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THE EFFECT OF VOLUME ON BITCOIN PRICE VARIATION

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ABSTRACT

This paper aims to investigate how Bitcoin price behaves relative to change in volume. Bitcoin has been a fascination in recent years because of beliefs that it can replace gold or even become a global currency. Cryptocurrencies as a whole present a unique opportunity to change the payment method network. Part of Bitcoin's success has been how it is created and the platform it works off of, much like the beginnings of the Internet. Whether or not Bitcoin stabilizes around a set price or proportion in relation to national currencies, the price movements of Bitcoin have been captivating and correlated with an increase in interest ranging from regulators to speculators. Since debate continues about Bitcoin either as a currency, property, or payment method, the price is important in understanding investor sentiment. With the decrease in price fluctuations, policymakers, consumers, and businesses will better be able to integrate Bitcoin into the transaction market.

In order to find out when or how Bitcoin will stabilize, it is useful to see what factors effect price movements in Bitcoin. This paper will look at a common comparison to price, "daily volume". Understanding volume's impact on price will help to gain a foundation for which other variables can be examined to explain price change. I examine six Bitcoin exchanges and use those as examples of how to track price changes over time with different volume levels. I create an Artificial Index to act as a way to link all the exchanges together on a total volume weighted average to create a new price and volume. I find that volume is statistically significant or that I cannot reject the null hypothesis, but believe other variables may have a greater impact. The paper concludes with my findings and offers some suggestions on how to model additional variables that may be able to prove better to model price change in the market.

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Chapter 1

What is Bitcoin?

Bitcoin is a cryptocurrency – an instantly transmitted, open source, peer-to-peer, decentralized digital currency that is able to utilize cryptography, thus enjoying anonymity from traditional financial institutions and unwanted third parties. Created in 2008 by a person or group with the name of "Satoshi Nakamoto," a white paper detailing the creation of and implementation of a cryptocurrency named Bitcoin surfaced (Nakamato).

Bitcoin is often referred to as a cryptocurrency, as it relies on methods of cryptography to be traded and generated in a secure manner, exempt from third party monitoring. Thus, each Bitcoin and each user is encrypted with a unique, untraceable identity. While transactions are visible to all users on the Bitcoin network, personal information of the involved parties is kept encrypted.

Figure 1-1 Bitcoin Wallet Example 1

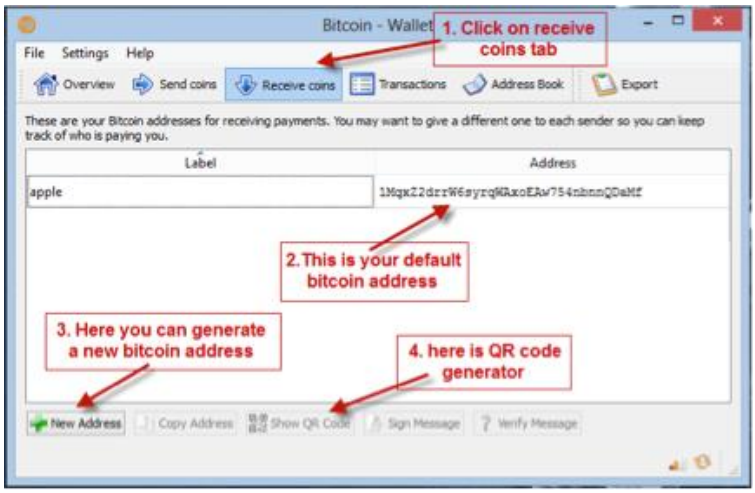


Figure 1-2 Bitcoin Wallet Example 2

The cryptographic techniques that make the existence of such a cryptocurrency possible allow users on the Bitcoin network, known as miners, to piece together transactions and compete to verify the validity of Bitcoin those transactions. By entering new transactions into a public ledger, known as the "blockchain," miners are able to ensure that Bitcoin transactions cannot be duplicated, effectively ensuring that the buyer has transferred the correct amount of Bitcoin, and also that that precise amount has been added to the seller's account. For providing this service, miners that successfully verify transactions are rewarded with 25 newly created Bitcoins by the network. This system of decentralized public management is in fact the defining technological aspect of the Bitcoin. The system effectively solves the problem of the individual spending money that they do not have, as forgery and counterfeiting are not possible, while third parties,

such as banks, are not necessary to verify transactions. As such, this type of public ledger technology could impact traditional methods of payments, but also may have wider implications on other types of transactions, including digitally traded and stored financial assets, such as stocks and bonds.

As 25 Bitcoins are currently rewarded to miners after completely processing the transaction in a block, this incentive system surrounding Bitcoin ensures that only about 21 million Bitcoins in total can ever be mined, as each new block of transactions becomes exponentially harder to mine than its predecessor.

Due to its cryptographic and anonymous nature, Bitcoin has recently made appearances in the news for both its association with illegal activities such as the drug and weapon trade online, in addition to its increasingly widespread acceptance among legitimate merchants. The price of a Bitcoin, or BTC as abbreviated by markets, has generally been volatile, ranging from anywhere from $2 to $1200 on Mt. Gox, the most popular USD-to-BTC exchange before December 2013 (McMillan).

Similar to the U.S. dollar and other common currencies, the Bitcoin has no intrinsic value, meaning that it is not that it is not redeemable for some amount of another commodity, such as an ounce of gold. Unlike traditional currencies, a Bitcoin has no physical form, nor is it legal tender or backed by any government. Its supply is not determined by a central bank and as such, is determined by the supply and demand of the online marketplace among speculators and investors (Elwell). While earlier digital currencies were governed by a supervising entity, the Bitcoin network is completely decentralized, as all stages of the transactions process are performed by the users of the system.

