



ESSEC Global BBA

BBA Dissertation

Bitcoin : The roller coaster

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Executive Summary / Le résumé managerial

As bitcoin arouses great public attention towards its roller coaster price changes, many wonder what will its future be. This research looks into the reasons behind bitcoin's price change and its huge volatility by evaluating its asset type, supply and demand as a cryptocurrency, market sentiments as well as influence from transactional environment. With primary in-depth interviews as well as qualitative and quantitative methods on secondary data, this report aims at establishing patterns and trend for bitcoin in the future, so as to raise several practical recommendations for investors, financial and industrial institutions and management.

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Introduction

Chapter / Chapitre 1 Introduction

Chapter / Chapitre 1.1 Background

Chapter 1.1.1 Introduction of Bitcoin

Bitcoin (BTC) is a cryptocurrency, that is, a form of electronic cash. Based on block chain technology, this digital currency has its most known characteristic of decentralization. Without a central bank, single administrator or government interference, it has published source code available to everyone, and it can be transferred among each and every participated individual via its peer-to-peer network.

The idea of bitcoin is first established in the late 2000s. The domain name "bitcoin.org" was registered on 18 August 2008 and was designed to be a peer to peer payment method in the year 2009. In its nature, it is not regulated by any government, and it gives the right of initial offering of currency to the general public. Everyone has a chance of writing the ledger that records all transactions in the decentralized system using script language. Consensus is reached using proof-of-work, or later on, proof-of stake, in order to determine which individual's records will be validated and published into the public. This records will then be everyone's records, thus keeping the system self-consistent.

Chapter 1.1.2 Price movement of Bitcoin

The price of bitcoin has surely gone through many bubbles and busts. Just as how it captured every investors' notice in 2011, as the value of 1 bitcoin rose from about US\$0.30 to US\$32, that is, more than 100 times elevated, before returning to US\$2. During the 2012–13 Cypriot

financial crisis, however, the BTC price began to rise, reaching a high of US\$266 on 10 April 2013, before crashing to around US\$50. On 29 November 2013, the cost of one bitcoin rose to a peak of US\$1,242, that is when many miners actually quitted or found that the investments in the mining equipment became worth a second thought. In 2014, the price fell sharply, and as of April remained depressed at little more than half 2013 prices. As of August 2014 it was under 600 USD. There, it goes up rapidly at around 4000 USD in 2017. No one would foresee a crazy rise of BTC suddenly to nearly 20,000 USD in December 2017. Compared to that year, all the bubbles and busts before 2017 were just nothing. Then, it crashes again down to 3500 USD in December 2018, with millions of market value evaporated. Just as everybody was saying the times for BTC is over, and that people who entered into the market recently will be getting zero back from their investment, the price rises rapidly again early 2019 to almost 2.5 times its price in three months, to a high of more than 8,000 USD.

As of 2014, BTC has a volatility seven times greater than gold, eight times greater than S&P 500, and 18 times greater than the US dollar.

Chapter 1.1.3 Context of the problem

The great price volatility, resulted from its nature as a cryptocurrency, has made some rich in a night and has also made some lost all in a day. BTC goes absolutely vital during the year 2017. The beginning of 2018 witnesses a huge volume of reports, news and of course investors that jumping into this market. The crash of price since then, however, has triggered great loss among many of them. As the family of cryptocurrencies keeps growing, the entering boundary of digital currency family is diminishing. Without requirements from the government of banking licenses or anything at all, all of us can create our own digital currency within merely seconds. What is more, the total amount of BTC is fixed, meaning

that the currency will by its nature, be depreciating. At the end of 2018, there seems to be more than one reason to believe that BTC will lose its ‘magic power’, and disappear from our investment portfolios. Surprisingly, however, as many lose their confidence in BTC, recently, the price has gone up greatly again. Why is that and where will it go in the future?

Chapter / Chapitre 1.2 Motivation

The motivation for the studies started from the Fintech innovations that has been heatedly discussed these days. With the bubbles bursted up in 2019 and the price of bitcoin increasing sharply again in 2019-2020, its determinants as well as the future implications are being examined again. As technology keeps evolving, investment market becomes more rational. Macro conditions and transaction environments are further shaping the market as governments, merchants and individuals taking measures to embrace the benefits of cheaper transactions, decentralized structures as well as speculative option. Where will bitcoin go therefore becomes an interesting topic. Enthusiasts say that bitcoin will remain one of the most powerful speculative tool with a bright future, others argue that it will be dying as other cryptos and initial coin offerings taking its place. Will the huge volatility remain its characteristic, or will the cryptocurrency bubble just diminish? Time series would not tell the future, and more market metrics can therefore be discussed under this topic.

Chapter / Chapitre 1.3 Parameters of Analysis

Chapter 1.3.1 Problematic

What are the factors that contribute to the change of price in BTC and how did they cause the huge volatility in bitcoin's returns? What does this implicate to the crypto market in the future?

Chapter 1.3.2 Objectives

The research objective is classified as the follows :

First, to understand the nature of cryptocurrencies in contrast of other asset classes.

Researcher wants to look into bitcoin as a digital currency as well as an asset type, study its price correlation with traditional asset types, the macro-environments, stock market in order to look for the factors that might have an influence on its returns.

Secondly, researcher looks at other qualitative information and examine their impacts on bitcoin's price volatility. The factors include aspects from the PESTEL model, and are divided into different aspects including the follows,

- a) returns of other asset types, i.e stock market, real estate market, other cryptocurrencies;
- b) macroeconomic conditions such as legal restrictions, political impacts, security issues, and average industrial returns in the market which represents a basis of asset returns;
- c) behavior economics factors regarding to investors' emotions and irrational behaviors.

Finally, researcher aims to analyze the historical data and to study its implications for practical implications. For example, despite the roller coaster side of bitcoin, this is a type of asset that may be able to provide excessive returns. Thus, should investors consider adding this into their portfolio as of present? Also, after analyzing its risks and trends, researcher

wishes to suggest its future perspectives as well as their implications on organizations, governments as well as evolving technology industries.

Chapter 1.3.3 Definitions

Price is taken as the average quote price rather than opening or closing price. Return is defined as the percentage price difference between today and yesterday.

Say price of bitcoin on day A is P0 and price on day A+1 is P1. We have the return on day A+1:

$$r1 = (P1 - P0) / P0 * 100\% \quad (1)$$

Price volatility is defined as the difference in returns between two transaction days. Say on Day t the return of bitcoin is r0 and it is r1 on day (t+1). So the price volatility aligns with returns, that is :

$$v = (r1 - r0) / r0 * 100\% \quad (2)$$

Chapter 1.3.4 Boundaries

To analyze the bitcoin prices, boundaries of what, when, where and who are formed to determine the studying universe. The bitcoin returns and the reasons for its characteristic of volatility are what to be studied. Time frame chosen is from March 2015 to June 2019, on the open market of the U.S. In addition, future anticipation and practical implications will be considered and discussed after this time frame.

Literature Review

Chapter / Chapitre 2 Literature Review

Chapter / Chapitre 2.1 Previous research work

2.1.1 Market Sentiments

To quantify market attitudes is a crucial step to consider its influence on the bitcoin's prices.

It is also a challenging part in this research. This literature link demonstrates a quantitative method on measuring market emotions, which is proved later in chapter 3 to be the major price determinator. The method created by researchers of the website *Alternative.me (2019)* found a way to measure the sentiments of bitcoin in the market. The index that they designed is called "fear and greed index". The author took market momentum, volatility, social media trends, surveys and so on so forth to establish a dynamic market emotion towards bitcoin as either more fear or greedier, updated daily. This measurement we use contributes to part of market emotions towards bitcoin.

Factors that contributed to the index are listed below. In addition, in the last column the author summarized evaluations of this literature, including both its strengths and weaknesses, and thereby linking to contributions that this research will make.

| Index | Weight | Measuring methods | Implications | Contribution and Limitations of this report |
|-------------------|------------|---------------------------------------|---|--|
| Volatility | 25% | To measure the current volatility and | We argue that an unusual rise in volatility is a sign | As the phenomenon being examined, the volatility |

| | | | | |
|------------------------|------------|---|--|---|
| | | drawdowns of bitcoin and compare it with the corresponding average values of the last 30 days and 90 days. | of a fear sentiment in the market. | will be studied against all the other factors. The author is aware that the volatility and market sentiments affect one another, and that in a mature market where investors are aware of this characteristic of bitcoin, this tends to contribute to a larger market momentum. |
| Market Momentum | 25% | To measure the market momentum in comparison with the last 30/90-day average values and put those two values together. | Generally, when we see high buying volumes in a positive market on a daily basis, we conclude that the market acts quite greedy. | Transaction volume is a reflection of liquidity and can potentially affect the price. This factor will be discussed in price determinant - bitcoin demand analysis. |
| Social Media | 15% | Gather and count posts on various hashtags for Bitcoin on Twitter and check how fast and how many interactions they receive in certain time frames. | An unusual high interaction rate shows grown public interest in the coin, corresponding to a greedy market behaviour. | The weak point of this argument is that it is not proved that high interaction necessarily shows greed in the market. |
| Surveys | 15% | Weekly crypto polls are conducted to see how | If people generally perceive the market as | Surveys will be conducted for a focus group that is |

| | | | | |
|------------------|------------|---|--|---|
| | | people perceive the market. | riskier, then there is a fear in the market. To the contrary, if more people are seeing a speculative opportunity, the market might be bullish. | deemed to be representative for bitcoin investors such that to decide their perception, level of knowledge and investment motivations. |
| Dominance | 10% | To measure the dominance of a coin resembles the market cap share of the whole crypto market. | The researchers of this website think that a rise in Bitcoin dominance is caused by a fear of (and thus a reduction of) too speculative alt-coin investments, since Bitcoin is becoming more and more the safe haven of crypto. On the other side, when Bitcoin dominance shrinks, people are getting greedier by investing in riskier alt-coins, dreaming of their chance in next big bull run. | The correlation between crypto market and the nature of the asset type will be further studied in this research, with the emphasis on bitcoin volatility. The dominance of bitcoin within the crypto market is not looked into as the research is more focused on bitcoin itself. |
| Trend | 10% | To pull Google Trends data for various Bitcoin related search queries and crunch those | A high search might mean a bullish market and a lower attention in | There is a limitation to this approach that during either extreme fear or greedy, the search index can both be |

| | | | | |
|--|--|--|---|--|
| | | <p>numbers, especially the change of search volumes as well as recommended other currently popular searches.</p> | <p>the public means a fear in the market.</p> | <p>high, and the trend is also impossible to predict as it is caused by random market events. As a result, in this report, the correlation between special black swan events and bitcoin returns will be studied in this report, aiming at explaining price volatility and unexpectations.</p> |
|--|--|--|---|--|

Table 1: Previous research work analysis: Market sentiment indexing

2.1.2 Empirical Models

Analysis on the influence factors of Bitcoin's price based on VEC model December 2017 by Yechen Zhu, David Dickinson and Jianjun Li, DOI: 10.1186/s40854-017-0054-0

They used monthly data from 2011 to 2016 to build a Vector error correction (VEC) model to exam how economic factors influence the price of BTC. Factors that they used included Custom price index, US dollar index, Dow jones industry average, Federal funds rate and gold price. They conducted variance decomposition and VEC model analysis on the price of bitcoin with all the variables they chose. They found out that although the price of bitcoin is related to macroeconomic conditions to some extent, it was mainly driven by random events. Finally they reached the conclusion that bitcoin can be treated as a speculative asset and not a proper credit currency.

