

ARE BITCOINS MONEY?

An Undergraduate Research Scholars Thesis

by

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TABLE OF CONTENTS

	Page
ABSTRACT.....	1
SECTION	
I INTRODUCTION	2
How It Works: The Bitcoin Network.....	4
II BITCOIN TOPICS.....	7
Law of One Price	7
Thiers' Law	9
Bitcoin as an Asset	11
Competing Currencies	16
Bitcoin Pricing	19
Fraud?	22
Seigniorage	24
III CONCLUSION.....	28
The Future.....	28
WORKS CITED	31
APPENDIX.....	32

ABSTRACT

Are Bitcoins Money? (May 2015)

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This paper is a primer on many topics related to the digital cryptocurrency, Bitcoin. Bitcoins have been developed and advertised as a private digital money. We analyze this claim, generally to conclude that Bitcoins as they presently exist are not money. They are not generally accepted in exchange and do not serve as a unit of account. We test the hypothesis that the value of Bitcoins are determined largely by network externalities, finding very limited data to support this claim. We analyze features of bitcoins, such as their high exchange rate volatility with respect to the U.S. dollar and other currencies. We examine pricing on various exchanges, and how the law of one price works in bilateral and trilateral exchange rates involving Bitcoins. The potential for arbitrage is examined. We look at the use of bitcoins at Overstock.com, and the impact of that decision on Overstock.com stock prices and on the value of Bitcoins. We consider Bitcoins as an asset and examine their contribution to portfolio holdings. We discuss Bitcoin's use in fraud resembling a Ponzi scheme. Finally, we speculate on the future of Bitcoins and the potential uses for the underlying technology.

SECTION I

INTRODUCTION

Bitcoin is a decentralized, peer-to-peer digital cryptocurrency that facilitates fast, cheap, and quasi-anonymous transactions via the internet. It has given rise to a plethora of similar cryptocurrencies that mimic Bitcoin in many ways. These cryptocurrencies (Bitcoin chief among them) are bought and sold for real currencies as well as transferred around the world for a multitude of legal and illegal reasons. Their price in terms of other more traditional currencies (e.g., the U.S. dollar) is volatile and unpredictable. Moreover, the design of Bitcoin and related cryptocurrencies differs in many ways from traditional currencies that economists have come to understand. It is therefore reasonable to ask what is the impact of these cryptocurrencies on the world economy? Why are cryptocurrency prices so volatile? What does the future hold for cryptocurrencies? And perhaps most fundamentally, should cryptocurrencies be considered a currency at all?

Bitcoin and cryptocurrencies in general are new, both to the general public and to the field of Economics. It is fair to say that economists are still forming their opinions of cryptocurrencies. There are mixed opinions about the features of Bitcoin and how it should be viewed, including the basic question, is Bitcoin a currency? This manuscript seeks to lay out basic details of Bitcoin, including conceptual details on its role as money.

It is important to research cryptocurrencies such as Bitcoin because they have the potential to have a massive impact on the economy and daily lives of people around the world. Bitcoin used to appeal a niche demographic of anarchist and computer enthusiasts, but increasingly individuals in China, Japan, the US, and Europe are beginning to investigate crypto-currencies and how they may be used in transactions and as an investment. In fact, millions of dollars have already been made (and lost) by people speculating on the price of Bitcoin. Additionally, millions of dollars of Bitcoins have traded hands as part of legitimate business transactions and millions more have been transferred as part of illegal business transactions. All of these facts make Bitcoin increasingly important to the economy. That being said, at the present time Bitcoin's presence is still only a small part of the economy. At the time this was written, Bitcoin had only about 60,000 transactions a day [Wan 2014] and a market cap of \$3,557,961,043¹. Bitcoin is tiny compared to traditional online payment systems, but it is growing rapidly and may soon become a major player.

We will focus on a series of issues that provide a background for considering the properties and features of Bitcoin and its role in the economy. We look at Bitcoin pricing to see if it violates the Law of One Price. We consider the significance of the extreme volatility that Bitcoin exhibits and how this compares to historical examples of volatile currencies. We apply Thiers' Law (considered to be the reverse of the more famous Gresham's Law) to Bitcoin, and consider how Bitcoin fairs as an asset held as part of a portfolio. Using event studies, we analyze the hypothesis that the value of Bitcoin is largely determined by network externalities. We discuss the claim that Bitcoin may resemble a Ponzi scheme. We also discuss the idea of seigniorage and

¹ The website <http://coinmarketcap.com> shows real time market capitalization for all major cryptocurrencies

the possible lost income that governments could face if they continue to allow competing currencies. Finally, we will hypothesize what the future could hold for Bitcoin and cryptocurrencies in general. Each of these questions will give us a clearer picture of Bitcoin that will help us to begin to answer the questions we have proposed.

How It Works: The Bitcoin Network

The Bitcoin network that handles the inner-workings of all Bitcoin creation and transactions is a technological marvel. The intricacies of the network are beyond the scope of this paper, but a basic understanding of how Bitcoins are created and exchanged is critical for understanding its significance. In 2009, an individual or group of individuals by the pseudonym Satoshi Nakamoto, published a 9 page document outlining the Bitcoin Network². The software that runs the Bitcoin network is entirely open-source and free for anyone to inspect or even copy for their own cryptocurrency as we have seen with alternative cryptocurrencies such as Litecoin.

Arguably the most important and ambitious part of the Bitcoin network is the fact that it is entirely de-centralized and dependent only upon its own users for its functioning and continued operation. There are two main players in the Bitcoin network: miners and users. An individual can be either or both of these roles. Miners provide the infrastructure that allows users to transact using Bitcoins.

When an individual wishes to participate in the Bitcoin community, he or she can download free software that generates a unique digital wallet. This wallet has two distinct identifying features, a private key and a public key. The public key is the address where others can send Bitcoins and

² The entire paper outlining Bitcoin and the Bitcoin Network can be found at <https://bitcoin.org/bitcoin.pdf>

the private key is how the owner claims the wallet. It is interesting to note that a single person can possess as many wallets as they would like. In fact, it is common practice to use a new wallet for every transaction to increase privacy.

When a user decides they would like to transfer Bitcoins they possess, he or she must know the public address of the wallet they would like to send Bitcoins to. They may then utilize any number of free programs to enter the public address of the recipient and quantity of Bitcoins that they would like to transfer. The software then submits this transaction to the Bitcoin network for verification and addition to the block chain.

The block chain is the public distributed ledger of all transactions on the Bitcoin network. It ensures that the same Bitcoin may not be spent twice by the same person. The block chain is formed one “block” at a time and a new block is added roughly every 10 minutes. A block is a group of transactions that miners are competing to verify. The miners compete in order to be the computer/node (or pool of computers) that is able to verify the transactions first. Once the first miner has successfully solved the necessary calculations, he or she is able to complete the block and add it to the block chain. Once this occurs, the other miners abandon work on that block and begin working on the next one.

Miners utilize real capital in the form of CPU power and electricity. In return, they are rewarded with newly created Bitcoins when they are the miner to solve the newest block. Currently, a miner is rewarded with 25 Bitcoins (about \$6,250 at time of writing) for solving a block but this amount is halved every 4 years. A block is added every 10 minutes, so there are roughly 144

blocks created every day. At 25 bitcoins awarded for every block, miners collectively create 3,600 Bitcoins (abbreviated BTC) every day. At the time of writing, that is worth approximately \$900,000 per day. This value fluctuates greatly as the exchange rate changes. However, it is clear that the potential to make money via mining is substantial. That being said, the winner-takes-all distribution and high overhead costs makes profitable Bitcoin mining difficult for the majority of users.