How Are Bitcoins Obtained?

Users must first download the free, open-source software in order to be able to interact on the Bitcoin network. After connecting to this network, the user is able to generate Bitcoins by three different means. First, a user can exchange traditional currency on an online exchange for a fee ranging from 0.5% for small transactions down to 0.2% for large transactions. As a second method of obtaining Bitcoins, a user can exchange various goods or services, accepting Bitcoin from a buyer for the sale of his product or service (Elwell). Third, a user may generate new Bitcoins by serving as miner and applying his or her computer's processing power to verify the validity of new transactions over the network. Thus, the probability of an individual generating new Bitcoins through mining is proportional to the amount of computer processing power that can be allocated and applied to the task. Because of this, there is a very limited use of one's typical office or home computer or device. As verification increases in difficulty, so does the requirement for computational power. Thus, the difficulty of verifying transactions increases exponentially in order to ensure that Bitcoins are able to be discovered at a limited and predictable rate across the entire network. As a result, the "supply of Bitcoins does not depend on the monetary policy of a virtual central bank. In this regard, despite being a currency with no intrinsic value, the Bitcoin system's operation is similar to the growth of money under a gold standard" (Elwell). Depending on one's perspective of the cryptocurrency, this attribute of the Bitcoin network can be viewed as either a positive trait or one that threatens its legitimacy.

Chapter 2

Impact of Volume on Price

Thesis:

How do changes in volume impact the change in price of Bitcoin? I begin first with trying different variations of regressions with respect to volume's effect on price. In order to measure the price and volume movements, I use the largest bitcoin exchanges to act as very large samplings of the total market transactions of Bitcoins. An issue I encountered was that the largest exchanges came into existence at different times and had different time periods needed before they were as capable in processing transactions as they are currently. To do account for this gap in time periods, I later create an Artificial Index to be able to compare the volume and price volatility among exchanges to see if volume influences daily price movement.

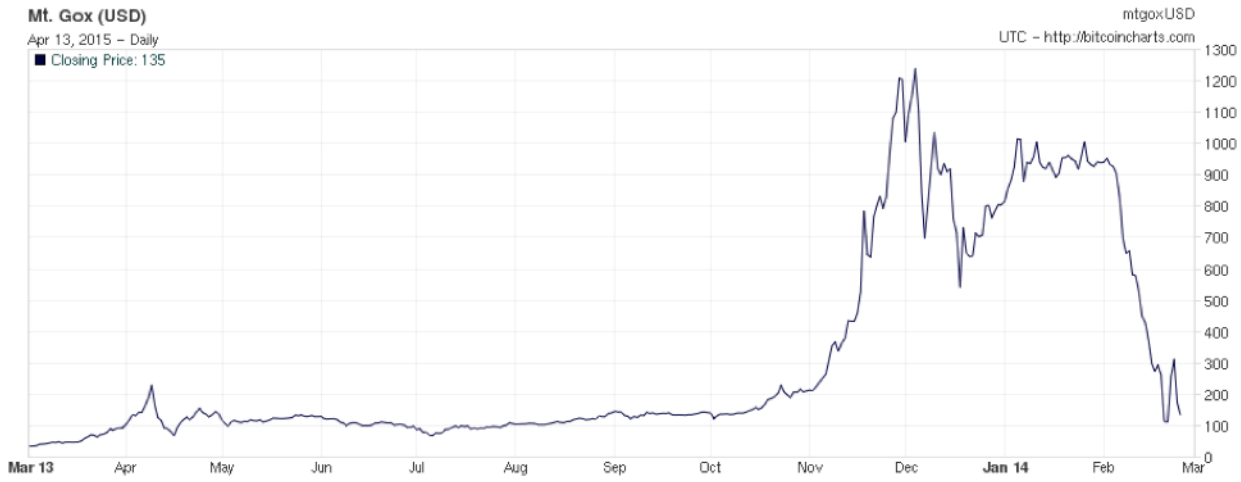
Methodology

Because Bitcoin is not a stock or currency, in that there is not one exchange in which a Bitcoin can be purchased at a spot price, it is therefore important to look at the largest exchanges that acted as both banks and brokerage houses. Even with the possibility that Bitcoin has a value of zero, as explained by a corresponding y-intercept of 0, finding the importance of volume on price will help to better understand what variables do impact the price movements of Bitcoin.

The data set I used gathered information from Mt. Gox, Bitstamp, Bitfinex, btceUSD, OKCoin, and btcnCNY. These exchanges represent a great sample of the largest exchanges in the world for Bitcoin. While some exchanges, such as OKCoin and btcnCNY were not very large in terms of total daily volume traded up until 2013, these two Chinese exchanges at times account for almost two-thirds of the current volume traded in the world (Bitcoin Charts).

This paper will give a brief description of the exchanges and explain what markets they represent. While there are over a hundred exchanges, these six make up over 80% of all volume at any given time (Bitcoin Charts). I include two Chinese yuan denominated exchanges "btcnCNY" and "OKCoin" because of the high level of volume that has risen almost in tandem with the collapse of Mt. Gox.

Figure 2-1 Price of Bitcoin at Mt. Gox August 2013 – March 2014



What is troubling is that the places where trades are occurring most have been on websites that have just as dubious beginnings as Mt. Gox. While I cannot attest to the legitimacy or intentions

of these websites, these are the leaders in terms of volume traded and will be used in my attempt to model the impact of volume and price volatility.

