) through the period of 1998 to 2001. Next, he states that the Euro rose to parity with the dollar in regard to being a unit of account given its command over a market for issuing international bonds. Then, he describes how the share of the dollar in global portfolios dropped significantly leading up to the introduction of the Euro, while other European currencies' shares increased. Given the success in introducing the Euro, he questions why the Euro's share of the world economy did not displace the dollar even more. He answers that question by discussing how users are more inclined to remain with a currency that all other users favor, and the effect of the economies of scale for lower transaction costs with larger volumes. He includes that the network externalities provided by an international currency do not require extra cost to grant extra utility in being able to transact internationally. He then highlights that the Euro actually

depreciated against the dollar for the first two years of its existence, but he notes that it is still early to fully ascertain how well it can displace the dollar. Frisch ultimately concludes that the future for the Euro looks quite favorable, and that the Euro can be on par with the dollar in regard to acceptance and performance. He concedes, however, that the process could be lengthy when considering how long it took the dollar to displace the British pound. Still, he notes that the United States current account deficit (in 2003) is unsustainable, and that the dollar would have to depreciate in order to continue to service net foreign debt in the future, ultimately benefiting the Euro.

4 Data

This paper uses seven time series variables: the number of vendors accepting Bitcoin, three variables of the weekly closing price of the exchange rate for Bitcoin, the United States dollar, and the Euro (all relative to the Japanese Yen), and three weekly percent changes for those exchange rates. Though Bitcoin launched in 2009, there does not seem to be data regarding the actual number of vendors. Thus, the number of vendors was gathered from the number of vendors on coinmap.org, a website where vendors can register to be added to a map depicting where Bitcoin is accepted for transactions. The weekly closing prices were obtained from coindesk.com, and the weekly percent change was calculated manually in R. There are 211 observation weeks from February 19, 2013 to February 28, 2017. Initially, the exchange rates were relative to the dollar, but that caused confusion in comparing each one without being able to discern the dollar's volatility. Therefore, each of the exchange rate variables is relative to the Japanese Yen so that they are all on a relative basis and can be compared to one another. The Yen was also chosen because historically it has been a relatively stable currency, and any

volatility it experiences will be reflected in each of the three. Table 1 includes the descriptive statistics for each of the variables described.

Descriptive Statistics of Selected Variables: Weekly from February 19, 2013 - February 28, 2017

	Number of Vendors	JPY Per BTC	BTC % Change	JPY per USD	USD % Change	JPY per EUR	EUR % Change
Minimum	0	2,748.12	-70.28	93.41	-4.857	111.15	-3.219
Mean	4955.68	46,654.62	3.064	109.23	0.105	131.11	-0.005
Maximum	8838	135,785.30	109.87	125.62	4.267	149.18	4.88
Std. Deviation	2884.33	26,905.12	16.65	9.057	1.48	8.76	1.42

Table 1

5 Methodology

The analysis tests whether increases in the volatility of the dollar or Euro causes the volatility of Bitcoin to increase, and also whether increased volatility of the dollar or Euro causes the number of vendors that accept Bitcoin to increase. A vector autoregression (VAR) is estimated using the following equations:

$$V_{BC_t} = \beta_0 + \beta_1 N_{BC_t} + \beta_2 N_{BC_{t-1}} + \beta_3 V_{D_t} + \beta_4 V_{D_{t-1}} + \beta_5 V_{E_t} + \beta_6 V_{E_{t-1}} + \varepsilon_t \quad (1)$$

$$N_{BC_t} = \gamma_0 + \gamma_1 V_{BC_t} + \gamma_2 V_{BC_{t-1}} + \gamma_3 V_{D_t} + \gamma_4 V_{D_{t-1}} + \gamma_5 V_{E_t} + \gamma_6 V_{E_{t-1}} + \varepsilon_t \quad (2)$$

In Equation (1), V_{BC_t} is the volatility of Bitcoin at time t, N_{BC_t} is the number of vendors that accept Bitcoin at time t, V_{D_t} is the volatility of the United States dollar at time t, and V_{E_t} is the volatility of the Euro at time t. All variables with a subscript of $t-1$ denote the lag of the respective variable by one time period. To determine the number of lags, selection-order criteria are implemented on the Bitcoin volatility and the number of vendors, including the volatility of

the dollar and of the Euro as exogenous variables. The number of vendors is also a non-stationary variable, so for this VAR the number of vendors is converted into first differences.

From the VAR, we generate impulse response functions (IRFs) of the number of bitcoins in response to a shock to the number of vendors. It is well known that the ordering of the variables affects the identification scheme, and therefore we will check both orderings. The results from those functions may produce significant long-term responses. If so, there is evidence of uncertainty about the future purchasing power of national currencies which also encourages the use of Bitcoin. Ultimately, these questions aid in determining the degree of viability of Bitcoin as a medium for international exchange.

