ANALYSIS OF FACTORS WHICH AFFECT BITCOIN RETURNS

What can explain the fluctuations in bitcoin returns?

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During my Master, I had courses such as risk management and entrepreneurial finance. I received information about the composing of investment portfolios and returns that were achieved with IPOs. In the summer of 2017, I started investing in bitcoin which has become a passion of mine. In this period, I got the idea to graduate in bitcoin returns. During the past academic year I have researched this topic. I found out that little is known about bitcoin returns in the scientific literature. It was not an easy subject but I am happy that I have fulfilled my wish. I want to thank my family and friends for their support and trust during my master. I also want to thank my supervisors. First, Dr. Huang, who guided me well in setting up this Master Thesis. If I had any questions, I would receive an answer very quickly. I really appreciated this. Second, Dr. van Beusichem, whose comments were instructive remarks. I learned from him to always look critically at subjects that you are enthusiastic about.

After reading my Master Thesis, I hope you have gained a better understanding of bitcoin and its returns. I also hope this information will be useful during investment decisions in bitcoin.

Enschede, August 2019
Damy Heuver

Master thesis - ANALYSIS OF FACTORS WHICH AFFECT BITCOIN RETURNS

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ABSTRACT

In the last years, bitcoin created a lot of attention among investors. This was partly due to the sharp price rises and decreases of bitcoin. Despite the attention there is still greater knowledge necessary to explain the factors that influence the bitcoin returns. Therefore, this Master Thesis explains how bitcoin can be characterized and examines the theories and factors that influence fluctuations in bitcoin returns.

The research question is: "What can explain the fluctuations in bitcoin returns? And the sub questions are: "How can bitcoin be characterized?", "Which economic theories are applicable on bitcoin returns?" and "Which factors influence bitcoin returns?"

The research method is multiple regression since the effects of independent variables on bitcoin returns are measured and all variables are metric. The research consists of 11 independent variables. The data is collected per week, which is in line with previous researches. The research period is from 1 May 2013 to 30 April 2019. The research period is spitted up in two periods, namely 1 May 2013 to 30 April 2016 and 1 May 2016 to 30 April 2019, to investigate differences between the results in the two periods.

The factors examined are energy prices, S&P 500 returns, search volume on Google, new post on bitcointalk.org, supply growth, volume growth, inflation rates and interest rates. The factors are linked to various theories including the cost-based pricing theory, demand and supply theory and technical analysis. Most factors are linked to demand and supply theory. Energy price is linked to the cost-based pricing theory and volume growth to technical analysis.

The results show that volume growth, S&P 500 have a significant and positive impact on bitcoin returns and supply growth a significant negative impact on bitcoin returns. Therefore, the demand and supply theory and technical analysis are applicable to bitcoin returns.

The results of this thesis must be interpreted carefully, because the models have a low explanatory power. Other limitations include electricity prices which are based on Dutch electricity prices, missing data of the volume growth in 2013, missing data for new post in 2018 and 2019 and inflation rates, interest rates and stock market returns are based on US figures.

This research adds information to the discussion about whether bitcoin is an asset, commodity or currency. The results of this study show that bitcoin has similarities and differences with an asset, commodity and currency. Therefore bitcoin is categorized as a hybrid because it has characteristics of a commodity, currency and asset.

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1. Introduction

Bitcoin created a lot of attention among investors. There are many questions about bitcoin between potential investors such as “what is bitcoin?”, “what function do bitcoins have?”, “how is bitcoin’s value determined?”, “am I too late to invest in it?” and “what makes bitcoin different from the traditional flat coins?” etc. A bitcoin can be described as a financial and technological innovation which have various use cases and applications for the financial world, consumers and businesses. For example payments transactions (Wang and Vergne, 2017). Bhatt (2014) adds that a cryptocurrency is an open currency which is not limited by state boundaries. The distinctions between cryptocurrency and traditional flat coins are the anonymity and decentralized characteristic (Feng, Wang, and Zhang 2018). Also the enormous volatility in prices of bitcoin is an important difference with the traditional coins (Feng, Wang, and Zhang 2018). The volatility is unfavorable for bitcoin because users of money want a stable currency to have certainty that the currency retains its value like dollar and euro. The blockchain technology behind bitcoin realized that two or more parties are able to trade with each other without the intervention of an intermediary (Tapscott and Tapscott, 2017).

In 2017 and 2018 has been a lot of attention for the sharp price rises and decreases of bitcoin. On 8 December 2018, 1,706 academic articles are available on Scopus about bitcoins and 29,156 on “normal” currencies. This signifies that there is only a small amount of academic articles available about bitcoins compared to ordinary currencies. However, there is need among (potential) investors to get more information about bitcoin returns. A frequently asked question is: “How arise the enormous returns and losses in bitcoin trading?” “and “which factors cause this volatility in returns?” Therefore, it is interesting to investigate the factors that influence bitcoin returns.

In 2017, the cryptocurrencies grew in value. The strongest climber was Ripple which became 360 times larger in value. In the period 1 January to 1 September 2018, the crypto market fell by more than 60%. The number of cryptocurrencies also increased sharply from 617 in 2017 to 1988 in September 2018 (Coinmarketcap, 2018). These figures correspond to the conclusions of Feng, et al. (2018) that the cryptocurrency market is very volatile. Ciaian, et al. (2016) adds that such market volatility is unusual in the traditional currencies. This suggest other determinants of factors which affect the bitcoin returns. Ciaian, et al. (2016) referred to Kristoufek (2013) who states: “bitcoin cannot be explained by economic theories such as future cash flows model, purchasing power parity or uncovered interest rate parity” (Ciaian, et al. 2016, p. 1799). The study by Ciaian, et al. (2016), refers to Bucholz, et al. (2012), which state that changes in bitcoin movements are caused by supply and demand. This leads to a discussion about whether economic theories can be applied to bitcoin returns. The discussion is also if the bitcoin must be considered as an asset, currency, commodity or a combination of these. This subject will be discussed further in this thesis.

Furthermore, there is little information about the influence of technological development on the returns. CoinGecko measures technological development based on eight factors. However, the company regards this information as proprietary. Therefore, little information is available about technological development and researching this factor is difficult. An agreement with CoinGecko ensured that Wang and Vergne (2017) gained insight in a small part of the available information about technological development. Wang and Vergne (2017) were the first researchers that investigate technological development and conducted research into this variable in the period 2014-2015. They found a positive and significant relation for technological development on weekly returns. On other factors such as public interest, volume and supply growth more scientific information is available. However, there is no consensus about their effects on bitcoin returns. For example, Wang and Vergne (2017) found a negative effect on public interest and Ciaian, et al. (2016) a positive effect. This is also the case with the amount of bitcoins (supply growth). In summary, there is no clear effect of factors on bitcoin returns and little scientific research has been done on bitcoin returns compared to "normal" currencies. Therefore, these factors deserve attention in further research which lead to the following research question:

<u>Research question</u>

- What can explain the fluctuations in bitcoin returns?

As described above, there is discussion on which economic theories can be applied to bitcoin. The basis for this research is formed by the factors and the economic theories which are discussed extensively in this Master thesis. Furthermore, there is discussion about how bitcoin can be characterized. Bitcoin could be considered as a currency, commodity or asset. To investigate this, three sub questions have been formulated:

<u>Sub questions</u>

- How can bitcoin be characterized?
- Which economic theories are applicable on bitcoin returns?
- Which factors influence bitcoin returns?

After the theoretical framework, the methodology part of this research is described. Then the results are presented and conclusions are drawn.

This thesis can be used by investors, researchers and interested people in bitcoin to increase their knowledge about bitcoin or to expand their investment portfolio with bitcoins or to start trading in bitcoin. With this research, risks can be avoided, opportunities can be better utilized and investments in bitcoin can be more profitable. This research also contributes to the scientifically available information regarding bitcoin which is still considerably less than the studies on normal currencies.

2. Bitcoin & blockchain

This chapter introduces bitcoin, blockchain, and explains different views of bitcoin as a commodity, asset or currency.

2.1 Bitcoin

Bitcoin is a digital monetary and payment system which is available online via decentralized and distributed networks. These networks use a shared ledger data technology, called blockchain coupled with secure encryption (Hayes, 2017). The top 5 cryptocurrencies based on market value (high to low) consists of Bitcoin, Ethereum, Ripple, Bitcoin Cash and Litecoin. The total cryptocurrency market has a current value of $218.005.670.715. Bitcoin is the largest cryptocurrency with a marketcap of $113.195.207.068, which is more than the half of the market. These figures are based on 26 September 2018 (Coinmarketcap, 2018).

Bitcoin emerged in 2008 and is an online payment system without intermediaries. Current intermediaries in the financial world such as banks are superfluous in the bitcoin process. Transactions are registered in a public ledger with the use of its own unit of account named bitcoin and abbreviated to XBT or BTC (Singh, 2014). The transactions of bitcoin take place over a peer-to-peer network. Bitcoin is a fully decentralized currency where nodes in the network are anonymous. Miners make their computing power available for the transactions process. In this phase transactions are verified and recorded in a public ledger (Ashwin, 2018). Miners receive a reward when they first find a solution for the block. New bitcoins are produced in this way. This phenomenon is known as “mining” and is carried out by individuals and companies (Hayes, 2017).

2.2 Blockchain

Satoshi Nakamoto introduced the blockchain technology (Pierro, 2017). It is a decentralized database technology that works on a network, which in many cases is the internet (Turk and Klinc, 2017). According to Pierro (2017), the technology solved the problem of a lack of trust in a distributed system. In detail, blockchain create a distributed storage of time stamped documents where no person/group can cheat with the data’s content or timestamps without detection (Pierro, 2017). New transactions are send to all nodes where they form a block. After computing work, transactions are only allowed if all transactions in the block are valid (Turk and Klinc, 2017). If a block is accepted by nodes, this creates a new block in the chain. A new hash is created based on the previous block (Nakamoto, 2009).

2.3 Commodity, currency or asset

There are many discussions on how bitcoin could be characterized; commodity, currency or asset. This is further discussed in this section.

2.3.1 Commodity

Commodities are labeled by Appadurai (1986, p. 3) as: “objects of economic value”. It is also added that: “commodities are things with a particular type of social potential, that they are distinguishable from products, objects, goods, artifacts and other sorts of things” (Appadurai 1986, p. 6). Bjerg (2015) (in Wang and Vergne, 2017) state that bitcoin is a commodity. Moreover, Baur, et al. (2018) add to this that bitcoin is scarce (limited supply growth) like a commodity as gold, because bitcoin's maximum number in circulation is 21 million in 2140. In August 2019, there are 18.9 million bitcoins in circulation (Coinmarketcap, 2019). Hence bitcoin meets the scarcity characteristic of a commodity. The supply growth is further explained in 3.3. Furthermore a commodity caries value (Wang and Vergne, 2017). However, bitcoin has no intrinsic value (Ciaian, et al. 2016; Cheung, et al. 2015, Baur, et al. 2018). Therefore, bitcoin carries no value and does not meet this characteristic of a commodity.

2.3.2 Currency

Greco (2001) describes a currency as an accepted medium of exchange, where its value is based on trust and remains its value in the future. In addition, a currency has both intrinsic value and value in the future exchange (Ciaian, et al. 2016). Also inflation and interest have influences the demand for currencies (Purnomo, 2017). Ciaian, et al. (2016) approached the bitcoin on characteristics of a currency and investigated whether the bitcoin could be considered as a currency. Ciaian, et al (2016) state that bitcoin is not used in production and consumption, so it has no underlying value. Furthermore the value of bitcoin is only driven by the value in the future exchange (Ciaian et al, 2016). Cheung, et al. (2015, p.2350) agree with Ciaian, et al. (2016) and state that: "it is supposed to be a currency but it does not essentially perform the functions of a currency" and states also that: "it does not have any intrinsic value - it is simply anchored on a computer program" (Cheung, et al, 2015; p. 2350). This does not correspond to the intrinsic value of currencies. The intrinsic value of money is low, but it has value. Bitcoin is not tangible and has no underlying value. Yermack (2013) adds to this that the bitcoin is too volatile to function as a currency/medium of exchange. The volatility is associated with a high risk for bitcoin users. In figure 5 on page 52, the daily volatility of bitcoin is displayed in US dollar in 2013 along with the volatility of the euro, Japanese Yen, Swiss Franc, British pound and gold. In 2013 Bitcoin's volatility 142%. The volatility of different currencies was between 7% and 12%. For example gold was 22%. Yermack (2013) concluded that bitcoin shows no correlation with these currencies. In order to become a currency in the future, the daily value of bitcoin must become more stable (Baur, et al. 2018). Only then it can function as a store of value, medium of exchange and unit of account in the commercial market (Yermack 2013). Kristoufek (2015) found that factors such as level of price, supply of money and use in trade play a role in bitcoin returns on the longer term. These conclusions correspond with the quantity theory of money and monetary economics (Kristoufek, 2015). The quantity theory of money is based on supply and demand which determines the price (Walker, 1985). According to Walker (1895) there are two rules for the quantity theory of money by unchanged conditions (same trade volume) are:

1. An increase in the quantity of money leads to price increases
2. A decrease in the quantity of money leads to price decreases

Monetary terms is defined by Wood (1995, p.4) and explains that: "monetary economics is concerned with determination of levels and rates of change of nominal variables". The nominal variable is the price level and rates of change are inflation, money supply and trade and interest rate (Walker, 1895; Wood, 1995). These findings corresponds with the conclusion of Kristoufek (2015) which means that the quantity theory of money and monetary economics is applicable to both bitcoin and currency. Fiat money is controlled by persons, groups, companies, central authorities or governments. In contrast to fiat money, bitcoin is not regulated because there is no legislation and cannot be controlled. Bitcoin is a digital investment and therefore it is more susceptible to cyber-attacks than fiat money (Ciaian, et al, 2016). This can ensure that all confidence in the bitcoin disappears and the currency collapses. Remarkable is the study by Hong, et al. (2018) which shows that bitcoin has currency attitudes. The currency attitudes perceived usefulness and transaction compatibility are positive related to bitcoin. However, there is no support for the currency attitude perceived ease of use. There are three comments about the study by Hong, et al. (2018): 1. the study consists of only 192 respondents, 2. the average age of these respondents was relatively young, namely 29,89 years. 3. The article is not from an economic journal, but from a journal of distribution science. Therefore, the results are not reliable enough. In short, the applicability of monetary economics, quantity theory of money to bitcoin corresponds to currencies. The value in future exchange also corresponds to currencies. However, bitcoin has many contradictions with currencies, namely: 1. bitcoin is not an accepted medium of exchange since it has no underlying value from consumption and production, 2. it is too volatile, 3. no intrinsic value, 4. it is not regulated, 5. bitcoin is more sensitive to cyber-attacks then fiat money through digital character. 6. It is doubtful whether the currency retains its value in the future, making it unreliable as a currency. It can be concluded that bitcoin is not a currency at the moment. However it has some characteristics. In the future it is possible bitcoin becomes a currency if it succeeds in expanding bitcoin's use in trade, consumption, production process and commerce and can reduce its negative implications such as regulation, cyber-attacks and volatility (Ciaian, et al, 2016).

2.3.3 Asset

Assets can be defined as economic resources that must realize a future economic benefit such as bonds or stocks (Atrill and McLaney, 2016). Assets must be able to be measured in monetary terms. However, it is difficult to measure bitcoin in monetary terms because there is no regulation for bitcoin. For example, due to the lack of regulation and the anonymous nature of bitcoin, it is difficult to levy taxes on the bitcoin. Many studies investigated whether bitcoin can be characterized as an asset. Kristoufek (2015) stated that bitcoin can be seen as speculative asset. The strong price increases and decreases can be traced (amount of search queries on Google and Wikipedia) on the interest in bitcoin on Google and Wikipedia. This is also underlined by Baek and Elbeck (2015) who stated that bitcoin is a speculative asset through buyers and sellers. This fits well with the findings of Kristoufek (2013) because bitcoin investors mainly consist of noise traders and trend chasers. These are amateur investors who mainly get their information from the internet. However, large and powerful professional investors who invest in assets on the stock market do not only get their information from Google and Wikipedia. Therefore it is unlikely that the price movements of an asset can be traced on the basis of the number of search results on Google or Wikipedia. Yermack (2013) state also that the bitcoin is a speculative investment through the volatility which is present in bubbles. In addition, Blau (2018) stated that the bitcoin is a speculative asset because the main reason why speculators choose bitcoin is the anonymity offered by buying bitcoin. The study by Hong, et al. (2018) shows also empirical evidence that bitcoin has asset attitudes. The asset attitudes profit expectability and trust are positive related to bitcoin. However, as stated in the currency part, there are doubts about this investigation. It is very debatable whether the enormous volatility of bitcoin goes hand in hand with trust in bitcoin under investors since investors in bitcoin consist of noise traders, trend chasers and short-term investors (Kristoufek, 2013). According to Chen (2018) these types of traders react very emotionally to price fluctuations, which is the opposite of trust. According to Grinblatt, et al. (2011) and Ansari (2000) there are the three asset characteristics; market capitalization, book-to-market ratios and momentum. Market capitalization can be defined as the market value of all outstanding shares of a firm, book-to-market value is the ratio of the firm's market value to book value and momentum is the return on an asset over the past six months (Grinblatt, Hillier, and Titman 2011). Book-to-market value does not apply to bitcoin since it has no intrinsic value. Market capitalization cannot be applied to bitcoin as it concerns the market value of all outstanding shares of a firm and bitcoin is not a firm. Therefore the comparison is not correct. Momentum is applicable to bitcoin since the return can be calculated over the last six months. Bitcoin has two similar characteristics of an asset namely future economic benefit and momentum. However, bitcoin also has inconsistencies with the characteristics of an asset. For example, bitcoin cannot be measured in monetary terms because bitcoin is not regulated. In addition, investors buy bitcoin because of the anonymity. However, anonymity is no reason to buy assets for investors on an official exchange such as S&P 500. In addition, book-to-market cannot be applied because bitcoin has no intrinsic value. This also applies to market capitalization. Bitcoin is not a company and has no outstanding shares. In conclusion, bitcoin is not fully an asset, but it does have two characteristics of an asset.