Mt. Gox

In 2011, Mark Karpeles, avid programmer and Bitcoin enthusiast, acquired the Mt. Gox exchange from an American entrepreneur named Jed McCaleb. McCaleb had registered the Mtgox.com web domain in 2007 with the idea of turning it into a trading site for the wildly popular Magic: The Gathering game cards. While he never followed through, in late 2010 McCaleb decided to repurpose the domain as a Bitcoin exchange with the idea to connect Bitcoin buyers and sellers. McCaleb soon was overwhelmed with tens of thousands being wired to him and decided to sell the company to Karpeles.

Karpeles soon set about rewriting the site's back-end software, eventually turning it into the world's most popular Bitcoin exchange. Despite having to shut down a few times, Karpeles maneuvered Mt. Gox out of some minor system crashes and earned the company a reputation for being trustworthy. Many other Bitcoin companies lost customer funds due to hackings and simply disappeared. While the company survived, the underlying code that the Mt. Gox system was built on was so poor that it would eventually lead to the company declaring bankruptcy after hackers and customers were able to siphon off money without the system realizing (McMillan).

Mt. Gox was at the epicenter of the rise in Bitcoin interest and excitement, claiming at one point to having as much as 70% of trading volume running through its platform in 2013

(Vigna). While Mt. Gox is currently in the process of going through bankruptcy, the importance of Mt. Gox functioning as close to a single exchange that represented the price and volume of Bitcoin cannot be overlooked.

Bitstamp

As of March 2015, Bitstamp was one of the three largest exchanges in the world by volume. The company was started in 2011 by Nejc Kodrič and Damijan Merlak. The company was initially founded as a European-focused competitor to Bitcoin exchange Mt. Gox, which was the leading exchange at the time. While Bitstamp trades in US dollars, it also allows money to be streamed through the European Union's Single Euro Payments Area. This creates a quick and low cost way of transferring money from European bank accounts to purchase Bitcoins. Bitstamp is relevant to this study due to not only its connection to European markets but also to its size. There was a breach in Bitstamp in 2015 and trading was stopped while they solved the hacking attempt. As one continues to see, the issue is less about "if" an exchange will be hacked and more about "when". The potential loss from the hacking was about 19,000 Bitcoin, at a current value of about $5.1 million (Rosenfeld, 2015).

Bitfinex

Bitfinex is a Bitcoin trading platform that, at the moment, exchanges three pairs of currency. Bitfinex is multifaceted in the sense that it is a website where a user can trade

currencies and it also offers margin trading and lending. These two features are connected in that the first one, margin trading, allows one to borrow funds from lenders, the second feature, to trade Bitcoins. Users may also place a hidden order. This does not show up on the order book, but, as expected, it has a fee.

Bitfinex was founded by French developer Raphael Nicolle. In January 2013 the site was open to the public for trading. iFinex, the company that owns and operates Bitfinex, is incorporated as a limited liability corporation in Hong Kong.

The server for the exchange is located in the United Kingdom. Although, the support from the Bitfinex team is inadequate. As of right now, the only way to get in touch customer support is by way of email. Also, the lack of a mobile app makes one skeptical about the legitimacy of the trading volume websites. As of the writing of this paper, Bitfinex was third to OKCoin and btcnCNY over a 30-day period.

BtceUSD

BTC-e, also known by its ticker symbol “btceUSD”, offers unique services not covered by Coinbase and Bitstamp. For example, BTC-e provides trading in alternative cryptocurrencies. Since the decline of Mt. Gox it has taken a larger market share and is now an extremely widespread exchange. We see this popularity particularly in Russia where Bitcoin trading is discouraged. The discreetness that permits this has been raised as an issue for other users. The exact location is even unknown. If the critics are correct and the exchange is located in Russia,

instead of Bulgaria, it would make it extremely vulnerable to being shut down by a much more authoritative government.

BTC-e began trading in 2011 and is a Bulgaria-based Bitcoin exchange. At its inception, the exchange offered trading between Bitcoins and many physical currencies including US dollars, Russian rubles and Euros. Since then, Russia has banned Bitcoin meaning transfers between Bitcoins and rubles are not allowed. BTC-e also offers other cryptocurrencies such as Litecoin and Namecoin. The site has English and Russian interfaces. These accommodations make it one of the most widespread of the major exchanges. However, BTC-e remains anonymous, which has led to discrepancies about it reliability. How can one trust its security if there is a lack of transparency around ownership?

OKcoin

This is one of the larger exchanges that exists and primarily engages the Chinese market. It has a wide array of abilities ranging from lending to trading futures. OKCoin.com is an international digital currency trading platform. Meanwhile, OKCoin.cn is focused solely on a Chinese trading platform. OKCoin.com is a Singapore registered company. The operations and data center are located outside of China. Although OKCoin.cn and OKCoin.com are owned by the same investors, they are two separate companies. From a user standpoint, the two platforms cannot be operated simultaneously from the same account.

OKCoin was founded in 2013 and received a US$1m Angel Investment from Tim Draper, Ventures Lab and Silicon Valley Venture Capitalist. In December 2013, OKCoin closed

a Series A round of funding in which it received US$10m (from Ceyuan and Mandra Capital). In March of 2014, OKCoin reached a BTC transaction volume of roughly 293,000 BT which is the highest cryptocurrency transaction volume that any exchange has ever had, even internationally.

It is important to note that the data was initially in Chinese Yuan. In order to compare multiple exchanges, I looked at the historical interbank exchange rate and then that was converted into dollars. Further research could add on exchange fees but this was the most basic way to conduct the research.

BtcnCNY

BtcnCNY, founded in 2011, was China's first and most established Bitcoin trading platform. BtcnCNY has had the highest trading volumes in China, and is competitive with the biggest exchanges worldwide. To its users, it provides unique features such as "deep order books" which are extremely liquid. Another unique aspect of BTC China is that it permits traders to buy and sell Bitcoins in the native Chinese CNY currency. There is also an opportunity for users to store their Bitcoins in their platform for security and safekeeping.