After generating the IRFs, we also conduct an analysis using Jordá's (2005) linear projection method. In order to do so, nine Newey-West regressions of the form

$$N_{BC_{t+h}} = \delta_0 + \delta_1 V_{BC_t} + \delta_2 V_{BC_{t-1}} + \delta_3 V_{D_t} + \delta_4 V_{D_{t-1}} + \delta_5 V_{E_t} + \delta_6 V_{E_{t-1}} + \varepsilon_t \qquad (3)$$

are estimated for all $0 \leq h \leq 8$. These regressions incorporate subsequent periods of the number of vendors to generate another IRF based on δ_1. These errors aid in reducing the amount of possible autocorrelation in the regressors and are less susceptible to possible heteroskedasticity. The advantage to running these regressions is that they do not require the same assumptions on the structure (i.e., the stationarity of the number of vendors), that the VAR requires.

6 Results

First, selection-order criteria are implemented to determine the proper number of lags to use. The results from that analysis are listed in Table 2.

Selection Order Criteria
Sample: 5 - 211 Number of observations = 207

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-2808.9				2.2E+09	27.1971	27.2361	27.2937
1	-1936.04	1745.7	4	0.000	502109	18.8023	18.8674	18.9633
2	-1834.07	203.94	4	0.000	194860	17.8557	17.9469	18.0811
3	-1818.97	30.19*	4	0.000	175062*	17.7485*	17.8657*	18.0383*
4	-1815	7.9508	4	0.093	175119	17.7488	17.892	18.103

Note: Asterisks denote significance.
Endogenous: Bitcoin Volatility, Number of Vendors
Exogenous: Dollar Volatility, Euro Volatility

Table 2

The selection-order criteria unanimously suggests a lag of three periods for the VAR. From the VAR, we generate IRFs which show the effect on each of the variables from a shock to any of the other variables. Here, we show the relevant impulse responses.

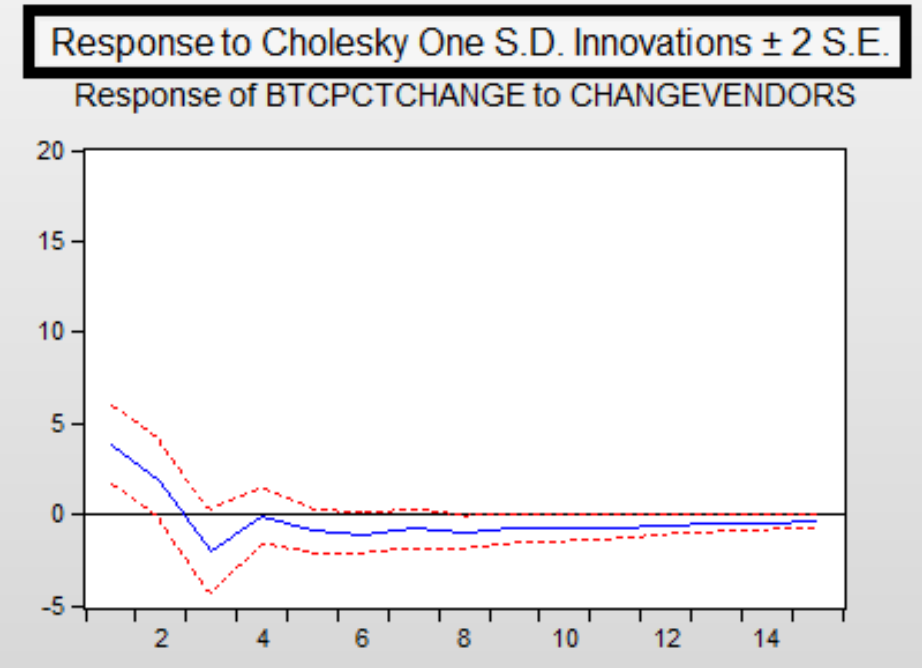

Figure 2

Figure 2 shows that an upward shock in growth rate of the number of vendors causes the Bitcoin volatility to increase in the first three periods and then decrease thereafter. This result implies that an increased number of vendors may ultimately contribute to a decreased level of Bitcoin volatility.