2.3.4 Conclusion commodity, currency or asset
In summary, many authors state that bitcoin is a speculative investment. Bitcoin has several similarities and differences with currencies, assets and commodities which are summarized on page 50. Therefore bitcoin has characteristics of commodities, currencies and assets and is hence categorized as a hybrid.

3. Theoretical framework
Bitcoin is characterized as a hybrid. Therefore theories / factors are examined that explain returns and have an effect on returns for assets, commodities and currencies. CAPM and the three factor model of Fama French were discussed during the risk management course. The theories of Capital Asset Pricing Model (CAPM) and three factor model of Fama French are used since it explains asset returns. Therefore it is discussed whether CAPM and Fama French are applicable on bitcoin returns. Bitcoin also has characteristics of a currency. Inflation and interest rates influence currency returns. That is why these factors are studied to determine their effect on bitcoin returns. Further, bitcoin is often compared to gold which is a commodity. Literature research has been conducted into factors that have an effect on gold returns. It is stated that inflation and gold production effects gold returns. After examining these factors, it can be concluded whether these commodity factors also effect bitcoin returns.

However, returns can also be explained on the basis of theories that determine the future price. There is much discussion about the underlying value of bitcoin. By applying the cost-based pricing theory to bitcoin returns, it may be possible to calculate a cost price for bitcoin. Thereafter, investors can estimate whether the price of bitcoin is cheap or expensive, wherefore more returns can be achieved. In this study will be researched if cost based pricing theory is applicable and which factors determine the cost price of bitcoin. This also applies to the functions of supply and demand. It is interesting to investigate whether bitcoin returns are also caused by supply and demand and by which factors. Finally, technical analysis is used by investors to realise more returns. Therefore, it is researched whether technical analysis is applicable and with which factors. In the following section of this chapter, the theories are linked to the variables from previous bitcoin studies followed by the formulated hypotheses.

3.1 Capital asset pricing model
Capital asset pricing model

For an investor, it is important to implement economic substance in the risk-expected return relation. CAPM is a powerful tool that provides good predictions for measuring risks and the relationship between expected return and risk (Fama and French, 2004). The CAPM method is used by consultants, pension funds, brokers etc. to formulate an investment strategy or provide financial advice. According to Ansari (2000), the model assumes that the market does not reward (return) the investor for the unnecessary risks. For the CAPM method, the assets variance is not an important factor for determining the expected return (Ansari, 2000). (Ansari, 2000). The market beta is an important factor and Ansari (2000) state that: “Technically speaking, ß is the covariance of a stock's return with the return on a market index scaled by variance of that index. It is also measured as slope in the regression of a stock's return on market” (Ansari, 2000 P.57). According to Dawson (2015, p.570) nine assumptions must be met to develop a CAPM namely: “All investors (a) are rational (i.e. they seek to maximize their individual economic utility or wealth); (b) are risk-averse; (c) focus on two primary asset characteristics – expected return and risk (as measured by variance in rates of return) – when making portfolio decisions (d) possess identical full knowledge and process it correctly to form homogeneous, correct beliefs about current and future returns, variances of returns and covariances of returns (each of which are normally distributed about their mean values); (e) can borrow and lend, as much as they wish, at the risk-free rate; (f) invest over one, and the same, holding period (whether it be a year, 20 years, etc.); there are (g) no taxes; (h) no transaction costs; and (i) no other illiquidities (e.g. assets are fully marketable)" (Dawson, 2015, p. 570). Assumptions g, h and i are frictionless market factors. Figure 1 shows the equation of the CAPM. $\bar{r}$ is the expected return, r_f is risk-free interest rate, β is the beta coefficient and $\bar{R}_m$ is the market portfolio expected rate of return (Ansari, 2000; Grinblatt, Hillier, and Titman, 2011).

Figure 1. CAPM equation. Retrieved from Grinblatt, Hillier, and Titman (2011, p. 142)

$$\bar{r} - r_f = \beta(\bar{R}_M - r_f)$$

The beta is: "ß is the ratio of covariance to variance " (Ansari, 2000, p. 57). Short-term Treasury bill returns were used as proxies for the risk-free return (Ansari, 2000). However, according to Black et al. (1972), (in Grinblatt, Hillier and Titman, 2011), the percentage of the short-term Treasury bill seems to be lower than the average return of a zero-beta risky asset. Another option to act as an alternative for risk-free return is to take the zero-beta expected return estimate which can be determined by fitting the intersection point in the risk-expected return equation to all assets (Grinblatt, Hillier, and Titman 2011). In reality, it is difficult to determine the real beta, but an estimate of it is possible on the basis of historical data. With linear regression, the slope coefficient can be recognized by the ratio of covariance to variance. The return of the asset(s) (R_M), on which the beta is estimated, is represented by the left-hand variable in the regression. The proxy for the market return is represented by the right-hand side, for example the return of the AEX. Today's software programs have built-in regression routines that allow them to estimate the beta as the regression slope coefficient (Grinblatt, Hillier, and Titman 2011). Finally, to determine the risk premium of the portfolio, the risk-free return must be deducted from the expected return of the market portfolio (Ansari, 2000). In figure 3, page 50 in the appendix, a regression result is shown that is consistent with the CAPM. Herefrom it can be concluded that the intercept (r_f) is the risk-free return and the slope ($\bar{R}_m$ - r_f) is the risk premium of the portfolio (Grinblatt, Hillier, and Titman 2011). In figure 4, on page 51 in the appendix, shows four regression results that are contradictory with the CAPM. Figure 4 shows that CAPM does not describe the relationship between risk and expected return. The figure also shows that historical returns can be explained by other asset characteristics (Grinblatt, Hillier, and Titman 2011).

3.1.1 Is the Capital Asset Pricing Model applicable to bitcoin?

The nine assumptions of CAPM are studied to assess whether the CAPM is applicable to bitcoin returns. The assumptions and asset characteristics are explained in the previous paragraph. It is very questionable whether bitcoin investors are rational, risk-averse, possess sufficient knowledge to form correct and have homogenous beliefs about current and future returns and focus only on risk and expected return. The reason for this doubt is that several authors state that bitcoin is a bubble, because the market value exceeds the fundamental value (Kristoufek, 2013; Kristoufek, 2015; Ciaian, et al. 2016; Grinberg, 2012; Cheung, et al, 2015; Wang & Vergne, 2017). Ciaian, et al. (2016) also stated that bitcoin has no intrinsic value. In addition, Kristoufek (2013) indicates that the market is dominated by speculators, noise traders, trend chasers and short-term investors. These types of investors act more emotionally than rationally, run high risks due to missing knowledge, are ignorant of the risks they run and are only focused on expected returns and have no insight into the high risks.

Therefore, the CAPM assumptions are not met. It is also excluded that all investors in bitcoin can borrow as much as possible at the risk-free rate. For noise traders and trend chasers, it is often the only investment. Also excluded is that ignorant investors invest over the same holding period. Every investor acts for himself and because of the enormous volatility and unprofessionalism, this type of investor becomes emotional which results in different holding periods. In addition, tax and transaction costs must be paid for trading in bitcoin. One CAPM assumption, no other illiquidities, can be applied since bitcoin is fully marketable. In other words, almost all assumptions of the CAPM.

According to West (1987), Diba and Grossman (1988) and Van Norden (1996), (in Cheung, et al, 2015), there is a bubble when the market value exceeds the asset's fundamental value. According to Ciaian, et al. (2016), a disadvantage of investing in a speculative investment, such as bitcoin, is that in the short term bubbles can arise. Several researchers concluded that the bitcoin is characterized by bubbles (Ciaian, et al. 2016; Grinberg, 2012; Cheung, et al, 2015; Wang & Vergne, 2017; Kristoufek, 2015). Therefore Yermack (2013) state that the possession of bitcoin is very risky. As a result, for bitcoin traders it is difficult to cover their risk and it is not suitable for risk management (Yermack, 2013).

In conclusion, the assumptions of CAPM are not met and bitcoin is characterized by bubbles which creates major risks for investors. This means that CAPM, a part of risk management, cannot be applied to bitcoin returns.

3.2. Fama French three factor model

Fama and French (1993), (in Fama and French, 2016), designed a three factor model which explains stock returns. According to Fama and French (1996) the three factors are: 1. Returns on a broad market portfolio (value weighted index portfolio and T-bills), 2. the difference in portfolio returns between small and large stocks, and 3. the difference in portfolio returns between high and low book-to-market stocks. Grinblatt, et al. (2011) suggest a long position in high book-to-market stock, small capitalization stocks and value weighted index portfolio and a short position in low book-to market stocks, large capitalization stocks and T-bills. Fama and French (1996) state also that other factors are related to firm's stock returns such as earnings / price, sales growth and cash flow / price. Gilbert and Loi (2018) developed an equation for the three factor model of Fama French which is shown in figure 2. $R_{b,t} – R_{f,t}$ is the excess return, $R_{m,t} – R_{f,t}$ is the return of the broad market portfolio, SMB_t the difference in return between small and large capitalization cryptocurrencies, HML_t is the difference in returns between high and low book-to-market cryptocurrencies and τt is the disturbance term.

Figure 2. Equation three factor model Fama French. Retrieved from Gilbert and Loi (2018, p.110)

$$R_{b,t} - R_{f,t} = \beta_0 + \beta_1(R_{m,t} - R_{f,t}) + \beta_2 SMB_t + \beta_3 HML_t + \tau_t$$

3.2.1 Is the Fama French three factor model applicable to bitcoin?

The first factor excess return on a broad market portfolio is applicable to bitcoin. Investors can compile a broad crypto portfolio consisting of multiple cryptocurrencies. For example a portfolio consists of 10 cryptocurrencies and each currency covers 10% of the portfolio. The second factor difference in returns between large and small stocks is not applicable. This factor looks at the size of a company because comparisons of returns are made between large and small companies with stocks. However, bitcoin is not a company and it has not issued any stocks. Therefore, no comparison is possible on the second factor. The third factor is about the difference in returns between high book-to market and low book-to-market stocks. It was stated earlier in this thesis that bitcoin has no intrinsic value (Ciaian, et al. 2016; Cheung, et al. 2015, Baur, et al. 2018).Therefore a comparison on book-to-market is not applicable on bitcoin returns. In conclusion, the three factor model of Fama French is not applicable on bitcoin returns. This is underlined in previous research of Liu and Tsyvinski (2018) and Gilbert and Loi (2018). In these researches the applicability of the three factor model on bitcoin returns was tested. Both researches stated that all three factors give insignificant results. Other factors such as earnings / price, sales growth and cash flow / price are logically not applicable to bitcoin either.

3.3 Which risk factors can effect commodity returns?

As concluded in section 2.3, bitcoin has a characteristic of a commodity namely scarcity. Bjerg (2016), (in Wang and Vergne, 2017), state that bitcoin is commodity money without gold. However, bitcoin is also seen as the new digital gold (Dyhrberg, 2016). There are similarities and differences between bitcoin and gold. According to Dyhrberg (2016) the similarities are that both gold and bitcoin are scarce. Furthermore the supply and production (mining) of bitcoin and gold is not controlled by the government and both investments have high price volatility (Dyhrberg, 2016). However, there are also contradictions between gold and bitcoin. Gold has underlying value and bitcoin has no underlying value. In addition, gold is a safe haven (Baur & Lucey, 2010), bitcoin is a new investment and has yet to prove itself. Also gold is physical and bitcoin digital. Therefore it must be stated that the comparison of bitcoin with gold is questionable.

According to Barro and Misra (2016) gold is a commodity. It is possible that risk factors which affect gold returns are applicable to bitcoin because it has a number of similarities with gold. Therefore the risk factors which influence the gold returns are studied. One of the risk factors that influence gold returns is inflation. Inflation can be defined as: “When the circulating money in community is too much, then inflation may happen. Inflation is the increasing of goods price continuously” (Purnomo, 2017, p.42). Blose (1996) stated that gold is a popular hedge against inflation. Long, et al (2013) add to this that gold returns and expected inflation have a one-on-one relation. This signifies that rising inflation must lead to rising bitcoin returns, if bitcoin is digital gold as Dyhrberg (2016) claims. However, few studies are available about the effects of inflation on bitcoin returns. Only Hong (2018) claims that Argentinians bought bitcoins to protect their savings against high inflation. Based on Hong’s claim, it must be assumed that high inflation leads to more demand for bitcoins and therefore higher bitcoin returns can be achieved. Due to the increased demand for bitcoins, the crypto coin is a competitor/substitute for investments in gold. Therefore, the inflation factor can be categorized under the demand and supply theory that is described in chapter 3.6.

Another factor that influences the return on gold is production. Shafiee and Topal (2010) show that in most cases (except 2003 and 2005) rising production (1997-2001) has led to a falling gold price and less gold returns, see figure 6 in the appendix on page 52. In 2003 there was almost a constant production but a falling gold price which means that the supply exceeds the demand. In 2005 production of gold increased and its price increased which means that the demand for gold exceeded its supply. It is concluded that losses were made by investors in gold during that period. From 2002 to 2007, there has been an average decrease in the production of gold. This has led to an increase in gold prices en higher returns. For example, investors were able to achieve returns during this period by trading in gold. Therefore, the rule that when production increases the price (returns) decreases is often the case, but the maxim is not always applicable. The production of gold can be compared to the mining of bitcoins because miners ensure the supply growth (maximum 21 million) of bitcoin with their production activities. The difference between bitcoin mining and gold production is that the production of gold can fluctuate and the production of bitcoin steadily declines. After a bitcoin halving, fewer and fewer bitcoins are added to the final maximum of 21 million bitcoins in 2140 (Hayes, 2017). The supply growth of bitcoin is linked to the demand and supply theory and categorized into suppliers in the Porter model (2008). This is further explained in section 3.6.

3.4 WHICH RISK FACTORS CAN EFFECT CURRENCY RETURNS?

According to paragraph 2.3, bitcoin has a number of similarities with currencies but also differences. Dyhrberg (2016) researched bitcoin returns in relation to hedging it with the US dollar and found evidence that bitcoin can act as a hedge for the US dollar. Hedging the US dollar against bitcoin yields a bitcoin return according to the results (0.338**) of Dyhrberg (2016). Unfortunately, Dyhrberg (2016) did not investigate the effect of inflation on bitcoin returns. According to Purnomo (2017) there are four factors that explain currency returns namely inflation rate, interest rate, government control and expectations. Government control is not applicable to bitcoin because it is not regulated. This means it is not controlled by the government. Furthermore, expectations are difficult to measure since the expectations about bitcoin differ greatly. Inflation rate and interest rate are best measurable in variables and therefore elaborated in this report. According to Purnomo (2017) there are three factors that contribute to inflation; demand-pull inflation, cost-pull inflation and inflation through quantitative easing. The demand-pull inflation arises when demand for certain goods / products rises. A cause of the increase may be that the government spends more money on buying goods / products or an increase in the demand for goods / products from individuals (Purnomo, 2017). These two elements ensure rising prices (Purnomo, 2017). Cost-pull inflation is caused by rising production costs. This inflation occurs due to rising raw material prices and other production-related costs such as wages. For example, increases in the price of steel or labor costs. These rising product costs are settled in the cost price, which results in higher selling prices and causes inflation (Purnomo, 2017). Inflation can also be applied through quantitative easing. This means there is an increase in the amount of money in circulation (Purnomo, 2017). The underlying thought idea is prices will rise if the quantity of goods remains the same and the quantity of money increases. This form of inflation can occur if the ECB decides to print extra money (Purnomo, 2017).

Ishaq et al. (2015) states that exchange rates for currencies and inflation are linked to each other. This is also underlined by Purnomo (2017) who add that changes in the inflation rate affects international trade. Due to inflation, changes occur in prices, which causes changes in trading activities. This has consequences for currency returns as the supply and demand for currencies changes which results in a change of the exchange rates of currencies (Purnomo, 2017). For example, inflation in the EU zone is higher than in the US. US products are on average cheaper than EU products due to higher inflation in the EU. As a result, there is more demand for dollars and more supply of euros. This ensures a fall / weakening of the euro which leads to a decline in returns or losses for investors trading in euros and more returns for investors trading in dollars. This example is confirmed by the numbers. In November 2014, Indonesia inflation amounted to 6.23% and was worth 1 dollar 12,167 rupiah. In December 2014, inflation rose to 8.36% and the rupiah fell to 12,410 for 1 dollar.