An important aspect of bitcoin to consider is that the rewards that are granted to miners is halved every four years. Currently 25 BTC are awarded for every block and this amount will halve sometime in 2016. Eventually, Bitcoin will reach a final arbitrary supply. The maximum supply of Bitcoins is 21 million BTC and it will be reached in the year 2140. After the year 2140, miners will be incentivized via transaction fees rather than new Bitcoins (Nakamoto 2009). The slowing rate of Bitcoin production causes the Bitcoin economy to exhibit deflationary pressure as the growth of the Bitcoin economy outpaces the growth of the supply of Bitcoins, causing prices to decrease. This runs counter to many traditional currencies that intentionally pursue inflationary monetary policy.

SECTION II

BITCOIN TOPICS

Law of One Price

At first glance, Bitcoin violates a fundamental law of economics, the Law of One Price. The price of Bitcoins frequently vary between exchanges; sometimes very widely. In other, more established markets, these differences would quickly be eliminated as investors (or their computers) rapidly engage in arbitrage until the price spread disappears. However, this is not what we have historically observed with Bitcoin.

Donald Marron of Forbes speculated about what has caused some of the extreme price spreads that were seen during the collapse of Mt. Gox (the largest Bitcoin exchange at the time). Mt. Gox, a Tokyo based company, went bankrupt when the US government accused it of operating an illegal money service business. Some of the largest spreads that have been seen (>40%) occurred between Mt. Gox and Bitstamp (the second largest exchange at the time) shortly before Mt. Gox's descent into bankruptcy. Marron speculates that these spreads occurred because Mt. Gox ceased to allow US dollar withdrawals from their exchange. Customers on this exchange would then have been forced to recover their money by buying Bitcoins, which were, ironically, more liquid than the currency they had on Mt. Gox. Then they would attempt to transfer these Bitcoins to a wallet outside of Mt Gox. This increase in demand for Bitcoin by desperate individuals drove the price up, but only on Mt. Gox specifically. It is unclear who would have

been willing to sell their Bitcoins for USD that they wouldn't be able to withdraw. Perhaps these individuals assumed Mt. Gox wouldn't go bankrupt or that their account balance would be insured in the event that it did go bankrupt. Prices on the other exchange were dragged up slightly at this time, but not nearly to the extent of the Mt. Gox price.

While the above seems like a reasonable explanation for price differences during the middle of 2013, what explains the price spreads that we see more recently between exchanges? These price spreads still do not violate the Law of One Price because for the Law to operate, it requires highly efficient markets i.e. simultaneous and speedy transactions, high volumes, low fees etc. The Bitcoin exchange market is far from highly efficient. First, fees can eat away much of the opportunity for arbitrage. A fee of around .5% per transaction is typical of a major exchange such as Bitstamp. Because arbitrage requires both a buy and a sell, you must pay this fee twice, resulting in about a 1% fee. Therefore, the price spread must be greater than 1% for an investor to even consider arbitrage. There can also be fees associated with withdrawing USD from the exchange, further widening the necessary spread in order to arbitrage. Additionally, transactions involving exchanges can be very slow in a number of ways. Depositing Bitcoins into exchanges takes 1 hour, making it impossible to quickly buy one Bitcoin on a cheaper exchange, transfer it to the more expensive exchange and sell it. One way to bypass this would be to hold a quantity of Bitcoins on both exchanges so you can simultaneously buy a Bitcoin on one exchange and sell one on the other. However, holding one's money in the form of Bitcoin exposes it to tremendous risk as the value of Bitcoin is incredibly volatile. This risk would defeat the purpose of arbitrage which is risk-free by definition. Therefore, the average spreads of less than 1% or 2% we observe between Bitcoin exchanges are impossible to arbitrage.

Furthermore, we predict that as volumes of Bitcoin transactions has increased over time, the price spreads would decrease accordingly. Figure 1 and 2 show that this is what we observe. In January of 2012 there was a total BTC volume of 955.75 on the two exchanges Bitstamp and BTC-E and an average price difference of 4.541%. However in January of 2014, the BTC volume on the same two exchanges was 28065.021 with an average price difference of 0.285%. The price difference of 4.541% that we observed in 2012 was clearly too high to persist and has now been brought down to a reasonable difference of 0.285%. The prices may never be completely identical as long as exchanges charge fees and impose time restraints.

Thiers' Law

Thiers' Law, named after French historian Adolphe Thiers, asserts that in the absence of legal tender laws forcing them to accept both currencies, sellers will choose to transact with the currency of higher perceived long-term value. Conversely, buyers will choose to pass on the currency that they perceive to be of the lowest long-term value and keep the currency of higher long-term value. Therefore, if sellers provide buyers with the opportunity to pay with either currency, transactions will occur using the currency of lower perceived long-term value. Thiers' Law is often considered to be the opposite of Gresham's Law. While Gresham's Law is commonly phrased as "Bad money drives out good", Thiers' Law can be stated at the opposite i.e. "Good money drives out bad".

Sellers in the US today have the choice of whether to accept Bitcoin, USD, or both. We would expect sellers to accept the money that they believe to be of the highest long-term value.

Therefore, sellers who believe that Bitcoin is of greater long-term value than the USD due to inflation should accept only Bitcoin. However, with Bitcoin being a niche market, most sellers aren't willing to exclude USD sales as it would cause them to lose too much revenue. So most sellers who choose to accept Bitcoins also accept USD. They accept Bitcoins at a fluctuating exchange rate tied to one of the main Bitcoin/USD exchanges. This passes on the decision of whether to transact in Bitcoin or USD to the buyer.

Theirs' law states that buyers, when given the choice, will choose to keep the money of greater perceived value and pass on the currency that they perceive as being of lower long-term value. Many people who hold Bitcoin do so because of its deflationary pressure (the value of it tends to go up). If people expect that Bitcoin is deflationary and the USD is inflationary, Bitcoin will have the higher perceived long-term value and people will thus choose to transact with USD. There is some anecdotal evidence that this is what is occurring in the Bitcoin community.

In Tokyo, there is a Bitcoin enthusiast group called the Tokyo Bitcoin Meetup Group who meets weekly at the Pink Cow, Tokyo's first restaurant to accept Bitcoin. At this meeting of Bitcoin enthusiasts one might expect most members of the group to pay for their meal with Bitcoin.

However, only one third of the members choose to use Bitcoin due to the deflationary pressure increasing their expectations of the long-term value of Bitcoin (Metz). The amount of Bitcoins they would have to spend to purchase the meal today could have a much greater value tomorrow or next week or next month. On the other hand, the Yen which they can also legally use, has a known inflationary expectation (Trading Economics). This series of circumstances will lead to many sellers who are willing to accept Bitcoin but few buyers who are willing to spend them.

This problem is known as hoarding and could be detrimental the adoption of Bitcoin as a currency in the future.