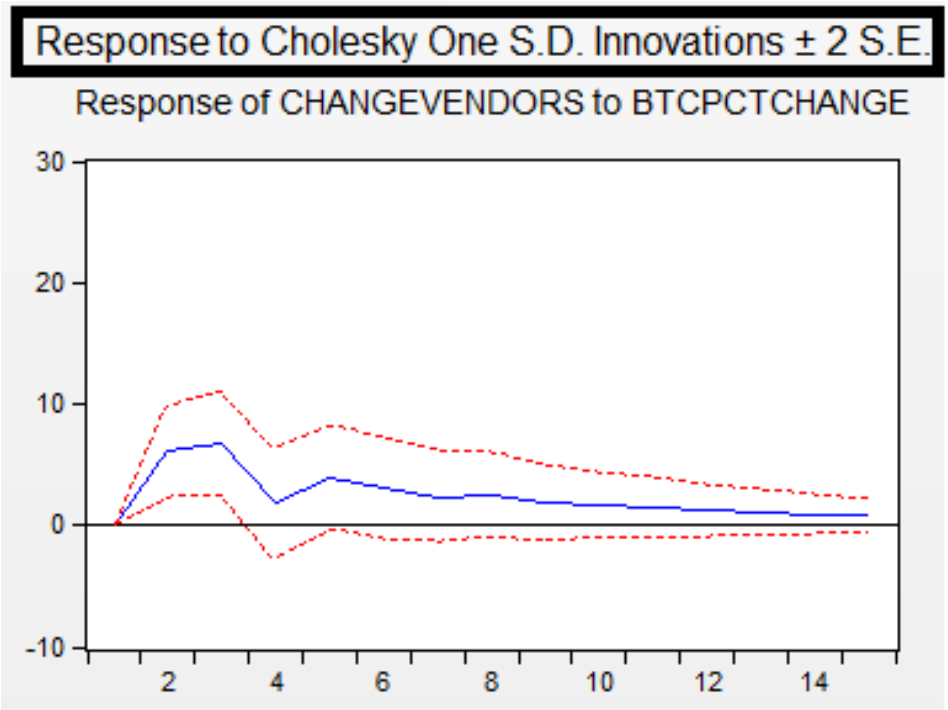

Figure 3

Figure 3 depicts the reverse ordering and implies that an upward shock in the volatility of Bitcoin causes an increase in the growth rate of number of vendors, which slowly decreases over time. This result implies that more vendors may accept Bitcoin as its volatility increases, which contradicts a typical expectation.

Next, we view the forecast error variance decomposition results from this VAR in Table 3. These results indicate that the ordering with Bitcoin volatility first and number of vendors second yields significantly greater effects than the opposite ordering. Therefore, we conclude that there are causal effects due to the order of the two variables.

Period	BTC % Change	Number Vendors
1	0.000000	100.0000
2	3.412607	96.58739
3	6.287804	93.71220
4	5.864959	94.13504
5	6.388515	93.61149
6	6.563616	93.43638
7	6.641071	93.35893
8	6.790408	93.20959
9	6.837175	93.16283
10	6.896370	93.10363
11	6.937858	93.06214
12	6.963361	93.03664
13	6.986553	93.01345
14	7.001356	92.99864
15	7.012697	92.98730

Cholesky Ordering: Number Vendors, BTC % Change

Period	BTC % Change	Number Vendors
1	5.955447	94.04455
2	13.96742	86.03258
3	18.93899	81.06101
4	18.51226	81.48774
5	19.62139	80.37861
6	20.10994	79.89006
7	20.36164	79.63836
8	20.68239	79.31761
9	20.82027	79.17973
10	20.95661	79.04339
11	21.05313	78.94687
12	21.11564	78.88436
13	21.16782	78.83218
14	21.20259	78.79741
15	21.22861	78.77139

Cholesky Ordering: BTC % Change, Number Vendors

Table 3

Next, the results from the nine regressions using Jordá's method are listed in Table 4.

Lead	BTC % Change	Lag BTC % Change	USD % Change	Lag USD % Change	EUR % Change	Lag EUR % Change	Number Obs.	Prob > F
0	-31.556*** (11.072)	-31.804*** (11.077)	-3.715 (165.527)	29.604 (160.078)	-126.738 (131.353)	-170.031 130.523	210	0.0008
1	-31.269*** (11.000)	-31.914*** (10.951)	-0.891 (165.772)	34.568 (160.177)	-150.047 (133.008)	-157.900 (128.138)	209	0.0005
2	-31.471*** (10.876)	-31.438*** (10.991)	1.284 (165.875)	35.853 (159.973)	-139.531 (131.122)	-153.672 (126.954)	208	0.0006
3	-30.935*** (10.839)	-31.775*** (10.929)	5.493 (165.834)	21.034 (160.592)	-135.733 (130.044)	-134.733 (125.620)	207	0.0007
4	-31.301*** (10.758)	-32.139*** (10.937)	-7.426 (165.854)	39.112 (159.162)	-118.950 (128.903)	-132.387 (125.005)	206	0.0008
5	-31.582*** (10.682)	-31.721*** (11.008)	11.093 (164.818)	35.646 (158.968)	-116.898 (128.024)	-128.682 (124.695)	205	0.0012
6	-31.022*** (10.683)	-31.298*** (11.029)	9.361 (164.838)	41.521 (158.257)	-116.845 (127.048)	-137.143 (123.882)	204	0.0015
7	-30.669*** (10.714)	-30.286*** (11.250)	16.218 (164.340)	60.428 (157.419)	-128.467 (126.155)	-139.868 (123.335)	203	0.002
8	-29.645*** (10.914)	-30.767*** (11.190)	35.074 (163.255)	60.319 (156.646)	-130.862 (125.484)	-139.043 (122.992)	202	0.0032