Chapter / Chapitre 2.2 Inadequacies of existing viewpoints

After the bitcoin price crashes in 2018, which was beyond the research universe of Yechen Zhu, David Dickinson and Jianjun Li (2017), the cryptocurrency investment market has become a lot more rational. The elimination of many speculators have given the market a buffer, and we have grounds to assume that the market nowadays is likely to comply more with basic market rules such as demand and supply changes and macroeconomic conditions. Random market events, on the one hand, are difficult to predict and therefore do not provide guidance on practical implications for individual or institutional participants.

Chapter / Chapitre 2.3 Potential contribution of the research

First of all, this research aims at a revised time frame which will be more up-to-date. By adding on the market data from 2017 to 2019, the most dramatic peaks and crashes of bitcoin to date will be included. The volatility of bitcoin has well exceeded expectations than before, and its trend has also been different from viewpoints at that time that was expecting a bear market. As the market evolves over time, it can be assumed that its patterns and relationships with macroeconomic conditions can be clearer, market emotions will be more mature regarding bitcoin's price change, and more data will be available with regards to attitudes and emotions among potential investors. Therefore, practical implications can be better suggested for the general public, including behavior finance perspectives for individual investors, the future development of new industries for institutions, as well as possible implications for the governments. This will increase the relevance of the research work.

In addition, this research also aims at quantification of market emotions for random events and consider them in trend predictions and future suggestions.

Method

Chapter / Chapitre 3 Method

Chapter / Chapitre 3.1 Classification model

The main research question is the reasons leading to the return volatility of bitcoin (BTC), which is further broken down into the following questions, answerable by different data:

1. Is bitcoin in nature a separate asset class, and how does BTC correlated with any existing asset class in terms of price and price change?
2. Do macro-economic conditions, along with geopolitical aspects have significant impact on bitcoins' price?
3. Do investors' emotions play a role in bitcoin's price change?
4. As practical implication, what does the volatility mean in the future for the investors?

The researcher therefore makes a classification model on the research questions as follows,

Figure: Classification Model

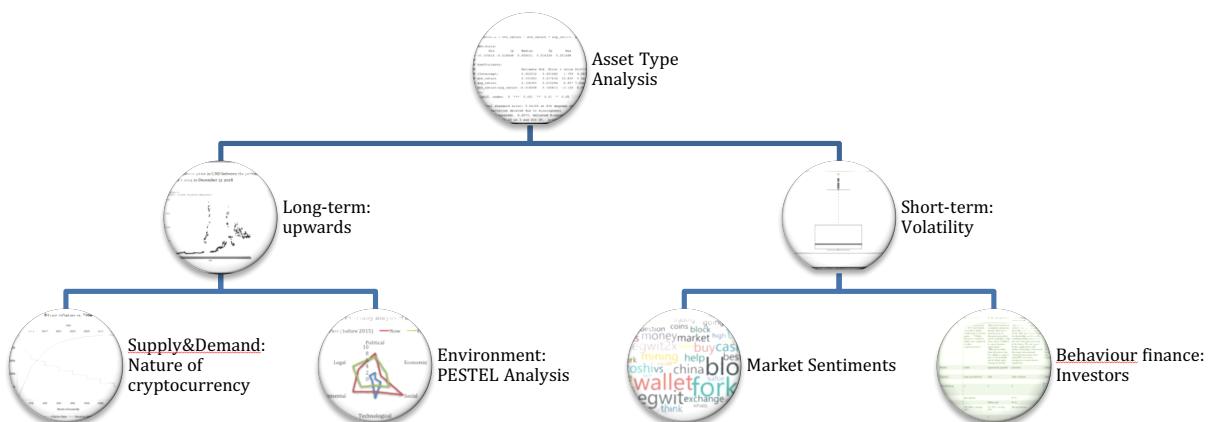


Figure 2: Classification model

Practical implication classification model

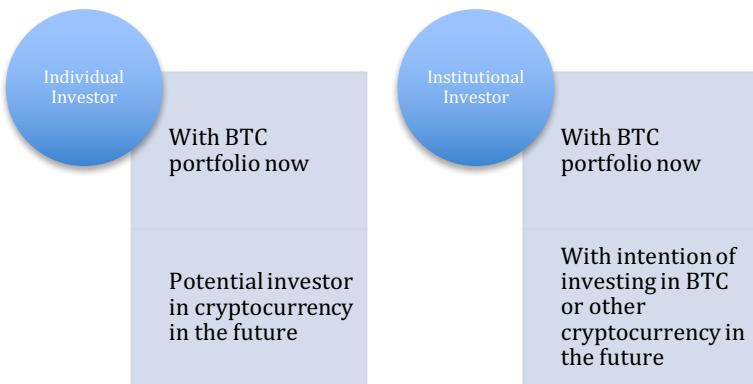


Figure 3: Practical implication classification model

These questions will be discussed separately using different data collection methods and analysis plans specified in the following chapters.

Chapter / Chapitre 3.2 Data collection methods

| A. <u>Supply side</u> | B. <u>Demand side</u> |
|---------------------------------------|--|
| 1. Asset Type – Quantitative analysis | 1. Macro-environment – Qualitative analysis |
| | 2. Market emotions index – Quantitative analysis |
| 2. Supply – Qualitative analysis | 3. Behavior finance Questionnaire – qualitative analysis |

Table 4: Data collection method matrix

To analyze the relationship of bitcoin's price change with other assets in the market so as to consider macro-economic factors, market conditions and its natural correlation with other cryptocurrencies and stocks, researcher aims to collect quantitative secondary data on prices of publicly quoted asset types in the U.S market during the time frame of research universe.

A dataset is obtained through online public websites consisting of the daily quotes of the following assets: gold, S&P 500, US dollar, ETH, BTC, XRP, etc. All data are downloaded directly into csv files and combined and pre-processed through Rstudio.

3.2.1 Transaction Environment

Articles are obtained from online financial publications focusing on macro-economic conditions surrounding bitcoin. I searched for articles, papers and published books to gather related information, particularly on the following six topics, with a comparison point of view among different time periods as well as different countries.

Political considerations may limit cryptocurrencies' future development. Qualitative information is obtained on political restricts and countries' different attitudes towards BTC. As cryptocurrencies raise lots of attention on political perspectives, especially those of currency regulations and governmental control.

Economic factors are built into the price movement model, which brings big impacts. To analyze this, quantitative dataset has been prepared for industrial average returns in the U.S market. Share indices have been obtained during the time frame. GDP and GDP growth statistics are obtained. The bitcoin transaction's nature and environment in those places are also gathered for qualitative analysis.

Society influence is split into quantitative part of market sentiments and qualitative information of bitcoin existing and potential investors. In-depth interviews are conducted for this purpose with a specifically chosen focus group, detailed in 3.2.3.

Technological perspectives are what determine the nature and future development of bitcoin. With this regard, qualitative information is sorted under the topic of technology development that made cryptocurrency networks possible.

As of environmental, quantitative data is obtained from online open datasets that includes the energy footprint per transaction of BTC, VISA and Alipay to help determine whether bitcoin could be a potential transaction method. If so, this application could boost demand side and energy its upwards trend in price. At the same time, qualitative information will also be obtained regarding environmental considerations of mining bitcoins, which impacts its supply in the future.

Legally speaking, qualitative data is collected via the Internet on countries' bans for BTC transaction. Information is obtained from online directories so that researcher can analyze liquidity, security and legal environments of bitcoin.

3.2.2 Attitudes to market events

Previous research (Zhu et al. 2017) shows a strong factor influencing bitcoin's price of random events. To better quantify and illustrate the market's attitude to black swans happened in the market, especially that of investor and potential investors, quantitative data is collected to support quantitative analysis regarding market emotions represented by the heat of discussion online. Searching index is created to serve this purpose. Researcher obtained searching index from the most used search engine in China, Baidu, set the keyword 'Bitcoin'. Searching index is defined as how many times some word which contains the keyword is searched in the engine in a day. The daily index then form a time series and secondary information including news, reports, discussions during its peaks are collected and analyzed. Using word clouding and text analysis through coding, the attitudes reveal, which is compared with each other and with bitcoin price changes for correlations and observations.

3.2.3 Market emotions

Primary data collection

Interview will be conducted with a focus group of 25-45 year olds, working class with relatively stable disposable income streams and a good number of savings, with ability and

needs for investments into the financial market. They are identified as current or potential bitcoin investors, thus their investment choices and rationales, their perception of bitcoin, their knowledge level in crypto market and Fintech can tell the story of bitcoin's price change and indicate the future of bitcoin.

Researcher wants to try to understand the following questions during the interviews. First, what is the average knowledge level of cryptocurrency for these potential investors? Second, what is their perception on bitcoin or cryptocurrency investment? Third, to understand how do they make investment decisions.

Limitations are taken into account from different perspectives. First, investment decisions could be very private and interviewees might be reluctant to answer. To solve this, while asking for permission beforehand, researcher also needs to ask indirect question during the interview. Second, because there can be cognitive bias in this process, questions need to be tailored to particular individuals during the interviewing process. For example, to ask indicative questions regarding investment portfolio components and assess the proportion of stock to fixed income funds. However, as this is in-depth interviews, there will be inevitably a very small sample taken, in this case five persons with different ages and professions. This insufficient number interviewed will cause errors in results. Similarly, when researcher includes potential investors of bitcoin in the pool as well due to difficulty to find actual, current bitcoin investors, the difference between the two groups also causes systematic errors.

Hypothesis is that individual investors tend to make irrational investment decisions that are influenced by emotions, both individual and that in the market. Typically, loss avoidance and follow suits investment decisions.