This still doesn't explain sellers who accept Bitcoins in order to immediately exchange them for the equivalent USD amount. These sellers are likely accepting Bitcoins because they believe the increased profit from increased sales (due to appealing to the Bitcoin community) and decreased transactions fees that come from using Bitcoin exceed the minimal cost of implementing such a system.

Bitcoin as an Asset

Is Bitcoin A Currency?

Bitcoin is frequently referred to as a cryptocurrency. The “crypto” (referring to cryptography) portion of the name is fitting. However, the “currency” portion seems to presume something that may not be valid. That is to say, it presumes that Bitcoin is in fact a currency. According to economic theory, in order to be a currency Bitcoin would need to act as a store of value, a medium of exchange and a unit of account.

To be a store of value, an asset must be able to be held for a length of time and still have a predictable value due to the inherent demand for that asset. Bitcoin doesn't quite seem to meet this criteria. Its volatility makes it impossible to store with any confidence that Bitcoin will retain any value at any future date. With no government backing or underlying physical assets, the price of Bitcoin could drop to zero tomorrow for any number of reasons. Someone wishing to store value for use a later time would be better off purchasing gold or holding a stable currency

with predictable rates of inflation. The short-term volatility and long-term regulatory uncertainty make Bitcoin a poor store of value.

Bitcoin also fails to be a medium of exchange. In order to be a medium of exchange, Bitcoin must be widely accepted as a means of payment. While Bitcoin is accepted at thousands of businesses worldwide, it is difficult to justify the claim that it is widely accepted. The term “widely accepted” means that an individual should be able to go out and purchase their daily needs using Bitcoin with little difficulty. Even in the most tech-savvy cities, it is difficult to survive using only Bitcoins³. The deflationary properties of Bitcoin make buyers reluctant to use it as a medium of exchange and the volatility of Bitcoin makes sellers reluctant to take it. An asset with more stable purchasing power, such as the USD, is preferable for both parties when making transactions.

Bitcoin also fails at the last characteristic of currencies, a unit of account. Bitcoin is too volatile, and at the present, too expensive to be a very useful unit of account for any transactions of a typical dollar amount. On Overstock.com and similar sites that accept Bitcoin, prices are quoted in USD and the Bitcoin price is adjusted to match the USD value in real time. This makes USD the actual unit of account against which we measure the value of the product. A business can't post a stable Bitcoin price because the purchasing power of that amount of Bitcoin varies too greatly from day to day. Additionally, the presently high value of Bitcoin makes expressing small prices very unwieldy and confusing for consumers. A price of 0.07877427 Bitcoin is not as easily understood a price of \$20 (the equal value of USD at the time of writing).

³ See Forbes article “Living On Bitcoin For a Week: The Journey Begins”

The fact that Bitcoin fails to meet the criteria to be considered a currency does not mean that it is useless. It simply means that Bitcoin may better be considered from the perspective of an asset. Specifically, a crypto-asset. Bitcoin's distributed ledger and peer-to-peer network make Bitcoin a technological innovation worth considering. However, if we only consider its uses as a currency, we may fail to realize its more productive potential uses. In the section titled "The Future", we will discuss what these potential uses may include.

Holding Bitcoin as an Investment

Whether or not Bitcoins are money, they certainly are an asset. Bitcoins pay no interest, so any return to buying and holding Bitcoins is a capital gain. This is similar to buying and holding a foreign currency, or buying and holding a commodity (e.g. gold).

It is important to distinguish the investment return from buying and holding Bitcoins in a portfolio, versus the return from investing in the capital required to go into the business of mining Bitcoins. This second activity is not the return to holding Bitcoins as an investment. The returns on Bitcoins have been large, and volatile. There are periods when Bitcoins prices (in US dollars) increased rapidly, and other periods where Bitcoin prices declined rather precipitously. While the price has risen tremendously from \$5 per Bitcoin at the beginning of 2012 to about \$600 per Bitcoin in August 2014, the path is far from smooth, as seen in Figure 5. In fact Bitcoin reached an overall high prices of just over \$1150 on Dec 4 2013, and has since given up much of that increase. Still, anyone buying and holding Bitcoins since its inception up until late 2013 will have seen prices rise far above their purchase price.

As Figure 5 makes clear, Bitcoin prices are volatile. Table 1 compares Bitcoin returns and volatility with various alternative investments. Several things stand out immediately. First, the return on holding Bitcoins over this entire period is very high, an order of magnitude higher than the return to holding the Wilshire 5000. By comparison, Gold and Oil had returns close to zero, or even negative, over this period. Second, the standard deviation of daily Bitcoin returns is an order of magnitude higher than the standard deviation of returns on the Wilshire 5000, and is substantially higher than the standard deviation of gold or oil returns. Third, the correlation of daily Bitcoin price movements with prices movements on gold, oil, or the Wilshire 5000 is very low for gold and essentially zero for both oil and the Wilshire 5000.

If one were to construct a portfolio consisting only of Bitcoins and the Wilshire 5000, and using the above historical returns, variances, and covariance estimates in place of expected future returns, variances, and covariance, the optimal portfolio weights would be 13.4% in Bitcoins and 86.5% in the Wilshire 5000. Of course, the experience in 2014 might lead one to reduce the expected future return on Bitcoins from the extremely high value in the table, lessening the attractiveness of Bitcoins. The minimum variance portfolio would have a weight on Bitcoins of 1.32%, reflecting the huge variance in Bitcoin returns compared to Wilshire 5000 returns.

Is Bitcoin a Bubble?

Bubbles are very hard to define for such a new and unusual asset like Bitcoin. In order to determine if the price of Bitcoin resembles a bubble, one must define the fundamentals of Bitcoin. Defining the fundamentals of Bitcoin is nearly impossible. There are no dividends, assets, or intrinsic value associated with Bitcoin. However, a bubble in the Bitcoin economy can

be pictured as a price of Bitcoin that far exceeds the value of the usefulness of the currency and is largely reflecting prices inflated by speculation.

In October 2012, the European Central Bank wrote in their paper “Virtual Currency Schemes” that they believe Bitcoin was exhibiting the characteristics of a bubble. They reached this conclusion by defining what they believe to be the determinants of the value of Bitcoin (or any virtual currency) and then observing the price of Bitcoin relative to changes in the determining factors. The factors that they defined as determinants are as follows:

- 1) The supply of money and issuer actions such as the decision to intervene in the market
- 2) Network externalities i.e. how many people accept and use Bitcoin.
- 3) Institutional conditions governing the virtual community e.g. transparent policies, state-of-the-art security
- 4) The virtual currency issuer’s reputation for meeting its commitments
- 5) Speculation regarding the future value of the currency and history of cyberattacks

As far as Bitcoin is concerned, factors 2 and 5 are the most important in determining the value as they are the ones that will change greatly over time. Factors 1, 3, and 4 are already established and can therefore be taken as given in the short run. The authors of the “Virtual Currency Schemes” paper claim that the price of Bitcoin appreciated greatly in a short period of time during which none of the factors above had changed. Therefore, they claim the “exchange rate evolution should probably be attributed entirely to speculation”. Their conclusion may be correct, however their logic is contradictory. They claim that none of the factors had changed, therefore the change in prices must be due to speculation. However, speculation is one of the factors (factor 5). Thus, increased speculation is by definition a change in one of the determining

factors according to their determinants. Despite this, their conclusion that the increase in price is due to speculation is a sound conclusion if you consider their list of determining factors to be exhaustive. While the network externalities have increased greatly over time, the value of Bitcoin has increased at much greater rates than can be explained by increases in network externalities. The “Event Studies” portion of this paper considers the notion that network externalities affect the price of Bitcoin.

