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A Comparative Analysis of Cryptocurrency Markets

By

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Hilde Camilla Mari Sæther**

MSc. Thesis

**University of Stavanger
June 2018**

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Erik Johan Helland, Hilde Camilla Mari Sæther

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Abstract

Cryptocurrency is a relatively recent economic and technological phenomenon, competing with established traditional third party financial systems through a trust-based peer-to-peer decentralized network. This unique financial and technological transactional structure opens new market opportunities and challenges, defining the cryptocurrency compared to the established financial market. To illuminate and analyse the inner workings of the cryptocurrency market, this thesis highlights the market drivers for the current top five cryptocurrencies in terms of market capitalization, by focusing on the current market situation and market history. This is supplemented by examining the history of traditional money and how cryptocurrencies can be compared with it. In addition, the technological and financial structure of the main cryptocurrencies and how the main components of the market work will be examined. Financial analysis such as price, volatility, market correlation, market history matching, liquidity of the cryptocurrency market and strategic market analysis were conducted as part of this study. By using this information, it is possible to establish a foundation for further market comprehension of the five major cryptocurrencies and the future challenges. Based on the analysis in this thesis, several findings were made regarding the nature of the cryptocurrency market. Generally, it is apparent that established market models are applicable to the cryptocurrency market. However, the cryptocurrency market experiences symptoms of its own free decentralized market model, technology, and limited public adoption.

Arguably, a common public opinion is that the cryptocurrency market is difficult to comprehend, and market development can often seem arbitrary and mysterious to outsiders. The market is complicated by periods of with seemingly arbitrary exceptionally high volatility. This along with historical growth levels that are unparalleled in many other industries are common in the cryptocurrency market. Other common unbalancing factors are the exposure to market manipulations, geopolitical uncertainties and agendas, and market responses to news and singular events. There are additionally several limitations and challenges with regards to the industry's technological foundations. This has the potential to impact the valuation and longevity of the different cryptocurrencies. By analysing these aspects, an insightful and comprehensive comparative market analysis of the cryptocurrency industry is formed.

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Glossary

Altcoins: Common term used to define any cryptocurrency that is not Bitcoin.

Bear market: A market with low activity where investments are pessimistic, and people are cautious. Also referred to as “boring low”.

Blockchain: Term used for the founding technology that run many of the cryptographic currencies.

Bull runs: periods where the market is exceptionally "bullish", where the investments are overly optimistic and can “ignore warning signs”.

Cryptocurrency: Umbrella-term used to describe any cryptographic currency such as Bitcoin, Ethereum, Ripple etc.

Cryptocurrency wallet: A physical address that allows for storage of one’s cryptocurrency. This is unique and personal, often protected with a encrypted password.

Double-spending: A financial problem that exist for electronic money, specifically the duplicability that exists naturally for electronic signatures and identification.

Fiat money: Symbolic money that is ensured public adoption by law.

FOMO: Fear Of Missing Out, often used to describe a market situation where buying is attributed to the fear of not getting in on the next bull-run.

FUD: Fear Uncertainty Doubt, used in situations where people are selling out in fear of a potential crash or market correction.

Hard fork: A radical change to the protocol that makes previously invalid blocks/transactions valid (or vice-versa). In other words, it is a permanent divergence from the previous version of the block-chain.

Hash: an algorithm that generate verifiably "random" numbers in a way that requires a predictable amount of CPU effort.

Hype: highly inflated degree of public engagement and optimism, often seen as a result of self-reinforcing optimism that spread among participants/users due to promotion or propaganda of exaggerated claims.

Liquidity: Term used to describe to which a degree an asset or security can be quickly bought or sold without affecting the markets price.

Market capitalization: total market value

Mining: The act of contributing with processing power to run the calculations in a cryptographic network for rewards such as a transaction fee or an amount of the cryptographic currency supported.

Nonce: An arbitrary number that can only be used once in cryptographic communication. This helps in improving the security of the blockchain and includes timestamps to ensure a specific timeliness.

Peer-to-peer: A concept of resource distribution in a network, which operates from person to person directly instead of a centralized server process.

Tender: Article or token (such as coins or banknotes) that serve as means of payment or settling dept.

Volatility: Term used to describe the amount of uncertainty or risk regarding a securities value.

Whales: Terminology used to describe holders in the cryptocurrency market that are holding huge amounts of cryptocurrency.

Disclaimer:

By combining the information in this thesis, it is possible to construct a comprehensive image of the cryptocurrency market and map its challenges and opportunities within a certain framework. The data with consequent analysis provided allows the authors of this thesis to draw conclusions, but also open for further studies which may prove valuable in the context provided in this thesis.

While as much information as possible is gathered from trusted and reviewed sources, we cannot rule out that some information provided in this thesis can be inaccurate. This is because of the large amounts of different web-sources that has been applied to the work in this thesis. Due to this, the sources listed in this thesis that are not reviewed have been crosschecked with other sources whenever possible.

The authors of this thesis do not have any stakes in the mentioned companies or currencies and have endeavoured to remain neutral in the discussions and presentations in this thesis.

1. Introduction

The cryptocurrency market came into existence with the invention of Bitcoin through the publication of Nakamoto's whitepaper in 2008 and the following activation of the Blockchain in 2009. Since then, thousands of alternative cryptocurrencies to Bitcoin has entered the market, and it is the sum of all these cryptocurrencies and all exchanges, miners etc. that make up the cryptocurrency market today. The cryptocurrency market has been experiencing especially huge growth over the course of 2016 and 2017, and popularity and public adoption has reached new heights. A natural consequence of this is that more first-time clients than ever before is being drawn to the market, in the hopes of riding the cryptocurrency wave. There are however significant differences to the cryptocurrency market with regards to market drivers and technological incentives compared to many other more traditional financial markets. Additionally, the cryptocurrency market can appear chaotic and difficult to understand due to the high volatility, high level of anonymity and high number of cryptocurrencies that is available on the market.

Because of the decentralized structure and differences to the traditional financial market, the cryptocurrency market has since the beginning challenged traditional established financial systems. This has caused the cryptocurrency market to often be a subject for controversy amongst the public and financial experts. As a result, it has been called everything from "evil" and "bubble" to "the next internet" and "democratization of finance"^{1 2}.

The cryptocurrency market offers innovative technology that has the potential to increase its value in the factor of thousands over relatively short periods of time. As has been seen before, there are also cases where other cryptocurrencies have lost almost all their value over equally short time. Combined with seemingly chaotic nature of the cryptocurrency market, it is understandable that the cryptocurrency market can appear intimidating to new entrants as well as existing users.

¹ Mazer, "Demystifying Cryptocurrencies, Blockchain and ICOs"

² Eha, "Why This Venture Capitalist Wants to Make Traditional VC Obsolete"

1.1 Objectives

The thesis will describe and clarify the inner workings in the cryptocurrency market by analysing its components separately and in context of each other by highlighting topics such as:

- The history of money and how cryptocurrencies can be related to money.
- The underlying technology and history of cryptocurrencies.
- The fundamental components of the cryptocurrency market.
- Market drivers and market history.
- Financial analysis based on market history.
- Challenges in the cryptocurrency market.
- Strategic market analysis for the future of the cryptocurrency market.

1.2 Thesis structure

To target the objectives set in chapter 1.1, and provide the reader with a chronological order of introduction to the different themes in this thesis and the findings, the thesis chapters has been structured in the following manner:

1. Introduction and background to the thesis with general objective and structure.
2. Chapter about the origin of money and how cryptocurrency is related to money and the traditional third-party financial systems.
3. Essential explanation of the history of cryptocurrency, in terms of technological framework, rationale and comparison of the involved cryptocurrencies.
4. Analysis of the components that make up the cryptocurrency market, along with a look at market history, market distribution, and market drivers.
5. An in-depth analysis of the financial aspects cryptocurrency market such as price history, volatility, correlation, liquidity, the use of cryptocurrencies as a substitute for fiat currencies and gold, market challenges and strategic market analysis.
6. Conclusions from the comparative market analysis.