<u>Interest rate</u>

Interest rate affects the exchange rate of a currency. Increasing or decreasing the interest rate is a measure of a central bank to manage the amount of money in circulation and to maintain the stability of the currency exchange rate (Purnomo, 2017). Changes in interest rates are of great importance for currency returns. There is greater demand for currencies from countries that raise their interest rates and vice versa. The reason is that investors always look for opportunities where they can achieve the most returns through higher interest rates (Purnomo, 2017). For example, the FED in the US decides to raise interest rates and in the EU the interest rate remains unchanged. Hereby it is more attractive to invest in the US due to higher returns than in the EU. There is more demand for dollars in exchange for euros. The dollar will rise against the euro, which results in higher returns for investors in the dollar and lower returns for investors in euros. It can be concluded that changes in interest rates have consequences on demand and supply of currencies. This is also confirmed by data. In November 2016 $ 1 was still worth 13,550 Rupiah and in December 2016 $ 1 was worth 13,436 Rupiah. This was due to the interest rate rise from 4.75% in November 2016 to 5.5% in December 2016 decided by the bank of Indonesia (Purnomo, 2017). As Dyhrberg (2016) has already shown, bitcoin can be used to hedge against the US dollar. Therefore it is a substitute for the US dollar, which falls under the competitor's category in the Porter model (2008). This means, a lower interest rate in America can lead to an increasing demand for bitcoins, which leads to higher bitcoin returns. Furthermore, there are also no scientific studies available about the influence of interest rates on bitcoin returns. However interest rates are low in recent years and investors are still looking for opportunities to achieve higher returns. It is assumed that interest rates have a positive impact on bitcoin returns.

3.5 Cost based pricing theory

The cost price of a product or service is established on the basis of a specified percentage profit margin calculated over the total costs (Noble & Gruca, 1999). The primary focus of the cost based pricing theory is on the internal costs such as fixed and variable costs. Diamantoploulos (1991), (in Noble and Gruca, 1991), claims that this strategy is the most chosen pricing strategy. The cost-based pricing theory is related to the miners of bitcoin, because with this method they can calculate from which cost price the mining activities become profitable. It was concluded earlier in the report that bitcoin has no intrinsic value. However, Hayes (2017) states that it is possible for traders to calculate an expected price for bitcoin. With this suggestion, a trader is able to calculate whether the bitcoin is cheap or expensive. An investor can decide to buy a bitcoin, in a cheap period, to make more return on it and vice versa. Questionable is whether the cost price gives a good estimate. For example, producing one 500 euro ticket costs less than one euro (Rendement.nl, 2016). There are good reasons to doubt the reliability of this research, because of the researchers' knowledge on this topic. The article is also not published in an economic or financial journal, but in Telematics and Informatics. Therefore the relation between cost based pricing theory and bitcoin is critically researched.

3.5.1 Is the cost based pricing theory applicable to bitcoin?

The cost price for bitcoins depends on three factors (Wang & Vergne, 2017; Hayes, 2017). The first factor is the technological development. Technological improvements can improve the mining hardware energy efficiency. This leads to lower costs of mining bitcoins and lower bitcoin prices. This can lead to higher demand for bitcoins and higher returns can be achieved. Technological improvements can also add extra hashing power to the global mining network which results. This results in more difficulty/ higher costs in mining Bitcoins which results in a higher price of bitcoins. This can lead to lower demand for bitcoins and lower returns. Technological development can result in both a lower as higher bitcoin return. Hayes (2017) made a recommendation for further research for technological development, however, Wang and Vergne (2017) conducted research into this topic. The variable in their research contains data which measures whether the underlying technology of bitcoin makes progress in collaboratively fixing, updating, and upgrading the coin such as improvements in mining hardware efficiency or adding additional hashing power to the mining network. The chairman of the U.S. Federal Reserve stated that "innovations [such as Bitcoin] may hold long-term promise, particularly if [they] promote a faster, more secure and more efficient payment system"' (Wang and Vergne, 2017, p.2). Wang and Vergne (2017) found a positive and significant effect ($P<0.001$) of technological development in bitcoin on weekly returns which corresponds to the statements of Bernanke. The second factor is the energy consumption which is necessary for the computational labor during the mining process. According to Hayes (2017), energy consumption is the most important cost item in mining bitcoin. Important energy cost issues are the cost of electricity and the energy consumption per unit of mining effort. Logically, miners, responsible for the production of bitcoins, find the most favorable places to settle. That is why "bitcoin boomtowns" originate in countries where energy prices are low, such as China, America and Iceland (Greenburg and Bugden, 2019). When bitcoins can be cheaply mined due to the low energy prices, the prices are also lower. A lower bitcoin price can lead to more demand, resulting in higher returns and vice versa. The third factor is the block reward. Miners get bitcoins as a reward since the bitcoin network can use the computing power of miners' equipment (Ashwin, 2018). Miners receive a reward when they first find a solution for the block. When bitcoin was launched in 2008, miners received 50 bitcoins for each block that was mined. Approximately, every four years the block reward for bitcoin will be halved (Hayes, 2017). In 2012 miners received 25 bitcoins for each block that was mined and 12.5 bitcoins in 2016. In 2020 the next halving will take place to 6.25 bitcoins. Due to the decrease in reward, fewer and fewer bitcoins are added. Hereby bitcoin becomes scarcer, which boosts returns. However, the cost of production increases after a halving for bitcoin mining if it is assumed that the price of bitcoin remains the same. This makes the bitcoin more expensive, which result in less demand and more supply and therefore lower returns. For example, the cost price for each block that is mined is $ 10,000. In this example, it is assumed that the price remains the same for bitcoin in 2020, namely $ 3,815 (bitcoin price 10-01-2019). Before the halving in 2020, a miner will receive $47,687.5 (12.5 x $ 3,815) for each block that will be mined and after the halving, $ 23,843.75 (6.25 x $3,815).

In conclusion, the cost-based pricing theory is applicable to bitcoin. The cost price of bitcoin consists of technological development, energy costs and the block reward. Since energy prices have by far the greatest influence on the cost price of bitcoin, this variable is examined in this report. As mentioned earlier, bitcoin miners look for places where they can mine cheaply. This leads to a lower cost price and therefore a lower bitcoin price. This Master Thesis assumes that a lower cost price for bitcoin leads to more demand. Therefore, the energy prices have a positive impact on bitcoin returns.

3.6 Demand and supply theory

Earlier in the report it was concluded that the quantity of theory of money is applicable to bitcoin. This theory is about supply and demand. Therefore this is worked out in more detail. The demand and supply theory consists of two factors: demand and supply. It contains the number of bitcoins that investors want to buy on the market (demand) compared to the number of bitcoins available on the market (supply). Kotler, et al. (2005) uses a different word for supply namely market offerings. According to Miller (1977, p. 1153): "the price is determined by the intersection of the demand and supply curves". Gale (1955) stated that prices in a free market depend on consumer / investor demand. Returns will rise if demand increases and supply remains the same or decreases. If the demand is greater than supply there is a rise in prices. After a while there is less demand due to the high price and therefore the returns automatically falls. This is also the case if supply is greater than demand then the returns drops. The lower price creates more demand among consumers / investors, which leads to the price rising again and higher returns. Companies can also produce more if there is a high price. This creates more supply and the price decreases. It also works the other way around if there is a low price. This free market mechanism assumes that prices will automatically adjust to values, that brings demand and supply back into balance. Ultimately these are the prices at economic equilibrium (Gale, 1955; Marshall, 1890).

Figure 7, in the appendix on page 52, gives insight in how demand and supply are displayed and how shifts look graphical. In figure 7 there is an increase in supply in all the three graphs. SS is the old supply, ss the new supply, AH the old equilibrium price/amount and ah the new equilibrium price/ amount. In all three graphs there is a decline equilibrium price and increase of equilibrium amount. However the drop in price equilibrium is larger in fig. 29 (where the supply line drops) then in fig. 27 and fig. 28 where the supply line remains stable or increased). Marshall (1890) states that the greater the elasticity is in demand, the larger the increase in production but the bigger is the fall in price and returns. (Marshall, 1890).

The graphs in figure 7 are interesting, however, how do changes in supply and demand arise? Changes in supply and demand can arise, among other things, due to changes in the micro environment. Kotler, et al. (2005, p.66) define the microenvironment as: “The actors close to the company that affect its ability to serve its customers— the company, suppliers, marketing intermediaries, competitors, and publics.”

The company consists of multiple departments such as finance, sales and marketing. These departments are (in)directly linked to each other and are (in)directly responsible for creating customer value and customer satisfaction. Changes may occur in supply and demand in the event of miscommunication between marketers and production / purchasing. For example, if the marketer communicates low prices to the customer while this is not possible because purchasing has still purchased expensive products or the innovation on the production floor is not ready yet (Kotler, et al. 2005). Another example is marijuana company Aphria where it became clear to investors that Aphria had diverted money into inflated investments of insiders. The results were a sales wave among investors, which resulted in a decrease of 23% of the Aphria share and losses instead of returns for many investors (Bloomberg, 2018). However, bitcoin cannot be seen as a company since it is not a central manager such as a bank.

Consumers/ investors are the most important players on the demand and supply side. Trading in bitcoin is a reseller market (Kotler, et al. 2005). In this kind of market consumers/ investors buy goods, services and shares to resell it with profit. Kristoufek (2013) stated that the demand side of the bitcoin market consists of investors who buy and keep it and sell it later. Investors buy and sell bitcoin with one reason namely to make profit. Kristoufek (2013, p.1) concluded that: “The market is thus dominated by short-term investors, trend chasers, noise traders and speculators”. Trueman (1988, p.83) defines noise trading as: “Noise trading is trading on noise as if it were information. People who trade on noise are willing to trade even though from an objective point of view they would be better off not trading”. Furthermore, noise traders act impulsive for example on news (Chen, 2018). Trend chasers are identical, because they only invest in bitcoin because of the good profit stories/ news about bitcoin. However they do not know in which they invest. This is confirmed by a study of Kristoufek (2015) which concluded that the returns of bitcoin can partly be derived from the interest on Wikipedia and Google. In conclusion, many good messages/news about bitcoin leads to more searches for bitcoin on Wikipedia and Google. The motivation of an investor in bitcoin is primarily to make profit.

Suppliers are responsible for delivering products to a company and are necessary for producing products and service. Problems with the supplier can lead to a decrease in sales or damage in customer satisfaction and lower returns. For example, due to increased supplier prices or delays in the delivery of products (Kotler, et al. 2005). The opposite is also true because Shaw (1985) showed that there was an increase in food consumption due to cheaper imported food which caused lower sales prices and higher returns. Bitcoin is fully decentralized where nodes in the network are anonymous. Miners make their computing power available for the transaction process and therefore rewarded with new Bitcoins (Ashwin, 2018). Hereby new bitcoins are created. This phenomenon is known as “mining” and is carried out by individuals and companies (Hayes, 2017). Miners can be seen as the suppliers of bitcoin. The maximum supply of bitcoins is 21 million and now there are approximately 17.5 million in circulation (Wang and Vergne, 2017) (Coinmarketcap, 2019). In the future, a growth in the supply of bitcoins can be expected since another 3.5 million will be mined. There is no consensus about which effect this will have on the bitcoin returns. Wang and Verge (2017) conclude a positive influence for two reasons. Firstly, a short term increase in supply ensures that current bitcoin holders reinforce their position aggressively to maintain or expand their market share. This confidence in the market attracts new buyers with little knowledge of bitcoin. Secondly, a short term supply growth is an effect of a peak in mining intensity. This indicator can be seen as the possibility is growing that bitcoin will become a medium of exchange (Wang & Vergne, 2017). Also the number of bitcoins is being steadily mined which ensures that there are no unexpected large increases in the number of bitcoins. Ciaian, et al. (2016) came to the conclusion that it has a negative effect on the bitcoin, because more supply leads to a falling price and lower returns.

Marketing intermediaries supports in distributing, selling and promoting products such as marketing service agencies, celebrity or physical distribution firms (Kotler, et al. 2005). For example, Nike did a promotional campaign with the football player Colin Kaepernick. As a result, the online sales of the shoe giant rose by as much as 31% (Bloomberg, 2018).

Competitors can ensure for a loss in market share. Competitors are active in the same market, substitutes or new entrants (Porter, 2008). A company must ensure that there is a strategic advantages in the positioning of the products in the minds of the consumer. Thereby allowing to stay ahead of the competitors (Kotler, et al. 2005). Activities which contribute are price discounting, product improvements, new products, improvements in service and advertising (Porter, 2008). Porter (2008) state that new entrants put the profits under pressure. Companies can deter new entrants by making it unattractive to start in the market due to high investments or keep prices low which results in unattractive returns. A substitute has the same function as the product of a firm. Substitutes limits the returns of an industry because it places a ceiling on the prices. The growth potential will decrease if a market does not know how to shake off substitutes due to product substitutes. However, Hong (2017) and Dyhrberg (2016) state that investing in bitcoin is an alternative for trading on financial markets such as S&P 500 and FTSE. Hong (2017) concluded that a combined portfolio of S&P 500 and bitcoin leads to a higher return. Hong (2017) argues that the greater the position size in bitcoin, the greater the return. However, it must be noted that trading in bitcoin involves high risks due to the enormous volatility. Trading in bitcoins is a serious substitute/ alternative investment for trading on the S&P 500. It is possible that a fall in S&P 500 returns leads to an increase in bitcoin returns. This can be tested by looking at a causality between returns of S&P 500 and the bitcoin returns. Changes in interest rates and inflation can bring about (major) changes in supply and demand, which has an effect on returns (Purnomo, 2017). Investors are always looking for opportunities for optimum returns. Hong (2017) claims that high inflation leads to more demand for bitcoins, causing an increase in bitcoins returns. Since bitcoin is a substitute for the dollar, a reduction in interest rates in the US could generate more demand for bitcoins and therefore a higher bitcoin return. These three factors (inflation, interest rates and S&P 500) can have a reinforcing effect on bitcoin as a substitute for traditional investments and ensure higher returns.

In figure 8, in appendix on page 53, the bitcoin dominance in the crypto market is shown in%. A decreasing bitcoin dominance is visible. At the beginning of 2016, the domination was still above 90% and in 2019 it is approaching 50%. Therefore other competing cryptocurrencies such as Ripple, Ethereum or new cryptocurrencies gain ground from bitcoin. However, the bitcoin is still by far the most important cryptocurrency (Coinmarketcap, 2019). Kotler, et al. (2005, p.69) stated that: “Public is any group that has an actual or potential interest in or impact on an organization’s ability to achieve its objectives”. According to Kotler, et al. (2005), media publics is one of the seven types of publics. Media publics contains internet media such as Google. Wang and Vergne (2017), Kristoufek (2013 and 2015) and Ciaian, et al. (2016) conducted research in media publics. Ciaian, et al. (2016) did research on new post on bitcoin forums, Wang and Vergne (2017) on public interest on Bing and

Alexa web traffic ranking, Kristoufek (2013 and 2015) on search volume on Wikipedia and Google and Kutlu, et al. (2017) on Google. New posts capture the attention driven behavior on bitcoin forums and reflects an increasing acceptance and trust in bitcoin. This results in declining uncertainty and transaction costs for bitcoin investors. This leads to more demand for bitcoin which results in higher prices and returns (Ciaian, Rajcaniova, and Kancs 2016). Public interest affects the expected uncertainty regarding future returns. Wang and Vergne (2017) use the term buzz factor for public interest. Wang and Vergne (2017) state that an increase in public interest by investors is as an indicator of rising volatility. Furthermore Wang and Vergne (2017, p.13) note that: "If market participants are risk-averse, given the same expected mean returns, they would be less willing to hold the cryptocurrency if future volatility increases" (Wang and Vergne, p.13). This leads to sale and decrease of demand in bitcoins which leads to a falling prices and losses/lower returns (Wang and Vergne 2017). Kristoufek (2013 and 2015) and Kutlu, et al. (2017) add to this that the bitcoin movements corresponds with the amount of search items on Google and Wikipedia. Kutlu, et al. (2017) also stated that more interest leads to a decrease in bitcoin returns. The effects of Wikipedia on the bitcoin returns are weakened over time, because Wikipedia only contains information about what bitcoin is (Ciaian, et al. 2016). Wikipedia is therefore not investigated further. In conclusion, most articles indicate that public interest has negative consequences for bitcoin returns. The effect of public interest on bitcoin is not clear.

3.6.1 Is the demand and supply theory applicable to bitcoin?

Demand and supply are the main factors that determine the bitcoin returns (Buchholz, et al. 2012; Ciaian, et al. 2016). The demand for bitcoin is driven by the value in future exchanges and the supply are the number of bitcoins in circulation (Ciaian, et al. 2016). The microenvironment model of Kotler, et al. (2005) can be applied to demand and supply factors, because almost all factors are applicable on demand and supply of bitcoin returns. Firstly, bitcoin traders are in a resell market. In this market investors try to sell their coins at a profit (Kotler, et al. 2015). Secondly, miners can be seen as the suppliers of bitcoin (Hayes, 2017) and are responsible for the supply growth in bitcoins. Ciaian, et al. (2016) and Wang and Vergne (2017) researched its effect on the bitcoin returns and came both to different conclusions. Thirdly, competitors are applicable to bitcoin. The dominance of bitcoin declined sharply in recent years because of competitive- and new cryptocurrencies. Adding to this, Hong (2017) and Dyhrberg (2016) concluded that investing in bitcoins is a substitute for the traditional market. Factors such as inflation, interest rates and S&P 500 can strengthen bitcoin as a substitute for the traditional market. Fourthly, publics is applicable to bitcoin. The studies conducted on publics in bitcoin can be categorized in media publics. In various studies there is no consensus about the consequences of public interest on bitcoin returns (Kristoufek (2013 and 2015), Ciaian, et al. (2016) and Wang and Vergne (2017)). The factor company in the model of Kotler, et al. (2015) is not applicable since bitcoin is not a central manager such as a bank. Furthermore it is decentralized with a peer to peer network. No researchers have been conducted on the effects of marketing intermediaries on bitcoin returns. In conclusion, the supply and demand theory is applicable to bitcoin.