As with the OKcoin, it is also important to note that the data for BtcnCNY was initially in Chinese Yuan. In order to get every exchange on an equal playing field, I looked at the historical interbank exchange rate and then that was converted into dollars.

Chapter 3

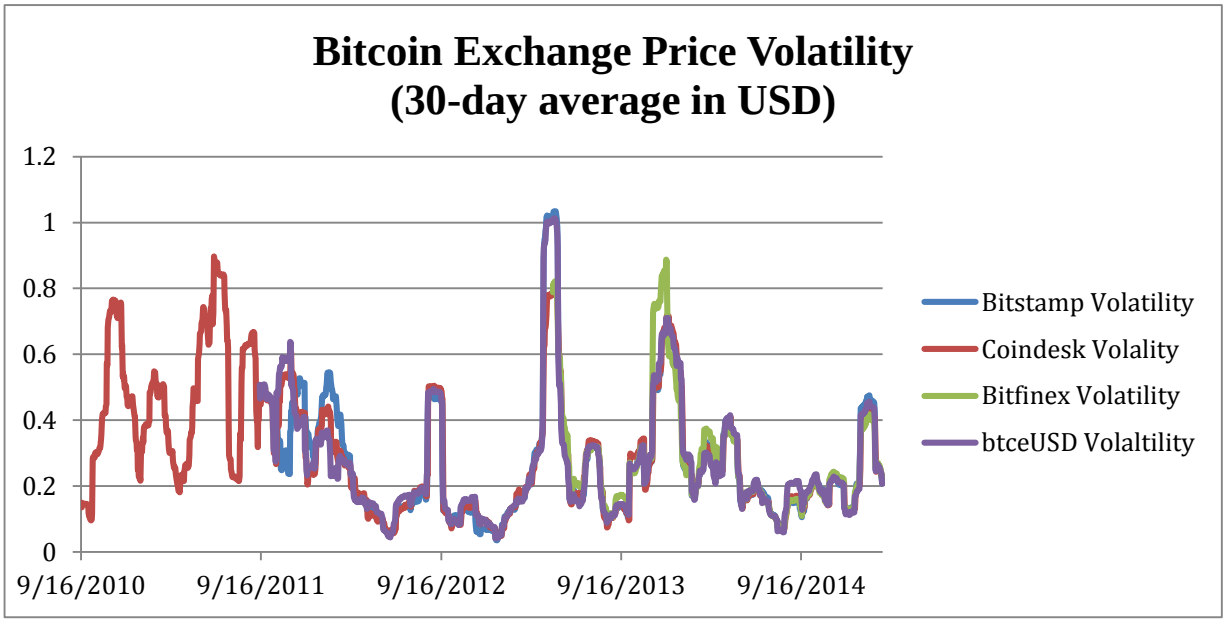
30-Moving Average Price Volatility

With the launch of an exchange or with any system that requires maintenance, there were certain dates in which the data on price and volume was unavailable. For the times in which the exchanges were closed, I used a 5-day rolling average as a placeholder for price in my regressions and put volume as "0" for the day. As exchanges came into the marketplace, the volatility for those exchanges were higher than previously existing ones, probably because the level of volume was low and the exchanges began to process deposits on a daily basis. Also, they may not have had the capability or legitimacy to be as competitive as the other exchanges in terms of handling volume or trades.

I used a 30-day moving average to create a price volatility comparison across the American exchanges. I excluded the Chinese exchanges because of the difficulties seen with volatility of currency conversion with the Chinese yuan. Mt. Gox is included by way of an index called "Coindesk", since the direct data for transactions is no longer available from Mt. Gox directly. The other three exchanges included are Bitstamp, Bitfinex, and btceUSD. From these exchanges, one can see that volatility is higher for newer exchanges, which means that price and volume vary among the exchanges, which will be a reason for the creation of a better index for gauging the importance of volume's influence on price.

Volatility is valuable because less volatile asset means that the cost of hedging drops, which is an important factor in the consideration of price for merchants. Lower volatility means the cost of exchanging BTC into dollars and vice-versa will decrease.

Figure 3-1 Bitcoin Exchange Price Volatility



I use a rolling average because of the nonexistent or sparse options market. While the derivatives market surrounding Bitcoin is growing and new products will be seen, the volatility used in the paper is a 30-day rolling average in lieu of a Black-Scholes pricing model which would give a more precise example of volatility, specifically *implied* volatility. From looking at the results of the moving average, the newer the exchange is relative to other exchanges, the higher the initial volatility in price. The spikes in volatility for newer exchanges seen above seem to be related influences like small volume activity and processing issues as trading platforms began to take on deposits. There is a clear lag that is seen by new exchanges while they gain legitimacy in comparison to more established Bitcoin exchanges. Because exchanges were