2. Cryptocurrencies and Money

2.1 Origin of money

The invention of money was a revolutionary milestone made by ancient humans that has helped the development of civilization. Money mainly holds three functions in society; it is a means for exchange, a unit of accounting and a store of wealth³. The medium of exchange means that money could act as an intermediate to make it easier to sell goods and services. Another important aspect of money is store of value. Store of value allows people to transfer the purchasing power of their present money income and wealth into the future. Ideally this would happen without the money losing its value between the time it is earned and the time it is spent. The third different aspect is unit of account. Unit of account serve as a way to measure and compare the value of goods and services in relation to one another. Individuals can comparatively determine if certain goods and services is a better buy than others by prices. In addition, it allows people to keep financial accurate records.

Money was gradually developed as a result of various different features of early societies; examples of this are ceremonies and feasts, compensation for doing someone a favour and the exchange of goods. This later allowed for the payment of workers and made it easier to buy and sell goods. Later it also helped connect different parts of the world, by granting traders access to travel across continents to buy and sell goods⁴.

The first ancient coin discovered originates from ancient china and was made out of cowrie shells. These coins are classified as primitive coins and have been used from 1600 BC in China to the 20th century AD in Africa. In the same period as these coins were used in china different commodities were used as payment in societies in the Mediterranean and Near East (Robertson).

³ Hermele, "Commodity money vs fiat money"

⁴ Robertson, "History of money".

2.2 Commodity money

Commodity money is a type of money that has an underlying value on its own, independent on any governing body. This means that the money itself will keep its value and is not just a symbol of financial value such as a dollar bill⁵. In other words when a commodity serves as a medium of exchange it is referred to as commodity money⁶. The most known commodity monies today are gold and silver. Through time many different commodities have acted as “money”. Cowaries, coins, cattle, grains, gold and silver are examples of such commodities. However, these commodities can be divided into two groups based on how they are “valued”. Commodities such as cowaries, coins, and cattle have often been counted, while the commodities grains, gold and silver have been measured. This impacts the convenience of using such commodities as money negatively, and it suggested that it’s more satisfactorily using a common measure of value such as fiat money⁷.

2.3 Fiat money

Fiat money is a type paper or symbol, which by law individuals can use to buy most things. By itself the fiat money does not hold any intrinsic value, but when used as a medium of exchange it holds value because the public believe that it will (Ledoit and Lotz). To simplify fiat money holds value only because governments say they do. Subsequently it allows people to buy products without trading product for product. Fiat money has storage power, which allows a business to use the same “product” to buy new equipment, hire and pay employees and expand into other regions. The value of fiat money depends on supply and demand, which again is dependent on interest rates in the country the money is belonging to. The interest rate is dependent on how a country’s economy is performing and how the country is governing itself. This means that a country that is experiencing political instability is likely to have inflated commodity prices and a weakened currency. Subsequently the people will no longer believe in the currency. When the public gains enough confidence in the currency’s ability to act as a storage medium for purchasing power it will function well. The most beneficial feature of fiat money is the

⁵ Herald, "Heralds Finacial Dictionary"

⁶ Ledoit and Lotz, "The coexistence of commodity money and fiat money"

⁷ Hermele, "Commodity money vs fiat money"

stability of its value, unlike some commodity money that is volatile to business cycles and periodic recessions. The financial crises that hit in 2008 have proved that the fiat money system could not keep recessions from happening. An argument against the stability of fiat money is that the supply of fiat money is unlimited, while for example the supply of gold is not, making gold a more stable currency⁸.

2.4 Digital money/currencies

Like with the origin of traditional money, digital currencies and money are a result of an emerging demand in a developing society. Digital currencies are money that does not have a physical equivalent in the real world and exists only in digital form. The payment method is not tangible and exists only in electronic form. It can however, often be used in the same manner as the traditional money, as it is possible to obtain, transfer and exchange it for other currencies. This can however also be restricted to certain online communities. Digital money allows for borderless and instant transactions, subsequently it has no geographical or political borders as it can be sent to and from anywhere in the world at any given time⁹.

Digital currencies can eliminate intermediate process steps and cost related to this, such as banks and/or clearing houses. Traditional money and payment methods cannot bypass these. As of currently digital money has a generally under-developed regulatory framework, such as tax treatments as they are still evolving. Some of the advantages of digital money are that it's simpler to make payments whenever as the transactions are independent of banking hours. It can as well help organizations reduce exposure risks by using them as transport currencies. Many banks do as of now not accept digital currencies and it can therefore not be earned interest on them by individuals or organizations in the traditional sense. Certain risks are associated with digital currencies such as security, currency volatility and payment beneficiary identification. Due to the uncertainty related to customer identification, there has been limited acceptance of digital currencies in the payment industry¹⁰.

⁸ Corporate Finance Institute, "What is fiat money".

⁹ Tar, "Digital money vs cryptocurrencies".

¹⁰ Techopedia, "What is digital currency?".

Cryptocurrencies can be explained as a variety of digital currencies and is an asset used as a means of exchange. Many crypto currencies use their blockchain as a decentralized ledger. The result of this is that no supervisory authorities control the transactions. No information is changed or interrupted during the transaction by third parties, as the cryptography's objective is to make secure communication by creating and analysing algorithms and protocols. Even if the cryptocurrency is a type of digital currency there are some differences in relation to structure, anonymity, and transparency. The structure of digital currencies is centralized, meaning that a group of people and computers regulates the transactions. On the other hand, cryptocurrencies are decentralized, and the majority of the community makes the regulations in regard to transaction etc. When it comes to anonymity, digital currencies require user identification in the form of documents issued by public authorities. In regard to buying, investing and other processes with cryptocurrencies, there is no requirement of user identification.

Cryptocurrencies are however, not fully anonymous. Each transaction is registered, and the senders and receiver's wallet addresses are publicly known as a part of the public ledger. Transactions with cryptocurrencies are transparent and the transactions made by any user become public information. The identity of the user is however not known if the user does not wish it to be. When it comes to transaction transparency for digital currencies, the transaction information contains the address of the wallets, but the money transfers are confidential. Digital currencies have a central authority that deals with transaction manipulation. The central authority can choose to cancel or freeze transactions upon the request of the participant or authorities. It can as well freeze the transaction when there is suspicion of fraud and money laundering. In regard to cryptocurrencies the community regulates them and there is little chance that the users will approve changes in the blockchain¹¹.

¹¹ Tar, "Digital money vs. cryptocurrencies".

3. What is Cryptocurrency?

Cryptocurrency is a relatively new phenomenon and technology based on cryptography, which started with Bitcoin in 2009. It has been expanding and developing over the last years and can due to recent newfound popularity and market expansion, be acquired in many different shapes and forms. As of writing this thesis there have been registered over 1600 different cryptocurrencies¹². Even though there are a vast number of different cryptocurrencies available with different targeted application areas and usages, many of these can be thought of as extremely volatile and have uncharted potential or low market adoption rates. This thesis will therefore narrow the study by focusing on the most adopted and popular cryptocurrencies by market capitalization. This includes cryptocurrencies like Bitcoin, Ethereum, Ripple, Bitcoin Cash, and Litecoin. The common element of cryptocurrencies is found in its public ledger often referred to as the “block chain”, a link between the members of the network and the usage of the digital cryptocurrency of the network.

Bitcoin is as of writing this thesis the main cryptocurrency on the market, with almost double the market capitalization as the cryptocurrency at second place, Ethereum. This combined with the fact that most cryptocurrencies are based around the founding technology that Bitcoin introduced, makes it important for future discussions that Bitcoin is properly understood both as a technology and as a key player in cryptocurrency market¹³.

3.1 Bitcoin

3.1.1 History of Bitcoin

The idea of Bitcoin was first introduced to the world through the white paper¹⁴ “Bitcoin: A Peer-to-Peer Electronic Cash System” by Satoshi Nakamoto in 2008. In this paper, Nakamoto describes an electronic transaction system centred around the idea of a decentralized digital currency called “Bitcoin”. In order to accomplish this, Nakamoto presented the blueprint to a network that through electronic cash aimed to allow for

¹² Coin Market Cap, “Global Charts”.

¹³ Coin Market Cap, “All coins”.