*** = 1%, ** = 5%, * = 10%
Note: Numbers in parentheses are the standard errors. Asterisks denote significance.

Table 4

In the first regression, Bitcoin volatility has a statistically significant effect on the number of vendors as demonstrated by the first row of results. The coefficient is -31.556, which implies that as Bitcoin volatility increases, the number vendors decreases by approximately 31.556. This result seems much more reasonable given that a more volatile currency is less likely to be accepted. We demonstrate the results of the other eight regressions with the corresponding IRF for the δ_1 coefficients in Figure 4.

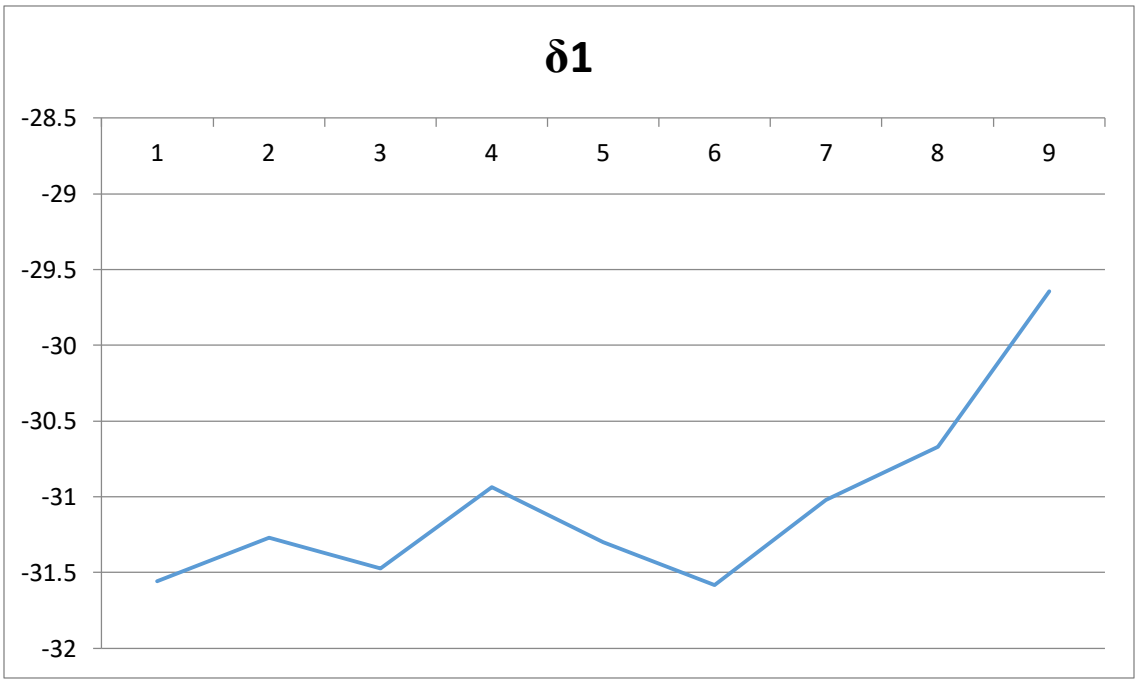

Figure 4

From this IRF, it appears that the coefficient values start off quite negative and then slowly increase over time. This result implies that an upward shock to the volatility of Bitcoin causes a sharp decrease in the number of vendors that slowly begins to increase after the sixth period.

7 Conclusion

The primary goal of this paper is to attempt to show whether Bitcoin's ability to act as a store of value and its level of price volatility affect the number of people that will accept it as a currency. The first VAR results are somewhat contradictory, implying that an increase in the

number of vendors causes the volatility of Bitcoin to both decrease and increase. The Newey-West regression results seem more reasonable given that they imply that a spike in the volatility of Bitcoin causes the number of vendors to decrease. Overall, the results from both methods imply that there is a significant effect from the volatility of the Bitcoin on the number of vendors. Thus, this evidence suggests that Bitcoin's level of price volatility directly affects the number of people that are willing to accept it as a currency.

An improvement upon these analyses would be to include more recent data as the data set was relatively small. Given that Bitcoin is still somewhat new, it continues to experience quite a lot of volatility, exemplified by its recent upward exchange rate spikes in May of 2017. Additionally, the number of vendors variable could be significantly improved upon given that it requires vendor to register on a specific website. As mentioned earlier, the true number of vendors may actually be more than 100,000 as of February 2015, and thus an improved number of vendors variable may lead to other or more significant conclusions.

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