If one applies the European Central Bank’s method of determining bubbles to price changes that have occurred since the publication, it would appear that Bitcoin has continued to resemble a growing bubble. The drastic price jump in November 2013 (one year after the release of the “Virtual Currency Schemes” paper) did not occur in conjunction with any equally drastic changes in the determining factors of Bitcoin’s value (except perhaps the factor of speculation). However, Bitcoin’s only value may not be as a traditional currency as was assumed. The best use of Bitcoin may not be as a currency but rather as a means of international money transfer (Dwyer 2014). This could give Bitcoin legitimate value that is not recognized by this model.

Competing Currencies

Currency Substitutions

Currency substitution occurs when residents of a country use a different country’s currency to replace part or all of the use of currency in transactions. Currency substitution has most frequently occurred when a country’s residents use US dollars in place of the local currency. This has occurred in response to financial market instability including high and volatile inflation rates in the official domestic currency.

Currency substitution is often unofficial or de facto. In these cases there remains an official domestic currency, but residents hold large balances of a foreign currency and use that currency for a substantial portion of transactions. In this case the foreign currency lacks any status as legal tender.

Sometimes countries outright adopt a foreign currency as the official currency. For example, Ecuador adopted the US dollar as its official currency in 2000. In this case Ecuador gives up its right to seigniorage from currency creation and instead cedes this revenue to the foreign currency creator, in this case the US government.

De facto currency substitution also results in a loss of seigniorage, as the use of a foreign currency reduces the demand for the official domestic currency and hence reduces the seigniorage the domestic government earns from creating high powered money. At the same time, the foreign currency demand leads to increased seigniorage for the foreign government that creates that currency.

Bitcoins, to the extent they would circulate in tandem with US dollars and would provide an alternative to US dollars in transactions, would be a substitute currency for the dollar. If Bitcoins were to be used in a substantial percent of transactions this would reduce seigniorage to the US Treasury. The ability of residents to engage in currency substitution depends in part on the domestic government's willingness to allow the substitution. Some countries jealously guard

their seigniorage flows and take actions to discourage currency substitution such as exchange controls and other legal restrictions.

The threat of currency substitution provides an incentive for governments to maintain stable financial institutions and to maintain low and stable inflation rates. Residents of a country with stable financial markets and low and stable inflation rates are unlikely to be tempted to use a foreign currency. Alternatively, residents of a country with unstable financial markets are much more likely to consider holding an alternative “safer” currency. Residents facing large risks of exchange rate devaluations, or high inflation rates, are also much more likely to hold an alternative currency that is likely to hold its value both relative to other currencies and relative to goods and services. Thus countries realize that mismanaging financial markets and mismanaging monetary policy can lead to currency substitution, lower seigniorage, and less control of domestic monetary policy.

Bitcoins would be a substitute currency for the US dollar within the US economy. If US residents feared for the stability of the value of the dollar relative to other currencies and especially relative to goods and services, they might well be tempted to switch to Bitcoins for regular daily transactions. This would be easier to do if the US government maintained its fairly hands off approach to the use of Bitcoins within the US. Residents engaged in foreign transactions would be more likely to use Bitcoins if the exchange rate risk of using dollars was high, especially relative to the exchange rate risk of Bitcoins.

At present, there seems little immediate concern in the US with respect to inflation, and the exchange rate risk with Bitcoins is much higher than the exchange rate risk with US dollars. Hence there seems little reason to expect wholesale adoption of Bitcoins as an alternative to the US dollar in monetary transactions within the US.

Bitcoin Pricing

Event Studies

In *Is Bitcoin a Bubble?* We discussed 5 factors that determine the price of a cryptocurrency. Factor 2 states that network externalities (how many people accept and use Bitcoin) will be a significant factor in determining the price. This makes intuitive sense. Few people want to hold a currency that no one accepts and few businesses want to accept a currency that few people hold.

Prior to January 2014, most of the businesses that accepted Bitcoins were small companies who catered to a niche market. This changed on January 9th of 2014 when Overstock.com began accepting Bitcoins relatively unexpectedly. Overstock's revenue in 2013 was \$1.3 Billion, making them orders of magnitude larger than previous retailers who accept Bitcoin. Overstock's large relative size means that its decision to accept Bitcoins could have had a large impact on the size of the Bitcoin economy, thereby increasing the network externalities of Bitcoin. What also makes Overstock's decision to accept Bitcoin useful is the fact that its announcement that it was accepting Bitcoin came unexpectedly. While CEO Patrick Byrne had expressed interest in accepting Bitcoin by the end of 2014, no one could have predicted that he would have achieved this goal in the second week of 2014. Therefore, we can use the date that Overstock began accepting Bitcoin as a useful event study on the impact of increasing the network externalities of

Bitcoin. We will look at the impact of Overstock's decision on the price of Bitcoin and also on the price of Overstock's stock prices.

You can see in Figure 3 that Overstock's decision to accept Bitcoin did not have the anticipated effect and may have had no effect at all. In fact, Bitcoin prices seem to follow a generally negative trend following Overstock's decision. One reason we may not see the results we anticipated is that perhaps Byrne's passing comments about accepting Bitcoin had already been factored into the price of Bitcoin. Another option is that Overstock may not be as large relative to the size of the Bitcoin economy as we hypothesized. Accurate estimates of the Bitcoin economy are difficult to make especially considering that for the majority of its lifespan Bitcoin has been used primarily in black markets.

Another interesting question is whether the decision to accept Bitcoins had an impact on Overstock's stock prices. It's possible that investors viewed this decision as too risky and a sign of the CEO's poor decision making or they may have felt the opposite.

Figure 4 shows the impact on Overstock's stock prices when Overstock began to accept Bitcoins. Again, the effects are minor or perhaps non-existent. However, if Overstock's decision had any effect on their stock price, it was negative. One plausible reason for this could be that people simply didn't utilize the ability to pay with Bitcoin. According to Byrne, Bitcoin accounted for \$1 Million in sales in the first 2 months. This rate of spending slowed down to \$2 Million total in Bitcoin sales by August 2014. For a company with \$1.2 Billion in revenue, Bitcoin is an insignificant portion of their sales and therefore may have little to no impact on stock prices.

It seems possible that the reason we didn't see a noticeable impact on the price of Bitcoin is because Overstock.com is a legal marketplace and the legal marketplace may not be a major determinant of the price of Bitcoin. Perhaps the only network externalities that one should be concerned with when considering the price of Bitcoins is the size of the black markets or deep web where Bitcoin is accepted. For that reason, we considered the impact of the closure of the most infamous deep web marketplace to date, The Silk Road.