Streamline

| Duration in minutes | Tasks | Outcome |
|---------------------|--|--|
| 2 | Introduction on the Topic and Interview explanation. | No outcome |
| 5 | Understand their investment portfolio, risk profile, investment decision-making strategy, investment in BTC and the percentage within their total portfolio if applicable. | Information on their investments + %BTC invested |
| 7 | Assess their knowledge level and emotions of cryptocurrencies; understand BTC's image to them. | Coding of labels + key words from association |
| 1 | Conclusion: other comments from the interviewee; and further explanation if applicable | Coding of labels |
| Total: 15 minutes | | |

Table 5: In-depth interview streamline

Chapter / Chapitre 3.3 Limitations

The data collected are majorly secondary datasets. I have noted that some of the data might not be consistent in nature. For example, the measurement of the price of bitcoin might be different, as its price varies every several seconds and some dataset uses the daily close, some uses daily average. But generally this is not a big range. Noted with this, we will take into the model only daily price change calculated from the above.

When considering macroeconomic conditions, researcher collected qualitative information from publications. However, some of the publications are not 100% neutral in their standings.

So there might be exaggerating cases or information that is not disclosed. Faced this this, we want to be as objective as possible when conducting the PESTEL analysis, and to make more comparison during different time periods rather than between countries.

As cryptocurrency investors compose a very small proportion of the investor population, I did not interview with all bitcoin investors. Some of them are potential investors that have similar risk profile as existing investors. And the sample size is very small. Therefore, it may not be representative to all bitcoin investors and potential investors. But we want to test, in a sense, in this sample what are the conclusions for our hypothesis, and to analyze whether the larger population will display a similar pattern or not through secondary data if applicable.

Chapter / Chapitre 3.4 Data Analysis Strategy

The analysis follows an internal logic flow. Qualitative and quantitative data are collected for every themes, and more data will be collected to answer subsequent questions deemed as needed during researches.

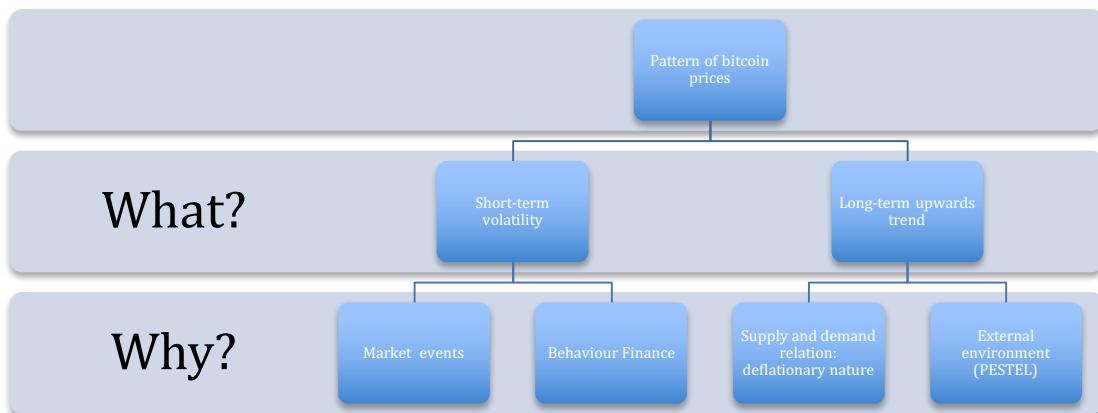


Table 6: Data analysis strategy matrix

To measure the significance on variables that may have an influence on bitcoin's prices, different strategies will be applied. For quantitative datasets, regressions and time-series are

made and visualized. For the determinants that are in nature qualitative, they will either be quantified using index and coding, or to be analyzed qualitatively to understand their influence upon bitcoin prices and practical implications in the future.

Chapter / Chapitre 3.5 Modeling

Considering the influence of macro-economic conditions, market's behaviour to random events, investor emotions and asset type influences, as of the time d1, where d0 is a previous timing :

$$Y(d1) = k1 * K(d1) + k2 * S(d0) + k3 * P(d1) + e$$

Macroeconomic conditions include all external factors that are fairly constant and shows a trend, represented by K. Investors' emotion level S, quantified by searching index, which is delayed by a certain period of time. P represents the price of other correlated asset types such as ETH. And e is the error in the model which considers random market events and other noises that do not show cycles or fixed patterns. This model is used in building time series regressions, and will be qualitatively reflected on in result parts.

Results

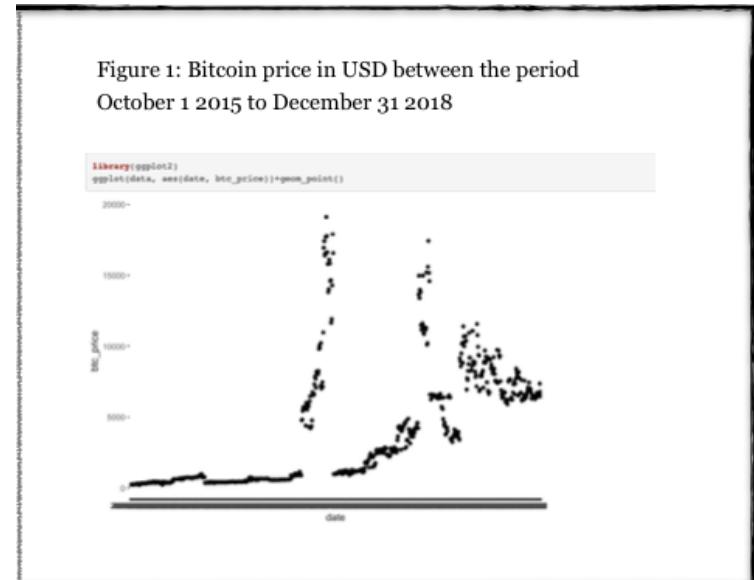
Chapter / Chapitre 4 Results

Chapter / Chapitre 4.1 Long term trend analysis

4.1.1 Quantitative analysis on returns

Figure 7: Bitcoin price in USD between the period October 2015 and December 2018

Figure 7 shows us an upwards trend in bitcoin with two peaks at the end of 2016 and 2017. This indicates a huge volatility in its prices. As bitcoin does not have official prices and only market equilibrium prices, its returns



are more subjective to liquidity. This price measurement is in line with results from Coindesk, bitcoin prices available online, which both shows great volatility as well as two peaks and crashes during 2017-2018. From this chart, we can observe that after one peaking time, the price would normally decrease to a similar level as before the price's drastic increase. The existence of a supporting level and the upwards trend both illustrate that the bubbles might be a direct result from extreme market emotions.

Time series include the trend, periodical noises and random noises. In this case, as volatility is our main subject of research, it is not appropriate to do a moving average to smooth the data as it affects the volatility. Two patterns of this chart attract the researcher's attention. First, if we remove the extreme values and noises, the price itself is going up as a general trend. As

we hypothesize that this might be a result of inflation, economic factors or bitcoin's cryptocurrency nature, the instinct implication of this will be further analyzed in later sessions. Second, concerning the noises themselves, there are clear random noises indicated by the scatter points that appear far from others and they do not show seasonal patterns. To determine whether the random noises are white noises or simply influenced by factors not in the current model, we will further analyze them in section 4.2.2.

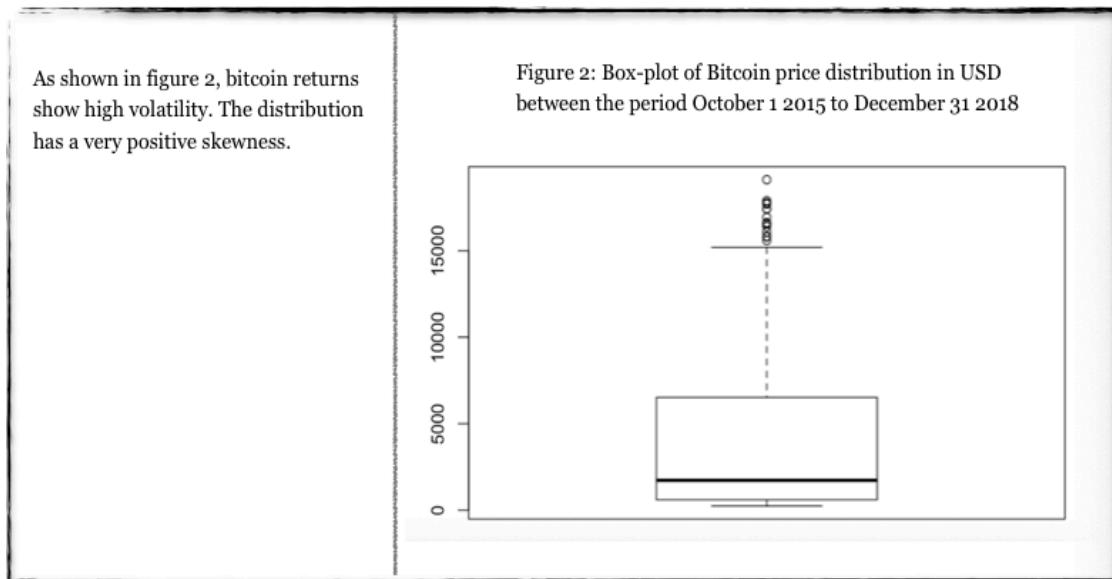


Figure 8: Boxplot of bitcoin price distribution between the period October 2015 and December 2018

The outliers are extreme values identified in bitcoin prices. The huge gap in the upper range illustrates that the market experienced more positive emotions, that has led to very high quotes during short periods of time. The noises are meaningful as they also evidence the huge volatility. We therefore establish hypothesis to evaluate the asset type of bitcoin.

Hypothesis I: Bitcoin returns is correlated with stock market.

Hypothesis II: Bitcoin returns is correlated with other cryptocurrencies.

```

model1 <- lm(vtc_return ~ usd_return * sp500_return, data= data)
summary(model1)

##
## Call:
## lm(formula = vtc_return ~ usd_return * sp500_return, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.192086 -0.017212 -0.000729  0.018029  0.247504
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)            0.004730  0.001644  2.878  0.00411 **
## usd_return           -0.163581  0.533325 -0.307  0.75913
## sp500_return          0.072803  0.206139  0.353  0.72405
## usd_return:sp500_return 62.380956 49.204580  1.268  0.20523
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04676 on 834 degrees of freedom
## (1 observation deleted due to missingness)
## Multiple R-squared:  0.002777, Adjusted R-squared:  -0.0008103
## F-statistic: 0.7741 on 3 and 834 DF, p-value: 0.5086

```

Figure 9: Linear model on bitcoin price with traditional asset class

The first regression model is built upon bitcoin, USD price and S&P 500 which represents the stock market average. It can be seen from the summary table that the results are all of no significance. During the period of October 2015 to December 2018, the returns of bitcoin is not significantly related to either the average stock market or economic inflation. What is more, any of the cryptocurrency types is not correlated with the stock market or US dollar returns which represent nominal economic growth. As the first hypothesis is rejected, another model is built to evaluate the second one. In addition, we can also conclude that the upwards trend of bitcoin is not a result for inflation as the two show no correlation and different patterns, and we establish an alternative hypothesis that this pattern is a result of bitcoin's nature from its supply-demand relations. The new hypothesis will be evaluated in section 4.1.2.