3.7 Technical analysis

Technical analysis is described by Antoniou, et al. (1997, p.361) as: "part of the process by which traders learn about fundamentals. Thus, traders use data on volume to update their beliefs, with the result that volume statistics not only describe the market, they also affect the market" (Antoniou, et al. 1997, p.361). Pau (1991, p.715) underlined this and stated that: "technical analysis consists in studying the curves representing price, index, ratio, and volume fluctuations over time, in order to infer some investment decisions from the local and/or global shape of such curves" (Pau 1991, p. 715). Neely, et al (1997, p.405) defines technical analysis as: "In its simplest form, technical analysis uses information about historical price movements, summarized in the form of price charts, to forecast future price trends". In conclusion, there is agreement among scientists about the definition of technical analysis. According to Antoniou, et al. (1997) the purpose of technical analysis is to determine whether efficient returns can be achieved by analyzing past volume and past returns data.

In the past there was criticism on technical analysis because no attempts have been made by the proponents to test the predictions of the techniques used (Neely, et al. 1997). However, skepticism was vanquished and academics have been investigating the usefulness of technical analysis. Taylor and Allen (1992), (in Neely, et al, 1997), did research under 200 traders on the London foreign exchange market and came to the conclusion that if traders increase the frequency of trading, the use of technical analysis also increases. Brock, et al. (1992) and Levich and Thomas (1993), (in Neely, et al, 1997), tested the profitability of some technical analysis rules. They discovered that by applying these rules in combination with daily observations profit would have been achieved. However, there are four disadvantages to this research. The first disadvantage is that it still has to be investigated whether the profits would continue to exist if the research period is shorter than a couple of years. This must be clear since traders cannot afford to make losses in the short term, even if the investment yields a profit in the extremely long term. The second disadvantage is the use of daily observations. However, according to Bank for International Settlements, more than 75% of the observations take place within the day in surveys on foreign exchange trading. The third disadvantage is that the research by Brock, et al. (1992), (in Neely, et al, 1997), did not include the transaction costs in the calculation of the profit. The last disadvantage is that these studies contain ex post simulations for trading rules and these may be used by traders. However, there is no evidence that these rules are applied by traders. In addition, these rules contain a small part of a large number of possible trade rules (Curcio, et al. 1997). Curcio, et al. (1997) take into account transaction costs in their research into technical analysis. They came to the conclusion that technical analysis does not generate profit. Also Dooley and Shafer (1983), (in Neely, et al, 1997), conducted research on the profitability of technical analysis. The researchers came to the conclusion that large profits were made for the Yen, German Mark and Pound sterling with technical analysis. Sweeney (1986), (in Neely, et al, 1997), concluded that gains were made with technical analysis since a 4% return was achieved by applying technical analysis. However, the significance of these profits could not be reliably assessed in the studies of Dooly and Schafer (1983) and Sweeney (1986). Neely, et al. (1995) investigated the profitability of technical analysis for multiple combinations between the Swiss Franc, Dollar, Yen, German Mark and pound Dollar. Their significant positive results provide a consistent picture of the potential gains through technical analysis. Even though there are differences in the amount of profit opportunities. There were also profit opportunities from significant results in trade between yen / German mark and Swiss franc / pound which has not been scientifically proven before (Neely, et al. 1995). In summary, there is no consensus on profitability by applying technical analysis in trading.

Above studies were conducted decades ago. Therefore, it is to analyze an article that has an overview of all the studies carried out on profitability through technical analysis over the years. Park and Irwin (2007) conducted research into 95 modern studies. The results show that 56 studies that the application of technical analysis provides profit, 20 studies indicate the application does not lead to profit and 19 studies show that the application of technical analysis leads to profit and loss.

Blume, et al. (1994) investigated the applicability of the information role of volume for technical analysis. Technical analysts argue that volume and price data are indicators of future price movements and the data provides information about fundamentals that provide returns. Volume in trading causes changes in returns. Large volume in trading causes major changes in returns. This can be expressed in both directions: increases and decreases (Blume, Easley, & O'Hara, 1994).

3.7.1. Is technical analysis applicable to bitcoin?

There are a few scientific sources available which examined whether technical analysis is applied to bitcoin. This is notable since it is applied in weekly videos of Miss bitcoin (Madelon Vos) on YouTube. However, research has been conducted into the effects of volume on bitcoin returns, a component of technical analysis according to Blume, et al. (1994) and Antoniou, et al. (1997). They concluded that a large volume leads to major changes in returns both positive and negative. Kristoufek (2015), Ciaian, et al. (2016) and Ciaian, et al. (2017) researched the effect of volume on the bitcoin. They discovered that there is one important reason why volume has a positive effect on the bitcoin returns. The reason is the usage of bitcoin because volume in trading increases the utility of holding bitcoin (Kristoufek 2015). Ciaian, et al. (2017, p. 181) add to this that: "market participants may hold currencies to bridge the gap between receipts and payments and to facilitate daily transactions." The usage of bitcoin increases the holding of it and leads to an increase of bitcoin returns. Also Wang and Vergne (2017) researched the volume and concluded a positive impact on the bitcoin returns. Therefore, their results are consistent with the findings of Ciaian, et al. (2016), Ciaian, et al. (2017) and Kristoufek (2015). Garcia and Schweitzer (2015) concluded that increases in volume and opinion polarization are indicators of rising bitcoin returns. They also state that algorithm trading is based on technical analysis. In conclusion, it can be stated that technical analysis can be applied to bitcoin.

3.8 COMBINING THE THEORIES AND FACTORS

In section 2.3 is explained that bitcoin is a hybrid. It has been concluded that the bitcoin is a speculative investment with characteristics of an asset, commodity and currency. If bitcoin is adopted by companies and consumers, it has the potential to become a currency in the future. However, less volatility is needed in the price trend and therefore a more stable price. The applied financial theories on bitcoin explain returns such as the capital asset pricing model and the three-factor model of French and Fama. In both models, bitcoin cannot / partially meet the assumptions of the CAPM and the factors of the three factor model. Therefore, the theories are not applicable to bitcoin. In addition, research was carried out into models that determine the future price, such as cost-based method, demand and supply and technical analysis. The research showed that all three models are applicable to bitcoin. The cost-based pricing method is applicable for minors of bitcoin, because it can determine the cost price of bitcoin on the basis of energy costs through mining, technology development and reward for mining. Also all three factors can have an influence (positive or negative) on the bitcoin returns (Wang & Vergne, 2017; Kristoufek, 2017; Greenburg & Bugden, 2019). Miners also can calculate a premium on top of these total costs. Interesting for this study is Hayes' (2017) claim that traders are able to estimate the price of bitcoin based on the cost price. Multiple researchers concluded that the demand and supply are the main forces of the bitcoin returns. The demand side is driven by the value of bitcoin in future exchanges whereas the supply side are bitcoins in circulation. Miners are responsible for bitcoins in circulation since they increase the circulation of bitcoins and record the transactions in the blockchain. Therefore, the demand and supply method is applicable on bitcoin. One component of the technical analysis is volume since large volumes cause major changes (positive and negative) in returns (Blume, et al. (1994). Kristoufek (2015), Ciaian, et al. (2016), Ciaian, et al. (2017) and Wang and Vergne (2017) researched volume in relation to bitcoin returns and found positive and significant results. In addition Garcia and Schweitzer (2015) stated that algorithm trading is based on technical analysis. By algorithmic trading, ten strategies for trading in bitcoin where developed by which they achieved big profits in a year. Therefore, technical analysis can also be applied to bitcoin. In conclusion, it can be argued that theories that use risk in combination with expected return are not applicable to bitcoin and models that predict the future are applicable to bitcoin returns.

Two interesting factors arise from the cost-based pricing model; energy costs and technological development. Technological development is positive and significant on bitcoin returns (Wang & Vergne, 2017). However, technological development is not feasible, since the eight factors that determine technological development are not all public on CoinGecko. Also, there is no information available on the weight of the eight components in determining technological development. Hayes (2017) research on energy costs did not show whether it has a positive or negative influence on bitcoin returns. This will therefore be further investigated in this study. In the demand and supply theory section is concluded that public interest, supply growth, interest rates, inflation rates and the S&P 500 can be linked to demand and supply theory and are applicable to bitcoin. New posts capture the attention driven behavior on bitcoin forums and reflects an increasing acceptance and trust in bitcoin. This results in declining uncertainty and transaction costs for bitcoin traders which raises demand for bitcoin and leads to a higher returns (Ciaian, Rajcaniova, and Kancs 2016). The long-term effects of new posts are significantly positive on bitcoin. New posts results in higher prices and returns. Ciaian, et al. (2016), Wang and Vergne (2017) and Kristoufek (2013) and Kutlu, et al. (2017) researched public interest and came to the conclusion that it can also be applied to bitcoin. However, there is more consensus on the negative effect of public interest on the bitcoin returns. Wang and Vergne (2017) and Kutlu, et al. (2017) found a negative significant result for public interest on bitcoin returns. Kristoufek (2013 and 2015) found evidences for both directions on daily search volume on Wikipedia, see figure 9 on page 53 in the appendix. This also applies to supply growth. Ciaian, et al. (2016) and Wang and Vergne (2017) researched the effect of supply growth on bitcoin returns and came to different conclusions. Ciaian, et al (2016) found negative significant results and Wang and Vergne (2017) found positive significant results. Hong (2017) found evidence that investors in the S&P 500 are able to achieve more returns by adding bitcoin to their portfolio. The greater the position of bitcoin in the portfolio, the higher the return. This makes the bitcoin an alternative investment/substitute for the S&P 500. However, an investor takes a higher risk due to volatility.

According to section 2.3, bitcoin has a few characteristics of a currency. Currencies are influenced by inflation and interest rates. Purnomo (2017) stated that changes in interest rates and inflation cause changes in supply and demand and effects returns. Long, et al. (2013) add expected returns going one on one with inflation. Dyhrberg (2016) stated that bitcoin is digital gold and claims that the dollar can be hedged against bitcoin. Notable are the similarities and differences of bitcoin and the comparison is debatable. If this claim is true, it means that a decrease in interest rates or low interest rates leads to more demand for bitcoins and higher returns for bitcoin investors. Hong (2017) stated that high inflation leads to more demand in bitcoins, which also yields more returns for bitcoin traders. According to Purnomo (2017) a higher interest rate leads to more demand in a currency. Also interest rate and inflation can strengthen bitcoin in a substitute/ alternative investment. A substitute is part of competitors in the Porter (2008) model and this model is linked to the theory of supply and demand.

Blume, et al. (1994) and Antoniou, et al. (1997) concluded that volume is part of technical analysis. Ciaian, et al. (2016), Ciaian, et al. (2017) and Kristoufek (2015), Wang and Vergne (2017) and Garcia and Schweitzer (2015) conducted research into volume in relation to bitcoin price and came to the conclusion that volume is applicable to bitcoin and it has a positive effect on the price.

3.9 HYPOTHESIS

In this section hypotheses are formulated from the theoretical framework based on the cost based pricing theory, demand and supply theory and technical analysis.

<u>Cost-based pricing theory</u>

The cost-based pricing theory section showed the influence of the energy price on the cost price of bitcoin. Cheap energy could lead to cheaper bitcoin which leads to more demand for bitcoins. This can boost the returns. Also, bitcoin miners look for the cheapest places (low energy prices) to mine. However, it is not clear whether the energy price has a positive or negative effect on the bitcoin returns since no previous research have been carried out. It can be assumed that energy prices have a positive impact on bitcoin returns. Therefore the following hypothesis is proposed:

1. Energy prices have a positive impact on the bitcoin returns.

<u>Demand and supply theory</u>

The demand and supply section showed the positive influence of new post on bitcoin returns. The more new posts, the more trust there is in bitcoin. Search volume on Google has a negative influence on the bitcoin returns. However, Google is a more powerful medium than a bitcoin blog. Therefore, it is assumed that public interest has a negative effect on bitcoin returns. Supply growth also influences bitcoin returns, but there is no consensus about what influence (positive or negative). However, based on conducted research can be expected that the price drops as a result of the increase in the number of bitcoins and therefore supply growth has a negative effect on bitcoin returns. The stock market returns (S&P 500) can be applied the demand and supply theory. According to the theory, the S&P 500 must have a positive influence on the bitcoin returns. Also, interest rates and inflation rates can have an influence on bitcoin returns. High inflation rates leads to more demand for bitcoins and therefore it is assumed that it has a positive effect on bitcoin returns. No previous research has been carried out into the effects of interest rates on bitcoins returns. Emerged from the demand and supply the following six hypotheses are proposed:

2. Public interest has a negative impact on bitcoin returns.
3. Supply growth has a negative impact on bitcoin returns
4. Inflation rates have a positive impact on bitcoin returns
5. Interest rates have a positive impact on bitcoin returns
6. Stock market returns have a positive effect on bitcoin returns.

<u>Technical analysis</u>

The technical analysis section showed that volume has a positive influence on bitcoin returns. There is unanimous consensus among researchers on the positive effect of volume on bitcoin returns. Therefore the hypothesis is as follows:

7. Volume growth has a positive impact on bitcoin returns

4. Methodology

The methodology chapter explains which research method is used in this research. Furthermore the research methods of comparable studies are described. This chapter consists of the following components; selection & sample, measurement, data collection, data analysis, descriptive statistics and correlations.

In a previous study by Ciaian, et al (2016), the stationary of time series was first tested to prevent spurious regression results. This was done by four unit four tests namely Dicky Fuller test, Zivot Andrews, Clemente Montañés Reyes test and Dicky Fuller GLS. The three outcomes based on these tests are: All variables are stationary, non-stationary or there is a mix. If all variables are stationary a Vector error correction (VEC) is suitable. If all variables are non- stationary a VAR model is appropriate and if the variables are mixed the auto regressive distributed lag (ARDL) is applicable. Finally, Ciaian, et al. (2016) chose for a VEC, VAR and ARDL model and in Ciaian, et al. (2017) is only chosen for the ARDL method. However, these methods cannot be executed in SPSS. Several researchers (Hayes (2017), Blau (2018), Wang and Vergne (2017) used a certain form of regression analysis in their studies on bitcoin. This research has several independent variables and one dependent variable. Therefore, the multiple regression research method is chosen for this study. Multiple regression analysis is described by Hair, et al. (2006, p. 176) as: "a statistical technique that can be used to analyze the relationship between a single dependent (criterion) variable and several independent (predictor) variables”. This is also underlined by Huizingh (2007) and adds that multiple regression is selected to decide if a linear relationship exists between multiple independent variables and a dependent variable. According to Henseler (2017) and Hair, et al. (2006), multiple regression can be applied if the independent variables and the dependent variable are metric. In addition, Henseler (2017) stated that regression analysis is a frequently chosen research method and that it can be applied to analysis of causes (causal relationships), forecasting the impact or something and time series analysis. Causal relationships are being investigated in this thesis, since the effect of independent variables on the dependent variable is examined.

The study by Wang and Vergne (2017) is the most similar to this study. Wang and Vergne (2017) investigated the effects of independent variables on weekly returns of multiple cryptocurrencies (dependent variables). However, this study only focused on bitcoin since only this coin has more than 50% of the market capitalization. Therefore, with one independent variable a large part of the research is done in cryptocurrencies. This research is also wider than the research of Wang and Vergne (2017). Their research focused on 1 year (September 2014 to August 2015) and this research focused on the period 1 May 2013 until April 2019. This observation period was chosen since reliable information is available on Coingecko.com and Coinmarketcap.com. Research is conducted on a weekly basis to increase the reliability of this research, since the research is done for a longer period. The previous sections in this study showed that variables are linked to theories. The energy price is linked to the cost-based pricing model, the variables public interest (new post and search volume on Google), inflation rates, interest rates, stock market returns (S&P 500) and supply growth are linked to demand and supply theory and that the variable volume is linked to technical analysis.

According to equations of Huizingh (2007), Ciaian et al. (2016), Wang and Vergne (2017) and Blau (2018) the equation applied to this research is as follows:

$$Bitcoin\ returns_t = \beta_0 + \beta_1\ Energy\ price_t + \beta_2\ Public\ interest_t + \beta_3\ Supply\ growth_t + \beta_4\ Inflation\ rates_t + \beta_5\ Interest\ rates_t + \beta_6\ Stock\ market\ returns_t + \beta_7\ Volume\ growth_t + \varepsilon_t$$

4.1 SAMPLE, SELECTION AND DATA COLLECTION

A statistical power of 0.8 is a good starting point for a reliable multiple regression analysis (Hair, et al. 2006; Henseler, 2017). To achieve 0.8 statistical power, the sample size must be at least 50 observations in most research situations (Henseler, 2017). According to Henseler (2017), the minimum ratio of observations is 5 observations to 1 variable. In this research there are 11 variables which means the minimum of observation is 55. This number of observations is above the minimum number of observations. However, more observations are made to achieve a higher statistical power. (Henseler, 2017). The observation period of this study is from May 2013 to April 2019 (6 years). This research is based on weekly data. Thereby, there are a maximum of 312 observations per variable. This is above the minimum number of 50 observations per variable to achieve a static power of 0.8 (Henseler, 2017). In line with Wang and Vergne (2017), weekly data is chosen for this research. Wweekends are excluded from the data since it is not possible to trade in currencies everywhere (dollar / euro exchange rate acts as a control variable). This prevents errors in measuring points and ensures that all variables are measured on the same data.