On October 2nd, 2013 the Silk Road was seized and shut down by the FBI. The Silk Road was a marketplace in the deep web (accessible only from the anonymous web browser Tor). On the Silk Road, users could purchase marijuana, heroin, ecstasy, etc. with Bitcoin exclusively. This created a large demand for Bitcoin that does not exist in legal marketplaces. When it comes to purchasing items in legal markets such as Overstock, it's a lot easier to use USD because most people already hold them. However, with the Silk Road you did not have that option. You had to pay with Bitcoin in order to facilitate pseudonymous international transactions. It therefore follows that when the US Federal Government shutdown the Silk Road, it would have decreased the overall demand for the currency. Figure 6 shows the resulting drop in price that corresponds with the seizure of the Silk Road. The price dropped about \$40, or roughly 33%, instantly. This is suggestive that the deep web marketplaces may be an important factor in determining the price of Bitcoins. These results are much more intriguing than the results observed in the legal market. Further research should be conducted to determine the significance of the deep web marketplaces on the price of Bitcoin.

Fraud?

Given Bitcoin's somewhat shady and anonymous beginnings, it seems appropriate to ask if Bitcoin is even a legitimate financial tool. It is possible that Bitcoin could be a modern interpretation of a Ponzi scheme whereby individuals can buy Bitcoins with real currencies but can only recover their investment if someone else wants to buy their Bitcoins. This would incentivize individuals to make sure there is a continued demand for Bitcoins so that they don't lose their initial investment. Dr. Eric Posner, a Law professor, writes:

“Unless a bitcoin has value as a currency, it has no value at all, and its price in dollars will fall to zero...Bitcoin will collapse when people realize that it can't survive as a currency because of its built-in deflationary features, or because of the emergence of [substitute cryptocurrencies], or both. A real Ponzi scheme takes fraud; bitcoin, by contrast, seems more like a collective delusion.” (Posner 2014)

While most Ponzi schemes have a supposed legitimate investment method that allows them to promise such great returns, Bitcoin is much simpler and makes no promises of great returns. If Bitcoin itself is a Ponzi scheme, it would be a naturally occurring “decentralized” Ponzi scheme. By decentralized, we do not mean that there is no middle financial intermediary as people usually mean when discussing Bitcoin. Rather, we mean that it would be a form of Ponzi scheme that is not orchestrated by an individual but rather fueled by legitimate speculation of many people. This form of Ponzi scheme resembles a speculative bubble which is discussed in section *Is Bitcoin a Bubble?* In a working paper from July 2014, the World Bank Group states that Bitcoin fits the standard definition of a speculative bubble and therefore meets the criteria to be

considered a naturally occurring (or decentralized) Ponzi scheme (Basu 2014). The European Central Bank also concludes that Bitcoin exhibits the behavior of a speculative bubble. This lends fairly substantial credibility to the idea that Bitcoin may be a decentralized Ponzi scheme but as stated previously, determining what constitutes a bubble for such a new security is incredibly difficult and speculative.

The lack of central figure means that Bitcoin is not a traditional, centralized Ponzi scheme. Additionally, it is difficult to see how it would be possible for any one person to profit largely and consistently off of Bitcoin without buying and selling it based on the unpredictable fluctuations of price. While miners certainly gain to profit some, they don't profit fraudulently. Miners profit by providing a legitimate service to the users, transactions processing. Also, while the creator of Bitcoin may be unknown, the features of Bitcoin are very well known. The software controlling Bitcoin is open-source and transparent which would make it very hard to pull off any fraudulent activity. In any case, Bitcoin does not resemble a traditional Ponzi scheme but may resemble a natural Ponzi scheme fueled by speculation.

Separate from Bitcoin's status as a decentralized Ponzi scheme, it may be useful as a method of creating a traditional (or centralized) Ponzi scheme. There has been at least one major Ponzi scheme using Bitcoin. From September 2011 to September 2012, Trendon Shavers operated a fraudulent investment called Bitcoin Savings and Trust (known as BTCST). Shavers collected approximately \$4.5 Million in primary investments by offering up to 7% weekly interest due to the huge opportunity for arbitrage that existed at that time⁴. However, nothing about this

⁴ See the full SEC complaint at <https://www.sec.gov/litigation/complaints/2013/comp-pr2013-132.pdf>

situation makes Bitcoin inherently fraudulent. Shavers was exploiting the general ignorance about Bitcoin that accompanies any new and sophisticated technology. Shavers could have made a Ponzi scheme using USD or any other currency but he chose Bitcoin to obfuscate the mechanics of his scheme. Bitcoin may have been a good method for securities fraud due to its technologically sophisticated and economically untested attributes as well as its lack of regulation, but it will continue to become less so in the future. As individuals gain more knowledge about Bitcoin (and exercise basic caution as they should with any claim of such high interest) the opportunity for this type of fraud will continue to shrink.

In summary, it appears that Bitcoin itself is not an intentional Ponzi scheme but could be a form of naturally occurring, decentralized Ponzi scheme and has been used as the currency of denomination in an intentional Ponzi scheme in the past. Bitcoin may be useful in committing frauds such as Ponzi Schemes but it was not inherently designed to do so. Therefore, Bitcoin should be treated as you would treat any other high-risk investment. Extreme caution should be used when considering investment opportunities and extraordinary claims should be treated with suspicion.

Seigniorage

Seigniorage is the government's (or sovereign's) revenue from money creation. In older times seigniorage was the difference between the value of a coin and the value of the metal contained in the coin, and represented the sovereign's revenue from the power to coin money. Today it is the revenue a government earns based on its control over the creation of money.

As a simple example, a government printing a \$20 bill spends a small amount to create the banknote, including paper, ink, and engraving costs per note. The Bank of Canada estimates, in 2013, that the cost of creating a note is \$0.19, that the note lasts 7.5 years in circulation, giving an annualized cost of about \$0.025. The Bank estimates the costs of distribution and replacing worn notes is about \$0.02 per year, giving a total annual cost of \$0.045. Thus the creation of a \$20 that is maintained in circulation generates an annual cost of \$0.045. If The Bank of Canada uses the newly minted \$20 to purchase a government bond in Canada, the interest rate is currently 1.11% for short term bonds (1 – 3 years to maturity) and 1.94% for long term bonds (5 – 10 years to maturity) If the Bank of Canada purchases the short term bond, the \$20 yields \$0.22 annually. Thus the newly minted \$20 yields net revenue to the Bank of Canada of \$0.175, revenue that eventually reverts to the Canadian government treasury.

Much money creation today is not physical banknotes but instead is electronic entries of “money” that occur only on the balance sheets of financial institutions. This money also earns seigniorage. If The Bank of Canada purchases a bond from a Canadian bank and credits the bank’s reserve account with an electronic entry indicating the bank has more funds in its account, then the Bank of Canada has created money at some low cost and in exchange earns interest on the bond purchased with the created money.

In modern monetary systems government-created money is called base money or high-powered money, and is the sum of currency and coinage in circulation plus reserves held by commercial banks at the central bank. Thus when The Bank of Canada prints a new \$20 bill (not a \$20 bill to replace one wearing out, but a \$20 bill that represents an increase in Canada’s base money) or

creates a new \$20 electronic entry in a commercial bank's reserve account, this is an increase in Canada's base money and hence generates seigniorage.

Private banks also create money using a nation's base money. This process is described in undergraduate money and banking texts or macro texts, where a given supply of base money supports a larger supply of money (M1 in the USA) that includes privately created and supplied money called checkable deposits. Checkable deposits also generate net revenue, but this flows to the private commercial banks that create the deposits and not to the central bank.