Figure 4: Linear Model on bitcoin returns with other cryptocurrency assets

The second regression model from the table in Figure 4 is built upon bitcoin, ETH and XRP which represents other cryptocurrencies in the market. The coefficients in this table safely establish significant relationships among all three of them. As BTC returns is not correlated with stock market but is with other cryptocurrencies, it is safe to conclude that cryptocurrencies are a separate asset class from traditional asset types(i.e., stocks, derivatives and normal currencies), and thus may display different patterns on returns.

```

model12 <- lm(vtc_return ~ eth_return * xrp_return, data= data)
summary(model12)

##
## Call:
## lm(formula = vtc_return ~ eth_return * xrp_return, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -0.155614 -0.018449  0.000031  0.016329  0.251498 
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)    
## (Intercept)            0.002532  0.001482  1.709  0.08787 .  
## eth_return             0.191063  0.017634 10.835 < 2e-16 ***
## xrp_return              0.106393  0.015294  6.957 7.04e-12 ***
## eth_return:xrp_return -0.518208  0.165813 -3.125 0.00184 ** 
## ---                     
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 
##
## Residual standard error: 0.04169 on 834 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.2073, Adjusted R-squared:  0.2044 
## F-statistic: 72.68 on 3 and 834 DF,  p-value: < 2.2e-16

```

Figure 10: Linear model on bitcoin returns with other cryptocurrency assets

The second regression model from the table in figure is built upon bitcoin, Ethereum (ETH) and Ripple (XRP) which are other major cryptocurrency types in the market. The coefficients in this table establish significant relationships among all three of them. Therefore, we accept the second hypothesis with a p-value of less than 0.0001. As bitcoin returns is not correlated with stock market but is correlated with other cryptocurrencies, it is safe to conclude that cryptocurrencies represent a separate asset class different from traditional asset types such as stocks, derivatives and normal currencies, and thus display different patterns.

As this is an unexpected outcome, secondary research is also conducted to confirm the outcomes. Research found that the result is in line with “Bitcoin is consistently the lowest correlated asset to other traditional asset classes,” in a research by Chris Burniske, blockchain analyst at ARK Investment Management, the first public fund manager to invest in Bitcoin, and co-author in the paper “Bitcoin: Ringing the Bell for a New Asset Class.” Retrieved January 31, 2017.

Noises in the model are automatically normalized and minimized in the regression models.

Within the regression combinations, we reach the last one with lowest F statistic and R-square, which gives us a model with significant contributors only. This shows a correlation between the prices of other cryptocurrencies and bitcoin with a minimal p-value.



Figure 11: 90-day correlation of S&P 500 and bitcoin daily returns. Source: datatrekresearch.com

However, as the market keeps evolving, many new aspects catch the attention of researcher. Regarding the correlation between cryptocurrency type and traditional class types, though it is proved with more than 99% confidence that they do not show significance in this research universe, the correlation changes over time. It seems that they do show correlation during some specific time range, especially during recessions and market black swan events. For example, during the recent coronavirus pandemic across the globe, bitcoin's price change has a correlation with the US stock market of 0.25-0.30. (The datatrek, 2020). It is intuitive sense that as during those times where market emotions play a more dominant part in asset prices, there will be a greater correlation between bitcoin and the stock market.

4.1.2 Qualitative Supply Analysis

To better understand the nature of cryptocurrencies as a separate asset, and to explain its price patterns, quantitative data analysis on secondary research is done to answer the question related to its supply.

Bitcoin has a fixed total amount of supply. (Shin, Laura, 2016). It can be obtained from transactions or from mining. Mining for bitcoin is effectively a competition of computing power of individuals. During the beginning phases of bitcoin, a normal laptop would do the work. A program will be run to solve a puzzle, and whoever is the first one to do that will get a certain amount of bitcoin from the miner. Thus puzzle is known as a hash, widely used for encrypting messages. Those old days didn't last for too long, when bitcoin has much less exposure to the general public, and its price was minimal. As more and more people are joining to mine for bitcoin, the difficulty level of the puzzles increased rapidly. In other words, the hashing got more and more complicated, with the hashes having more and more digits. Now, as the electricity and cooling fees composite the main costs of mining, pool mining is widely in use to maximize profits from mining. Big factories are built in China for example (AntPool.com, 2019), with minimum labor costs only for mining machine maintenance, getting the most from stronger, combined computing power to get more chance of winning the bitcoin for every puzzles. However, the reward goes down by half approximately every four years, and in the end, when it goes down to zero, transaction fees will be the only compensation. (Ritchie S. King et. al, 2013) As the cryptocurrency does not have underlying value, it does not have fundamentals and its price is solely dependent on what the buyers are willing to pay.

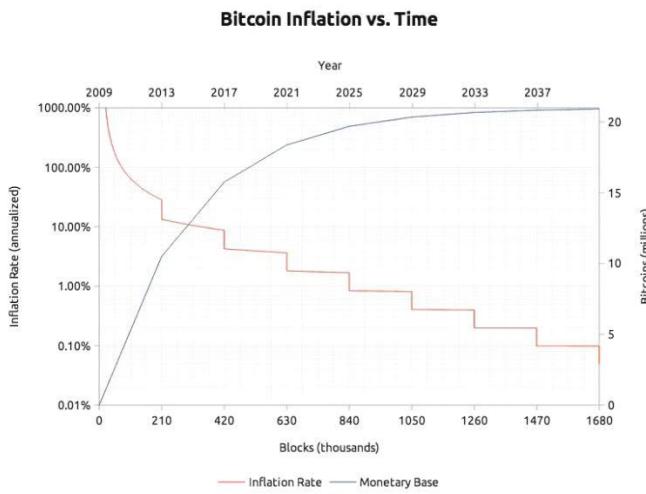


Figure 12: bitcoin inflation.

Source: www.buybitcoinworldwide.com/kb/investing-in-bitcoin/

This is a time-series visualization on bitcoin supply. We see the supply of bitcoin goes up and finally reaches an upper limit of 21 million. Inflation rate on the left side for bitcoin is defined as coin base * blocks / existing coin base. This means the loss of coins is the main factor, which happens more often towards the beginning of bitcoin's lifetime and is not significant during our studying universe starting from 2013. From the chart we can see a decreasing inflation rate of bitcoin. It implicates that in nature, bitcoin is designed to be deflationary with its fixed supply ceiling. As an amount of 18.13 million of bitcoin has already been mined (M. Szmigiera, 2020, Statista.com), bitcoin will naturally increase in value as it becomes increasingly rare in the circulation.

What is more, people tend to save rather than spend bitcoin when they process it. In fact, statistics estimate that 64% of bitcoins has not been transferred but kept in owner's digital wallet during the year 2018-2019. (William Suberg, 2019) In other words, only 36% of bitcoin maximum are actively in circulation, which is quite a small number. As the supply is decreasing, meaning bitcoin is likely to be more valuable in the future than now, processors

can exchange for more with their bitcoin in the future, so they tend to save them for future transactions. The large holding positions in turn make bitcoin even more deflational.

From there, we conclude that although supply plays a minor part in its volatility, it affects the price pattern of bitcoin. The deflationary nature and supply and demand relations provide its return with a bullish potential, and they also explain the long term trend that is gradually going upwards.

4.1.3 Macro Transaction Environment

PESTEL analysis is utilized to provide a macro-level vision of bitcoin's transactional environment. First of all, politically, many argue that central governments and central banks should have full control to its currencies, therefore providing appropriate macroeconomic controls such as effective monetary policies. This will be a constraint of bitcoin and therefore restricting its future potential. Nevertheless, as an asset, the return of bitcoin is not going to be affected significantly by issuance of governmental controlled digital currencies. But the political influence is surely a factor to consider, and a new trend is appearing.

On June 18, 2019, Facebook announced the launch of the digital currency Libra, which caused the central bank of many countries to be vigilant and became an important turning point in the central bank's digital currency practice exploration towards cryptocurrencies. (Libra.org, 2020) Countries are wary of Libra on the one hand because Libra's positioning is a super-sovereign digital currency. If it is successfully implemented, the Libra Association may assume the responsibility of central banks to some extent. This will cast doubts upon currency sovereignty for any country. Another deeper reason comes from Libra's future layout.

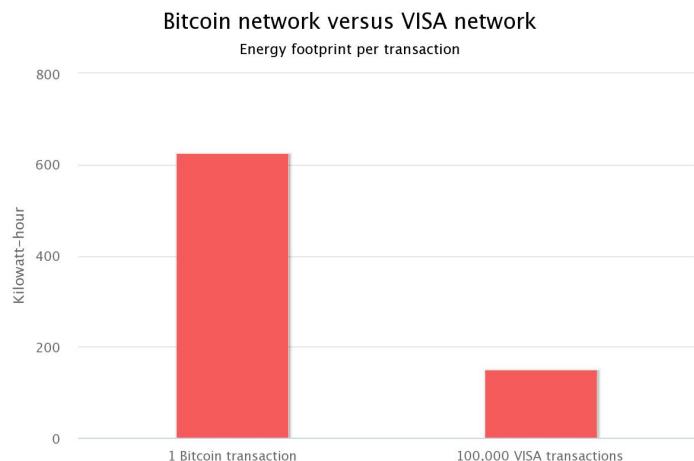
Different from bitcoin which is decentralized, there is a huge business cooperation system behind Libra. The leading company behind it covers nearly 2.7 billion users and 168 countries around the world. Such a large coverage area and potential mobilization ability, will cast greater resistance to the future promotion of digital currencies in various countries.

On one hand, the increasing number of cryptocurrencies make bitcoin a more understandable asset in the market. On the other, questions upon national currency sovereignty keeps affecting its legality, and thereby impacting bitcoin transactions and liquidity.

