

Bitcoin Is Volatile! Isn't that Right?

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Abstract. In this study, we substantiate with financial data collection and analysis the hypothesis regarding the volatility of Bitcoin exchange rate against common currencies. Financial data were collected from July 2010 until April 2014. The raw annualised volatility of Bitcoin is compared to conventional and major exchange rates. The first set of results indicate a high value of annualised volatility for the Bitcoin exchange rate. When the volume of Bitcoin transactions is considered, the volatility of the Bitcoin exchange rate stabilizes significantly.

Keywords: Bitcoin · Exchange rate · Volume · Volatility

1 Introduction

Bitcoin is a digital, decentralized, online financial mechanism, proposed by Nakamoto [9]. Almost since its first deployment in 2009, this financial system attracts considerable attention, due to its unique set of features that set it apart from other existing financial systems. Unlike preceding online payment systems, Bitcoin is not denominated in fiat currency. However, Bitcoin's features resemble those of cash. Like established currency systems, Bitcoin has its own money creation and transaction protocol. Like cash, Bitcoin transactions are irreversible and do not explicitly identify the payer or the payee. Contrary to established currencies, however, Bitcoin is not based on any commodity, like gold or silver. It is not even backed by any sovereign obligation. Bitcoin relies on public key cryptography and a peer-to-peer network of participating entities for transaction validation and certification. Each participant is obliged to maintain the entire transaction history of the system rendering all transactions transparent.

Being decentralized, anonymous, transparent and incurring minimum transaction fees it would be expected that Bitcoin is valued for its set of features. However, since the beginning of 2014, Bitcoin exchange rate performance has deteriorated substantially and has only begun to recover in the second quarter of the same year. Nonetheless, during the first quarter of 2014 the exchange rate of Bitcoin had decreased to \$298.73 from \$1,128.47 since November 2013. Adverse events such as the closing of the Mount Gox Exchange and the negative outlook from the Chinese government have all played a role in damaging the performance of Bitcoin. Indeed, it is widely perceived in the social media and fora that Bitcoin is a substantially volatile and, thus risky financial system.

In this study, we focus our attention on the topic of Bitcoin volatility. We examine the hypothesis regarding the volatility of Bitcoin exchange rate against common

currencies through collection and analysis of financial data. Primarily, we study the raw annualised volatility of Bitcoin in comparison to the conventional and major exchange rates using daily data from July 2010 until April 2014. The first set of results indicate a high value of annualised volatility for the Bitcoin exchange rate, in conjunction with ECB [4], Harper [6] and Yermack [12]. However, these studies ignore the volume of transactions and its impact on the performance of the Bitcoin exchange rate. We believe that the volume of transactions is a crucial factor whilst determining the volatility of Bitcoin and, accordingly, we adjust the volatility of the Bitcoin exchange rate with its volume of transactions. Our results indicate that the volatility of the Bitcoin exchange rate stabilizes significantly once the volume of transaction are taken into consideration.

The academic economic literature on Bitcoin is scarce and majority of economic studies are focused on legal and regulatory aspects of Bitcoin. To the best of our knowledge, this is the first study that measures the volatility of Bitcoin once adjusted for volume of transactions. The remaining of this paper is structured as follows. Section 2 reviews relevant literature and Sect. 3 presents the data collected and the methodology followed for the analysis. Section 4 presents and analyses the empirical data and Sect. 5 concludes this paper.

2 Literature Review

The current academic literature on Bitcoin is predominantly focused on the legal aspects of Bitcoin and the on-going debate as to whether Bitcoin is a currency, a commodity or an investment. However, the economic literature of Bitcoin and its implications to the financial markets are scarce. In this study, we compare the value of the Bitcoin exchange rate and its annualised volatility against the US dollar to other major global currencies. In addition, we show that the value of the Bitcoin exchange rate is not as volatile as widely acclaimed once the low volume of trades are taken into account. The most prominent studies on the financial aspects of Bitcoin and its price formation are outlined below.

The popularity of Bitcoin and its rise in value have attracted studies from Grinberg [5], Barker et al. [2] and Kroll et al. [8]. Nonetheless, Buchholz et al. [3] focused on the demand and supply factors as determinants of affecting the value of Bitcoin. The authors argue that the supply of Bitcoin is determined by the amount of Bitcoin in circulation and the amount of transactions of the Bitcoin exchange determine the demand.