This research focuses only on bitcoin returns. The three reasons for this decision are as follows:

1. In scientific literature most studies on cryptocurrency focus on bitcoin.
2. Bitcoin dominance in the crypto market has almost always been above 50% till April 2019.
3. Since bitcoin's market cap amounts to tens of billions dollar ($ 70.9 billion on March 21, 2019), this crypto coin is less susceptible to manipulation by large investors than other altcoins with less market cap (coinmarketcap, 2019). To give the reader an impression of the difference in market cap with other currencies in comparison with bitcoin, the market cap of the second largest coin Ethereum is given and amounts 14.3 billion on 21 March 2019. The base of bitcoin is therefore more stable than that of altcoins. This choice must ensure that a reliable research can be carried out.

Table 1 shows the monthly returns. It can be concluded that huge returns and losses can be achieved with trading in bitcoin. Therefore, this research is split into two periods, in addition to the entire research period, to investigate whether the independent variables show the same effects in the different periods on bitcoin returns.

Table 1. Monthly bitcoin returns, retrieved from Coinmarketcap (2019)

Year	Jan	Feb	Mrt	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	-	-	-	-	-	-0,80%	-25,02%	19,09%	28,12%	-5,90%	66,58%	340,80%
2014	-1,35%	-12,57%	-30,54%	-19,16%	-5,56%	47,43%	-2,80%	-5,85%	-17,86%	-31,51%	0,33%	14,26%
2015	-29,80%	-15,17%	15,36%	0,50%	-7,80%	-4,21%	17,76%	4,32%	-15,16%	-0,74%	36,86%	19,65%
2016	10,28%	-14,12%	10,40%	3,32%	7,27%	27,14%	14,65%	-5,22%	-2,47%	0,33%	16,33%	8,81%
2017	29,12%	2,98%	23,25%	-12,98%	22,24%	86,34%	-0,55%	28,59%	42,92%	-4,26%	68,42%	52,84%
2018	24,72%	-41,39%	39,44%	-40,65%	40,92%	-19,94%	-17,38%	10,70%	3,06%	-9,06%	-3,87%	-34,83%
2019	-1,66%	-14,99%	10,90%	6,77%	-	-	-	-	-	-	-	-

The data for the bitcoin price, volume and bitcoins in circulation are retrieved from coinmarketcap.com. These are two reliable and well-known information sources for the trade in bitcoins. The information for energy prices comes from the Dutch website Central Bureau of Statistics (CBS). This Dutch institution conducts research for the government, science and business. The limitation is the focus of this research on energy prices in The Netherlands. However, this data is very reliable and focuses on energy costs other than the prices of gas, oil and coal. These raw materials have much more applicability then provide miners with energy. On the website of CBS, the transaction price of energy over 150,000 mwh is chosen. The data is in euros and has been converted into dollars with the exchange rate of the relevant month. The article from Deingenieur (2017) showed that there are 300,000 bitcoin transactions every day and that each transaction consumes 200 kWh of energy. Monthly this amounts to 1,800,000,000 Kwh which is 1,800,000 mwh. Data of energy prices are available until the end of 2018. The variable new post is retrieved from the website bitcointalk.org. New post data is available until the end of 2017. Search on Google is extracted from the website Google Trends (https://trends.google.com/trends/). The data from Google trends is only available in a scale from 0 (minimum) to 100 (maximum). Research is done on the search term "bitcoin" for Google. Inflation is based on US inflation because this is the largest market in the world. It is retrieved from the website usinflationcalculator.com. US interest rates are retrieved from the Federal Reserve. The exchange rates for USD/JPY, USD/Euro, Euro/USD and the S&P 500 index are retrieved from investing.com. (Wang & Vergne, 2017; Ciaian, et al. 2016; Kristoufek, 2013; Kristoufek, 2015)

4.2 MEASUREMENT

The previous section explained why the only dependent variable of this study is the monthly bitcoin return. In this section the independent variables are explained and structured based on the linked theory as described in chapter 3.

4.2.1 Dependent variable

The dependent variable of this research is the bitcoin return. According to Campbell and Schiller (2002) and Siddikee (2018), researchers use arithmetic return or logarithmic return when calculating return. Osterrieder, et al. (2017) Kristoufek (2013) and Pichl and Kaizoji (2017) logged the bitcoin returns in their research. Pichl and Kaizoji (2017) explained the advantage of applying logarithmic return, namely: "The advantage of the logarithmic return over the prices is a symmetric representation of price increase and decrease by the same multiple, which differ only by the sign of the respective log return; constant price levels are represented by the zero return, and, importantly, unlike from the non-stationary price process, the time series of logarithmic return can often be approximated as stationary" (Pichl & Kaizoji, 2017, p. 478). Therefore, logarithmic returns are used in this study. According to Siddikee (2018) and Pichl and Kaizoji (2017), the bitcoin return can be represented in the equation below;

$$Bitcoin\ returns_t = Ln\ (Bitcoin\ price_{t+1}\ /\ Bitcoin\ price_t)$$

4.2.2 Independent variable

The independent variables in this research are energy prices, public interest, supply growth, interest rates, inflation rates, stock market returns and change in volume. In this section the independent variables are subdivided into, cost-based pricing model, demand and supply theory and technical analysis.

Section 3.5 shows that according to Hayes (2017) energy prices are the largest part of the bitcoins cost price. This is due to the mining (production process) of bitcoin. Therefore section 3.5 shows that the cost-based pricing model can be applied to bitcoin by linking the price movement of energy prices to the bitcoin return. However, Hayes did not investigate the effects of energy price on bitcoin returns and did not indicate the effect (positive or negative) of the energy prices on bitcoin return. However, in this research it is assumed that a lower energy price leads to more demand for bitcoins and therefore energy prices have a positive impact on bitcoin returns. Section 3.6 shows that the demand and supply theory can be applied to bitcoin. This theory is represented by the variables supply growth, new post and public interest on Google and Wikipedia, inflation, interest rates and S&P 500. For all these variables, a link with the bitcoin price has been established in previous studies (Kristoufek, 2013; Kristoufek, 2015; Kutlu, et al. 2017; Ciaian, et al. 2016; Wang and

Vergne, 2017). The studies by Kutlu, et al. (2017), Kristoufek (2013), Kristoufek (2015) and Ciaian et al. (2017) found evidence that the number of search results on Google related to bitcoin have an effect on its return. It was stated earlier in the study that there is no agreement on the types of effects (positive or negative) of public interest on bitcoin return. For new post and search volume on google (scale from 0 to 100) the absolute numbers are used which is in line with Ciaian, et al. (2016).

Ciaian, et al (2016) and Wang and Vergne (2017) found evidence for the effect of supply growth on the bitcoin returns. There was no agreement on the consequences (positive or negative) of supply growth on bitcoin returns between the two studies. However, it is assumed that the increase in the number of bitcoins have a negative effect on bitcoin returns. According to Wang and Vergne (2017) supply growth can be represented in an equation as follows:

$$Supply\ growth_t = (Suppy_{t+1} - Supply_t)/\ Supply_t$$

As the theory shows, inflation rates, interest rates and stock market returns (S&P 500) can have a reinforcing effect on bitcoin as a substitute and thereby increase bitcoin returns. Hong (2017) stated that high inflation leads to an increasing demand in bitcoin. Therefore, inflation has a positive effect on bitcoin returns. Bitcoin is a substitute for S&P 500 and adding bitcoin to a S&P 500 portfolio yields more returns (Dyhrberg, 2016; Hong, 2017). Changes in interest rates have an influence on the supply and demand of currencies (Purnomo, 2017). Since bitcoin has characteristics of a currency, it is possible that bitcoin will respond to changes in interest rates. Interest rates and inflation rates are available in absolute numbers. According to Investopedia (2018), the dividends are included in the S&P 500 index level. In the research of Hong (2017) there is no equation for S&P 500 returns. Given the advantage of logarithm return, described by Pichl and Kaizoji (2017), logarithm return is also applied to stock market returns. The stock market returns has the following equation:

$$Stock\ market\ returns_t = Ln\ (Index\ level\ S\&P\ 500_{t+1}\ /\ Index\ level\ S\&P500_t)$$

As described in section 3.7, technical analysis is applicable to bitcoin and this model is represented by the independent variable volume (Blume, et al. 1999). Several studies by Ciaian, et al. (2016), Ciaian, et al. (2017) and Kristoufek (2015), Wang and Vergne (2017) and Garcia and Schweitzer (2015) concluded that volume has a positive effect on the bitcoin return. According to Wang and Vergne (2017) the equation for volume is:

$$Volume\ growth_t = (Volume_{t+1} - Volume_t)/\ Volume_t$$

4.2.3 Control variables

Most of the crypto data is shown in US dollars. However, currencies can appreciate or devalue against another currency, for example the dollar versus euro. According to Ciaian, et al (2016, p. 1806), this has an effect on bitcoin returns and state that: "if the US dollar would appreciate against euro, most likely it would also appreciate against the BitCoin". So fewer dollars are needed to buy a bitcoin and this results in a decline of the bitcoin returns. Therefore, one control variable is the exchange rate of USD/Euro. A recent article from February 2019 also shows that the Japanese Yen has passed the dollar as the largest currency with which bitcoins are purchased (Engelbarts, 2019). The Japanese crypto market is better regulated by the Japanese regulator which could be an important reason (Financial Services Authority) then the SEC (American regulator). Therefore it has been decided to add the USD / JPY exchange rate as a second control variable.

4.3 DATA ANALYSIS

As described in the introduction of this chapter, multiple regression is used in this research. Henseler (2017), Hair, et al. (2006) and Huizingh (2007) stated that multiple regression can only be applied if both the dependent variables and the independent variable are metric which corresponds to this research. Bitcoin returns, energy prices, search volume on Wikipedia, search volume on Google, new post, supply growth and volume are metric variables. Henseler (2017) claims that multiple regression is one of the most chosen data analysis methods and the method is applicable to analysis of causes, forecasting the impact or something and time series analysis. The decision process of multiple regression consists of six stages which is summarized in figure 10 (Henseler, 2017, p.7). This figure is shown in the appendix on page 54.

Ciaian, et al. (2016) and Ciaian, et al. (2017) split their sample in two periods to examine whether variables have the same or different effects in two periods. Looking at the significance, it can be concluded whether there are similarities or differences in a variable. Therefore, in this study the sample is split up in two periods. The first period is from 1 May 2013 to 30 April 2016 and the second period from 1 May 2016 to 30 April 2019. These periods have been chosen since there was a sharp rise and fall in bitcoin price in both periods. Also, a regression analysis is carried out over the entire period (May 2013-April 2019). For example, search volume on Wikipedia can be positive significant in period 1, positive but not significant in period 2 and positive and significant in the total period. If the research is only carried out over the entire period, erroneous conclusions are drawn for period 2. In this way reliable conclusions can be drawn in similarities and differences on the same variable over multiple observation periods and the total observation period.

4.3.1 Assumptions in multiple regression analysis

According to Hair, et al. (2006) and Henseler (2017), multiple regression must meet four assumptions to calculate the regression coefficient and to predict the dependent variable. Each assumption is explained in this section. The four assumptions are: "linearity of the phenomenon measured, constant variance of the error terms, independence of the error terms and normality of the error term distribution" (Hair, et al. 2006, p. 204).

Linearity of the phenomenon measured

The linearity of the phenomenon measured can be described as: "the relationship between dependent and independent variables represents the degree to which the change in the dependent variable is associated with the independent variable" (Hair, et al. 2006, p.205). The range of values of the regression coefficient must be constant for the independent variable (Hair, et al. 2006). The correlation between dependent variable and independent variables must be characterized by a linear relationship which is of great importance during the multiple regression analysis. The linearity of the relationship can be assessed by applying a normal P-P plot (Huizingh; 2007). Corrective measures must be taken if a constant curvilinear pattern is visible in the residuals. According to Hair, et al. (2006) there are three corrective measures:

1. Data values from independent variables must be transformed.
2. Nonlinear relationships must be included directly. This can be achieved by applying polynomial terms.
3. Applying methods which are developed to accommodate curvilinear effects of independent variables. For example nonlinear regression.

Constant variance of the error term

Unequal variances, also called heteroscedasticity, is a common threat in the assumption of multiple regression (Hair, et al., 2006). Heteroscedasticity can be determined by residual plots or simple statistical tests. SPSS has the Levene test to determine the homogeneity of variance and measures the equality of variances for two or more variables (Hair, et al., 2006). The Levene test is recommended by Hair, et al. (2006) since it is disturbed to a lesser extent by deviations from normality which is also a common problem during multiple regression analysis. Two solutions are possible if there is heteroscedasticity. The first solution is that if the threat comes from one independent variable through residual plots, the weighted least squares procedure can be applied. The second solution is that a number of variance stabilizing transformations can be applied. These transformations allow the transformed variables to achieve homoscedasticity (equal variance) in the multiple regression analysis. However, a Levene test is not possible because there are more than 50 groups within bitcoin returns. According to Huizingh (2007) and (Institute for digital research & education, 2019), a scatter plot must be performed with the standardized residuals (ZRESID) and standardized predictions (ZPRED). Therefrom it can be deduced whether there is heteroscedasticity or homoscedasticity.

Independence of the error terms

During the multiple regression analysis, every predicted value must be independent so that the predicted value is not linked to another prediction of another variable (Hair, et al., 2006). The independence can be easily tested by plotting residuals against another variable. If the pattern is random and equal to the null plot (in the form of a circle), there is independence of the error terms. Disruptions in the independence can be detected by a consistent pattern in the residuals (Hair, et al. 2006). According to Huizingh (2007), the Durbin Watson test can be applied to test the independence of variables. The Durbin Watson value goes from 0 to 4. With a value close to 2, there is no autocorrelation. There is a positive autocorrelation if the value is smaller than 2. A high value means a negative autocorrelation. The rule of thumb for the Durbin Watson test is that the error terms independence is not met if the value is lower than 1 and higher than 3 (Huizingh, 2007). Haery et al. (2013) add to this that there is no autocorrelation between residuals with a Durbin Watson score between 1.5 and 2.5.

Normality of the error term distribution

According to Hair, et al. (2006) non-normality of the independent and dependent variables is the most common assumption threat. The easiest method to establish the normality of the error term distribution is by performing a histogram of the residuals (hair, et al., 2006). Thereby, it is possible to deduce from the histogram in a fairly simple manner whether there is normality or the error term distribution. An alternative method is to execute the normal probability plot. By this method, the normal distribution of residuals can be recognized by the fact that the residual line must close follow the line (Hair, et al. 2006).

4.3.2 Corrective measures and specification test

According to Henseler (2017), influentials, leverage points and outliers caused by the conditions are shown below. Each of the condition contains a different solution.

1. A mistake during the observations or when entering data. The solution is to correct the mistakes in the observations or delete the data.
2. An exceptional observation which is valid but can be explained by an extraordinary situation. The solution can be realized through the deletion of the case. It may not be deleted if variables representing the extraordinary situation.
3. An observation which is exceptional and has no commentation. The solution is that there are no arguments to delete this observation since it represents an exceptional observation. Henseler (2017) indicates that an analysis with and without exceptional observation must take place to be able to determine whether there are differences between the two analyses.
4. A normal observation of the individual characteristics but infrequent in the composition of the features suggest changes in conceptual basis. Therefore nothing needs to be deleted.

Multicollinearity

Huizingh (2007, p.309) defined multicollinearity as: “multicollinearity refers to high correlation among independent variables”. Hair, et al (2006, p. 186) underlined this definition and stated that: "the impact of multicollinearity is to reduce any single independent variable's predictive power by the extent to which it is associated with the other independent variables". According to Hair, et al. (2006), multicollinearity can be tackled if the researcher collect independent variables which have a low correlation with each other. However, there must be a high correlation between the dependent variable and independent variables (Hair, et al. 2006). A suitable test to determine the multicollinearity is the variance inflation factor (Huizingh, 2007; Henseler, 2017). A rule of thumb for the VIF is that there is multicollinearity with a value higher than 10 (Huizingh, 2007). A value of the VIF below 10 is required to conclude that there is no question of multicollinearity. A VIF value below 5 is even better (Henseler, 2017).

Coefficients correlation

An analysis of correlation provides insight into the relationship between two variables and shows the strength and direction between each other. A method to determine the coefficients correlation is the Pearson correlation (Huizingh, 2007). A strong correlation is a Pearson score of 0.6, -0.6 or higher (McSeveny, et al., 2009). Variables that have a higher correlation than these scores are therefore tested separately to create a reliable study.