Figure 13: bitcoin network versus VISA network

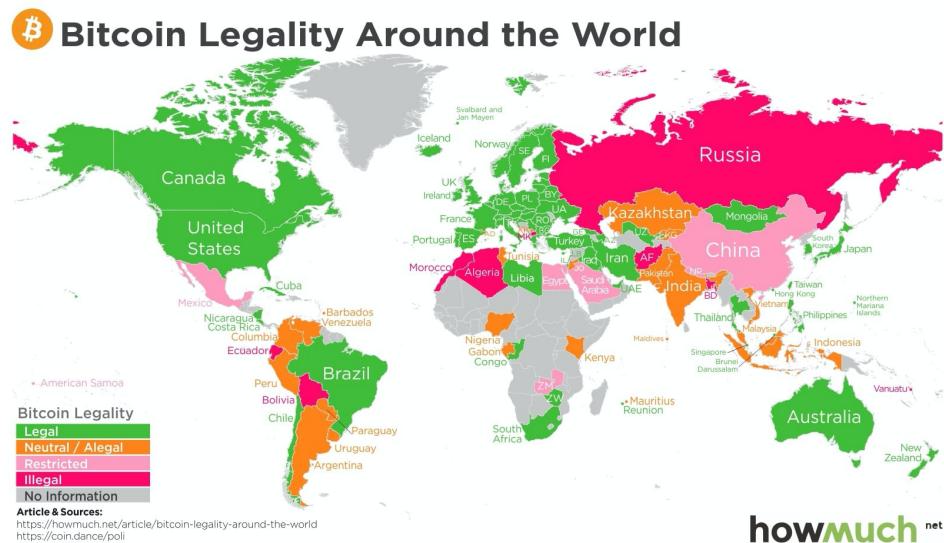
Environmentally, I compared per transaction energy cost in bar charts in figure 13. A clear discrepancy is shown between VISA and bitcoin in terms of energy use every transaction.

This implicates that as a transaction method, Bitcoin is not very environmental friendly and might be costlier. This is one of its constraints in future.



From a legal perspective, secondary data indicate a trend in increasing legal constraints in bitcoin transactions.

Figure 14: Ban of bitcoin map



Source: <https://www.valuewalk.com/2018/01/bitcoins-illegal-russia/>

Figure 14 shows that strict legal regulations are in place for bitcoin transactions in many parts of the world as of January 2018. For those countries in green color, and there are approximately 111 of them bitcoin transaction and purchases can be legally conducted. Among the top 20 countries that bitcoin transactions happen most frequent, three of them are not completely legal, which are Indonesia, Nigeria and Vietnam. (Coin Dance, 2019) This shows that there are many restrictions to bitcoin liquidity, and therefore, its price. This is in line with literature records that January 2019, after China's ban on ICO, the price of bitcoin decreased by 5%. However, this influence might be limited, as there are still transactions happening in places where bitcoin is not allowed due to its virtual nature.

In April 2020, Chinese government started its cryptocurrency scheme, Central Bank Digital Currency (CBDC), and put its real-life testing into practice. The currency will also be encrypted and designed to support real-time, offline transactions. (Phoenix New Media, 2020) In the future, alternative cryptocurrencies that are controlled by central government might be a choice to make for those countries that introduced a ban on bitcoin, to benefit from the

payment technology. The difference, however, remains that neither a decentralized structure or mining costs, that is, costs for obtaining the currency will not be in place for those alternatives. As these currencies are in nature a replacement for physical currencies, they will not be an asset class and will not be affecting bitcoin market. However, regarding the low entry barrier for creating cryptocurrencies, these initial coin offerings might occur much more frequently in the future, which might negatively impact bitcoin prices in the market.

There is a positive trend in the social perspective of bitcoin, which is detailed in the section 4.2.1 below.

From a technology perspective, cryptography plays a key role in the issuance and circulation of the entire digital currency market. Cryptography is one of the foundations of cryptocurrencies' research and development. According to the existing technology, bitcoin is mined through many trials using huge computing power to comply with specific rules. Technically, the one that first solved the puzzle, that is, the one has the most computing power, gets the right to write the block. During each transaction, similarly, editions will be made and posted on the blockchain to form a smart contract. This will allow truthful, unchangeable information to be recorded. Furthermore, the transaction costs have been decreasing as the technology matures, and it uses a market-based flat fee structure, depending on the amount a miner wishes to pay to mine the bitcoins. It is now about 0.75\$ (Bitcoin course online by Jbaczuk, 2018), which makes any transactions above 75\$ cheaper to make via bitcoin networks.

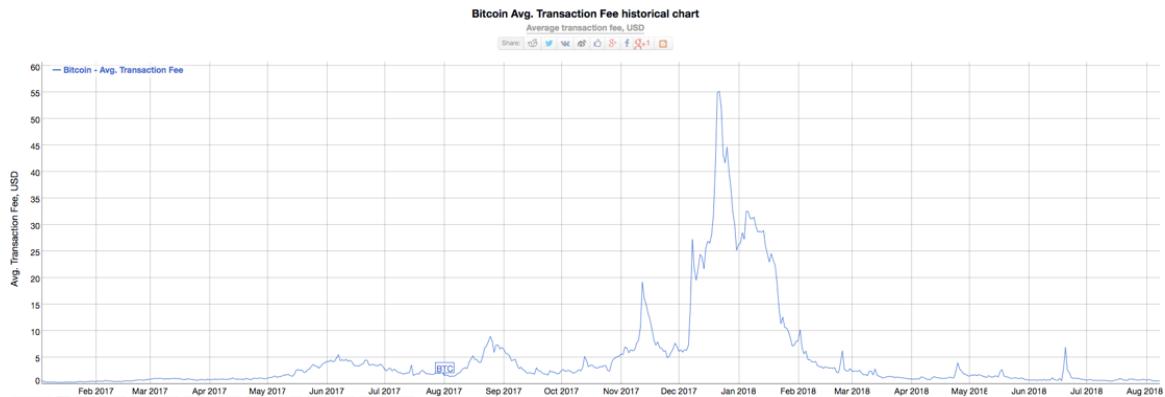


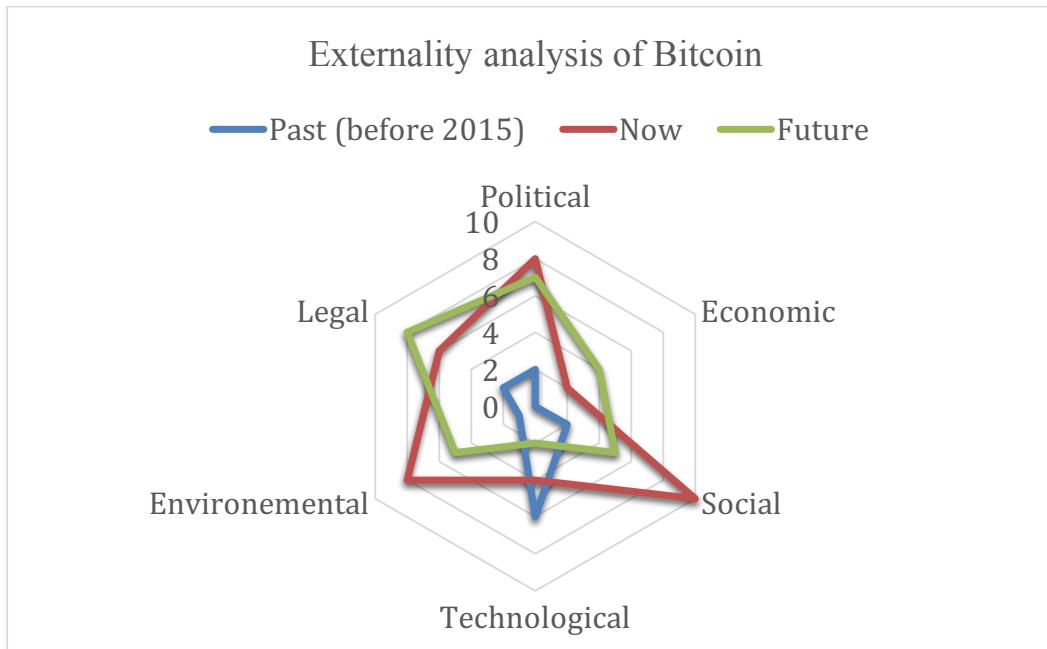
Figure 15: Bitcoin average transaction fee historical chart. Source: Blockchain.com (2020 blockchain Luxembourg S.A)

Viral effect describes a phenomenon that the usage of a service or product can have huge influence on non-users that are in contact with existing customer base, and therefore the user base tends to increase quite rapidly. This is the case with almost all social network services due to the nature of interaction between people, where organic growth can be expected so long as first loyal user base is established. Payment networks share similar natures. If in the future, political and technology environment allows the usage of bitcoin to be a method of payment, increasing merchants will start to accept it, and customers will use it because of the cheaper transaction costs and environmental benefits.

This provides opportunities for bitcoin as a payment method in the future. If the crypto payment network keeps evolving and expanding in the future, the increase in demand is likely to push up bitcoin's price and lowering its volatility.

To conclude, the macro environment for bitcoin development and transaction changes rapidly, and it contributes to the volatility of the price of bitcoin. The radar chart below summarizes the impact as well as the trend by measuring the pressure coming from the outside. Macro

environmental constraints are measured on a scale of 10, to demonstrate the potential power range of bitcoin represented by the area in the middle within the lines.



Radar chart 16: Externality analysis of bitcoin

In the past, when bitcoin first made its appearance, less social attention was attracted. Government regulations were weak, and technology was also just starting. Environmental impact was also weak as mining costs were quite low. Bitcoin topics were very rare among the public. This scenario was altered after 2015 and especially during 2017-2018, when the price of bitcoin raise sharply that more people began to be curious about it or see it as a speculative tool. Heated discussion of blockchain technology and paymenttech as well as their future implications were brought to the public. Mining costs sharply increased such that only pool mining became profitable, which created big energy costs and environmental effects. Extreme social emotions led to the volatility of bitcoin returns. In the meantime, although bitcoin is not correlated with the economic growth, the economic influence is still present when emotions dominate the investment market. Legal and political constraints became higher, as some security issues such as theft of bitcoin and illegal activities being spotted related to bitcoin transactions. In the future, however, technology development such as

improved method of hashing is likely to minimize unnecessary environmental costs. Political and legal aspects will surely improve. As market generally becomes more familiar and educated about this topic, investors could become more rational, therefore decreasing social and economic pressure to bitcoin.

Chapter / Chapitre 4.2 Short term volatility Analysis

4.2.1 Market Attitudes

From the bitcoin returns time series, it is found that although white noises and seasonal patterns are neglectable, there should be an explanation for the huge volatility appeared among very short period of times. Therefore, we assume that market attitude caused by random events is the main reason. To evaluate the hypothesis of whether market attitudes are correlated with bitcoin market price, Baidu Index is introduced to measure the level of discussion among the general public.