On the other hand, Kristoufek [7] argues that the value of Bitcoin is not affected by the standard economic theories and demand and supply fundamentals. In particular, the author claims that standard financial theories such as cash-flow models, purchasing power parity and uncovered interest rate parity do not play a role in determining the value of Bitcoin. In contrast, Kristoufek believes that it is only speculation that drives the value of Bitcoin and he tests the relationship between the value of Bitcoin with search queries on Google trends and Wikipedia respectively. The results indicate a positive relationship for both correlation pairs.

Furthermore, Van Wijk [10] applies macroeconomic and financial variables as potential determinants of the Bitcoin value. Specifically, the author incorporates the Dow Jones Industrial Average Index, the euro-dollar exchange rate and the WTI oil

price index as factors affecting the value of Bitcoin and he finds significant results. Ciaian et al. (2013) use a multi-variable analysis and incorporate the studies of Buchholz, Kristoufek and van Wijk by incorporating all the potential factors: supply-demand fundamentals, investors' behaviour and global financial indicators. The results indicate that Bitcoin market fundamentals and Bitcoin's attractiveness to investors have an impact on the price formation of Bitcoin.

A recent study by Briere et al. [2] shows that the returns and volatility of Bitcoin are significantly high, with low correlations with other traditional assets and alternative investments. However, the authors do show that even with small amounts of Bitcoin added to a diversified portfolio will dramatically improve the risk-return trade-off of well diversified portfolios.

Indeed, it is widely acclaimed that Bitcoin is a very risky currency with high values of volatility. Yermack [12] undertakes a study by measuring the annualised volatility of Bitcoin and compares it to different currencies. In his paper, he finds that Bitcoin is highly volatile and that the correlations with the other traditional currency exchange rates are very low, implying little, if none, implications for hedging purposes.

Nonetheless, the social media and the adverse shocks that Bitcoin has faced have greatly contributed to the low volume of transactions that Bitcoin has experienced in the first quarter of 2014. In this study, we integrate the volume of trades and show that the volatility of Bitcoin is not as high as commonly perceived. As a result, the volume of trades should not be ignored when determining the riskiness and volatility of the Bitcoin exchange rate.

3 Data and Methodology

This study seeks to determine whether the exchange rate of Bitcoin is indeed as volatile as acclaimed. In particular, we measure the performance of the Bitcoin exchange rate against the US dollar and compare it to other renowned exchange rates. Further, we aim to prove that the volatility of the Bitcoin exchange rate is simply due to the low volume of trades that the currency has experienced.

3.1 Data

This paper uses the exchange rate of Bitcoin against the US dollar and compares it to six different currencies as well as the London price of gold. Upon choosing the various currencies as a comparison to the Bitcoin, we aimed to underpin different markets and economies, developed and emerging, around the globe. The currencies that were used in our study as comparison to the Bitcoin are shown in Table 1.

For each currency we used the daily midnight exchange rate against the US dollar as well as the volume of trades, starting from the 19th of July 2010 up to the 9th of April 2014, providing us with 1,361 observations.¹

¹ The data for the Bitcoin exchange rate as well as the exchange rate of all other currencies was used from www.quandl.com and www.oanda.com.

Table 1. Exchange rates and country of domicile.

Currency	Country/Continent
Euro	Europe
GBP (Sterling Pound)	UK
Yaun	China
Yen	Japan
Ruble	Russia
Franc	Switzerland

3.2 Methodology

In order to examine whether indeed the exchange rate of Bitcoin is as risky and volatile as widely acclaimed, we primarily study the evolution for its exchange rate against the US dollar. In order to develop the daily change in the exchange rates for each currency of analysis, the following computation was employed:

$$\Delta \text{ in Exchange Rate} = \left(\frac{ER_t - ER_{t-1}}{ER_{t-1}} \right) \quad (1)$$

Therefore, this supplies our research with a sample size of 1,360 observations, where all the exchange rates are calculated at the midnight of each day in our sample period. In addition, so as to compute the volatility of each exchange rate and the London price of gold, we use the annualised volatilities, as proposed by Yermack [12]. For each of the currency changes in exchange rates and gold, the standard deviation was primarily determined, which represents the 1-day volatility of each exchange rate. Assuming that there are 252 trading days in the year, the volatility can be annualised by multiply the standard deviation of the exchange rates by the square root of 252. This is shown in Eq. 2:

$$\text{Annualised Volatility} = \text{Standard Deviation} * \text{SQRT}(252) \quad (2)$$

Indeed, in order to verify that the value of the Bitcoin exchange rate is not as volatile widely perceived, we attempt to dispute this by standardising the daily change in the exchange rate of Bitcoin by the daily volume of trades. This can be seen in Eq. 3:

$$\text{Adjusted Return} = \frac{\Delta \text{ Exchange Rate}}{\text{Volume of Trades}} \quad (3)$$

4 Empirical Results

Indeed, Yermack [12] claims that the value of Bitcoin exchange rate against the US dollar is substantially more volatile than any other currency he used in his comparison. In our study, we extend the analysis that Yermack provides and include more currency

exchange rates for comparison. Furthermore, and more importantly, we show that the value of the Bitcoin exchange rate is not as risky and volatile as widely acclaimed.