4.4 Descriptive statistics and correlations

Table 2. Descriptive Statistics data

	May 2013 - April 2016					May 2016 - April 2019					May 2013 - April 2019				
Variables	**N**	**Min**	**Max**	**Mean**	**S.D.**	**N**	**Min**	**Max**	**Mean**	**S.D.**	**N**	**Min**	**Max**	**Mean**	**S.D.**
Bitcoin return	155	-0,130	0,251	0,004	0,052	157	-0,153	0,150	0,007	0,051	312	-0,153	0,251	0,005	0,051
Energy price	156	0,077	0,126	0,100	0,015	140	0,009	0,104	0,078	0,012	296	0,009	0,126	0,090	0,017
S&P 500 Return	155	-0,064	0,036	0,002	0,017	157	-0,074	0,049	0,002	0,018	312	-0,074	0,049	0,002	0,018
Google	156	2,000	12,000	3,628	2,317	157	3,000	100,000	15,962	17,900	313	2,000	100,000	9,815	14,178
New post	156	5205,000	23458,000	11895,237	4129,450	85	6060,000	63672,000	19776,294	14532,948	241	5205,000	63672,000	14674,863	9958,636
Supply growth	155	0,000	0,005	0,002	0,000	157	0,001	0,002	0,001	0,000	312	0,000	0,005	0,001	0,001
Volume growth	121	-0,785	7,089	0,294	1,134	157	-0,628	2,373	0,106	0,450	278	-0,785	7,089	0,188	0,825
Interest rates	156	0,060	0,380	0,133	0,088	157	0,340	2,440	1,300	0,697	313	0,060	2,440	0,718	0,767
Inflation rates	156	-0,200	2,100	1,031	0,730	157	0,800	2,900	2,013	0,531	313	-0,200	2,900	1,524	0,805
USD-Euro	156	0,719	0,941	0,818	0,078	157	0,805	0,959	0,878	0,038	313	0,719	0,959	0,848	0,068
USD-JYEN	156	96,160	124,850	110,528	9,346	157	100,630	117,540	109,344	3,722	313	96,160	124,850	109,934	7,099

The descriptive statistics above show the number, minimum value and maximum value, mean and standard deviation of the (in)dependent variables in the three different research periods. May 2013 – April 2019 is the full sample period. Earlier in this thesis it was indicated that the sample period was split into two periods. The first sample period is therefore May 2013- April 2016 and the second sample period is May 2016 – April 2019. The variables bitcoin return, S&P 500 return, supply growth and volume growth are in percentage. Energy price, Google, new post, interest rates, inflation rates, USD/Euro en USD JYEN are in absolute values.

Table 3. Coefficients correlation matrix 1 May 2013 - 30 April 2019

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Bitcoin return	1										
2. Energy price	-0,016										
3. S&P 500 Return	0,036	-0,012	1								
4. Google	0,077	-,214**	0,013	1							
5. New post	0,166**	-,191**	0,059	0,828**	1						
6. Supply growth	-0,022	0,713**	0,004	-,382**	-,328**	1					
7. Volume growth	0,143*	0,097	0,026	-0,015	0,085	0,070	1				
8. Interest rates	-0,037	-,392**	0,010	,418**	0,643**	-,736**	-0,117	1			
10. Inflation rates	-0,007	-,134*	0,024	,364**	,410**	-,441**	-0,069	0,588**	1		
11. USD/EURO	0,013	-,743**	-0,026	-0,042	-,130*	-,599**	-0,102	,260**	-,185**	1	,511**
12. USD/JYEN	-0,013	-,306**	-0,028	0,025	-0,017	-,222**	-0,014	0,068	-,305**	,511**	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

It can be deduced from the Pearson correlation matrix that a number of variables correlate too much (higher than 0.6) with each other for the period 1 may 2013 till April 2019. New post and Google correlate too much with each other (higher than (,828**) and must be tested separately. Supply growth must be tested separately from energy price (0,713**). Interest rates must be tested separately from new post (,643**) and supply growth (-,736**). USD/Euro (-,743**) must also be tested separately from energy price. Variables must be tested separately to account for correlation. Therefore the full sample period has been tested in seven models with different combinations of variables. All variables were tested in models 1 and 2. In model 3 the cost-based pricing model variable has been tested. Demand and supply variables were tested in models 4 and 5. In model 6 the technical analysis variable was tested and in model 7 all variables. The overview of the variables in different models can be found in table 9 on page 54.

Table 4. Coefficients correlation matrix 1 May 2013 - 30 April 2016

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Bitcoin return	1										
2. Energy price	0,099	1									
3. S&P 500 Return	-0,051	0,076	1								
4. Google	0,153	,389**	0,020	1							
5. New post	-0,116	,180*	0,034	,459**	1						
6. Supply growth	-0,034	,702**	0,038	,259**	0,112	1					
7. Volume growth	0,115	0,138	0,059	,191*	,252**	-0,080	1				
8. Interest rates	-0,015	-,659**	0,019	-,197*	-,224**	-,380**	-0,126	1			
10. Inflation rates	-0,001	,557**	0,035	,219**	,487**	,455**	0,025	-0,155	1		
11. USD/EURO	-0,035	-,876**	-0,084	-,405**	-,518**	-,630**	-0,113	,554**	-,797**	1	,894**
12. USD/JYEN	-0,071	-,803**	-0,069	-,289**	-,381**	-,668**	-0,100	,317**	-,809**	,894**	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

From the correlation matrix (previous page) can be concluded that supply growth (,702**), interest rates (-,659**), USD/Euro (-,876**) and USD/JYEN (-,803**) correlate too much with energy price and must be tested separately from it. Supply growth correlates too much with USD/Euro (-,630**) and USD/JYEN (-,668**). USD/Euro (-,797**) and USD/JYEN (-, 809**) correlate too much with inflation rates. USD/euro (,894**) correlate too much with USD/JYEN and vice versa (,894**). All these variables will be tested separately for the period may 2013 till April 2016. Variables were also tested separately in this sample to take account for the correlation between variables. In models 1 to 4 all variables are tested together. The cost-based variable was tested in model 5. In model 6 the demand and supply variables were tested and in model 7 the technical analysis variable. In model 8 all variables were tested simultaneously. For an overview of the models, reference is made to table 10 on page 55.

Table 5 Coefficients correlation matrix 1 May 2016 - 30 April 2019

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Bitcoin return	1										
2. Energy price	-0,130	1									
3. S&P 500 Return	0,120	-0,143	1								
4. Google	0,081	0,092	0,002	1							
5. New post	,305**	0,128	0,085	,837**	1						
6. Supply growth	0,093	-,257**	0,067	-0,118	-,221*	1					
7. Volume growth	,278**	-0,130	-0,018	0,058	0,109		1				
8. Interest rates	-0,128	,436**	-0,016	0,154	,746**	-,484**	-0,090	1			
10. Inflation rates	-0,074	0,128	-0,013	,196*	,288**	-,503**	-0,044	,434**	1		
11. USD/EURO	0,072	-,179*	0,045	-,556**	-,724**	0,127	0,098	-,433**	-,217**	1	0,055
12. USD/JYEN	0,053	0,040	0,018	0,126	0,192	-,365**	0,045	,226**	,346**	0,055	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The correlation matrix for the period from May 2016 to 30 April 2019 has three too high correlations that will be tested separately. These correlations are new post (,837**) with Google, Interest rates (,746**) and USD/Euro (-,724**) with new post. The last sample consists of seven models. Models 1 and 2 test all variables together. Model 3 is the cost-based pricing variable, models 4 and 5 are the demand and supply variables, model 6 is the technical analysis variable and model 7 test all variables simultaneously. An overview of which variable each model consists is shown in table 11 on page 55.

5. Results

The results of this report are analyzed in this chapter. As described earlier, research has been conducted in the period from 1 May 2013 to 20 April 2019. Also this research period has been split into two periods in order to discover differences or similarities in the same variable. These two different periods run from 1 May 2013 to 30 April 2016 and 1 May 2016 to 30 April 2019. All three periods (including the entire period) are shown in these paragraph. It is a one-sided test because it is examined whether the predictive (independent) variables influence bitcoin returns and not vice versa. Therefore the P value is calculated by dividing the P value by 2. If the unstandardized beta coefficients were not in line with the alternative hypothesis, the formula 1- (P value / 2) was applied. For energy prices, S&P 500 return, volume growth, interest rates, inflation rates USD/EURO and USD/JYEN a positive beta (β>0) is expected and for Google, new post and Supply growth a negative beta (β<0) is expected. It was decided to look at the standardized betas because they facilitate comparisons between regression coefficients (Huizingh, 2007). (Huizingh, 2007; Vos, 2015).

5.1 RESULTS ENTIRE RESEARCH PERIOD

The multiple regression analysis for the entire research period consists of seven models because of correlations between variables. Variables with correlations to each other have been tested in separate models to get reliable results. For example new post and Google that have a high correlation with each other. In models 1 and 2 all variables are tested. In model 3 the cost-based pricing theory is tested. In models 4 and 5 the demand and supply theory is analyzed and in model 6 the technical analysis. All variables are tested in model 7. From this multiple regression analysis it becomes clear that volume growth (models 1, 2, 6 and 7) is significant at a level of 0.05 and 0.01 and has a positive influence on bitcoin returns. Supply growth is tested in three models (2.5 and 7). Only in model 7 is this significant at a level of 0.1. Therefore, supply growth has a negative impact on bitcoin returns. At the same time there is no autocorrelation between residuals since all Durbin Watson scores are between 1.5 and 2.5. The explanatory power (adjusted R Square values) is low.

Table 6. Results 1 May 2013 - 30 April 2019

Variabeles / Models	1	2	3	4	5	6	7
Energy price	**-0,180**		**-0,016**				**-0,214**
	0,228		*0,180*				*0,492*
S&P 500 Return	**0,021**	**-0,098**		**0,036**			**-0,096**
	0,165	*0,194*		*0,167*			*0,192*
Google	**0,111**			**0,111**			**0,239**
	0,000			*0,000*			*0,001*
New post		**0,228**			**0,141**		**0,116**
		0,000			*0,000*		*0,000*
Supply growth		**-0,134**			**-0,078**		**-0,189***
		7,851			*4,734*		*8,568*
Volume growth	**0,145*****	**0,132****				**0,143*****	**0,127****
	0,004	*0,003*				*0,003*	*0,003*
Interest rates	**-0,138**			**-0,084**			**-0,268**
	0,006			*0,005*			*0,022*
Inflation rates	**0,051**	**0,026**		**0,001**			**0,071**
	0,005	*0,005*		*0,005*			*0,006*
USD-Euro		**0,125**					**-0,007**
		0,075					*0,107*
USD-JYEN		**0,200**					**0,046**
		0,000					*0,000*
N	261	206	295	312	240	278	206
Adjusted R2	0,041	0,103	-0,003	0	0,025	0,02	0,119
Durbin Watson	2,243	2,257	1,83	1,874	1,795	2,097	2,335
*** Correlation is significant at the 0.01 level							
** Correlation is siginificant at the 0.05 level							
* Correlation is siginificant at the 0.1 level							

5.2 Results first research period

The first research period has been split into 8 models. Models 1 to 4 are all variables in different settings taking into account the Pearson correlation. Model 5 is the cost-based pricing theory, 6 represents the demand and supply model, 7 is the technical analysis model and model 8 are all variables together. Based on the results, it can be established that supply growth, volume growth and inflation rates have the most significant results. New Post has only one significant result in model 6. The results of supply growth are significant at a level of 0.05 and 0.01 and all three models show that supply growth has a negative impact on bitcoin returns. Volume growth is significant at a level of 0.1 in models 2, 3 and 4. All results show that volume growth has a positive effect on bitcoin returns. Inflation rates has been tested in three models. The results are significant at a level of 0.1 in the models 6 and 8. It can be stated that inflation rates have a positive influence on bitcoin returns. New post has been tested in six models and is only significant at a level of 0.01 in model 6. This result shows that new post has a negative effect on bitcoin returns. There is no question of autocorrelation between residuals on the Durbin Watson scores since all scores are between 1.5 and 2.5. However, in all models it is clear that the adjusted R square values is low. The explanatory power of the models is therefore low. This also applied in previous studies of Wang and Vergne (2017) and Blau (2018).

Table 7. Results 1 May 2013 - 30 April 2016

Variabeles / Models	1	2	3	4	5	6	7	8
Energy price		**-0,285**			**0,099**			**0,011**
		0,934			*0,283*			*1,690*
S&P 500 Return	**-0,096**	**-0,079**	**-0,093**	**-0,098**		**-0,043**		**-0,071**
	0,209	*0,216*	*0,214*	*0,214*		*0,233*		*0,215*
Google	**-0,077**	**-0,032**	**-0,131**	**-0,129**		**0,300**		**-0,05**
	0,004	*0,004*	*0,004*	*0,004*		*0,002*		*0,004*
New post	**0,106**	**-0,016**	**0,140**	**0,104**		**- 0,328*****		**0,23**
	0,000	*0,000*	*0,000*	*0,000*		*0,000*		*0,000*
Supply growth	**-0,255****					**-0,174****		**-0,256*****
	10,991					*10,338*		*11,084*
Volume growth	**0,092**	**0,150***	**0,131***	**0,138***			**0,115**	**0,081**
	0,004	*0,004*	*0,004*	*0,004*			*0,003*	*0,004*
Interest rates	**0,026**	**-0,123**	**0,022**	**0,073**		**-0,070**		**-0,124**
	0,044	*0,077*	*0,048*	*0,047*		*0,051*		*0,080*
Inflation rates		**0,145**				**0,162***		**0,322***
		0,009				*0,007*		*0,013*
USD-Euro			**0,164**					**0,443**
			0,116					*0,329*
USD-JYEN				**0,099**				**0,061**
				0,001				*0,002*
N	121	121	121	121	155	155	121	121
Adjusted R2	0,036	-0,004	-0,004	-0,008	0,003	0,056	0,005	0,025
Durbin Watson	2,307	2,368	2,347	2,333	1,731	1,821	2,315	2,387
*** Correlation is significant at the 0.01 level								
** Correlation is siginificant at the 0.05 level								
* Correlation is siginificant at the 0.1 level								

5.3 RESULTS SECOND RESEARCH PERIOD

The second research period consists of seven models. Models 1 and 2 are possible analyzes of all variables taking into account the Pearson correlation. The cost-based pricing theory is represented in model 3. Models 4 and 5 consist of the variables of demand and supply theory. Model 6 analyzes the variable of technical analysis, namely volume growth. Model 7 contains a multiple regression analysis of all variables. Two significant variables come from the results of this analysis: S&P 500 and volume growth. S&P 500 has been tested in four models. Models 1 and 4 produce significant results with different significant levels of 0.1 and 0.05. The results show that S&P 500 returns have a positive influence on bitcoin returns. Volume growth has been tested in five models (1, 2, 4, 6, and 7) and all models are significant with a level of 0.01 and 0.05. It can be stated that volume growth has a positive influence on bitcoin returns. The Durbin Watson scores of all models is between 1.5 and 2.5 which means that there is no autocorrelation between residuals. The explanatory power of the models is low but higher than the first research period.

Table 8. Results 1 May 2016 - 30 April 2019

Variabeles / Models	1	2	3	4	5	6	7
Energy price	-0,024	-0,078	-0,130				-0,078
	0,445	*0,651*	*0,387*				*0,672*
S&P 500 Return	0,115*	-0,127		0,121**			-0,135
	0,251	*0,465*		*0,224*			*0,469*
Google	0,108			0,088			0,304
	0,000			*0,000*			*0,001*
New post		0,304			0,305		0,148
		0,000			*0,000*		*0,000*
Supply growth	0,051	0,075		0,029			0,06
	22,801	*20,766*		*20,772*			*21,711*
Volume growth	0,244**	0,231**		0,265***		0,278***	0,200**
	0,010	*0,009*		*0,009*		*0,009*	*0,009*
Interest rates	-0,126			-0,092			-0,071
	0,013			*0,007*			*0,031*
Inflation rates	-0,005	0,044		-0,024			0,006
	0,012	*0,012*		*0,009*			*0,018*
USD-Euro	0,014						0,061
	0,17						*0,311*
USD-JYEN	0,074						0,049
	0,001						*0,000*
N	140	85	140	157	85	157	85
Adjusted R2	0,063	0,114	0,01	0,076	0,082	0,071	0,106
Durbin Watson	2,269	2,337	2,04	2,24	2,141	2,158	2,407
*** Correlation is significant at the 0.01 level							
** Correlation is siginificant at the 0.05 level							
* Correlation is siginificant at the 0.1 level							

5.4 COMPARISONS RESULTS BETWEEN DIFFERENT RESEARCH PERIODS

S&P 500 is positive significant (0.121**) in the analysis of 1 May 2016 - 30 April 2019. However, the results in the first research period and the entire research period are not significant. A possible cause for this results in the first period is that most investors on the S&P 500 did not know the bitcoin at that time. The fact that the results in the second research period are significant is possibly due to the increasing awareness of bitcoin and the good performance of the S&P 500. This enabled investors to invest (a part of) their S&P 500 profits in bitcoins which increased the returns on bitcoins. New post is only negative significant (-0.328**) in the first research period. The second research and entire research period it becomes insignificant, which is in line with the research by Ciaian, et al. (2017). Supply growth is negative significant in the first period (-0.255**, -0.174**, -0.256***) and entire research period (-0.189*). No significant results were found in the second period. Inflation rates are only positive significant (0.162*, 0.322*) in the first research period. No significant results were found for the second- and entire period. This is new information since no previous research has been done on the influence of inflation rates on bitcoin returns.

5.5 OVERALL RESULTS

Hypothesis 1: Energy prices have a positive impact on bitcoin returns

The analysis showed that there were no significant results for the impact of energy prices on bitcoin returns. This hypothesis is therefore rejected. In conclusion, the cost based pricing theory and the associated variable energy price cannot be applied to bitcoin returns.