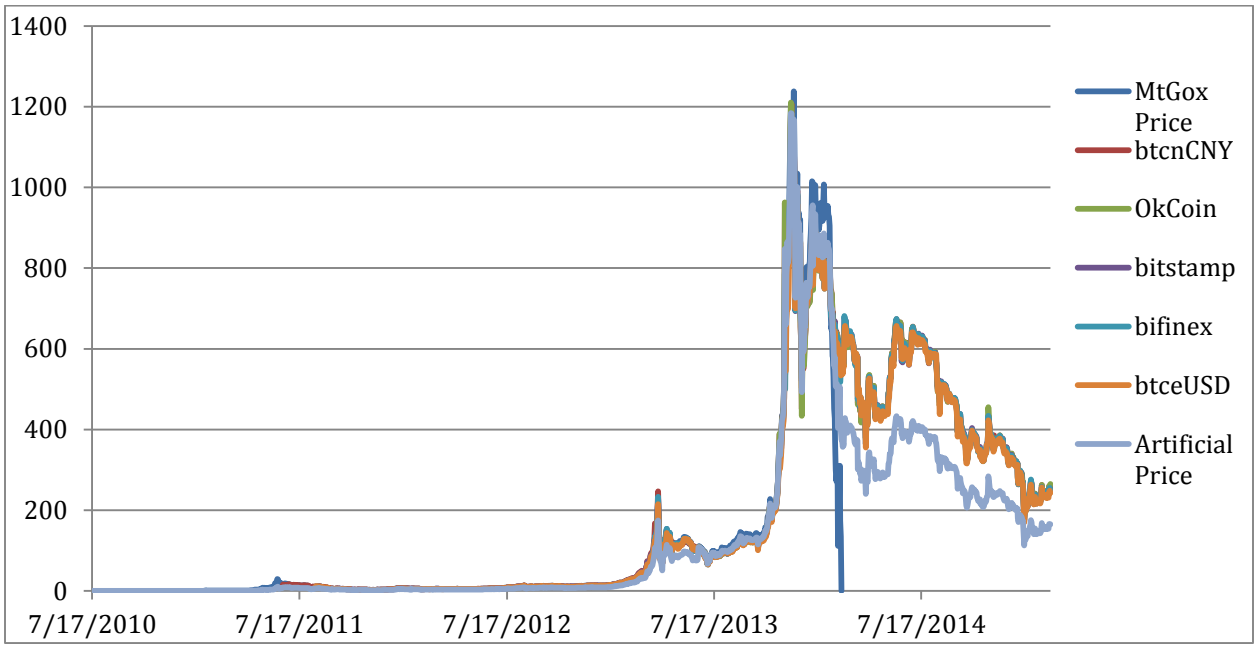
created at various time frames, the need arose for a single exchange price and volume to represent the six exchanges.

Creation of Artificial Index

I created an Artificial Index that summed the total volume traded on each exchange since inception to create a new metric that assigned a weighted average to each exchange based upon the total amount of volume that had ever been transacted on the exchange. The reason I did this instead of a simple average of existing exchanges was to avoid having the price and volume on the Artificial Index be reduced as soon as a new exchange came online. As one can see in the volatility chart above and also in the values of the regressions below, older exchanges more closely mirror the overall market average of price, but the newer exchanges are much more volatile in terms of volume, as measured in daily percent change. In terms of inclusion of Mt. Gox, more will be discussed later as to why the weighting value should not be zero for Mt. Gox.

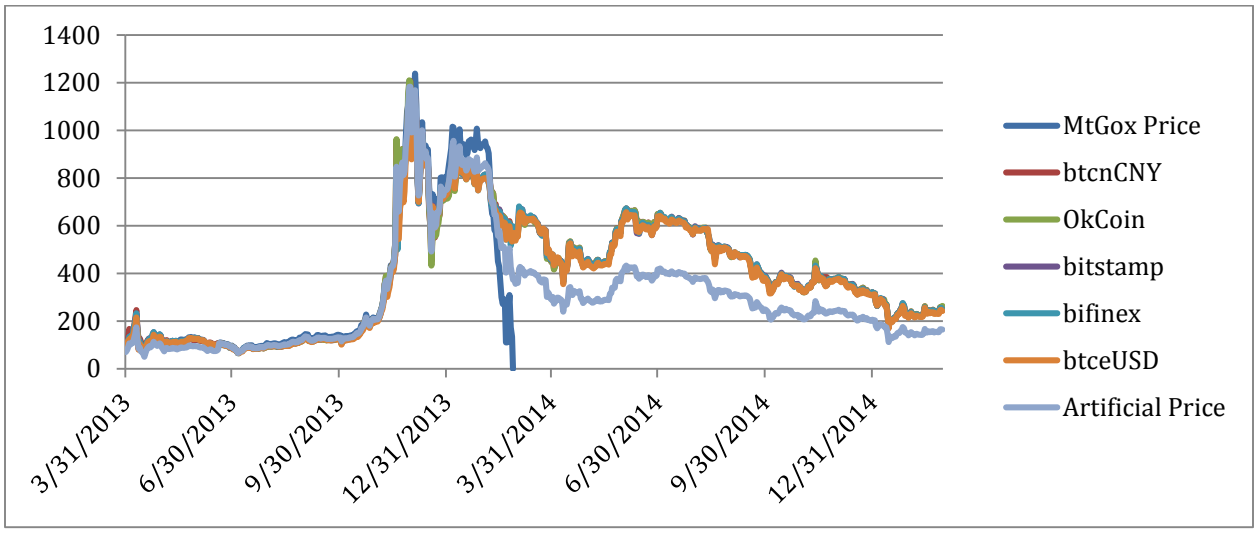
With this new column of volumes, I created a continuous stream of dates and accounted for lapses in the data, either from an exchange entirely closing or not yet created. From this new index, from here on referred to as Artificial Index, one can see how the different exchanges varied from the index in terms of both volume and price. With this new information I was able to create a graph comparing the six exchanges to the new Artificial Index.

Figure 3-2 Bitcoin Price on Exchanges with Artificial Price index



From looking at the prices of the different exchanges, I can notice that real discrepancies in price only take place beginning in July 2013, when news and rumors began to circulate that Mt. Gox was not as secure as many had believed, until the collapse of Mt. Gox in the first quarter of 2014 (Erb). Below is a more magnified view:

Figure 3-3 Magnified View



The Collapse of Mt. Gox and its Effects Predicted by the Artificial Price

After the collapse of Mt. Gox and effectively saying that all Bitcoin price from Mt. Gox has been 0, the Artificial Price index begins to run at a discount relative to the other five exchanges. Because Mt. Gox ran so much of the volume of the total Bitcoin marketplace exchange, I see that the Artificial Index is a better predictor of the price of Bitcoin going forward and that the other exchanges approach the level of the artificial price because of the weighting from Mt. Gox being less significant as the total volume of trades shifts greater in favor of the exchanges that replace Mt. Gox.