Baidu search index is a dataset organized by Baidu, the most used search engine in China, on the number of posts and searches each day for a certain keyword. As we call for ‘bitcoin’ as our keyword, the Baidu index measures how many times the word ‘bitcoin’ appeared in searches on Baidu. From figure 8 and figure 9 we can see certain events trigger peaks of searching bitcoin, most of them being major price changes, heated discussion on the technology or security related to cryptocurrency, each representing significant emotion change in the population to bitcoin (Baidu.com). Figure 6 also illustrates bitcoin’s increase of popularity since year 2017, where its price went up the most, and before this it has not been very popular except for the discussion on its volatility initially in 2013. The trend is relatively

stable with a gently decreasing popularity, implicating investors have become more rational and used to this new type of asset. Meanwhile, this also implicates that emotions were more or less driven by price changes, and market events have a major impact on emotions. As indicated in t-test, $p=0.05$ conducted, Baidu Search Index is significantly related to bitcoin prices.

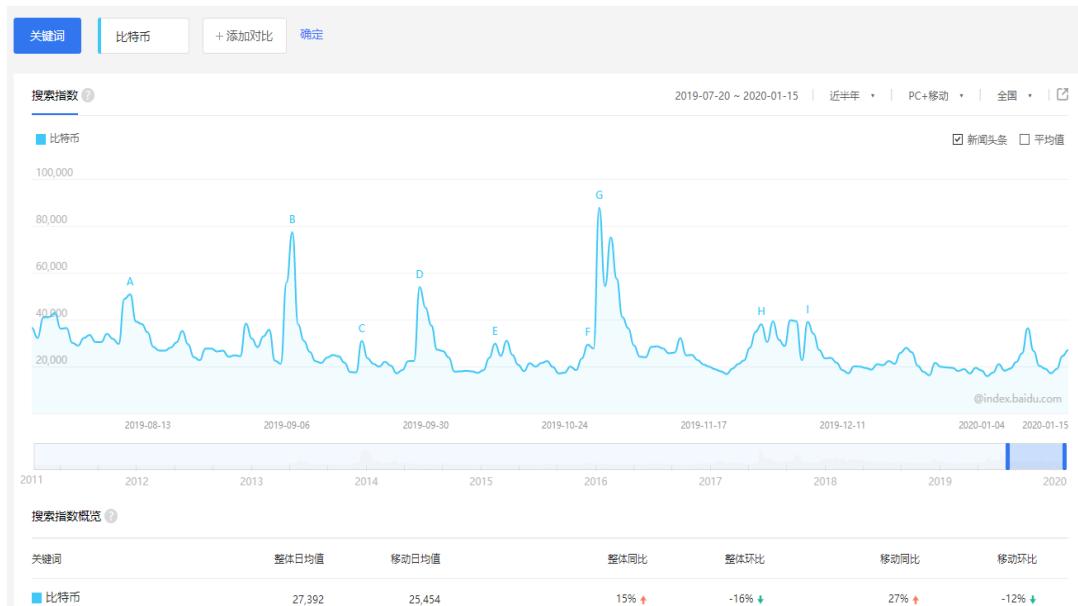


Figure 17: Baidu Search Index from 2019 to present.

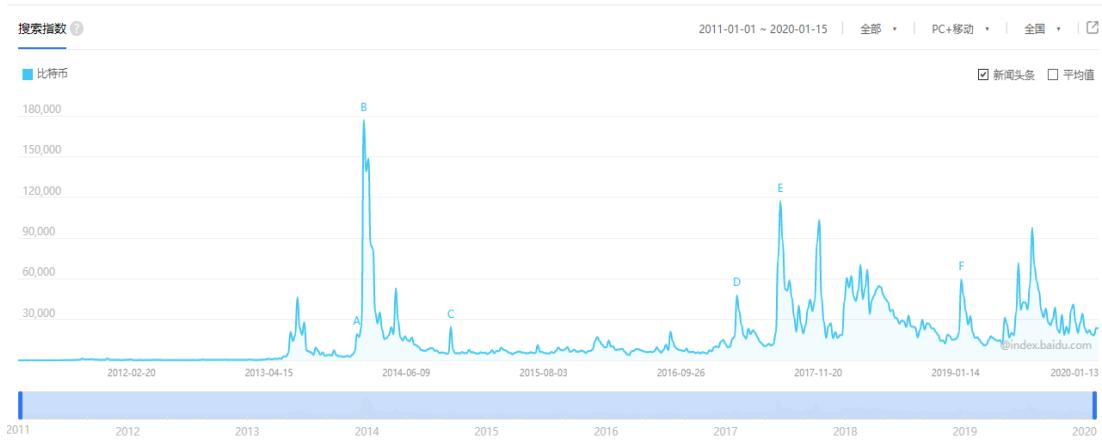


Figure 18: Baidu Search Index for 'Bitcoin' from 2012 to 2020. Source: Baidu.com We discuss our study universe which is 2015 until 2019.

There, we check public activity of bitcoin related posts and count of queries on Baidu. An unusual high interaction rate results in a grown public interest in the coin and in our eyes, corresponds to a greedy market behavior.

When we look at bitcoin price's volatility, the conditions set by its nature and macro environment which are different from traditional asset types do contribute. However, these alone cannot explain its extreme roller coaster side, in particular during 2017-2019. The media index research above explains market emotions, which to some extent implicate investors' rational levels. From this research, we found a clear correlation between index volatility and bitcoin returns volatility, as well as a strong pattern of special event's occurrence and bitcoin's daily price change. Therefore, market emotion plays an important role when it comes to bitcoin's volatility, especially during extreme peaks and crashes. In fact, market emotion is the cause and result of great price volatility of bitcoin at the same time, and the two factors correlate with each other. As bitcoin return represents the first derivative of bitcoin price (from definition (1)), it means when return is higher than average, there is a tendency that market is more greedy than fearful, and that bitcoin is priced above normal level.

4.2.2 Behavioural economics on investment decisions

Apart from the market attitudes that describe the general sentiments in the market, it is the sentiments and decision taking processes of investors that directly impacted an asset's price. As is the case for bitcoin, without underlying or fundamentals, the demand of it determines its price and thereby determining the returns. To further understand the profiles and motivation of investor and potential investors of bitcoin, in-depth interview on a focus group is conducted. Data is collected and analyzed, with findings summarized as in table 10.

Figure 10: In-depth interview Result Summary

| | | Qualitative Interview | | | |
|---|---------------|--|---|--|---|
| Coding | | A, 25, student | B, 38, entrepreneur | C, 48, manager in corporation | D, 30, employee in finance industry |
| Image | Quotes | "I lost so much from my BTC investments and I don't think I would want to do that again..." "I think bitcoin is a relatively stable asset compared to other cryptocurrencies." | "Bitcoin investment is so popular among my friends. Fintech is a heated arena of discussion nowadays and I would like to dig more into it. I think it is a great business opportunity." "[Bitcoin is] riskier than derivatives, but I'm willing to make it part of my portfolio and it brings topics among my friends." | "[bitcoin is] a mysterious currency that goes up and down like crazy. It is very risky. As the older generation I have less knowledge on this newly established thing, however, I am sure it has great potential in the future. We can expect further applications with similar technology. I also heard that many international criminal transactions favor using BTC as it is less transparent to government regulations." | "[it reminds me of] blockchain. [As a] crypto currency, it has high volatility, [and is] a good choice for reckless and opportunistic investors. Personally I am relatively risk adverse so I have not been an investor to any cryptocurrencies." |
| | Positive | stable | opportunity, popular | potential | technology |
| | Negative | huge potential loss | risky | risky, criminal | volatility |
| Emotions (scale of five, 1 being fear and 5 being confidence) | Overall Image | 3 | 4 | 2 | 2 |
| Motivation | | Speculation | | N/A | N/A |
| | | | Follow-suit | N/A | N/A |
| Investment% as of whole portfolio | | 30%-80%, average 50% | 8%-20%, average 10% | Not an investor | Not an investor |
| Knowledge (scale of five) | | 1 | 2 | 1 | 4 |

Figure 19: In-depth interview coding

| | Investors | Non-investors |
|--|-----------|---------------|
| Average level of knowledge of bitcoin (scale of five, 5 being having proficient knowledge and 1 being minor understanding) | 1.5 | 2.5 |

Table 20: average knowledge level for investors and non-investors

Among the limited sample in the interview, non-investors tend to have higher knowledge level than current bitcoin investors. One possible explanation might be that people with background in finance and investments tend to be more familiar with bitcoins, but they are also the group that understand alternative investments. Therefore, this group may have wider range of investment options to choose from. This group may be more cautious on their risk

profiles and risk management, and they are less likely to invest out of sudden impulse or to follow-suit. Having wider access to the market and with professional judgements, many don't choose to invest in bitcoin. On the contrary, people with investment needs but don't really understand bitcoin can be easily influenced by market emotions, rumors or speculative motivation, regardless of their risk profiles or understanding of finance knowledges.

While potential investors in the market seem to be more concerned about the risks associated with bitcoin investment now, previously, different key words have caught the attention of investors. From secondary data, using word clouding, we can see what the most heated topics are on public bitcoin forums.

As of 2015, the market was relatively stable and not overheated. People were more interested in its technology prospect. The bitcoin wallet concept was quite new and appealing at the time, and the first bitcoin forum builder Satoshi was also popular among searches.

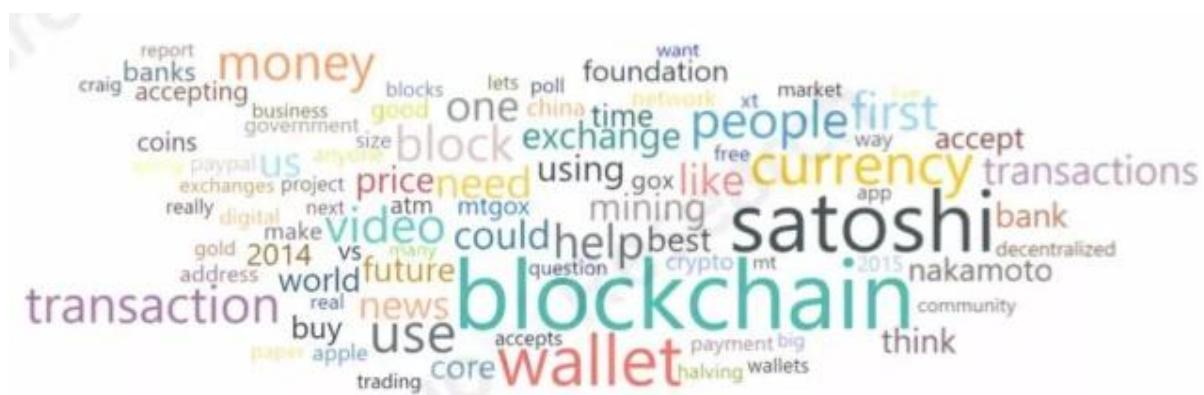


Figure 21: Word clouding in forums of bitcoin, 2015

Year 2017 witnessed a major increase in price of bitcoin. In that year ‘price’ was cared about. People were trying to understand the technology and nature of bitcoin, heated discussion have

been on crypto, transactions, blockchain, hoping to understand the nature of bitcoin. In that year, fork becomes a new thing, as bitcoin spread into different rules, new perspectives have been brought in which aroused another round of discussion on its future in security and speculation.