4.1 Performance of Bitcoin

In his analysis, Wallace [11] claims that 'Nakamoto' introduced the first 50 Bitcoins into circulation in 2009. However, it was in July 2010 that Bitcoin began to trade on a Japanese-based online exchange, Mount Gox, and started to attract interest and gain its popularity. On the first trading day, the value of Bitcoin was \$0.05. During the subsequent two and a half years, the value of the Bitcoin against the US dollar remained at relatively low levels, and almost a year into trading it managed to surpass the one dollar mark. However, it was in the beginning of 2013 that the performance of the Bitcoin exchange rate picked up. This can be clearly seen in Fig. 1, which shows the value of the Bitcoin-Dollar exchange rate, from the 17th of July, 2010, until the 9th of April, 2014. During the first three quarters of 2013, the value of Bitcoin exhibited a steady rise, reaching a maximum value of \$200. However, it is the month of November 2013 that the value of Bitcoin increased rapidly. In particular, at the start of November, Bitcoin was trading at \$202.09 and on 1st of December, 2013, the value of Bitcoin increased to \$1,128.47. Those that had invested in Bitcoin had experienced an increase in return of 4.5 % in just one month!

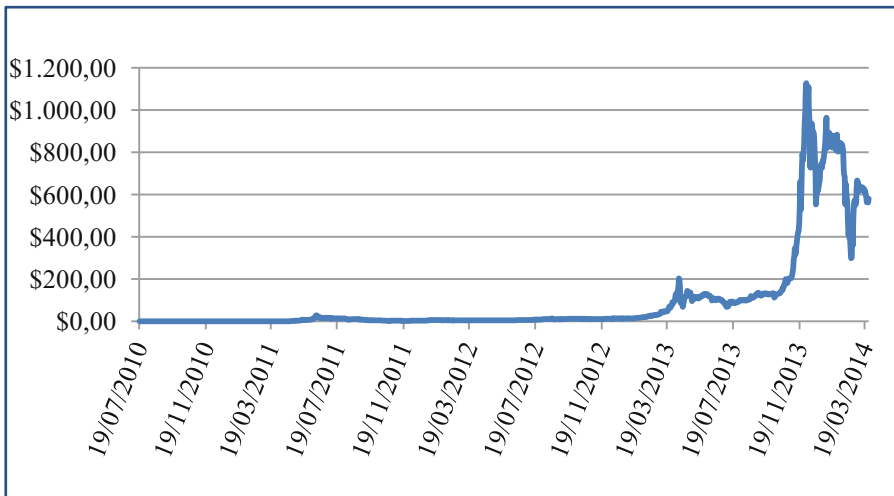


Fig. 1. Bitcoin-Dollar exchange rate

Nonetheless, as Fig. 1 shows, by the end of December the value of Bitcoin dropped to \$758.53 and we see that the first quarter of 2014 has somewhat been unsteady in terms of the Bitcoin-Dollar exchange rate. In fact, the lowest value traded was \$298.73 on the 22nd of February, 2014 (close-down of Mt Gox). Nevertheless, during the last couple of months of our analysis, we see that the value of Bitcoin has improved from that lowest point, averaging an exchange rate of approximately \$500.

Furthermore, we also measure the percentage change in daily exchange rates for all of our currencies in analysis, with Fig. 2 showing the daily change in the Bitcoin exchange rate measured against the US dollar. This can be viewed as a form of return of the Bitcoin exchange rate. As can be seen from Fig. 2, the change in the value of Bitcoin exhibited high variations throughout the period of analysis. This variation is most prominent in the first two years of our sample period, as well as from the first quarter of 2013 up until the end of our analysis period. In comparison to the other currencies of analysis, the performance of the change in the Bitcoin exchange rate is the most radical, which can be seen in Table 2. The average percentage change of Bitcoin is 0.6702 %, whereas the other currencies exhibit a substantially lower average amount. In addition, Bitcoin earned a maximum return of 53.59 % over our analysis. On the other hand, the lowest return measured was on the 13th of April, 2014, yielding a decline in return of 49.75 %. When taking into consideration the other currencies' variation in the returns, the difference is considerably smaller.