I can look at the Artificial Index and notice that because so much volume came from Mt. Gox, as the Mt. Gox system collapsed, the expected price decreased heavily because of the strong influence in weighting. After Mt. Gox stopped allowing trades, the artificial price index begins to narrow the gap of approximating the price because of the other exchanges now taking

on most of the volume of trade. I can look at the Artificial Price index and see that while it underperformed the prices of the other indices, it approximated the current future price much better than if I had just looked at the other exchanges. Next I look into the regression of my artificial price and artificial volume and see how much of the change in price is explained by the change in volume.

Chapter 4

The Trials of Finding a Relationship Between Volume and Price

In order to look at how price is impacted by volume, I look at several different regressions, and then examine what the similarities are and what the statistics tell us about the relationship. I begin first with volume with respect to price and then replace the variables in order to explain more. I will look at the R-squares, coefficients of the intercepts, standard errors, t-Stat, and P-values.

Regression of Volume with Respect to Price

The most basic way to examine price and volume is by taking the six exchanges and looking at the relationship of the regression and summary outputs. In the table below, each exchange is represented by daily closing price with respect to the total volume of the trades made that day on the exchange.

Table 4-1 Exchange Summary Statistics Volume on Price

Volume on Price						
Exchange	Intercept	Slope	Std Error	t Stat	P-value	R Square
MtGox Volume	109.7	-0.000451	0.000128	-3.54	0.00	0.9%
btcnCNY	184.5	0.001083	0.000125	8.69	0.00	5.3%
OKCoin	408.7	0.000264	0.000141	1.87	0.06	0.6%
bitstamp	137.2	0.008905	0.000506	17.60	0.00	19.7%
bitfinex	394.3	-0.000339	0.000413	-0.82	0.41	0.1%
btceUSD	146.6	0.009036	0.000596	15.15	0.00	15.1%
Artificial Index	93.73	0.001613	0.000203	7.93	0.00	3.6%

What I gain from this series of regressions is that almost all exchanges are statistically relevant and I can reject the null hypothesis that volume is non-influential. The only one that wasn't significant was OKCoin and Bitfinex, and this could have been because of the exchange rates or just because the exchanges were newer than Bitstamp and btceUSD, for example. It's interesting to note that all of them have a positive correlation between price and volume except Mt. Gox. One can see that Mt. Gox, even though it has the most observations, shows a negative t-stat, but with minimal variance in the price attributable to total volume on a given day. One issue that may be holding back the significance of OKCoin is the exchange rate of dollars to yuan, but the same issue is not present in btcnCNY. Because I use the exchange rate available to high level transactions, or the interbank exchange rate, the shift could have led to significance in the t-stat. The intercepts vary because of the difference in inception of the exchanges, but are somewhere between 90 and about 400. Next I will examine the regression of Artificial Price vs. Volume.

Explanation of Artificial Price Trendline Equation

In the previous graph, I plotted the re-weighted volumes and prices in order to create an index that more nearly approximated the value of all Bitcoin transactions based upon price and volume in each exchange. With this new index, I can create a scatter plot and use a power trendline instead of a linear regression in order to capture more of the non-linearity. The equation above shows us that given a volume (X), I can approximate a price (Y).

Observations of Age of Exchange

What I encountered in creating my regressions was the difference in using as many data points as possible and the issue of Bitcoin exchanges being so young or novel that the price variations were so dramatic no relationship could be found. I shifted my focus in the regressions to January 1st 2013 because that was the year in which Bitcoin began to rise in terms of not just price, but also volume. By excluding the very nascent years or months of the exchanges, I was better able to predict how price would react to volume changes. The importance being that the lack of volume in the very beginning was so evident that using the daily change before any type of market depth or popularity led to the inclusion of too many outliers.

Differentiation of log volume vs volume

In certain regressions, the variable log (volume) was used instead of volume. When using volume, the B_1 observed after the regression is a slope implying by how many units the dependent variable has moved. When log (volume) is used as the independent variable, the resulting B_1 gives the amount of movement in the dependent variable resulting from a 1% increase in volume.

I restricted with using the log variable feature because it cannot take on negative values. Therefore, a variable like log (change in price) or log (change in volume) would have too many negative values to ignore that it would skew the data. The use of an absolute value of these numbers was considered but not put to use when using log due to the lack of information on the direction of change in each variable. This shows that price has increased over time while volume

has done the same. What I want to observe is how price changes according to volume. As I look to see what type of relationship volume has on price or price change, it is important to note that an R-squared value that explains most of the price change is unlikely. In currency markets and even equity markets, the presence of outside "noise" makes creating an equation that captures all the variables of price change difficult.