¹⁴ Nakamoto, “Bitcoin: A Peer-to-Peer Electronic Cash System”.

online payments directly from one party to another, so called peer-to-peer. The currency would be separated from any financial institution, effectively decentralizing the transaction. In order to be able to provide a decentralized electronic cash transaction while also solving the famous double spending problem, Nakamoto presented a method of using the peer-to-peer network to generate computational proof of the chronological order of transactions (more on this in Chapter 2.1.2).

Despite public curiosity and investigation, the true identity of “Satoshi Nakamoto” is not known, and the name is likely a pseudonym used by a single person or a group of people that still remains a secret. After the publication of the paper in August 2008, the original Bitcoin Network was activated by Nakamoto in January 2009 from the first open-source Bitcoin client¹⁵. Following the activation of the network, the world’s first Bitcoin transaction of 10 Bitcoins occurred between Nakamoto and an early-phase backer and programmer Hal Finney¹⁶.

Bitcoin started off with a small number of dedicated backers, primarily consisting of programmers and other enthusiasts. The greater public interest would not manifest before many years yet. Due to growing interest and market backing, the Bitcoin Network passed a total market capitalization of 1 million USD in 2010 and has been getting increased media exposure and popularity ever since. While the Bitcoin Network has been actively expanding (Figure 1) and experienced wide fluctuations in price (Figure 2) over the last years, it experienced huge growth, with over 1300% increase in price in 2017 alone.

¹⁵ Nakamoto, “Bitcoin v0.1 released”.

¹⁶ Peterson, “Hal Finney received the first Bitcoin transaction. Here’s how he describes it.

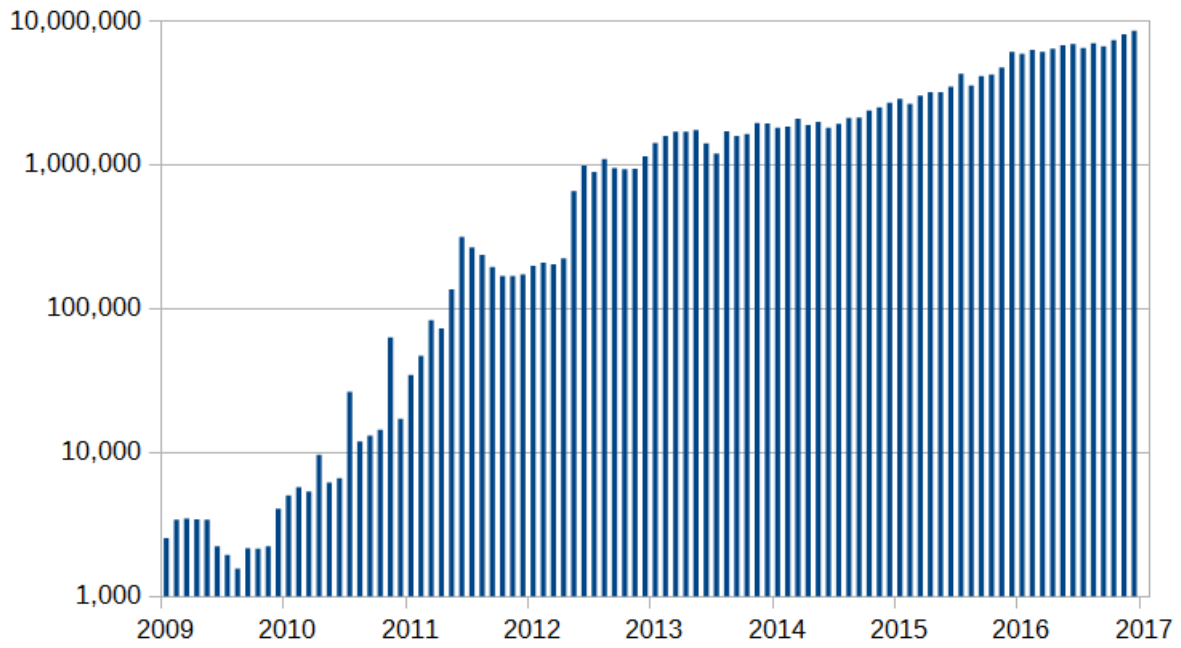


Figure 1: Number of bitcoin transactions per month (logarithmic scale). Source: https://en.wikipedia.org/wiki/History_of_bitcoin



Figure 2: Bitcoin price and Market Capitalization in USD from 2013 to present day (Logarithmic scale). Source: <https://coinmarketcap.com/currencies/bitcoin/>

3.1.2 Technology behind Bitcoin and blockchain.

Nakamoto describes in his 2008 paper Bitcoin as a system for electronic transactions without third party interference based on a peer-to-peer network, using proof-of-work to record a public history of transactions. In order to understand why Bitcoin as a system is completely different from any standard electronic cash system based on fiat currency, it is important to not only understand the vision behind Bitcoin, but also the fundamentals of the technology that the Bitcoin network is based on. Additionally, the fundamental principles of how digital transactions work today and how bitcoin deals with the double-spending situation should be understood.

The main idea behind the Bitcoin network as envisioned by Nakamoto, is to provide the willing transacting parties with an electronic payment system based on cryptographic proof instead of trust. This approach allows the transaction to happen directly between any two willing parties without the necessity of a third party such as banks. By effectively cutting out the third party, Nakamoto meant for Bitcoin to reduce transaction costs and increase the limit of minimum practical transaction size while protecting the privacy of the involved parties in the transaction¹⁷.

In order to do this however, the system has to provide a sufficient method of safely processing transactions while also dealing with the double-spending problem. The double spending problem represents a potential flaw in any digital transaction as any digital token represents a file that can be duplicated or falsified¹⁸.

¹⁷ Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System".

¹⁸ Chohan, "The double spending problem and cryptocurrencies".

In a standard transaction between two transacting parties, Person A and Person B, Person A will send the agreed upon amount of money and Person B will send the commodity that Person A paid for (Figure 3). However, it is important to notice that with no regulations, the transaction will be based entirely on trust between the transacting parties.

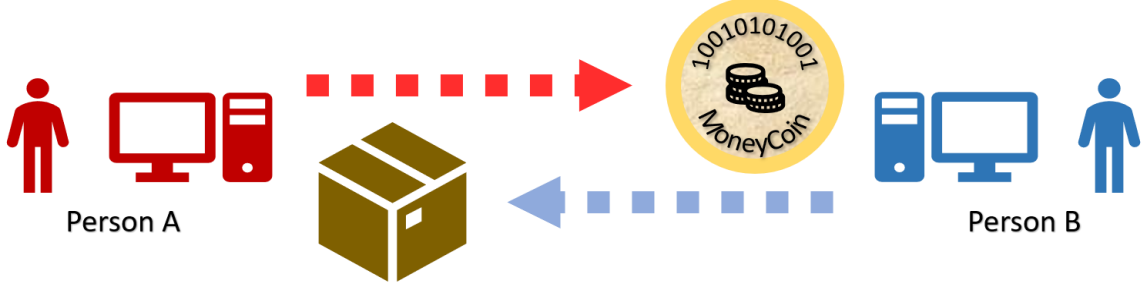


Figure 3: Illustration showing a basic trade between two parties with a cryptocurrency.

If no security measure exists to hinder double spending, it would allow the person spending the currency to take advantage of the digital system. In a double spending situation, Person A could take advantage of the fact that files are duplicatable. This could allow Person A to use a unit file of currency to pay for a commodity from Person B while simultaneously sending a copy of that same file to Person C (Figure 4). This would effectively allow Person A to spend one unit of money twice while still acquiring two commodities. This is only one example of the problems raised by duplicating digital money.