Figure 22: Word clouding in forums of bitcoin, 2017. Figure 11 and 12 Source:

<https://baijiahao.baidu.com>

Figure 23: Word clouding, as of interview 2020

Next, researcher made a word clouding image from the coding from in-depth interviews that were conducted for this research as in Figure 23 on the right. Words that are mentioned more by interviewees are volatile, potential, risky, opportunity and negativity towards bitcoin.



potential, risky, opportunity and technology, which indicates a balanced positivity and negativity towards bitcoin.

Apparently, the word clouding in figure 23 shows more of the attitudes among potential investors, who have relatively limited knowledge and resources towards bitcoin. They are more sensitive of its price change, more aware of their portfolio, as well as the potential or risks of their investment. However, in ‘Read through inflation and deflation of bitcoin in one article’ by Mars Financial, attitudes towards bitcoin were more focused on technology discussions of new concepts. The discrepancy is because of the difference in text samples. From interviews I want to understand people’s perception of bitcoin investment, whereas the texts from online articles and forums are more discussion among an informed audience of blockchain technology and want to investigate into crypto. While not in line with the literature, my word clouding still can implicate a trend herniated from the previous market attitude evolution, which went from curiosity and speculation purpose to more serious discussion in its nature, comparison between risks and opportunity, with a view from potential investors.

As investors’ emotions play an important role when it comes to bitcoin’s volatility, we want to further analyze investors’ perceptions and heated topics around bitcoin in different years. From the above literature and interviews, we can conclude that market is evolving from a volatile and speculative one to a more technology-based, rational one. Thus, the volatility evolving from market emotions is likely to decrease in the years to come.

Chapter / Chapitre 4.3 Conclusions

In this research, we find that bitcoin is significantly correlated with other cryptocurrencies such as ETH, XRP, but does not show significant correlation with any existing type of assets including USD and gold. As a result, we conclude that bitcoin in nature a separate asset class, that is, cryptocurrency. This asset type is in nature very volatile.

We conclude that transaction environment has an impact on bitcoin's prices, usages and its future in particular. Legal restrictions can impact bitcoin price negatively instantly, therefore contributing to its short-term volatility. We also studied environmental concerns that might be its shortcomings, involving possible risks and obstacles of its development in the future.

Bitcoin's supply does not directly cause its volatility, to the contrary, it might be market emotions that caused its great volatility. As speculation, follow-suit attitudes identified in investors of bitcoin, we can see irrational actions among those with less knowledge in crypto crushing into the market, thus causing the huge ups and downs in the market, especially during 2016-2019. Behavior finance plays a significant role in bitcoin's price change.

In commodity markets, price volatility is influenced by the relative positions of supply and demand, as well as the basis that represents the costs of transportation, storage, quality differences and the convenience yield, which is the uncertainty on physical supplies. In a similar sense, bitcoin price volatility also depends on its supply and demand balances.

Bitcoin is a quite volatile asset type in nature. Created using block chain technologies, it is a decentralized currency which is faced with political pressures, legal constraints as well as market emotions everyday. As the demand and supply of it is not controlled by any monetary policies, the returns are directly impacted by random market events, investors' emotions, all of which fluctuate a lot in real life.

All in all, five aspects were taken into account when discussing the volatility of bitcoin. The first problematic is its asset type. From the time series, long-term trend and short-term volatility becomes the major observations.

Discussion

Chapter / Chapitre 5 Discussion

Chapter / Chapitre 5.1 Implications for practice

5.1.1 For investors

It is worth noticing that either bitcoin investment or mining is highly risky investment options, and that most of the investors and potential investors do not have a thorough comprehension of bitcoin's nature, price change possibility or analysis into this asset type. More often than not, market emotions play a more important role in decision-making strategies in bitcoin. As the technology is more matured, secured, and continuously established and known to all, as well as the diminishing supply and more rational demand, bitcoin market is supposed to have lower expect values and more stability in its prices. Faced with this, investors should gain more knowledge in bitcoin, to correctly judge its risks and opportunities to fit one's risk profile. It is also recommended that a balanced portfolio is

determined to spread over all types of assets, considering bitcoin as an uncollated one with traditional asset types, and rationally manage the portfolio according to one's risk appetite and financial capacity.

The lack of correlation between traditional asset types as well as its increasing significance prove that when it comes to the returns of bitcoin, market emotion is indeed an important factor. People tend to get greedy when the market is rising, as it will be the times when general fear of missing out opportunities arouse in the market. To the contrary, people often sell their coins in irrational reaction when they witness prices' breaking down, as naturally they fear that a further decreasing in prices will arrive. With regard to behavior finance, it is common practice for investors to catch market emotions and use it to guide their investments:

- Extreme fear may be a sign that investors are too worried which could be an opportunity to enter into the market.
- When some words are increasingly popular and heatedly debated, and when investors getting greedy, there are bubbles in the market and it might be due for a downwards correction.
- In general, when market discussion and popularity rises to its peak, price and returns are likely to reach its breaking point.

5.1.2 For institutions

The future for this technology is still unknown but indeed has huge potential. From the analysis, we see how supply and demand of the crypto asset type involve noticeable volatility. While government regulations, environmental considerations and market emotions are all influencing the price change of bitcoin, it seems to still be a popular mean of transaction

among many sellers. Users say they have not found the volatility or liquidity as a major issue to it, and so we wonder what the future of crypto would be.

Faced with a more rational market with this naturally volatile asset, institutional investors need to be more aware with the shortcomings that might bring. Institutions should shoulder the responsibility of prevent and not involve in possible collusion, illegal behaviors and lack of security in bitcoin transactions. With this regard, strict internal control measures need to be in place to manage the high risk associated. Social responsibility for institutions involved in cryptocurrency market, blockchain technology investment as well as industries dependent on relevant technology should be aware of the risks. Considering market emotions and behavior investing, it is also advised for them to educate investors with more crypto knowledges and help them with informed investment decisions, rather than impulsive gambling for profits. Furthermore, as bitcoin returns are largely dependent on investor expectation and perceptions rather than fundamentals, institutional investors need to study market emotions and momentums such as emotion index, in order to better predict the market.

Based on three unique technical approaches to digital currency, three themes in investment of digital currency reveal. First, the two-tier operating structure is expected to spur new demand for IT systems from banks. As part of the decentralized structure, a commercial bank is not enough to complete and maintain the operation of this system (Guotai Junan Securities, 2019). As the crypto eco system keeps evolving, professional IT service providers will be required to build a huge and stable system, which is a challenge as well as opportunities for IT service providers at the same time. Relevant IT service innovators and cryptography applications might be the new boosting sectors in the future. Commercial banks and central banks are expected to lead and promote this transformation, so the cross-discipline arenas will be their

growth opportunities. Secondly, there may be a new demand for updated equipments in all payment scenarios in the society. Following the paymenttech enabled by cryptocurrencies, not necessarily bitcoin but other types that might be more liquid, the dual offline function is expected to grow. Most of the existing client machines, such as POS machines and ATM machines, do not meet the needs of digital currency systems. There is a greater risk of incompatibility of systems and machines, and a greater demand for updating the equipments. Huge market for equipments exists in the future as the paymenttech keeps evolving. Wallet service and payment service providers are expected to benefit from the transformation. The third is the demand for key-related technology research and development. According to the patents applied by the Central Bank's Monetary Research Institute, the patents for the process of digital currency release, circulation, and return all involve the key part, and listed companies related to security encryption and KYC certification will benefit from these further developments.

5.1.3 For management

As blockchain technology is becoming increasingly relevant to finances and tactic innovation of business operations nowadays, management and leaders of corporations may want to gain knowledge in digitalization and Fintech arenas to be the pioneers in business activities. Though bitcoin is not suitable for risk hedging or business transactions for now, in the future related technology and other cryptos might be. For example, blockchain is used a lot in project management, where information can be updated by everyone and shared within the team timely and accurately. In data management functions, blockchain technology is used to maintain cross sector data and their security. In complex companies with a matrix structure, especially those international companies with different functional sectors, data management becomes critical. It is with trusted, real time updated, cross referenced data that a company's

digital transformation and integrated business analytics can happen. It is also with the developed technology such as blockchain that new competitive advantages can be created. Cryptography, on the other hand, will be a new challenge for many companies using clients' data, or have to store and share internal datasets. The fierce market competition nowadays results in rapidly-changing, real time big data. An effective data structure is thus critical for them to be utilized. To protect these business secrets and to enable authorized sharing and transfers, established data frameworks are required. Evolving new technologies need to be applied to improve security and support organizational digital development. That is why top management and leaders should be focusing more on blockchain technologies in the future.

Chapter / Chapitre 5.2 Limitations

A model was built to analyze the volatility of bitcoin, that is, to find out significant variables, categorize them into supply and demand sides and analyze their level of significance respectively. However, there is an inherit limitation in this empirical approach, that many other factors might be influencing bitcoin's returns. The factors researched and analyzed under the model therefore might not be completely comprehensive to tell bitcoin returns. What is more, there is huge volatility and uncertainty even for these factors themselves, for instance, investor attitudes, market event and political environment in particular. As the independent variables are unknown, the depend variable which is bitcoin's volatility in this case, becomes difficult to quantitatively predict. Researcher therefore can only suggest on future trends and practical implications based on this model and the historical data.

Besides the inherit deficiencies of the research methodologies, there are limitations involved in data analysis phrase. Firstly, in the interviews there are insufficient participators to generalize a persuasive pattern for all bitcoin investors and potential investors in the future,

because every market participant can only have a say for themselves and does not necessarily represent the whole population. Secondly, past data is not representative of future data, thus even if progressions and correlation tests are conducted, the models are all based on historical circumstances and may not tell the stories of the future.

Many assumptions are made in the processes of data analysis. Returns are calculated by taking daily average quotes, volatility are used by comparing daily quote with month averages, and the coding of surveys also introduce subjectivity into the analysis. All of these have potential limitations as the results will be based on the assumptions that the analysis could truthfully disclose the properties of our dataset. However, the secondary research results are not fully objective and trustworthy, and the methodologies on interview coding is dependent on researcher to make their own judgements.