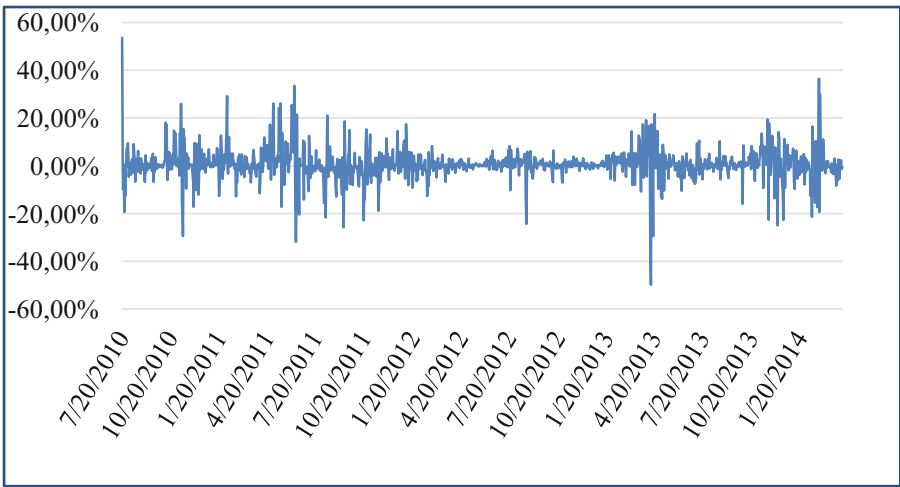


Fig. 2. Change in Bitcoin exchange rate in US dollars

Table 2. Average percentage change in exchange rates of all currencies and gold.

Currency/Gold	Average change	Maximum	Minimum
Euro	0.0047 %	1.9472 %	-1.8510 %
GBP (Sterling Pound)	0.0064 %	1.4728 %	-1.5500 %
Yaun	0.0070 %	1.0000 %	-1.0000 %
Yen	-0.0118 %	2.3906 %	-3.2003 %
Ruble	-0.0096 %	3.2790 %	-3.1933 %
Franc	0.0126 %	2.4464 %	-4.5272 %
Bitcoin	0.6702 %	53.5962 %	-49.7501 %
Gold	0.0067 %	4.2775 %	-4.3418 %

4.2 Volume of Bitcoin Trades

The volume of Bitcoin trades has to some extent experienced a similar trend as to the value and daily percentage change of the Bitcoin-Dollar exchange rate. This can be clearly seen in Fig. 3, which shows the daily volume of Bitcoin trading in US dollars. Up to 2013, over two years since Bitcoin trading had begun, the volume of trades was significantly low, even though the value of the Bitcoin-Dollar exchange rate was at its lowest points. This coincides with the general lack of confidence and fear of the 'unknown' that investors had with the Bitcoin. It is in the first quarter of 2013 that the volume of trades of Bitcoin had started to depict higher amounts, with amount of trades reaching more than \$72 million by the end of 2013. Taking into consideration the uncertain and crisis-prone European markets, and the bail-in of the Cyprus banks in 2013, the investors' confidence in a centralised banking system had reversed, which demonstrates the increase in volume during 2013. Nonetheless, the volume of trades does decrease in the first quarter of 2014, which coincides with the close-down of Mount Gox in February. Many investors and traders that are holding Bitcoin continue to do so, because, following one of the first rules of investing, no one wants to sell at the lowest value. Everyone anticipates the value to increase and thus decides to hold. Holding Bitcoins over longer periods will decrease the volume of trades and ultimately drive the price down. There have been 12.7 million Bitcoins mined,² which shows that Bitcoin is still well into circulation, except that investors are holding them. Therefore, the decrease in value of Bitcoin-Dollar exchange rate is not due to its uncertainty or riskiness, but due to the low volume of trading as the majority are choosing to hold their Bitcoins.