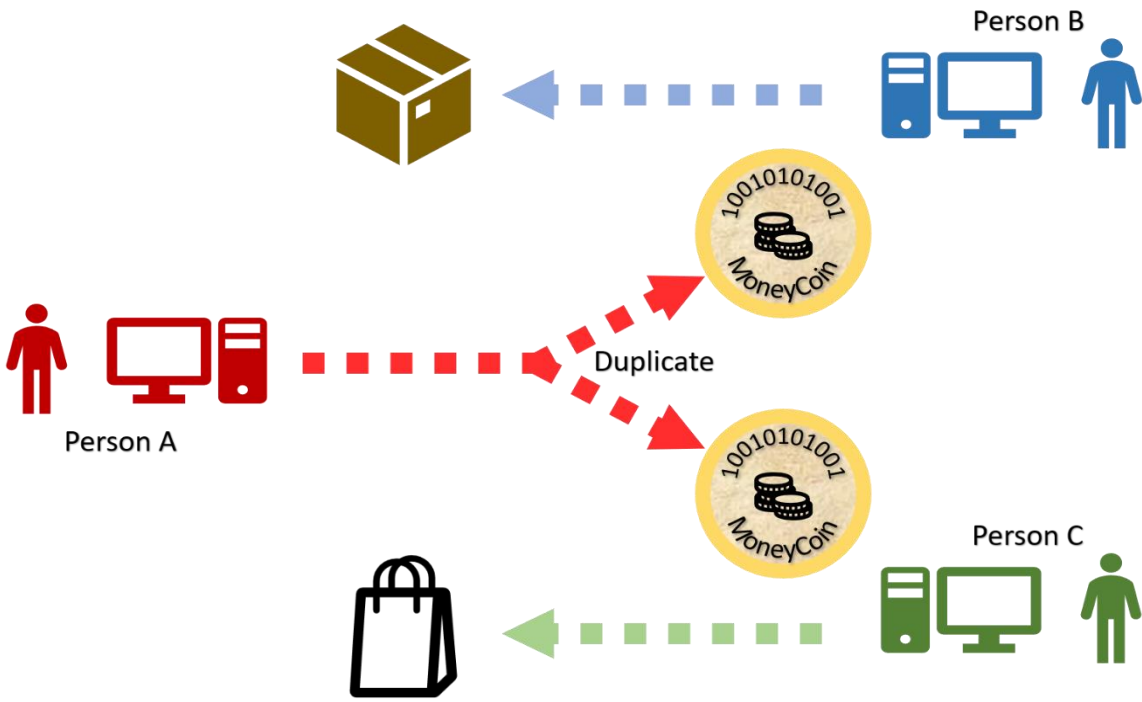


Figure 4: Example of a transaction with a double-spending situation.

Traditionally with digital transactions, the workaround to the double-spending problem has been to have a third party such as banks, or through services like PayPal to overlook and confirm transactions between the transacting parties. This allows the third party to control that the money or computer file has left Person A's inventory and send it to Person C, logging the transaction and preventing Person A to use a file with the same ID again. If Person A attempted to double-spend in such a situation, one or both transactions would be annulled (Figure 5).

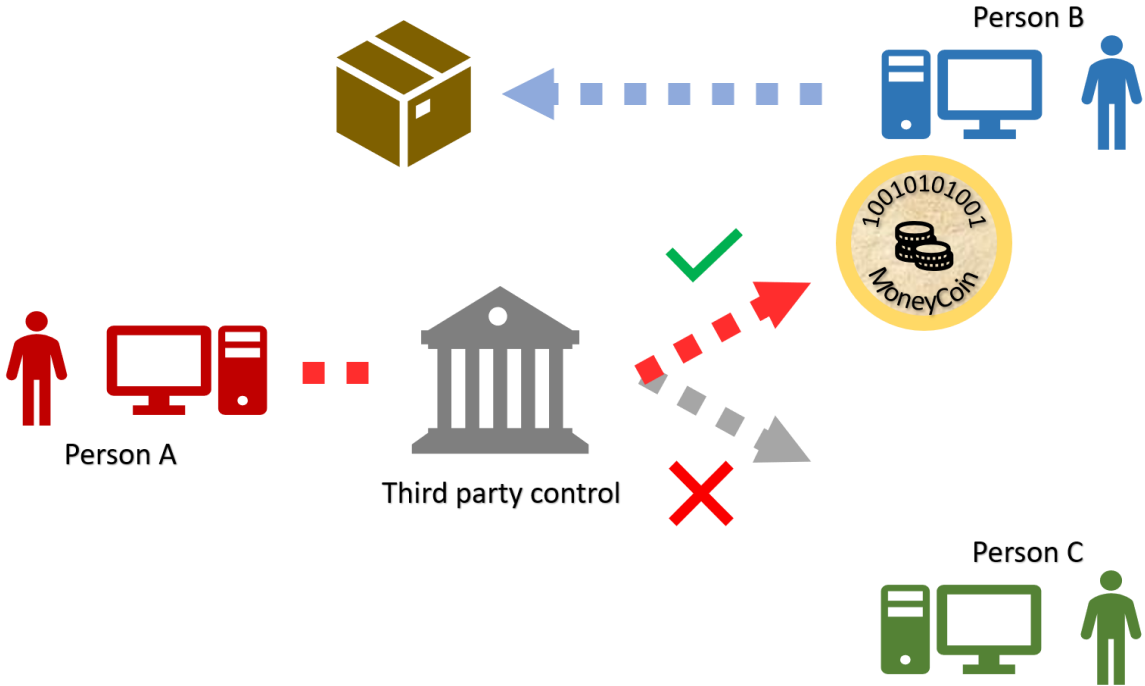


Figure 5: Transaction where a third party governs the double-spending issue.

As the double-dealing problem is essential in any transaction with digital currency, and poses an accounting and accountability challenge, it was important to overcome this problem if the idea of a decentralized transaction system of Bitcoin was to ever be implemented. Nakamoto proposed a way to overcome the double-spending problem by using a peer-to-peer distributed timestamp to generate computational proof of the chronological order of transactions. By the use of such a cryptographic proof system, the two willing parties would effectively bypass the trusted third-party control and remove the trust component all together.

Traditionally an electrical coin can be seen a chain of digital signatures where each owner transfers the coin to the next owner by providing a digital signature to a hash* of the previous transaction (Figure 6) and the public key of the next owner adding these to the end of the coin (Nakamoto, 2008).

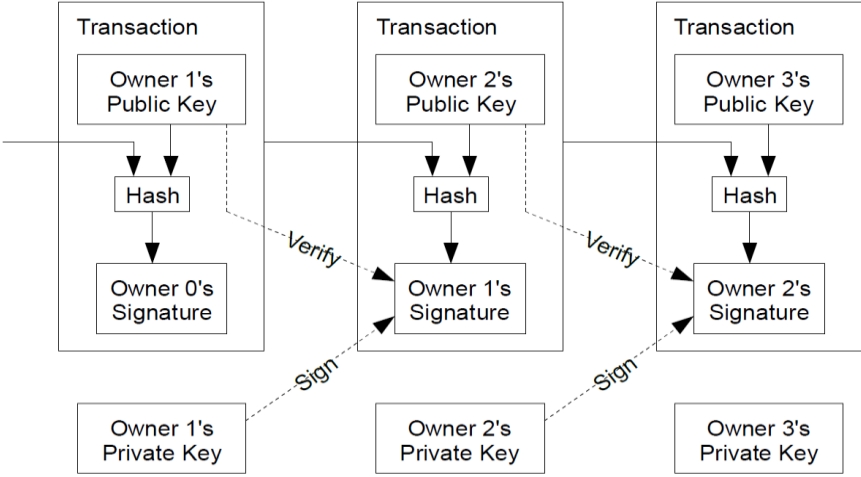


Figure 6: Schematic of a typical transaction chain in the Bitcoin Network, Source: Nakamoto, Satoshi, 2008

By relying on this system alone, it is not possible for one payee to verify that one of the previous owners did not double-spend the coin. To solve this without relying on the interaction of a trusted central authority, Nakamoto proposed to publicly announce the transaction through a system in which “participants” can agree to in which order the transactions are received. This would provide the payee with proof that at the time of each transaction, the majority of the nodes in the network agreed it was the first received.

To be able to timestamp the transactions, Nakamoto proposed to actively use a timestamp server in all transactions by taking a hash of a block of items to be timestamped before widely publishing the hash, proving that the data existed at the stamped time. Following this, each timestamp would include the previous timestamp in its hash, reinforcing the stamps before it (Figure 7).