Hypothesis 2: Public interest has a negative impact on bitcoin returns

For the public interest variables Google and new post, no / few significant results were found to draw a reliable conclusion. Only new post is once significant in the first period and also in the first period of the study. Hypothesis 2 is rejected and Google and new post variables can therefore not be applied to bitcoin returns. Based on this finding, the demand and supply theory cannot be applied to bitcoin returns.

Hypothesis 3: Supply growth has a negative impact on bitcoin returns

Supply growth shows significant results in the first period and the entire period. Only in the second period of the study no significant results were found. However, sufficient significant results have been found that supply growth has a negative impact on bitcoin returns. Therefore this hypothesis is accepted and supply growth is applicable to bitcoin returns. In contrast to hypothesis 2, the demand and supply theory can be applied to bitcoin returns.

Hypothesis 4: Inflation rates have a positive impact on bitcoin returns

Inflation rates show two significant (0.1 level) and positive results in the first period of this study. The second period and the entire investigation period do not provide significant results. There is insufficient evidence whereby hypothesis 4 is rejected. In conclusion, inflation rates and the demand and supply theory cannot be applied to bitcoin returns.

Hypothesis 5: Interest rates have a positive impact on bitcoin returns

No evidence of interest rates was found in all models. Hypothesis 5 is rejected. It can be stated that Interest rates and the related demand and supply theory cannot be applied to bitcoin returns.

Hypothesis 6: Stock market returns have a positive effect on the bitcoin returns

S&P 500 is significant at the 0.1 and 0.05 level in the second period. No significant results were found in the first and entire period. It can be concluded that the results in the second period have become significant compared to the first period. Two main reasons are that, in the second period, investors of the S&P 500 knew that investments could be made in bitcoin and that the S&P 500 achieved good results during this period. As a result, S&P 500 investors started investing (a part of) their profits in bitcoin. This resulted in rising bitcoin returns. The reason for no significant result in the first period can be found in the lack of knowledge about investment opportunities in bitcoin which may also disrupt the entire research period. Therefore hypothesis 6 is accepted which means stock market returns has a positive effect on bitcoin returns. The demand and supply theory and the associated S&P 500 variable can be applied to bitcoin returns. Bitcoin can be seen as a substitute / alternative investment

Hypothesis 7: Volume growth has a positive impact on the bitcoin returns
There is sufficient evidence from all three research periods that volume growth is significant and has positive impact on bitcoin returns. Hypothesis 7 is accepted. This means volume growth and the associated technical analysis theory can be applied to bitcoin returns.

6. Conclusion

The reason for this research was the lack of scientific information about factors which affect bitcoin returns. Therefore it was researched which economic theories and factors can be applied in explaining bitcoin returns. Furthermore, the characterization of bitcoin was studied. In this thesis an answer was given to the following research question;

"What can explain the fluctuations in bitcoin returns?"

The research question was split in three sub questions, namely:

"How can bitcoin be characterized?"
"Which economic theories are applicable on bitcoin returns?
"Which factors influence bitcoin returns?"

<u>Which factors influence bitcoin returns?</u>
The independent variables that were investigated to explain bitcoin returns are: energy price, S&P 500 returns, search volume on Google, new post on bitcointalk.org, supply growth, volume growth, interest rates and inflation rates. No significant results were found for energy prices. It can be concluded that energy prices have no (positive) impact on bitcoin returns. In the second period of this study, the S&P 500 became significant and positive on bitcoin returns. Since 1 May 2016, bitcoin has served as a substitute / alternative investment option for trading on the S&P 500. Increasing awareness of the possibilities to invest in bitcoin and the good performance of the S&P 500 are two explanations of the significant results in the second research period. It can be concluded that stock market returns have a positive impact on bitcoin returns. No search results were found for search volume on Google and new post on bitcointalk.org. There is insufficient evidence that public interest has a (negative) impact on bitcoin returns. Furthermore, the results show that supply growth has a negative impact on bitcoin returns. This does not apply to volume growth since it has a positive impact on bitcoin returns. Volume growth has also shown the most significant results in this study. No significant results were found for interest rates and therefore interest rates does not (positive) impact bitcoin returns. For inflation rates, only significant positive results were found in the first period. However, the most recent research period (May 1, 2016 - April 2019) showed that these results are no longer significant. There is not enough recent evidence that inflation rates have a positive impact on bitcoin returns. It should be noted that the explanatory power of all models are low. This corresponds with previous researches, for example those of Wang and Vergne (2017) and Blau (2018). Furthermore, in all models the Durbin Watson score is between 1.5 and 2.5. This means that there is no autocorrelation between residuals.

<u>Which economic theories are applicable to bitcoin?</u>
The economic theories which have been discussed and investigated are the capital asset pricing model, Fama French's three factor model, cost-based pricing theory, demand and supply theory and technical analysis.

There was no previous research about the applicability of CAPM and the three factor model. According to the literature, bitcoin does not meet the CAPM assumption and factors of the three factor model. It is concluded that CAPM and three factor model of Fama French are not applicable to bitcoin in order to achieve more return with an investment portfolio. The cost based pricing theory has been tested based on energy prices. This variable did not have any significant results. It can therefore be established that the cost-based pricing theory cannot be applied to bitcoin returns. The demand and supply theory has been tested by various variables including public interest (Google and new post), supply growth, interest rates and inflation rates. Supply growth has a negative and significant result. As a result, there is evidence that an increase in bitcoins in circulation means less demand and more supply for bitcoin, which negatively influences bitcoin returns. The demand and supply theory can be applied to bitcoin returns. Technical analysis has been tested by volume growth. Since the significant results for this variable it is concluded that technical analysis is applicable to increase bitcoin returns

<u>How can bitcoin be characterized?</u>
Section 2.3 contributed to the discussion about whether bitcoin is an asset, currency or commodity. Bitcoin has similarities and differences with all three categories. As concluded in section 2.3, bitcoin is a hybrid with characteristics of an asset, commodity and currency. The theoretical framework shows that bitcoin is not an asset since the assumptions of CAPM and the two of the three factors of the model of Fama French are not applicable on it. Therefore the influence of interest rates, inflation and supply growth was studied to contribute to the discussion whether bitcoin is an asset, currency or commodity. There are no / insufficiently significant results for inflation and interest rates which means that bitcoin is not a currency. Only supply growth has negative significant results. This corresponds to a commodity characteristics, namely production. There is therefore support that bitcoin has a characteristic for commodity but it does not fully belongs to it. Moreover, the positive significant result of stock market returns for bitcoin returns reinforces the conclusion that bitcoin is an alternative investment. Since investors (partially) invest the S&P 500 returns in bitcoin.

<u>What can explain the huge fluctuations in bitcoin returns?</u>
The findings show that stock market returns and volume growth have a positive impact on bitcoin returns. Little scientific research was carried out into stock market returns in relation to bitcoin returns. Only Hong (2017) concluded that by adding bitcoin to a traditional investment portfolio, the returns of the portfolio increase. The linked theory to stock market returns is the demand and supply theory. This theory is applicable to bitcoin returns. More scientific research had already been conducted in volume growth. The positive impact of volume growth from this study is in line with earlier studies by Ciaian, et al. (2016), Ciaian, et al. (2017), Kristoufek (2015), Wang and Vergne (2017) and Garcia and Schweitzer (2015). Volume growth has been linked by Blume, et al (1994) to technical analysis and due to the significant results, this theory can be applied to generate higher bitcoin returns. Furthermore, the results show that supply growth has a negative impact on bitcoin returns. This is in line with the research of Ciaian, et al. (2016) but contradictory with the findings of Wang and Vergne (2017). Supply growth is linked to demand and supply theory. This means that the demand and supply theory can also be applied to bitcoin returns. These conclusions do not agree with the opinion of Kristoufek (2013) that economic theories cannot be applied to bitcoin returns.

7. Discussion

This chapter explains the limitations of this research. In addition, advice is given on possible future research into bitcoin returns.

7.1 Limitations of this research

The first limitation of this study is the lack of data of the new post variable in 2018 and 2019. The new post variable was available until the end of 2017. The second limitation is that the electricity prices are only based on Dutch electricity prices. These were stated in euros and have been converted into US Dollars. The third limitation is that the search volume on Google is only available per month if you want to research over a longer period. The fourth limitation is that stock market returns are only based on the S&P 500. However, there are more exchanges for which bitcoin can serve as an alternative investment option such as the NASDAQ or CSI 300 index (Chinese exchange). The fifth limitation is that the volume was not available on coinmarketcap until the end of 2013. The sixth limitation is that there has never been any scientific research done into the effects of interest rates, inflation rates and energy prices on bitcoin returns. An example was therefore not available. The seventh limitation is that the data of interest rates and inflation rates are based on American data. However, every country has its own inflation and interest rates figures. The last limitation is that the models in this study have a low explanatory power (Adjusted R square).

7.2 Future research

This research was only conducted on bitcoin returns. However, it would be interesting to expand research to other coins such as Ethereum, Ripple, Stellar Lumens, EOS and Cardano. For example, it can be assessed whether these altcoins show the same or different results as bitcoin. In this study, it was concluded that S&P 500 returns have a positive influence on bitcoin returns. However, there are more stock markets. A new study can be conducted into the effects of different stock market returns on bitcoin returns. A complete study can also be carried out into the electricity prices of different countries in relation to the bitcoin returns. In conclusion, more scientific literature on this subject will lead to a higher reliability of the results. For example, a higher reliability whether stock market returns have an effect on bitcoin returns. The same applies to inflation rates and interest rates. Also, an investigation can be started on the impact of inflation and interest rates of different countries on bitcoin returns. Finally, a study can be done by testing various fictional portfolios combining traditional investments with investing in bitcoin and measure the effects on returns.

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9. Appendix

9.1 Overview similarities and differences of bitcoin with commodity, currency and asset

Commodity	**Currency**
Similarities	**Similarities**
Scarcity	Value of bitcoin is only driven by the value in the future exchange
	Quantity theory of money and monetary economics are applicable
Differences	**Differences**
Carries no value	Not an accepted medium of exchange because it has no underlying value from consumption and production
	It is too volatile,
	No intrinsic value
	Not regulated
	More sensitive to cyber-attacks than currencies through digital character
	It is doubtful whether the currency retains its value in the future

Asset
Similarities
Profit expectability
Can calculate momentum
Differences
Not able to measure in monetary terms because of no regulations
Price movements can be traced from interest on Google and Wikipedia
Can not calculate book-to-market and market capitalization
Investors buy bitcoin because of the anonymity
Bitcoin investors consist of noise traders, trend chasers and short-term investors

9.2 Regression data (in)consistent with the CAPM

Figure 3. Regression data consistent with the CAPM. Retrieved from Grinblatt, Hillier, and Titman (2011, p. 150)

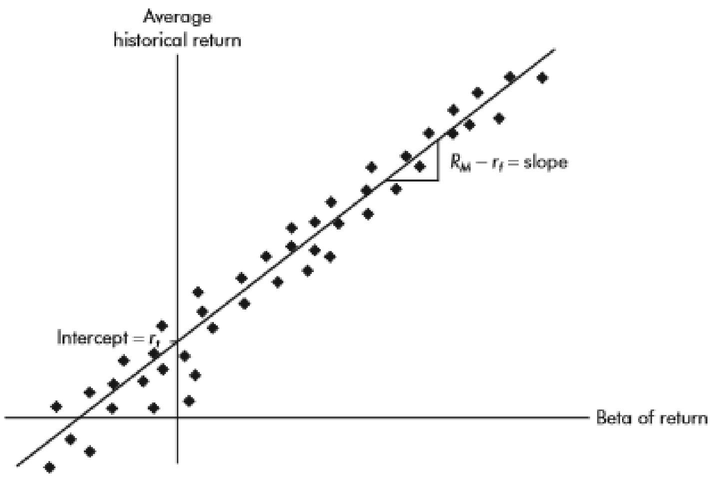
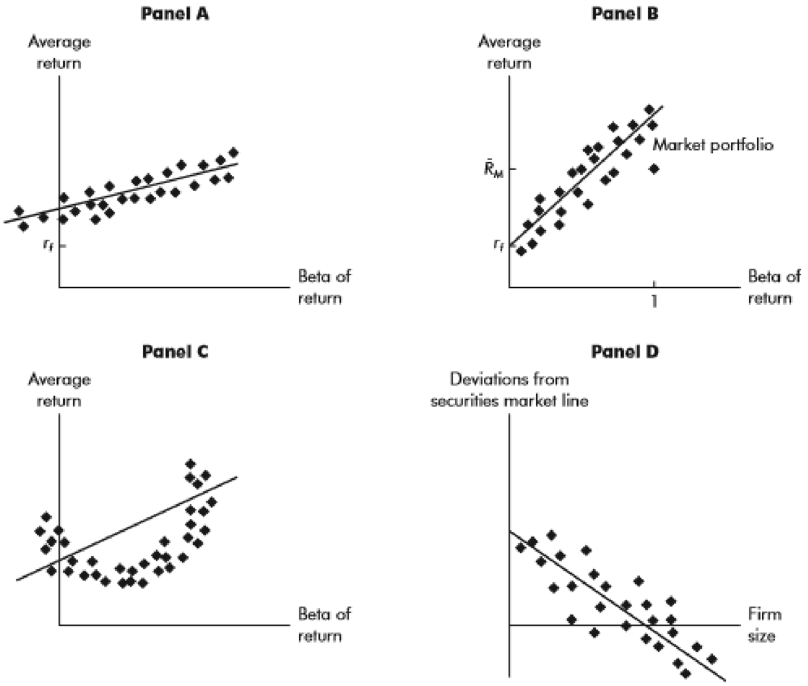


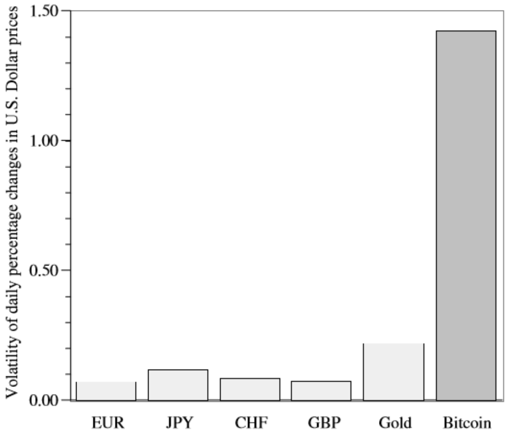
Figure 4. Regression data inconsistent with the CAPM. Retrieved from Grinblatt, Hillier, and Titman (2011, p. 151)



Panels	Explanation
A	Wrong intercepept
B	Wrong slope
C	Securities are in a curve and this has to be on the line
D	The deviations from the average returns of the securities market are set against the size of the company

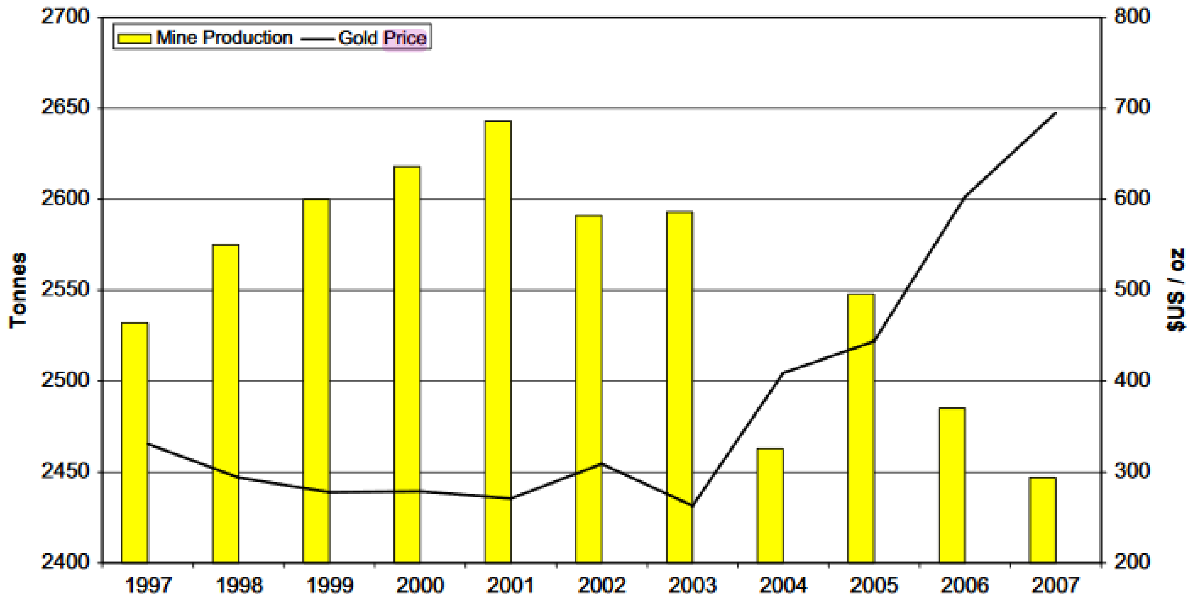
9.3 VOLATILITY OF DAILY PERCENTAGE

Figure 5. Volatility of daily percentage changes in U.S. Dollar prices in 2013. Retrieved from Yermack (2013, p. 21)