Some will argue that The Bank of Canada, or any central bank, will increase the monetary base but not use the newly created base money to purchase bonds. This is not relevant to the seigniorage calculation of course, as the bond interest rate represents the opportunity cost of whatever spending is paid for with the increase in base money.

Finally, what has all this to do with Bitcoins? The US government's seigniorage depends on its ability to increase the quantity of base money, and this depends on the demand for dollars to use as money. If the demand for dollars decreases, then at any given supply of base money there would be a lower interest rate (reducing seigniorage). Alternatively, to keep the interest rate at any specific level, the supply of base money would have to contract (reducing seigniorage). If Bitcoins become widely acceptable in exchange, so that a significant volume of transactions in the US occurred in Bitcoins instead of dollars, there would be a reduced demand for dollars and lower seigniorage earned by the Federal Reserve System and ultimately by the US Treasury.

Do Bitcoins earn seigniorage? No, because there is no sovereign to collect the seigniorage. The mining of Bitcoins to create additional coins may well generate net revenue to private agents – the miners – but this does not revert to any government.

It bears emphasis that Bitcoins held as an investment will not have any direct impact on seigniorage, just as gold held as an investment does not have any direct impact on seigniorage. It is only in the situation that Bitcoins become widely used as money, so that transactions that would have occurred in dollars start occurring in Bitcoins, that seigniorage would be impacted. This does not seem to be happening to any appreciable extent for most transactions.

There is one area in which Bitcoins may be costing governments seigniorage, and this is in the area of money used for illegal or black market activities that occur in the deep web. Before Bitcoins, black market activities, including large international transactions, often occurred in US dollars, or increasingly, in Euros. The US government, and increasingly the European Central Bank, earned seigniorage from the international demand for base money in the form of \$100 notes or 500 euro notes. The use of Bitcoins in black market transactions including international drug trade has no doubt reduced seigniorage to the Federal Reserve System and to the European Central Bank.

SECTION III

CONCLUSION

In general, we conclude that Bitcoin is not currently a widely accepted medium of exchange, not a good store of value, and is not an actual unit of account and thus does not meet the criteria to be considered a currency. However, we do note that even though it is not a currency, it could still be a useful asset to hold as part of a portfolio. We noted that Bitcoin may be exhibiting behavior indicative of a bubble and may be largely speculation driven. We also feel that national governments are losing revenue from seigniorage and will be unlikely to allow Bitcoin to continue operating in its present form. Despite these challenges we think Bitcoin is a massive technological leap mainly through the creation of the block chain, a publicly distributed ledger. We feel this technology could be leveraged to significantly benefit growing issues of digital asset management.

The Future

When considering the future of Bitcoin in an online article, Michael Suede concluded “All of these facts point to a future dominated by stateless voluntary currencies, which will leave humanity free from wars, organized theft, violent black markets and the deleterious effects of inflation”. It is difficult to share such an optimistic point of view but we feel Bitcoin may still have a useful role in the future. While that future is uncertain, there are several key areas that Bitcoin stands to make a significant impact.

Economists propose that perhaps a better use of Bitcoin is in simplifying exchanges of foreign currency (Dwyer 2014). Converting one's local currency to Bitcoins and then selling and withdrawing it in the local currency of their destination is a cheap alternative that allows one to bypass certain currency controls instituted by national governments.

Another potential use the Bitcoin Network that is currently being explored is to use a copy of the Bitcoin Network to facilitate the transfer of assets that exist digitally. The Bitcoin public ledger, the block chain, could allow for something that has proven very difficult to accomplish, the transfer of digital property. Most technology that exists today for "transferring" digital property such as digital media assets don't really "transfer" anything, they copy it. Online torrenting (a common form of digital file sharing) allows for two people to possess exact copies of the same digital asset. This causes the problem of allowing illegal copies of music and movies to be made. This particular problem has been largely sidestepped with the creation of services such as Pandora, Spotify, and Netflix that don't actually sell the digital media to you, they simply allow you to stream it from their servers. So, while implementing a block chain-like network could be of use in the management of this digital media, this is becoming largely a non-issue. Instead, we should be looking to the horizon for where the block chain can still have the most impact.

3D printing is an area that is rapidly expanding and will have a need for some system of digital rights management. The consumer market for 3D printers grew by 100% in 2013 according to Credit Suisse. Most consumers lack the technological expertise required to make sophisticated 3D models that allow you to print objects. Therefore, there is a large market for 3D printable files. Currently, intellectual property legislation does not specifically deal with 3D printing,

forcing the existing marketplaces to solve the problem in their own way. Many methods of dealing with this problem allow for the possibility of illegal copying, sharing, and sales of 3D printable files. An enterprising and technologically advanced company could take the block chain from the Bitcoin Network and repurpose it to allow for the sale of 3D printable files that cannot be copied or counterfeited. Creating this new network would not be a simple undertaking because several key components of the block chain would have to be modified to fit this new use. For example, in the Bitcoin network miners are rewarded with Bitcoins, the very good the network exists to transact. That same system won't work in this new case because you can't reward miners with 3D printable files that they may or may not want. However, you could reward them with a network-specific currency that allows for the purchase of 3D printable files and can perhaps even be exchanged for real-world currencies. It's hard to say what this system would look like but it is just one example of an industry that desperately in need of a system like the block chain.

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APPENDIX

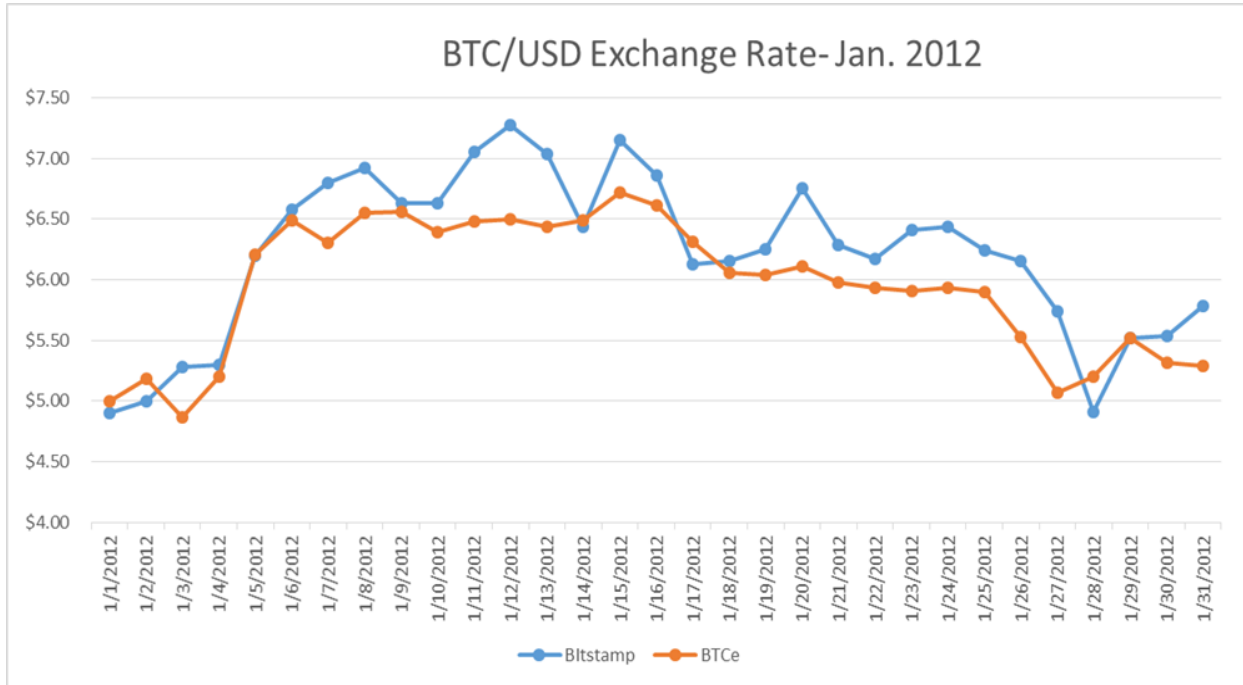


Figure 1 shows the USD per Bitcoin exchange rate on two exchanges in January 2013