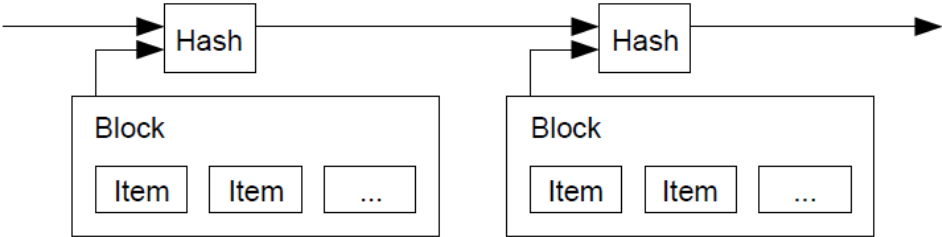


Figure 7: Schematic of a timestamp function in a hash block. Source: Nakamoto, Satoshi, 2008

To implement this timestamp server on a peer-to-peer basis Nakamoto suggested the employment of a proof-of-work system by incrementing a nonce* in the block until a value is found that gives the block's hash its required bits. What this effectively means is that once the CPU effort has been applied to validate the proof-of-work, a block cannot be modified or changed without redoing all the work after that block. The longest block-chain in the network which has the greatest proof-of-work effort invested in it represents the majority decision, making sure that as long as the majority of the networks CPU power is controlled by "honest nodes" the honest chain will grow the fastest and outpace any competing chains (Figure 8).

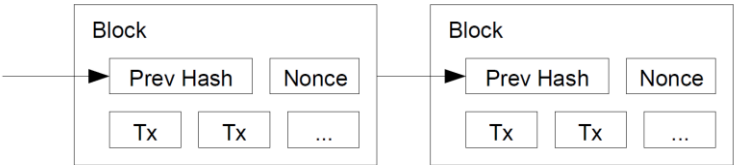


Figure 8: Sketch of the block-chain setup with timestamps and hash. Source: Nakamoto, Satoshi, 2008

Nakamoto argues the result of this is that any attempt to falsify a transaction or form an attack on the network quickly becomes computationally impractical as long as honest nodes control the majority of CPU power, making the network robust in its own unstructured simplicity.

To summarize and simplify, a typical transaction using this system will follow a specific series of events (Figure 9).

- 1) The transaction starts off with Person A sending Person B a Bitcoin ID.
- 2) This Bitcoin ID is then joined with other transactions into a “block” before being broadcast to all nodes in the network.
- 3) These nodes then race to verify the block of transactions by finding a difficult proof-of-work for that specific block, making sure in the process that the block is only accepted as long all transactions in the block is valid and not already spent.
- 4) When a node then finds proof-of-work, the block is added to the blockchain which works as a shared ledger for all Bitcoin transactions and the new blockchain is broadcast to the network. Finally, the transaction is confirmed, and Person B receives the Bitcoin.

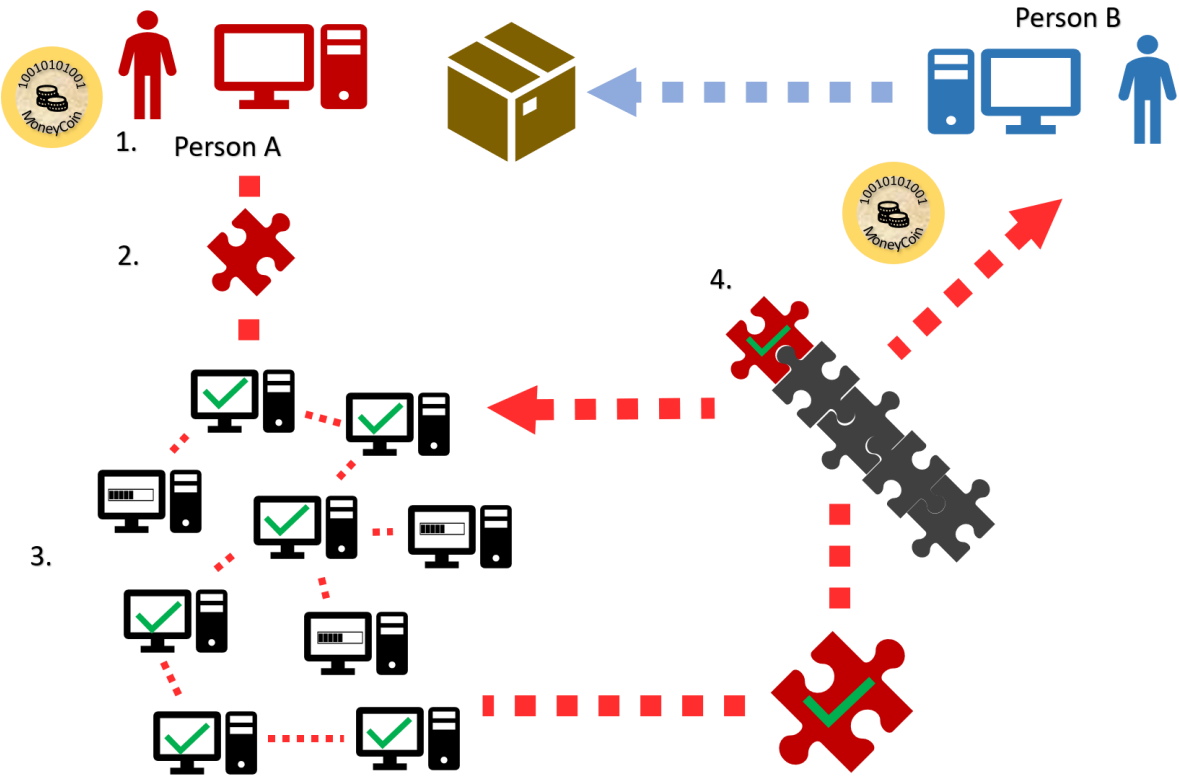


Figure 9: Illustration of a typical transaction in the blockchain.

3.1.3 Mining Bitcoin

For the Network to keep operating in a decentralized function, there needs to be a proper incentive for the individual node to support the network. Nakamoto suggested to solve this by distributing coins into circulation by awarding the nodes contributing with CPU power, referred to as miners. This term is an intentional reference to traditional goldmining as goldminers would expend personal resources such as time, equipment and money to add gold to circulation. The current incentive today is a small amount of Bitcoin per transaction confirmed by a node, provided as new bitcoins on the market. The maximum number of coins that can enter circulation in the network is set to a predetermined number of 21 million, by using a decreasing supply algorithm. This was done in order to simulate the rate commodities like gold are mined and to prevent standardized inflation¹⁹. Once the maximum number of Bitcoins has been released to the market, Nakamoto aims to keep the incentive for the miners with a transaction fee percentage from confirmed transactions.

Mining in its purest form involves verifying and adding new blocks to the blockchain by solving the computational proof-of-work problems discussed in the previous chapter. The difficulty of this computational solving is regulated by the Bitcoin Network in a fashion such that new blocks are formed approximately every 10 minutes²⁰. As the number of remaining bitcoins are dwindling and competitions increases, the difficulty of mining new bitcoin increases, demanding more processing power than before. Where a simple home computer was able to run standard mining operations before, the process today requires much more processing power. There has also traditionally been a monetary incentive for miners to operate individually, but with the increased mining difficulty it has become more common to join so called “mining pools”. These pools are used to divide earnings over a network of individual contributors based on contributed processing power, this is done in order to provide a steadier income compared individual operations. The most common bitcoin mining pools and miners can be seen in the infographic below (Figure 10).

¹⁹ Bitcoin Wiki, “Controlled Supply”.

²⁰ Antonopoulos, “Bitcoin and The Blockchain”.