Table 4-2 Volume on Absolute Percent Price Change

Volume on Absolute Daily Price Change					
Exchange	Slope	Std Error	t Stat	P-Value	R Square
MtGox Volume	0.00000052	0.0000000413	12.48	0.00	10.6%
btcnCNY	0.00000010	0.0000000259	3.79	0.00	1.1%
OKCoin	0.00000017	0.0000000299	5.69	0.00	5.0%
bitstamp	0.00000151	0.0000001028	14.64	0.00	14.5%
bitfinex	0.00000079	0.0000000823	9.54	0.00	11.5%
btceUSD	0.00000223	0.0000001027	21.71	0.00	26.7%

Chapter 5

Conclusion

Having found that volume is not a consistent predictor of price across the largest exchanges, I moved my attention into hypothesizing what other variables may better estimate the change in price of Bitcoin. Because Bitcoin has a finite amount that can be created and I can find the present amount of Bitcoins that have been mined, a variable to look at is the possibility of theft (hacking) or loss. Theft may be important because of its relationship to major shock events and loss may be useful in finding the exact amount of Bitcoin that have the potential to be in circulation. If the supply of Bitcoin decreases, for example, if a million Bitcoin are unrecoverable after a hard drive malfunctions for an individual and is not backed up, the supply of Bitcoin diminishes and the price would theoretically go up. It is with the presence of theft that future research might shift into the exploration of deriving an equation to establish the possibility of theft (hacking) or loss into the value of a Bitcoin.

I can look at the more recent Bitcoin transactions that have occurred in the past year or two and make a variable for the possibility that the individual might lose all their Bitcoin. This is based off the assumption that most people keep their Bitcoin online instead of on a hard drive or offline. On the other hand, one could look at the Bitcoin that have seen little to no activity since the inception of Bitcoin and find a possibility that someone loses their wallet or their password to their wallet, I could use news examples about the larger events, for whenever the value was more than $100,000 and attempt to aggregate an estimate of the amount of Bitcoin lost in a given year contingent on the total supply ever mined.

Potential Equation for Modeling Theft and Loss

This will be applied at a microfoundational level in which only one good and currency (Bitcoin) exist. As I add in a variable that decays the value of Bitcoin to the holder, the value in a transaction and the willingness of an individual to accept or carry Bitcoin decreases. Now I need the basic formula for valuing a currency, with probability of someone accepting it. I then work from here to add in decay for possibility of theft based upon the instances of theft historically observed and using some type of weighting, such as moving weighted average or relating it to being domestic or foreign. I can also look at the stability of exchanges or indices such as OKCoin in China or Bitstamp in the US. Once I have probability of theft I can then decide what the relation to the price on the marketplace should be relative to what I discount it at.

Another assumption I would make is that the holder of Bitcoin loses all the Bitcoin or keeps their Bitcoin, such as a 0 or 1 switch. I make this assumption that most people do not spread their Bitcoin across different holding platforms and if there are accounts in other platforms, I could see it still as the account losing all its value and that having a separate account would still have the possibility of losing the Bitcoin be the same.

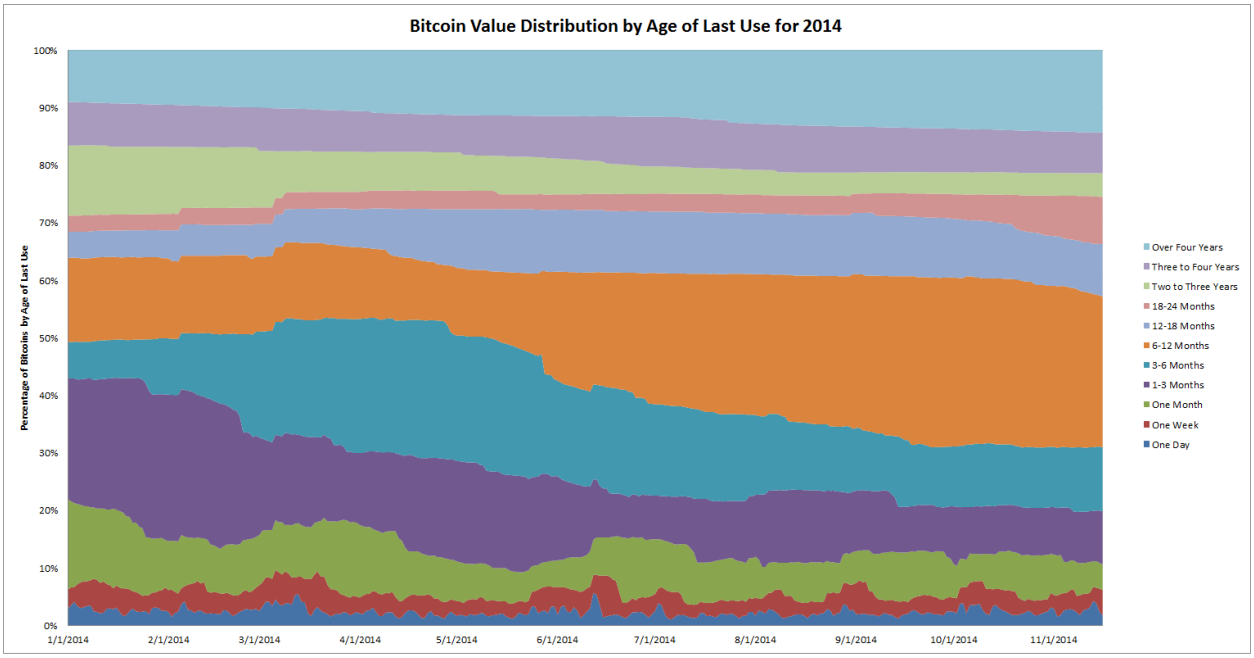
Going forward, I find that while research has been conducted looking into the relationships between news events and the volatility of Bitcoin price, there is no work looking into creating a model that creates a way to express, at least in a rudimentary sense, the value a Bitcoin has when the possibility of theft is factored into the quoted price. This is different from theories such as the strong market hypothesis because this aims to apply a discount (or possible premium) onto the price of Bitcoin when buying a good. Another factor that plays into

understanding the monetary theory behind Bitcoin price and its ability to purchase a good or service is something that I need to expand on to further understand the model/equation I created.