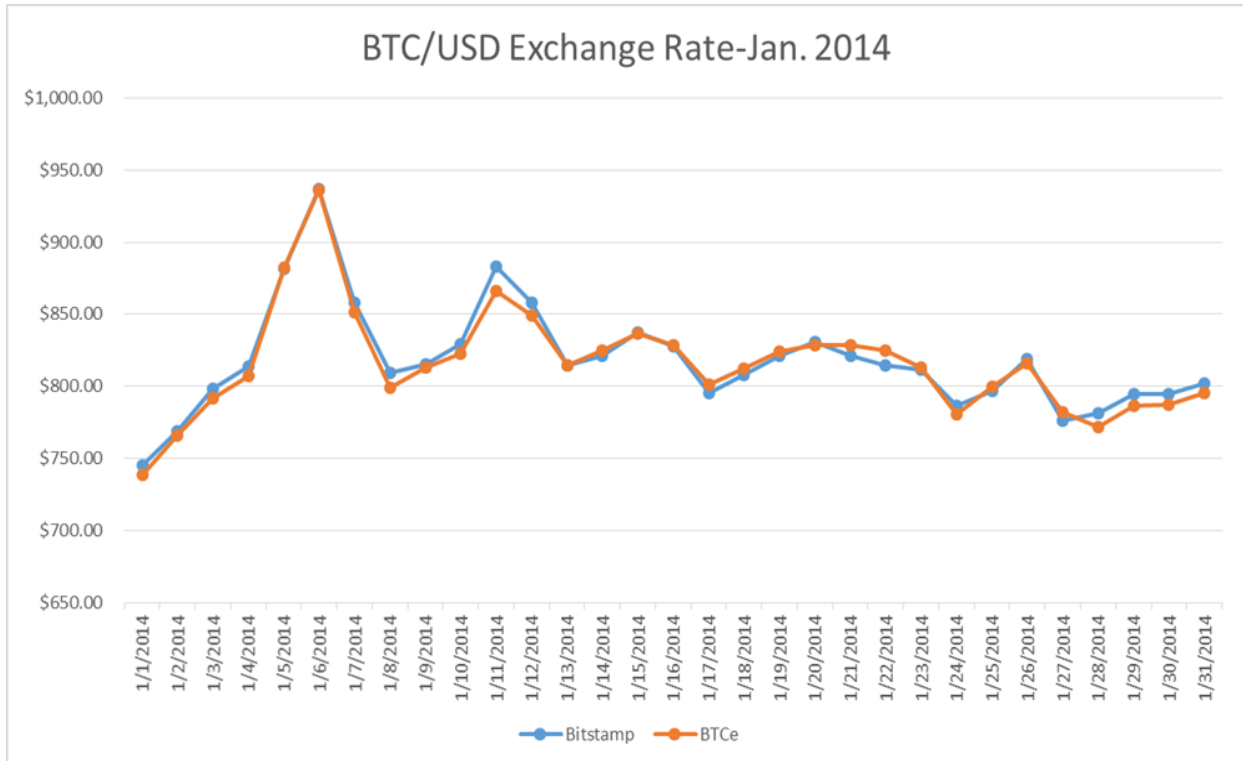


Figure 2 shows the USD per Bitcoin exchange rate on two exchanges in January 2014

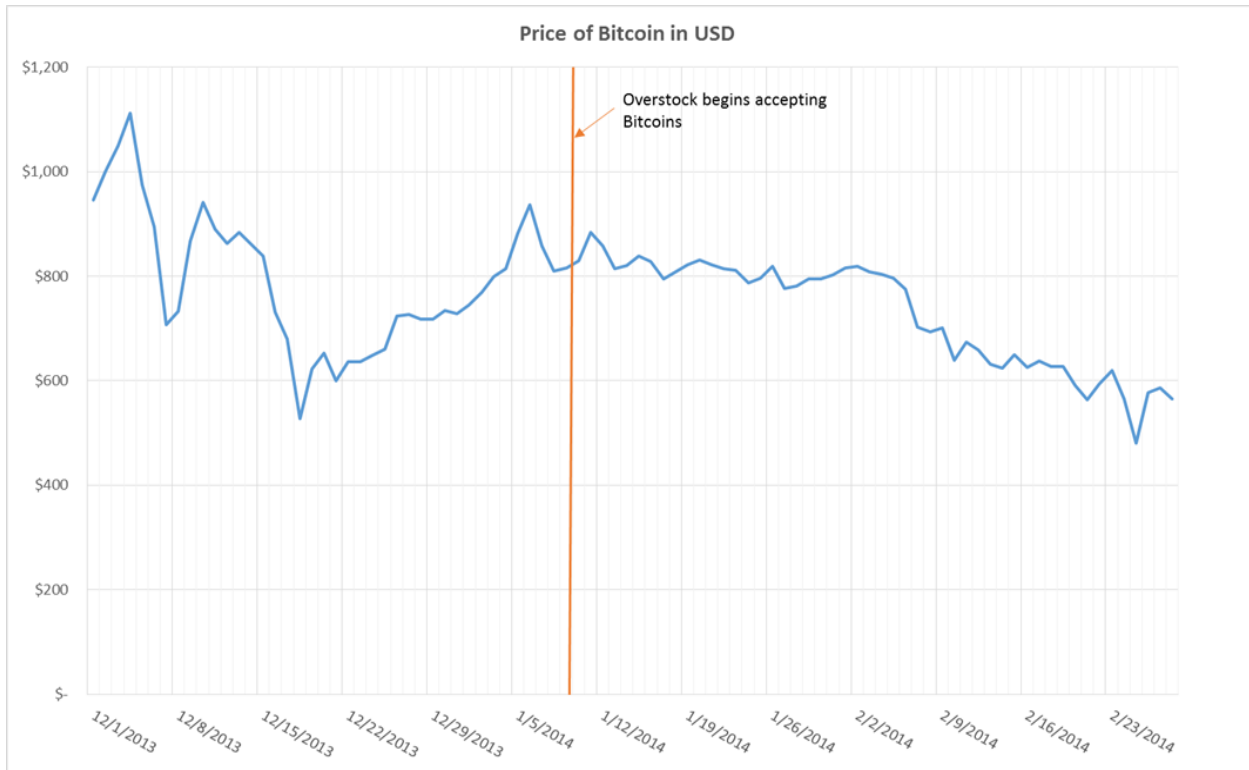


Figure 3. The orange line shows the date that Overstock first accepted Bitcoin and the blue line is the USD per Bitcoin rate