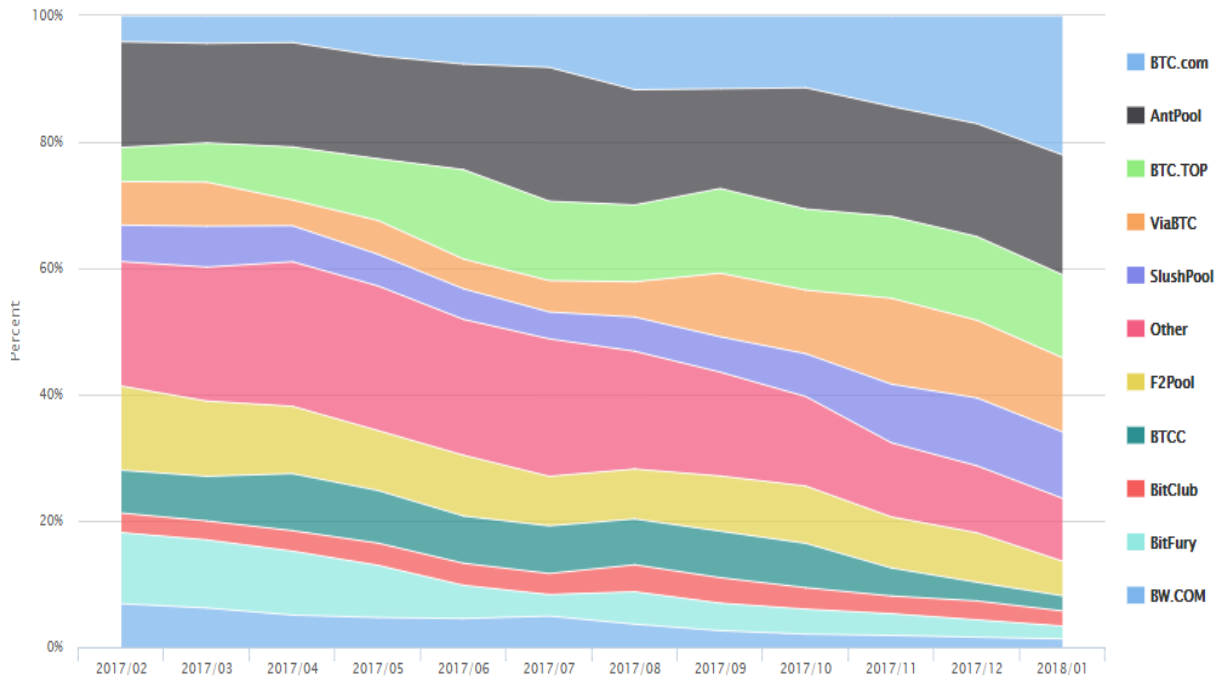


Figure 10: Most common bitcoin mining pools. Source: https://btc.com/stats/pool?pool_mode=year

The expected profitability of mining Bitcoin depends on many different factors such as hardware, electricity cost, price of a Bitcoin and mining competition. Today, the profitability margin of mining from home has been steadily narrowing due to the increased difficulty and needed processing power, competition from other miners, and organized mining facilities operating with super computers mining ideal locations such as arctic conditions to save electricity costs on cooling.

3.2 Altcoins and Comparison to Bitcoin

Even though Bitcoin is the original cryptocurrency, it is far from the only cryptocurrency available on the market. As mentioned before there are over 1600 other crypto currencies available as of writing this thesis, where these are often referred to as “Altcoins”. Many of these crypto currencies are based on the same or a similar technological foundation as the Bitcoin Network, often seeking to alter, replicate, parody or improve. With so many available Altcoins, it is bound to be some “bad apples”, with scams, fakes, copies and parodies. There are however as mentioned, also viable Altcoins available and several cryptocurrencies that have altogether different fundamental technologies behind them. These Altcoins often borrow concepts from Bitcoin while providing features that address perceived shortcomings the original Bitcoin Network or target other applicational areas through innovative solutions.

A very brief comparison of the five most popular cryptocurrencies on the cryptocurrency market will be presented in a descending order of market cap (as of writing this thesis). There will however not be any in depth analysis to the history or technology of these Altcoins, such as with Bitcoin. This comparison is done to provide further insight in what opportunities these Altcoins represent compared to Bitcoin. Understanding how these Altcoins relate to Bitcoin on a market level is central in understanding the situation of the cryptocurrency market today, as Altcoins have over 65% of the total cryptocurrency market cap as of writing this thesis²¹

²¹ Coin Market Cap, “Global Charts”.

3.2.1 Ethereum (ETH)

Ethereum holds roughly 20% of the market capitalization and was introduced in 2015 based on a white paper written by Vitalik Buterin²². Ethereum is a currency in the Ethereum protocol which was originally conceived as an upgraded version of cryptocurrency, sporting several features such as on-block escrow, withdrawal limits and financial contracts, gambling markets and the like through a generalized Turing-complete programming language. Vitalik meant for Ethereum to provide much more than “just” currency by providing other peer-to-peer services through an economic layer, providing more of a platform than a pure alternative cryptocurrency compared to Bitcoin. In general, if Bitcoin is a decentralized alternative to regular money, Ethereum can be perceived as a platform which facilitates peer-to-peer contracts and trading through its own currency vehicle Ether²³.

3.2.2 Ripple (XRP)

Number three ranked with regards to market capitalization is Ripple, with around 10% of the total market capitalization. Ripple Labs Inc. introduced Ripple in 2012, and Ripple is based on the Ripple Protocol. Unlike many other cryptocurrencies, Ripple is not decentralized and is instead centrally controlled as a part of the Ripple Labs Inc. Ripple is also not based on a public blockchain, but instead an “enterprise blockchain” ledger whose specifics are not known to the public. Ripple has had a clear focus from the beginning to be adopted by cross-border banking systems and to be implemented instead of the SWIFT-network that is being used today²⁴. The idea is not to replace the fiat system like Bitcoin, but rather improve the banking industry today. Another one of the main ideas behind Ripple has been based on improving the apparent high latency induced by the requirement of synchronized network node communication that Bitcoin has. By contrast, the Ripple Protocol can process transactions in a matter of seconds²⁵. Ripple also opens for the potential of transferring any digital currencies, not just their own native cryptocurrency token.

²² Buterin, “A next generation smart contract and decentralized application platform”.

²³ Bajpai, “Bitcoin vs. Ethereum”.

²⁴ Coincentral, “Ripple vs Bitcoin”.

²⁵ Schwartz. Youngs. Britto, “The Ripple protocol consensus algorithm”.

3.2.3 Bitcoin Cash (BCH)

Bitcoin Cash was created in August 2017 as a result of a debate regarding the future of Bitcoin as a payment option. Today, Bitcoin cash holds around 5% of the total market cap and has experienced a rapid value growth since its creation²⁶. Bitcoin Cash exists as alternative to Bitcoin to address the scalability problems that Bitcoin has with its slow transaction times and high transaction costs. Essentially, Bitcoin Cash operates under the assumption where Bitcoin can be seen as a “store of value” for cryptocurrency as a whole, such as gold is to fiat currency. Bitcoin Cash split from Bitcoin in order to provide a cryptocurrency which is essentially Bitcoin, but easier to send, receive and transact with through changing the underlying technology and network in the system²⁷.

3.2.4 Litecoin (LTC)

Litecoin was released in 2011 and is often referred to “silver” to Bitcoins “gold” and is another altcoin that aims to fix certain aspects of the original Bitcoin network. It currently holds around 2% market capitalization and is technically almost identical to Bitcoin. It was made as an alternative to promote reduced transaction time through a separate algorithm called Scrypt, in order to further decentralize the mining aspect²⁸.

As can be seen from the brief comparison above, there are several viable options to Bitcoin in many of the Altcoins presented that meet other market demands that exist in the cryptocurrency market. Due to how many of these differentiate from Bitcoin in their technology or purpose, the relation between Bitcoin and many Altcoins is what defines the market today.

The adoption of altcoins has increased significantly over the last years and has steadily been eating away at the Bitcoin market dominance (Figure 11), making it more important than ever to understand the characteristics separate them from another.

²⁶ Wikipedia, “Bitcoin Cash”.

²⁷ Finder, “Bitcoin vs Bitcoin Cash”.

²⁸ Fernando, “Bitcoin Vs. Litecoin: What’s the difference?”