Chapter / Chapitre 5.3 Reflections

Surprising outcomes include multiple prospects. When researcher first conducted an asset class test, they didn't expect such strong correlation of cryptocurrencies as a group and very insignificant links between them and other asset classes. With an interest in whether the price of bitcoin is related to other asset types so as to determine the causes of volatility, regressions and statistical tests are conducted. It was after those surprising outcome that relevant literature was introduced to prove the phenomenon. Second, in investor attitudes, before the personal interviews, researcher has not expected that the overall image of bitcoin would turn out to be more positive than negative (an average rating of 2.75 out of 5). From the coding we can see that the development of the technology seems to be playing a part, as people get more comfortable with them as well as optimistic about its potential. This is quite different from the market emotions in general in 2015 or 2017, and quite unexpected from the online text

research that was found among more informed market researchers. There are also many comments that researcher didn't expect at all, such as 'stable' or 'dangerous', which indicates a broader spread of image links the public may have towards bitcoin. These impressions are all codes, scaled and analyzed in the in-depth interview section, and recommendations are made based on the codes.

Conclusion

Chapter / Chapitre 6 Conclusion

6.1 Research questions and objectives

The research aimed at solving the myth of the roller coaster level of returns of bitcoin. It started from a look at bitcoin price change patterns from 2015 to 2019, discover its trend as well as its correlation with other asset types. As both literature and regression on primary dataset implicate a general lack of correlation between bitcoin price and traditional asset types, focus is on bitcoin's special nature.

From there, we discuss bitcoin's supply and demand sides and their influences on the returns. At the same time, secondary data illustrate a significant correlation of the two during those times when there is a special event in the market. From there, market emotion and public attitudes are taken a closer look at to explain the volatility. Macro transactional environments of bitcoin is analyzed with the PESTEL model with both historical and forward looking point of view.

Research objectives on reasons of bitcoin prices' volatility and its implications are met. The problematic is divided into different categories that are linked to one another, and they are analyzed using both primary and secondary data to reveal a conclusion. The sub-conclusions also lead to new problematics and therefore link the conclusions together.

6.2 Main findings

The research concludes that volatility of bitcoin derives from its nature as a cryptocurrency, with no significant influence from stock market. The reasons include macro-environment like legislative and technological factors, supply nature which is not inflationary, and especially market sentiments among investors.

6.3 Recommendations

There are two types of existing investors of bitcoin. Some invest in the long term, hoping to leverage upon the technology development of digital tokens. Others try to speculate on this highly volatile asset, making their purchases and sells within short periods of time. For the first group, investors are recommended to diversify their portfolio and keep the percentage of bitcoin to a level that correspond to their risk profile. They might want to monitor their digital wallet and pay close attention to externalities, such as security issues, new legislations and developing technology for transactions. For instance, Binance has experienced large scale bitcoin theft during a data breach, where hackers succeeded in passing the security test and stole more than forty million dollars from the digital wallet account. (Binance cryptocurrency exchange, 2019) Whether safely choose a transactional platform or enhance systematic safety checks, investors for the long run want to keep their private key for future usages. For the second type of investors, they are recommended to reassess their risk tolerance and appetite in order to determine the appropriateness of their investment. While historical data such as buy-in price can be a consideration, it is not as important as future aspects as the market is evolving at a rapid pace. It might be worthwhile to reconsider on their investment objectives and motivation of investing in bitcoin. As the market matures, speculative opportunities diminish, and as peaking times passed, market sentiments will tend to be milder. So they may wish to reflect on their portfolio management considering the market changes and risks.

For potential investors, choices need to be based on thorough considerations. People with investment needs should reflect on their knowledge level on cryptocurrency types and consult professionals for suggestions where applicable. As is shown in the interview, investors that have less financial background and just follow suits tend to overestimate the potential benefits brought by bitcoin investment. Bitcoin's low correlation with stock market or traditional asset types can be a good opportunity to take, as it avoids uncertainties of future economic growth and is thus a unique hedge.

Its nature of anti inflation provide those that have lose confidence in their central banks an alternative to store their wealth. As the market is becoming more and more rational and extreme peaks like in 2017 is expected to be rare in the future, long term bitcoin portfolio holding might be more favorable. Investors can diversify their portfolio by start to invest a very low percentage in bitcoin as an experimental move.

Most of financial service institutions don't have bitcoin or any other type of cryptocurrencies in their portfolio. While this might be an appropriate choice for the majority of investors, they are still recommended to pay close attention to the evolution of bitcoin and its dominance among all cryptocurrencies.

6.4 Conclusion of research processes

The aggregated model was designed to predict bitcoin prices and returns in the future. Consisting of all variables that are deemed as significant, the model would draw upon predictions of previous market emotions and macro-economic conditions to determine the future trend of bitcoin. However, either factor among macro economic conditions, or market emotion is hard to predict, and they do not necessarily follow the pattern of time series from past data. This makes future coin prices remain mysterious. So this research could only discuss the reasons and the trend. However, with established predictions on these factors, like the level of dominance of bitcoin among all cryptocurrencies and possible legal and political pressures, the correlation between these factors can be told (i.e., k1, k2 and k3 respectively in the model). Providing all significant variables can be reasonably predicted, with the established model, predictions can be made for bitcoin price. Considering all the uncertainties and unpredictable variables, a complete empirical model for prediction is difficult to build. Yet correlations can be summed up to conclude on the trends of bitcoin prices and its implications, which is presented in this research.

6.5 Future directions

A good extension of the pricing model is to establish scientific methods on predictions of the independent variables, such as economic prosperity, investor confidence level and dominance of bitcoin among cryptocurrencies for quantitative price predictions. The methods to quantify the qualitative information and to consider them into the model are also worth discussing. For example, to measure market emotions, researcher can conduct sensitivity analysis on the weights allocated to each variable in the index and to confirm its accuracy by comparing the index with codes from in-depth interviews.

A second thought on return prediction is to create a dummy variable of price change, 0 being negative and 1 being positive change in bitcoin prices. The model can therefore be trained to predict the dummy variable (response type) using machine learning considering all applicable variables. Test and train models will both use historical data that are deseasonalized. This is likely to increase accuracy and lower uncertainties and noises due to the defined scale, and thereby presenting a predictive method for bitcoin returns in the short run.

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Word clouding tools available at <https://www.wordclouds.com/>

Appendix / Annexes

R codes for regression models

Chihyen Chen

2/23/2019

Use Excel formula to do the daily returns

Read the data with both prices and returns

```
data <- read.csv("assetprice.csv")

summary(data)

##          date      sp500_price      usd_price      btc_price
## 2015/10/1 : 1   Min.   :1829   Min.   :115.2   Min.   : 236.1
## 2015/10/12: 1  1st Qu.:2127   1st Qu.:119.7   1st Qu.: 600.0
## 2015/10/13: 1  Median :2391   Median :121.9   Median :1724.2
## 2015/10/14: 1  Mean    :2395   Mean    :122.3   Mean    :3720.3
## 2015/10/15: 1  3rd Qu.:2670   3rd Qu.:124.6   3rd Qu.:6524.4
## 2015/10/16: 1  Max.    :2931   Max.    :129.1   Max.    :19114.2
## (Other)     :833

##      eth_price        xrp_price      sp500_return
##  Min.   : 0.4348   Min.   :0.004090   Min.   :-0.0409792
##  1st Qu.: 10.7300  1st Qu.:0.006484  1st Qu.:-0.0023840
##  Median : 88.9500  Median :0.158883  Median : 0.0002790
##  Mean   : 218.2280  Mean   :0.264840  Mean   : 0.0003518
##  3rd Qu.: 328.6800 3rd Qu.:0.392344  3rd Qu.: 0.0040878
##  Max.   :1299.7400  Max.   :3.200000  Max.   : 0.0495938
##           NA's     :1

##      usd_return       vtc_return      eth_return
##  Min.   :-0.0197248  Min.   :-0.212381  Min.   :-0.2530355
##  1st Qu.:-0.0017083  1st Qu.:-0.012758  1st Qu.:-0.0312243
##  Median : 0.0000000  Median : 0.003606  Median :-0.0000979
##  Mean   : 0.0000767  Mean   : 0.004387  Mean   : 0.0094729
##  3rd Qu.: 0.0018302  3rd Qu.: 0.022586  3rd Qu.: 0.0381622
##  Max.   : 0.0166594  Max.   : 0.252472  Max.   : 0.6666667
##  NA's   :1           NA's   :1           NA's   :1

##      xrp_return
##  Min.   :-0.297619
##  1st Qu.:-0.026462
##  Median :-0.004193
```

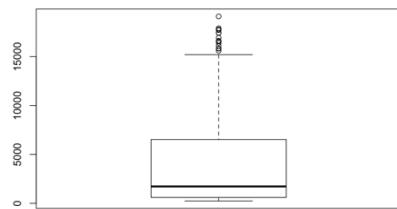
```

##  Mean    : 0.008802
##  3rd Qu.: 0.022481
##  Max.    : 1.118759
##  NA's    :1
#there is a typo in btc_return, I typed vtc_return but it means the former.

library(ggplot2)
ggplot(data, aes(date, btc_price))+geom_point()

boxplot(data=data,x=data$btc_price)

```



Linear model of btc, usd and sp 500.

```

modell <- lm(vtc_return ~ usd_return * sp500_return, data= data)
summary(modell)

##
## Call:
## lm(formula = vtc_return ~ usd_return * sp500_return, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -0.192086 -0.017212 -0.000729  0.018029  0.247504 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 0.004730  0.001644   2.878  0.00411 **  
## usd_return  -0.163581  0.533325  -0.307  0.75913    
## sp500_return  0.072803  0.206139   0.353  0.72405    
## usd_return:sp500_return 62.380956  49.204580   1.268  0.20523  
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04676 on 834 degrees of freedom
##     (1 observation deleted due to missingness)
## Multiple R-squared:  0.002777,  Adjusted R-squared:  -0.0008103 
## F-statistic: 0.7741 on 3 and 834 DF,  p-value: 0.5086

```

Not significant.

Linear model 2 is taking a look at btc return's relationship as to xrp and eth.

```
model2 <- lm(vtc_return ~ eth_return * xrp_return, data= data)
summary(model2)
##
## Call:
## lm(formula = vtc_return ~ eth_return * xrp_return, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -0.155614 -0.018449  0.000031  0.016329  0.251498 
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)    
## (Intercept)            0.002532  0.001482   1.709  0.08787 .  
## eth_return             0.191063  0.017634  10.835 < 2e-16 *** 
## xrp_return             0.106393  0.015294   6.957 7.04e-12 *** 
## eth_return:xrp_return -0.518208  0.165813  -3.125  0.00184 ** 
## ---                
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 
##
## Residual standard error: 0.04169 on 834 degrees of freedom
## (1 observation deleted due to missingness)
## Multiple R-squared:  0.2073, Adjusted R-squared:  0.2044 
## F-statistic: 72.68 on 3 and 834 DF,  p-value: < 2.2e-16
```

Significant. We can see the percentage from r^2 above.