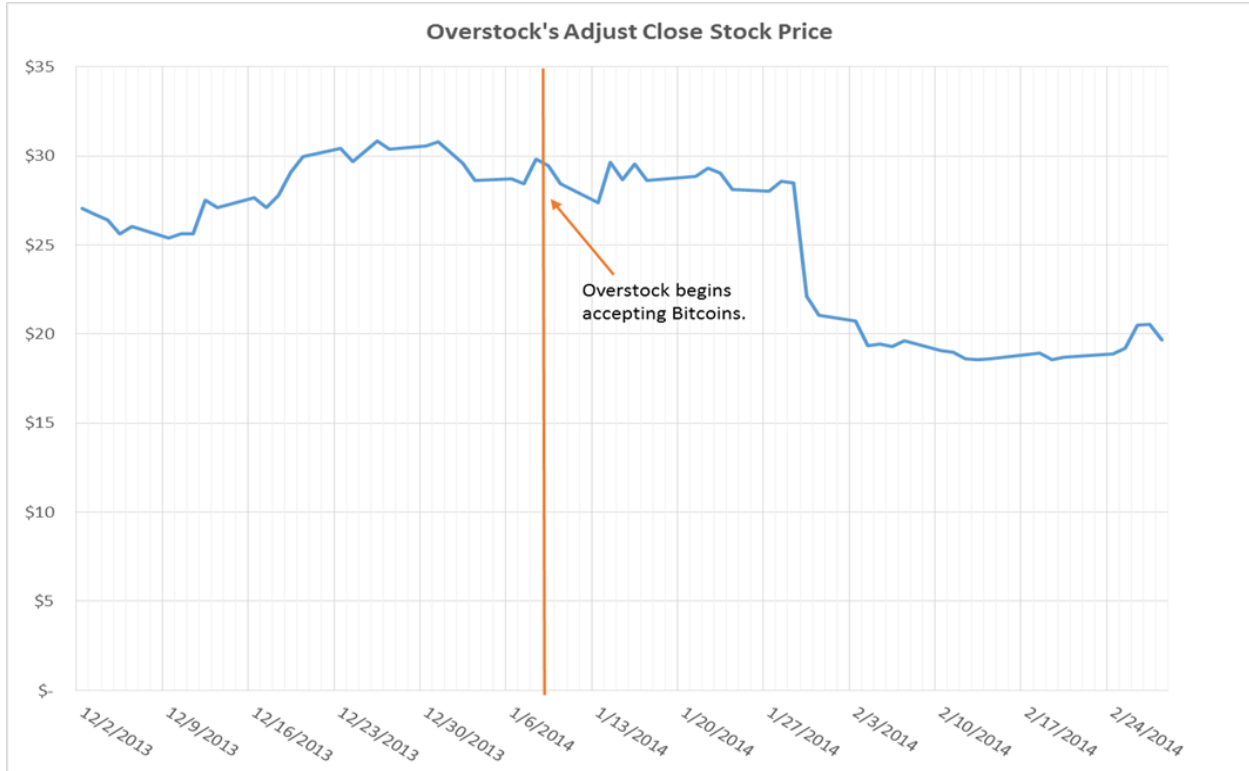


Figure 4. The orange line shows the date that Overstock first accepted Bitcoin and the blue line is the stock price over Overstock

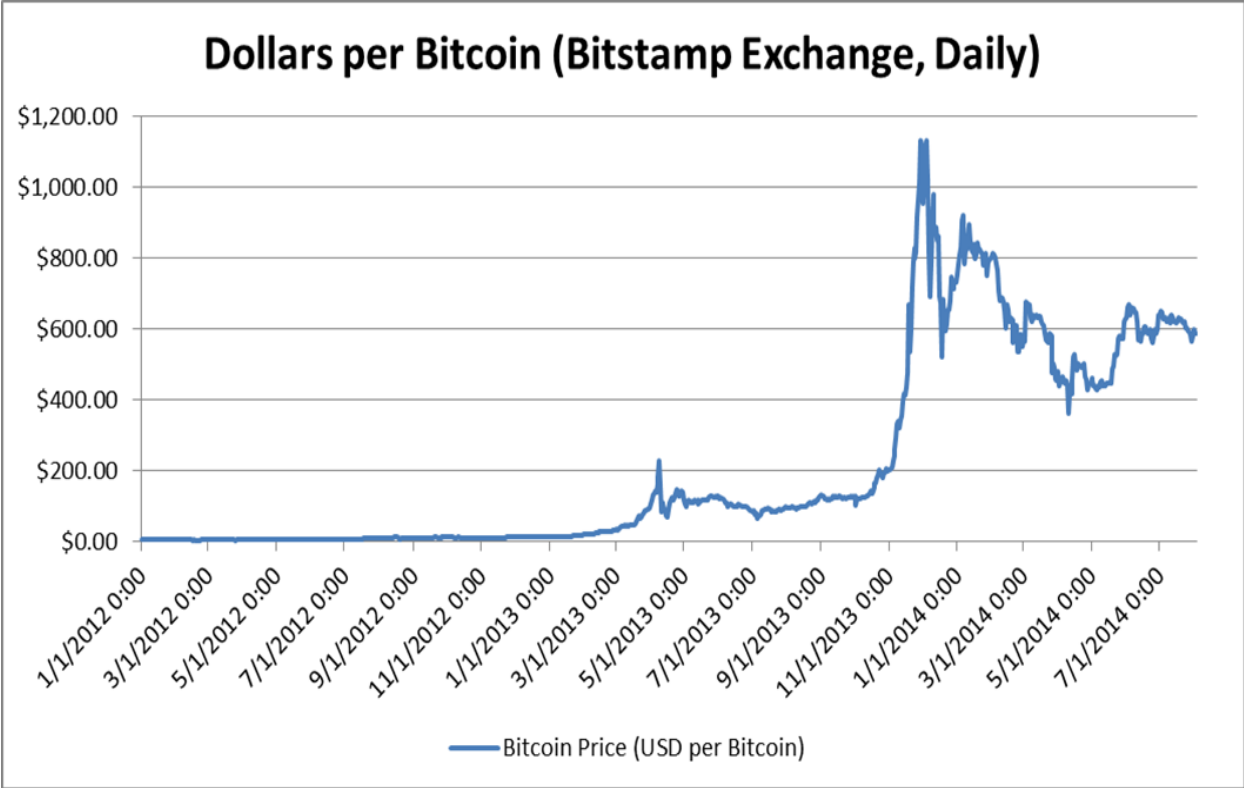


Figure 5 shows the USD per Bitcoin exchange rate from January 2012 through July 2014



Figure 6 shows the price of Bitcoin when the Silk Road marketplace was shut down in October 2013

Table 1 shows some comparative statistics between Bitcoin, Gold, Oil, and the Wilshire 5000 Stock Index

Daily, January 3 2012 -Aug 8 2014	Bitcoin	Gold	Oil	Wilshire 5000 Stock Index
Mean Daily Return	$.10296 \cdot 10^{-1}$	$-.00220 \cdot 10^{-1}$	$.00003 \cdot 10^{-1}$	$.00782 \cdot 10^{-1}$
Standard Deviation	.07066	.01073	.01211	.00773
Correlation with Bitcoin Return	--	.06428	.01450	-.01333