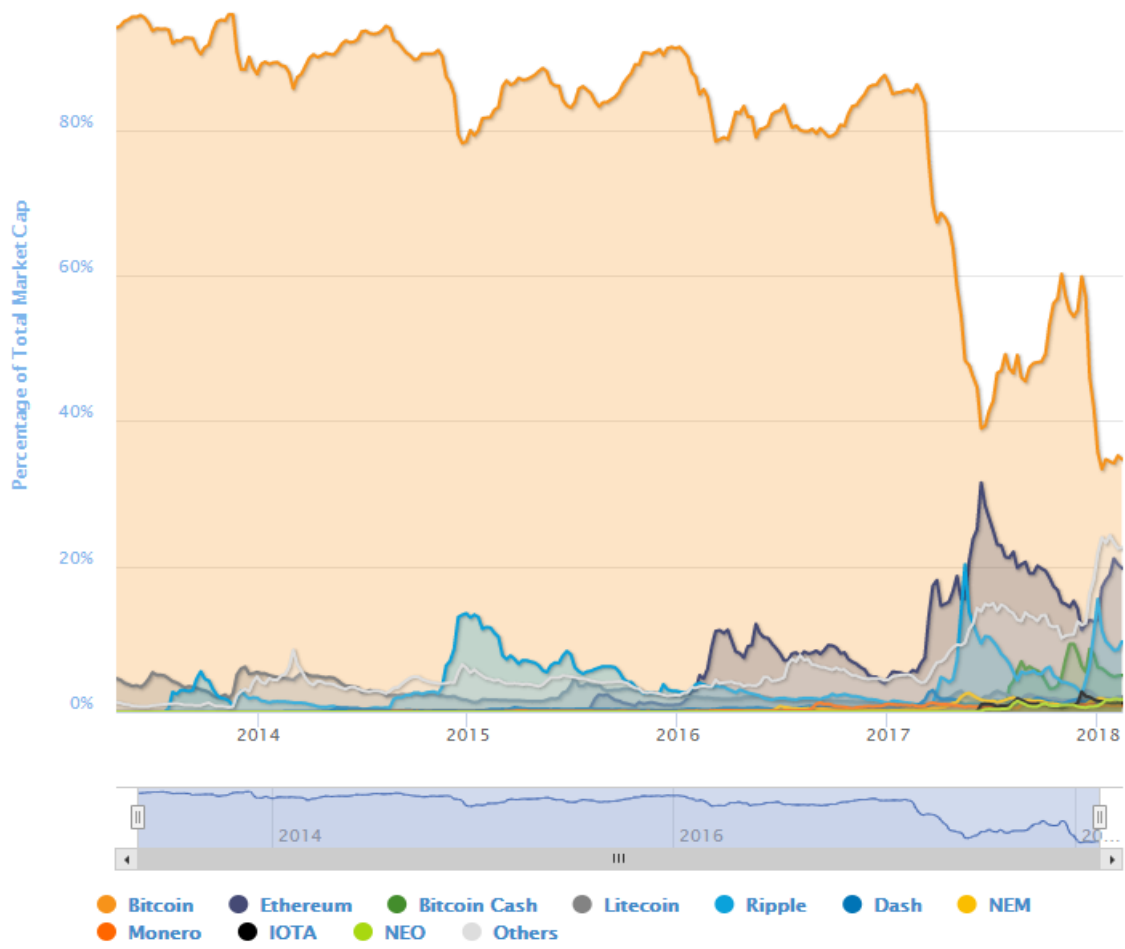


Figure 11: Percentage total market cap held by the top 10 cryptocurrencies.

4. The Cryptocurrency Market

Previously, the relationship between the main cryptocurrencies in the market with regards to market capitalization (Figure 12) has been explored briefly. These same cryptocurrencies will be used as examples in the following analysis of the current cryptocurrency market. Several different ways to utilize cryptocurrency exist, such as spending for commerce, investing, and trading between cryptocurrencies or fiat currencies etc²⁹. Hileman and Rauchs categorized the cryptocurrency industry into four key sectors and their primary function on the global cryptocurrency market.

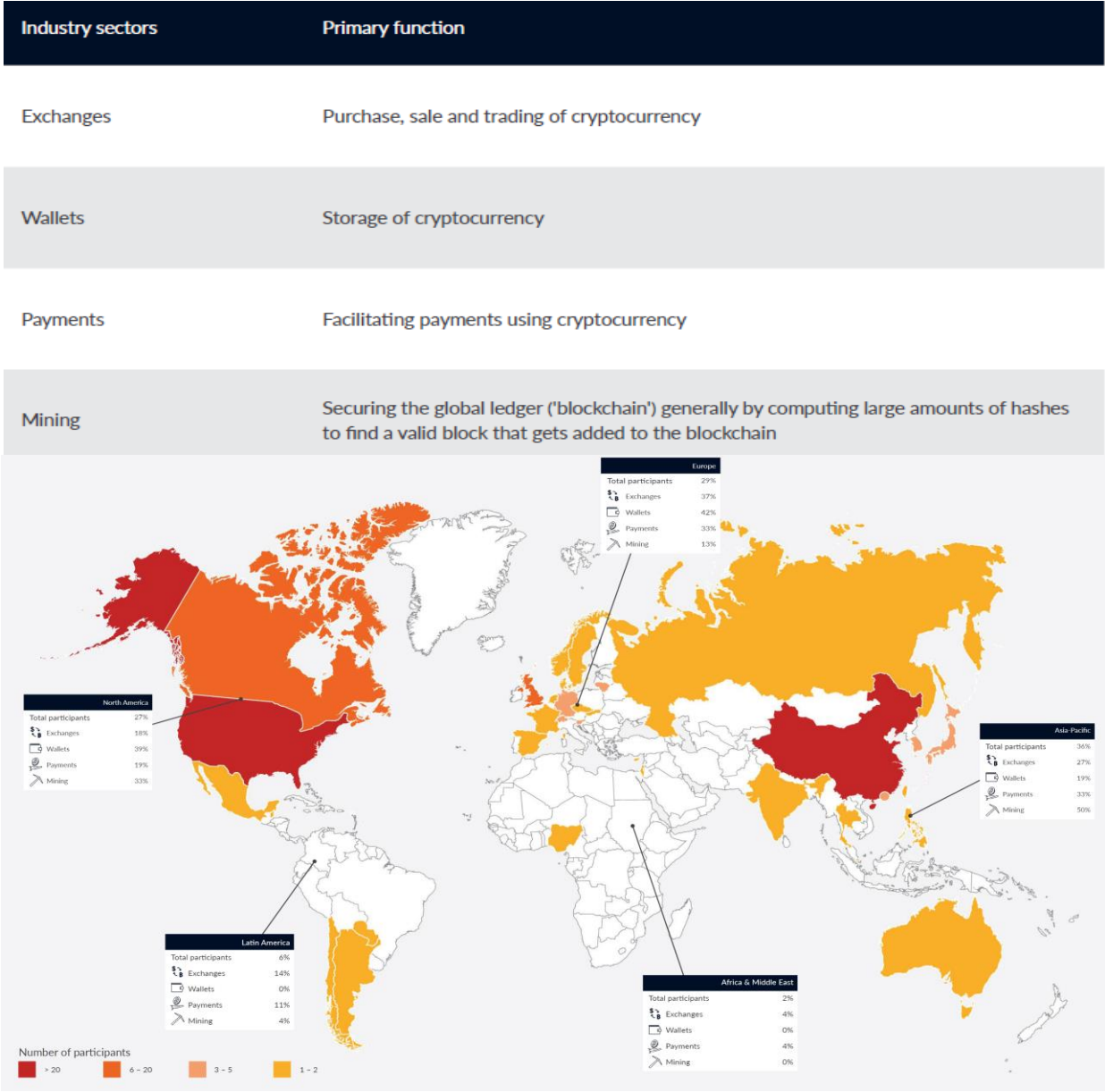


Figure 12: Industry sectors and primary market functions. Source: Hileman, Rauch (2017).

²⁹ Hileman, Rauchs. "Global cryptocurrency benchmarking study"

4.1 Acquiring and Spending Cryptocurrency

To acquire cryptocurrency, one can traditionally buy cryptocurrency from others, trade it against any other commodity or mine it (covered in chapter 2.1.3). Buying cryptocurrency is normally done through exchange platforms such as Bitfinex, Coinone, Coinbase etc. or from private owners. Exchange platforms such as these normally provide the user with the opportunity to purchase from a select number of cryptocurrencies with Visa/Mastercard or through bank transfers. Such sites also often facilitate sending or receiving cryptocurrencies to or from other cryptocurrency “wallets” with personal cryptocurrency addresses or labels, making it easy to pay, receive money or trade from, to and within the exchange platform (Figure 13).