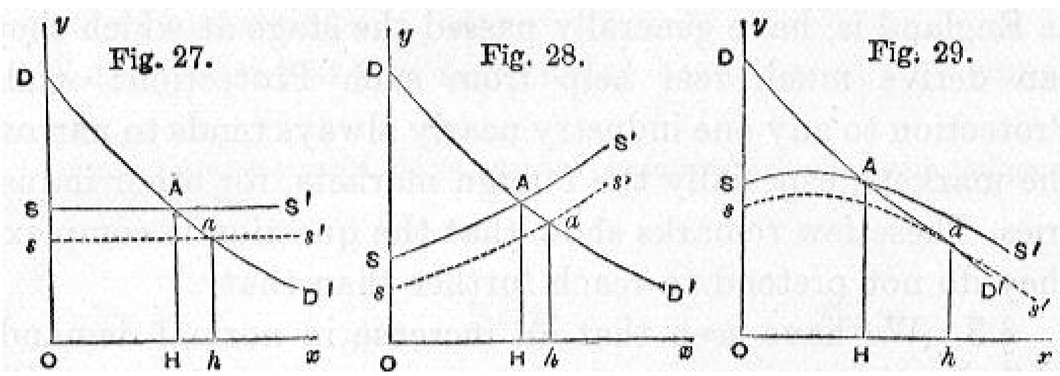
9.4 GOLD PRODUCTION AND RETURNS

Figure 6. Gold production and returns retrieved from Shafiee and Topal (2010, p. 181)



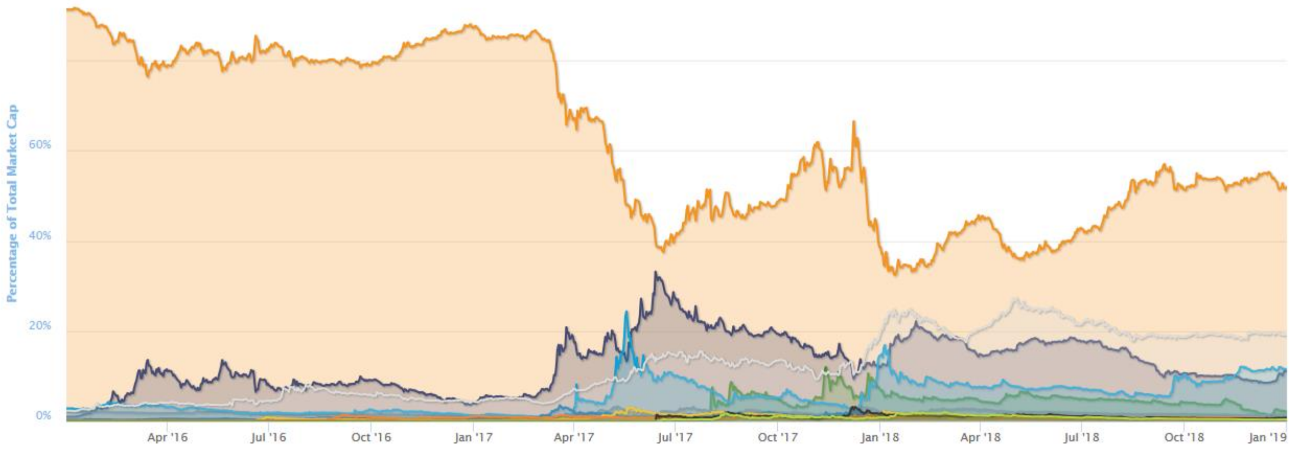
9.5 DECLINE IN SUPPLY

Figure 7. Three graphs of decline in supply. Retrieved from Marshall (2017, p. 572)



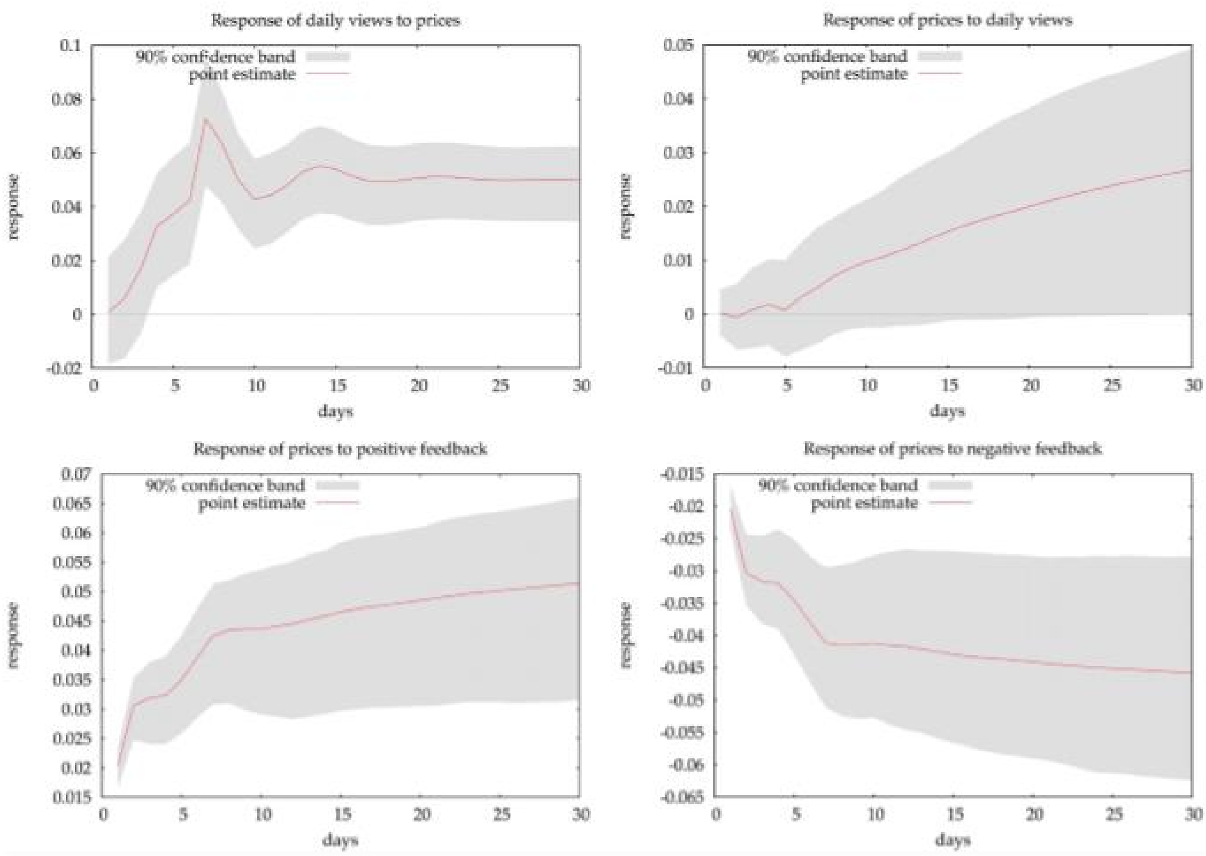
9.6 BITCOIN DOMINATION

Figure 8. Bitcoin domination, retrieved from coinmarketcap



9.7 EFFECTS SEARCH VOLUME ON WIKIPEDIA ON BITCOIN

Figure 9. Effects search volume on Wikipedia on bitcoin, retrieved from Kristoufek (2013, p. 5)



9.8 Six stages decision process multiple regression

Figure 10. Six stages decision process multiple regression. Retrieved from Henseler (2017, p.7)

Stage 1: Objectives of multiple regression
Stage 2: Research design of multiple regression
Stage 3: Assumptions in multiple regression analysis
Stage 4: Estimating the regression model and assessing overall fit
Stage 5: Interpretation of the regression results
Stage 6: Validation of the results

9.9 Combinations of variables in models

Table 9. Combinations of variables in models (period May 2013 till April 2019)

Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
inflation rates	supply growth	energy	inflation rates	supply growth	volume	Energy price
interest rates	new post		interest rates	new post		S&P 500 Return
volume growth	s&p 500		Google			Google
Google	volume growth		S&P 500			New post
S&P 500	inflation rates					Supply growth
energy price	USD/EURO					Volume growth
	USD/JYEN					Interest rates
						Inflation rates
						USD/EURO
						USD/JYEN

Table 10. Combinations of variables in models (period May 2013 till April 2016)

Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
S&P 500 Return	Energy price	USD/euro	USD/JYEN	energy price	S&P 500 Return	Volume growth	Energy price
Google	S&P 500 Return	S&P 500 Return	S&P 500 Return		Google		S&P 500 Return
New post	Google	Google	Google		New post		Google
Supply growth	New post	New post	New post		Supply growth		New post
Volume growth	Volume growth	Volume growth	Volume growth		Interest rates		Supply growth
Interest rates	Interest rates	Interest rates	Interest rates		Inflation rates		Volume growth
	Inflation rates						Interest rates
							Inflation rates
							USD/EURO
							USD/JYEN

Table 11. Combinations of variables in models (period May 2016 till April 2019)

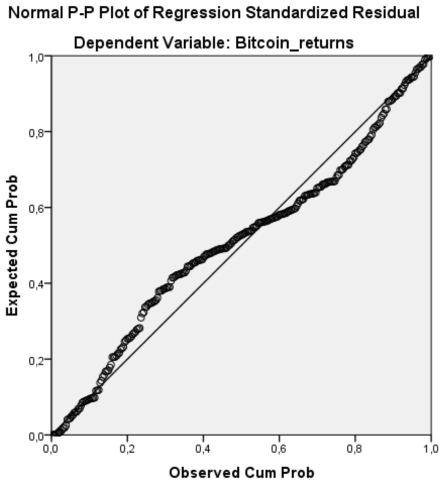
Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Energy price	Energy price	energy	S&P 500 Return	New post	Volume growth	Energy price
S&P 500 Return	S&P 500 Return		Google			S&P 500 Return
Google	New post		Supply growth			Google
Supply growth	Supply growth		Volume growth			New post
Volume growth	Volume growth		Interest rates			Supply growth
Interest rates	Inflation rates		Inflation rates			Volume growth
Inflation rates						Interest rates
USD/EURO						Inflation rates
USD/JYEN						USD/EURO
						USD/JYEN

9.10 ASSUMPTIONS IN MULTIPLE REGRESSION ANALYSIS AND MULTICOLLINEARITY

Linearity of the phenomenon measured

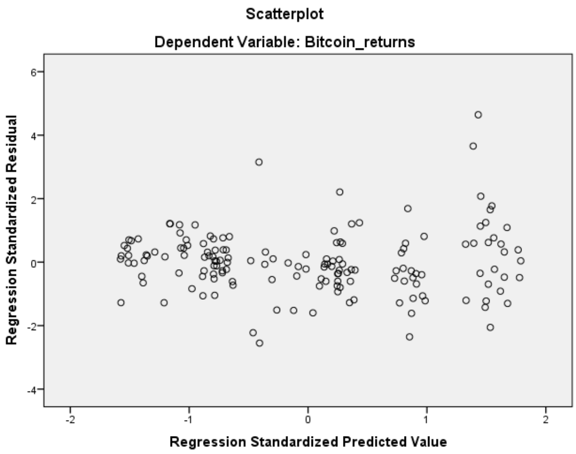
From the scatterplot is concluded that the dots closely follow the line. So there is linearity.

Normal P-P plot entire period



Constant variance of the error term

In the scatterplot below is concluded that the dots are not grouped together. So there is homoscedastity.



Independence of the error term

The Durbin Watson score is between 1,5 and 2,5 which means there is independence of the error term.

Model Summary[b]

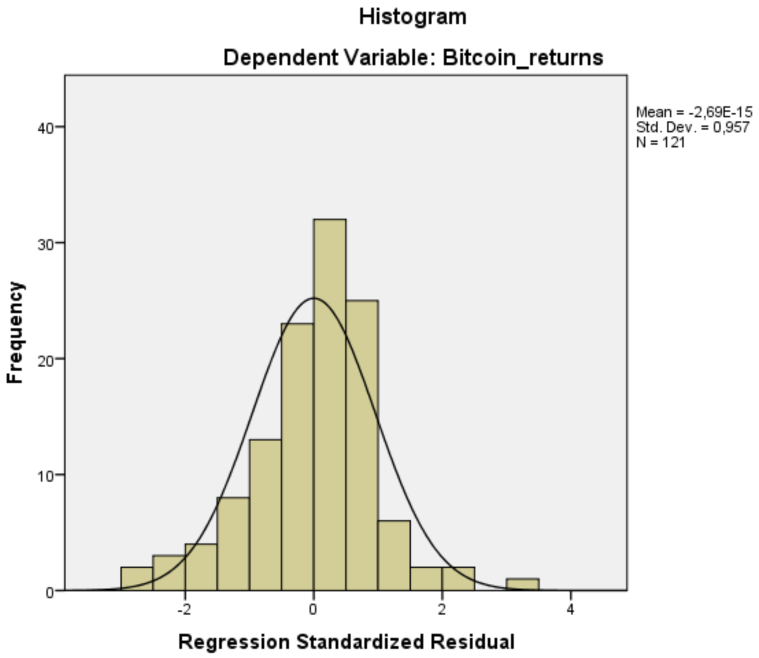
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	,365[a]	,133	,103	,0434181451	,133	4,354	7	198	,000	2,257

a. Predictors: (Constant), USD_JYEN, Supply_growth, Volume_growth, SP500_return, Newpost, Inflation_rates, USD_Euro

b. Dependent Variable: Bitcoin_returns

Normality of the error distribution

As shown below in the histogram, it is normal distributed.



Multicollinearity

The figures of VIF are under the 5 which means no multicollinearity.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	,055	,021		2,607	,010	,013	,096		
	Energy_price	-,643	,228	-,180	-2,820	,005	-1,092	-,194	,908	1,102
	SP500_return	,056	,165	,021	,339	,735	-,269	,380	,987	1,014
	Search_Google	,000	,000	,111	1,591	,113	,000	,001	,763	1,311
	Volume_growth	,008	,004	,145	2,368	,019	,001	,015	,978	1,023
	Interest_rates	-,010	,006	-,138	-1,523	,129	-,023	,003	,450	2,221
	Inflation_rates	,003	,005	,051	,613	,541	-,006	,012	,532	1,880

a. Dependent Variable: Bitcoin_returns

9.11 Multiple regression results

It is checked whether the unstandardized beta is positive (sig value / 2) or negative 1- (sig value / 2). The P value must be divided by 2, because it is a one-sided test. Research is only conducted into the effect of independent variables on the dependent variable and not vice versa.

Entire period (1 May 2013 – 30 April 2019)

Model 1

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	,251[a]	,063	,041	,0478177322	,063	2,841	6	254	,011	2,243

a. Predictors: (Constant), Inflation_rates, SP500_return, Volume_growth, Energy_price, Search_Google, Interest_rates

b. Dependent Variable: Bitcoin_returns

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	Upper Bound	Collinearity Statistics Tolerance	VIF
1	(Constant)	,055	,021		2,607	,010	,013	,096		
	Energy_price	-,643	,228	-,180	-2,820	,005	-1,092	-,194	,908	1,102
	SP500_return	,056	,165	,021	,339	,735	-,269	,380	,987	1,014
	Search_Google	,000	,000	,111	1,591	,113	,000	,001	,763	1,311
	Volume_growth	,008	,004	,145	2,368	,019	,001	,015	,978	1,023
	Interest_rates	-,010	,006	-,138	-1,523	,129	-,023	,003	,450	2,221
	Inflation_rates	,003	,005	,051	,613	,541	-,006	,012	,532	1,880

a. Dependent Variable: Bitcoin_returns

9.12 P values different research periods

1 May 2013 - 30 April 2019							
Variabeles / Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Energy price	0,9975		0,6060				0,9280
S&P 500 Return	0,3675	0,9285		0,2655			0,9270
Google	0,9435			0,9595			0,9675
New post		0,9965			0,9810		0,7550
Supply growth		0,1115			0,1245		0,0580
Volume growth	0,0095	0,0255				0,0085	0,0305
Interest rates	0,9355			0,8760			0,9370
Inflation rates	0,2705	0,3865		0,4920			0,2415
USD-Euro		0,1345					0,5180
USD-JYEN		0,3975					0,2805

1 May 2013 - 30 April 2016								
Variabeles / Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Energy price		0,1165			0,1100			0,4900
S&P 500 Return	0,8540	0,8010	0,8405	0,8545		0,7100		0,7775
Google	0,2670	0,4105	0,1530	0,1635		0,9995		0,3730
New post	0,7760	0,4685	0,7295	0,6350		0,0010		0,7790
Supply growth	0,0110					0,0410		0,0115
Volume growth	0,1715	0,0635	0,0915	0,0845			0,1045	0,2140
Interest rates	0,3935	0,7610	0,4200	0,2480		0,7875		0,7540
Inflation rates		0,1880				0,0585		0,0855
USD-Euro			0,7810					0,2295
USD-JYEN				0,3430				0,4305

1 May 2016 - 30 April 2019							
Variabeles / Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Energy price	0,5965	0,7695	0,9370				0,7620
S&P 500 Return	0,0865	0,8850		0,0600			0,8970
Google	0,8510			0,8660			0,9405
New post		0,9965			0,9975		0,7025
Supply growth	0,6855	0,7200		0,6200			0,6725
Volume growth	0,0200	0,0150		0,0005		0,000	0,0320
Interest rates	0,7960			0,8405			0,6295
Inflation rates	0,4845	0,3655		0,6005			0,4870
USD-Euro	0,4560						0,3960
USD-JYEN	0,2150						0,3425