While Bitcoin may fluctuate in price, other currencies do as well. The importance is in the microeconomic theories of monetary policy and how two players react in a situation where they have either an indivisible good or indivisible money. In my adaption, I change the money into Bitcoin and from there I will look at how, once I add additional factors, the value and probability of trade change due to additional uncertainties of the currency being a store of value.

Factors to include in a "theft variable" would be taking into account the total amount of Bitcoins in the world, and then those that have been in recent circulation, as many accounts are revealed to have been dormant for many years, and to which I can also further apply a discount to those that are either lost or hidden on a hard drive somewhere (Hajdarbegovic). With the current number of Bitcoins in circulation known, as well as the price and the volatility, I can trace the impact that major thefts or frauds, such as the collapse of Mt. Gox and the hackings at places such as Bitstamp, have as a percentage of the total actively circulated Bitcoins. I emphasize actively circulated because this would better measure the possibility of a person who is willing to trade with their Bitcoin or is speculating. What may arise from this is that people have been saving their Bitcoin for years and will not bring them out of storage until they seem something worthy to purchase come into the market. I argue that I could discount the difference in time since last use. See chart below:

Figure 5-1 Bitcoin Value Distribution by Age of Last Use



So now I have a model that focuses, with some confidence interval, on the possibility that engaging in Bitcoin transactions using an online exchange will lead to the potential loss of all of one's Bitcoin. To make this easier to model, I can assume that the individual does not have other accounts and that if the company or trading house is hacked they will lose all of their currency. From here I can find that holding Bitcoin decreases its value to purchase goods because there is an increased level of risk that not only will the currency not be able to store value, but has a possibility of disappearing before a transaction can occur.

While much of the change in price of Bitcoin could not be explained in daily volume change, I have moved towards a better approximation of the Bitcoin price changes and how external events have an impact on Bitcoin price.

Concluding Remarks

I see that daily change in volume was not a very useful predictor for finding the daily price change. This is completely acceptable because in most markets, the explanation of a currency's or even a stock's change have many other variables that interact with the price change. What this research does show is a foundation of which I can begin to introduce more variables in order to capture more of the change, as represented through additional variables with higher R-squares. As the paper concludes, it offers a few suggestions as to what variables could be included, particularly a variable to encompass the possibility of theft. While volume was not as useful as might have been theorized, it did rule out that volume was the sole predictor of price across exchanges, going forward, the other unexplained portion could be found using additional variables that might include interaction terms between the exchanges.

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EDUCATION

The Pennsylvania State University | The Schreyer Honors College — **University Park, PA**
Smeal College of Business | Bachelor of Science in Finance, Minor in International Business — Class of May 2015
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Thesis: Modeling the Possibility of Theft in the Value of Bitcoin

La Universidad de las Américas — **Puebla, México**
Spanish Language, Art, and Mexican Culture — *May 2012 - July 2012*

BUSINESS EXPERIENCE

J.F. Lehman & Company — **New York, NY**
Private Equity Summer Analyst — *June 2014 - July 2014*

- Selected as the only Summer Analyst for a boutique private equity firm specializing in aerospace, defense, and maritime acquisitions with approximately $700 million in assets under management
- Created investment memorandums and presentation materials for potential acquisitions, such as a portable communications company with an enterprise value of $135 million
- Performed in-depth research such as analysis of U.S. missile programs to contextualize and revise management's predictions for the acquisition of a missile component company with over $70 million in sales

Hintz Capital Management, Inc. — **Morristown, NJ**
Analyst — *July 2014 - Present*

- Reviewed client portfolio holdings ranging from $20 to $50 million with varying risk profiles for a private hedge fund
- Represented Hintz Capital Management at hedge fund management presentations and meetings
- Researched and advised Mr. Hintz on decisions ranging from diversification and consolidation to charitable contributions

Center for Global Business Studies — **University Park, PA**
Research Assistant — *August 2013 - May 2014*

- Researched and analyzed the influence of NGOs and how governments and corporations should position strategies accordingly
- Compiled a report of twelve global trends and challenges for business leaders in the next thirty years under Dr. Fariborz Ghadar
- Evaluated risk levels for future conflicts and the alternative approaches governments and corporations should consider implementing

Hudson Institute — **Washington, D.C.**
Research Assistant — *May 2013 - August 2013*

- Published an analysis on US global troop deployment and the social and economic impacts of troop fluctuations on host countries
- Updated and evaluated a unique data set that tracks US troop levels in every country from 1950 to 2012
- Reviewed speeches and policy papers relating to global U.S. Naval presence, specifically Pacific Ocean trade implications

Uplifting Athletes, Inc. — **Harrisburg, PA**
Financial Analyst — *Fall 2012*

- Co-authored 117-page *Uplifting Athletes, Inc.* Strategic Business Plan for 2012-2017
- Forecasted financial statements from 2012 to 2017 with annual revenues of over $700,000

Wall Street Boot Camp **University Park, PA**
Participant *Spring 2014*

- Selected for an exclusive group of 40 students from among over 300 applicants to participate in weekly sessions presented by Wall Street professionals on topics such as investment banking, sales and trading, private wealth management, and asset management

LEADERSHIP

Presidential Leadership Academy **University Park, PA**
Member *March 2012 - Present*

- Selected as one of thirty students for a three-year seminar class taught by the President of Penn State focusing on the development of leadership and critical thinking skills through curricular and co-curricular opportunities
- Collaborated on a policy paper presented to the Penn State President to influence the diversity portion of the 2014-2019 Strategic Plan

SKILLS/INTERESTS

- Conversational Spanish; working towards fluency
- Boeing Latin America, Android vs. Apple Case Competitions - 1st Place 2012 and 2013
- Immersed travel, international trade, sustainable agriculture, personal investing, rowing