Indeed, simply basing our analysis on the raw data of the Bitcoin-Dollar exchange rate, the volume of trades and its daily percentage change would be wrong to conclude

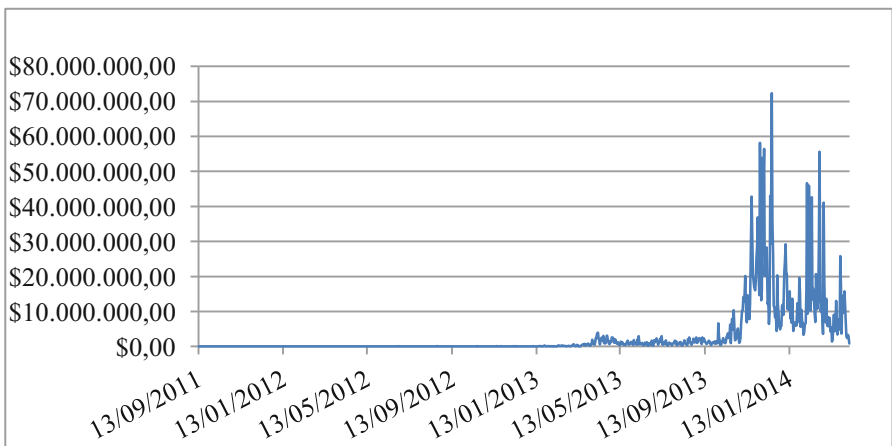


Fig. 3. Bitcoin trading volume in US dollars

² www.cryptocoinsnews.com

that Bitcoin has not exhibited a volatile performance in general. However, in this study we attempt to prove that Bitcoin is not as volatile as widely perceived.

4.3 Is Bitcoin as Risky as Assumed?

In concurrence with Yermack [12], we also find that the value of Bitcoin exhibits the highest annualised volatility even when adding more currency exchange rates in comparison and extending the sample period. Figure 4 demonstrates the annualised volatility of the percentage change in daily exchange rates for six major currencies, gold and Bitcoin, all measured against the US dollar, during our period of analysis. Without a doubt, studying the ‘raw’ annualised volatility deduces that the Bitcoin’s exchange rate has been the most volatile during our sample period in comparison to gold and other major currencies. Specifically, the Bitcoin’s exchange rate volatility yields values higher than 130 %, whereas the volatility for other currency exchange rates and gold varies between 2 % (Chinese Yuan) and 12 % (London price of gold).

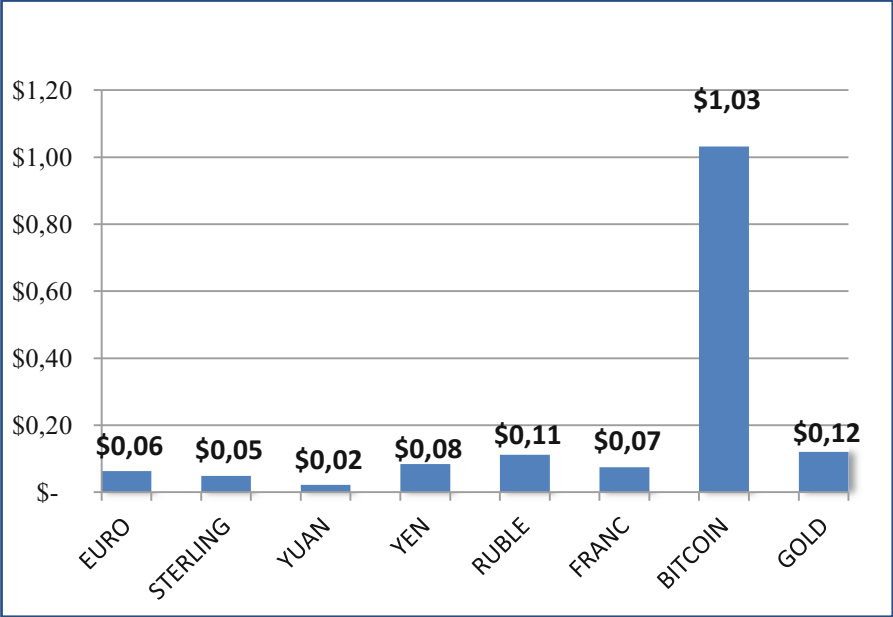


Fig. 4. Annualized volatility of Bitcoin and major currencies

However, what other authors and advocates of a volatile and risky Bitcoin fail to acknowledge is that simply taking the annualised volatility as an indication of the Bitcoin riskiness may lead to wrong conclusions. The low volume of trading that Bitcoin has experienced simply cannot be ignored. As explained in Sect. 4.2, the low trading volume, with investors and traders holding the Bitcoin, has led to inevitable changes in the value of the Bitcoin exchange rate. As a result, the volatility measured

will be higher. For that reason, we determine the daily percentage change in the Bitcoin-Dollar exchange rate as per daily volume of trades. The result is shown in Fig. 5. When comparing the raw representation of the percentage change in Bitcoin exchange rates (Fig. 2), it can be clearly seen that the trend and general performance of the Bitcoin is to a greater extent more stabilized.

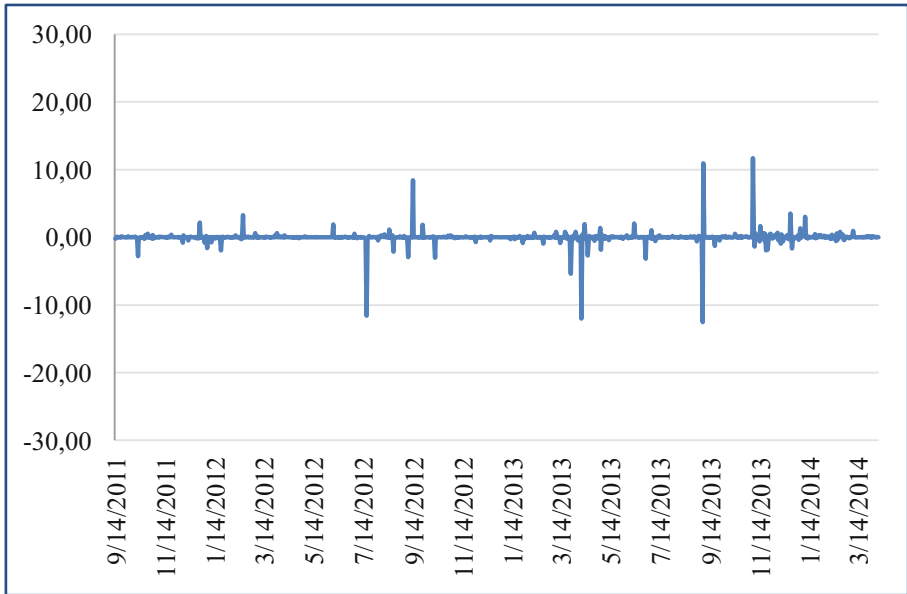


Fig. 5. Percentage change of Bitcoin as per volume of trades

This can be further determined when taking into account the average percentage change in Bitcoin exchange rate as per volume of trades, and the maximum and minimum amounts. We carry out the same analysis of the percentage change in the exchange rate of Bitcoin as in Table 1; however, we now demonstrate the change in those results when volume is taken into account. This can be clearly seen in Table 3, where the average percentage change of Bitcoin is -1.10% . In addition, the range between the maximum and minimum percentage changes in the Bitcoin exchange rate is now considerably smaller (24.2%) as opposed to the initial difference in the maximum and minimum percentage changes in Bitcoin (103.3%).

Table 3. Average percentage change of Bitcoin as per change in volume

Currency	Average % Change	Maximum	Minimum
Bitcoin	-1.1%	11.69%	-12.52%

Therefore, through this analysis, we show that Bitcoin is not as volatile and risky as widely acclaimed. The volume of trading, or more specifically the low amount of trades made, simply cannot be ignored. Holding a currency does not imply volatility. The low

volume of trading have caused the price variation of the Bitcoin exchange rate, which have led to a misinformed conclusion that Bitcoin is highly risky. Through our study we show that this is not the case when volume is taken into account, where the value of Bitcoin is in fact more stable and the variation substantially smaller.

5 Conclusion

The popularity of Bitcoin and other virtual currencies has grown immensely in the past few years. Apart from the fact that Bitcoin is a decentralised financial system with miniscule transaction costs, it also provides high returns. Nonetheless, due to adverse events and excessive media speculation, Bitcoin has to some extent received a reputation of being a highly volatile currency that needs to be taken with caution. However, not all is as it seems.

In this study, we do show that when raw changes in the Bitcoin exchange rate are taken into account the volatility of the currency is much higher than the other major currencies used in our analysis as a method of comparison. However, the major currencies did not suffer the large negative shocks that have played a vital part in the amount of Bitcoin transactions being traded. For this reason, it is of utmost importance to adjust the change in the Bitcoin exchange rate with the volume of trades when determining the volatility of Bitcoin.

Indeed, when taking into account the low volume of trades for Bitcoin that were exhibited in the first quarter of 2014, our results indicate that the volatility of the Bitcoin exchange rate subsides substantially. The volume of trading, or more specifically the low amount of trades made, simply cannot be ignored. Holding a currency, as was the case with the Bitcoin exchange rate, does not imply volatility.

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