Figure 13: Coinbase front page. Source: Coinbase.com

It is possible to use cryptocurrencies as a payment option for certain products, but due to the anonymous nature of many of the cryptocurrencies it is very difficult to provide any accurate numbers on how many are actively using cryptocurrency for purchasing products today³⁰. Hileman and Rauchs (2017) states that in a 2016 joint report from Coinbase and Ark Investment, only 46% of Coinbase users use Bitcoin as a transactional medium, but this is not necessarily representative of the entire market as Coinbase is just one exchange platform of many. In addition, the price of cryptocurrency has changed a lot since 2016, likely deterring the use it has a transactional medium as it is difficult to predict the future value.

³⁰ Quora, “How many people in the world own Bitcoin or Ethereum?”

By analysing the average transaction fee³¹ (Figure 14) for Bitcoin in USD and average transaction time (average block time = 10 min * average confirmations / transaction = 60min), it is clear that Bitcoin is not suited for small everyday purchases with today's market situation. It is however possible to imagine that in situations where larger quantities of currency are to be transferred or used to acquire a product, this transaction cost and time would be negligible and a small price to pay for the decentralization.



Figure 14: Average Bitcoin transaction fee for late 2017 and early 2018. Source: <https://bitinfocharts.com/comparison/bitcoin-transactionfees.html>

There are however as mentioned, cryptocurrencies that outperform Bitcoin in terms of small payments. Ripple is one of these and operates with much lower average transaction fees (Figure 15) and transaction times of 4 seconds³². However, seeing how Bitcoin is still the most popular cryptocurrency combined with a relatively limited number of places that accept cryptocurrency, the percentage of cryptocurrency owners using cryptocurrency as a payment option today is believed to be very low.

³¹ Bitinfocharts, "Bitcoin-Avg. transaction fee."
³² Ripple.com

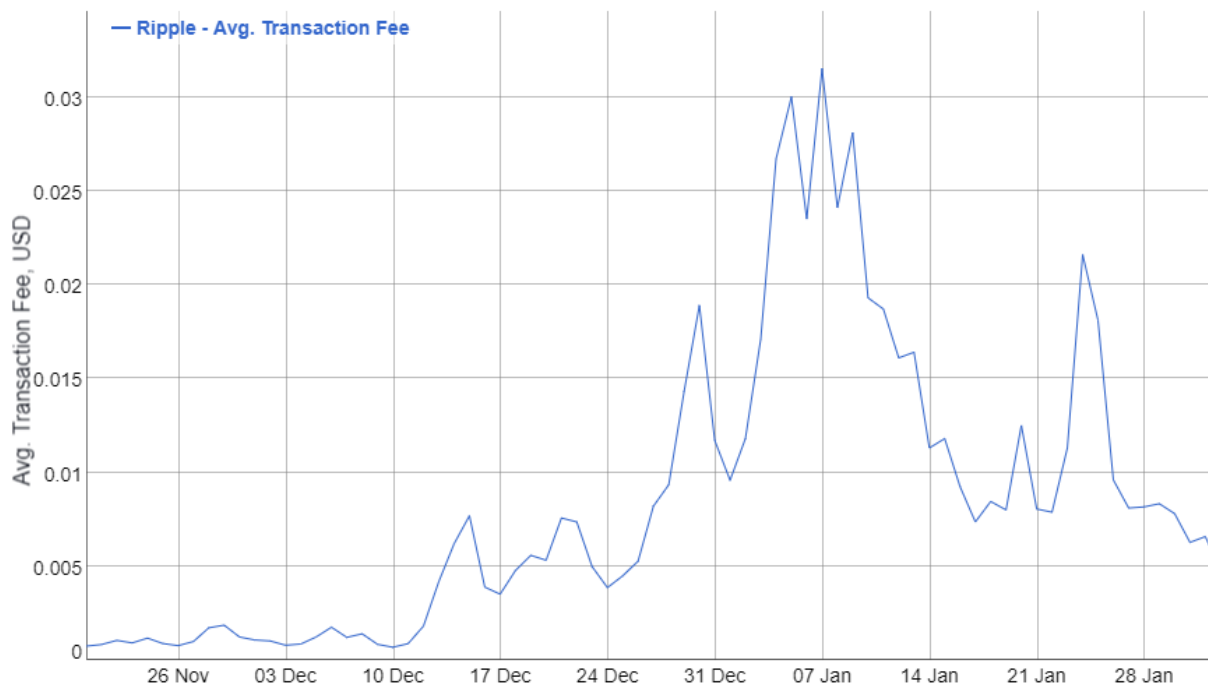


Figure 15: Average transaction fee for Ripple in late 2017 and early 2018. Source: <https://bitinfocharts.com/comparison/ripple-transactionfees.html#3m>

4.2 Trading and investing in cryptocurrency

While the amount of Bitcoin users spending cryptocurrencies as a currency is believed to be low, there is a much wider audience speculating, investing and trading in the cryptocurrency market. As of writing this thesis there are over 10M users on Coinbase alone. This exchange platform allows for buying and selling a selection of cryptocurrencies by trading against fiat currency such as Euro or USD with an exchange rate. The exchange rate is often used when presenting the value of a certain cryptocurrency and is often presented in the exchange rate of one unit of cryptocurrency versus one unit of USD, Euro, Chinese Yen or Japanese Yen (Hileman and Rauchs, 2017).

Additionally, the exchange platform also allows for trading between the supported cryptocurrencies and transfer to and from cryptocurrency wallets, making it possible to transfer between exchanges and personal wallets. There exist several exchange sites similar to Coinbase that in varying degree support similar features and options for trading, buying and selling (Figure 16).

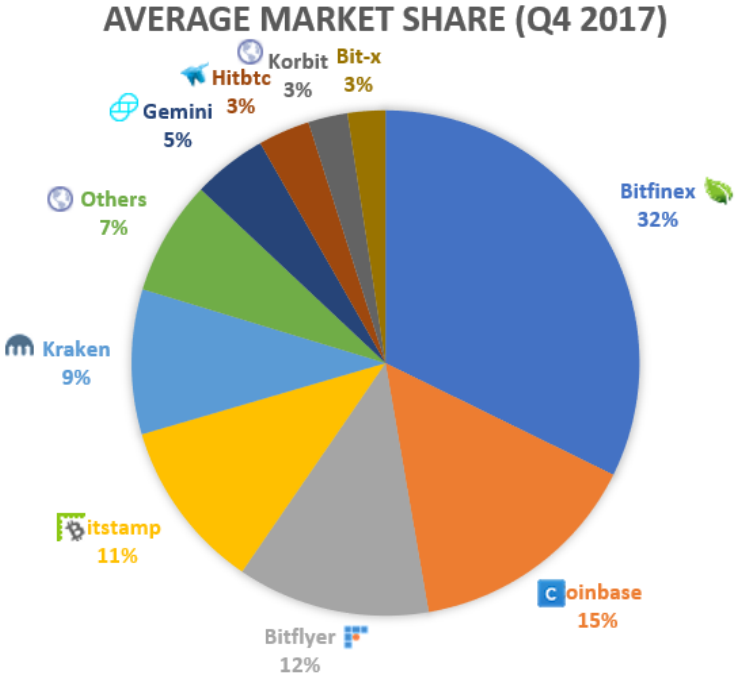


Figure 16: Average market share of the top cryptocurrency exchanges. Source: <https://data.bitcoinity.org/markets/volume/30d?c=e&t=b>

Due to the rapid price fluctuations that the cryptocurrency market has been experiencing over the last years and in particular in 2017 and early 2018, speculating in the future values and adoption of different cryptocurrencies has been gaining popularity and public interest.

To exemplify how the price has been increasing since 2016, a graph displaying the price multiplier of the different cryptocurrencies³³.

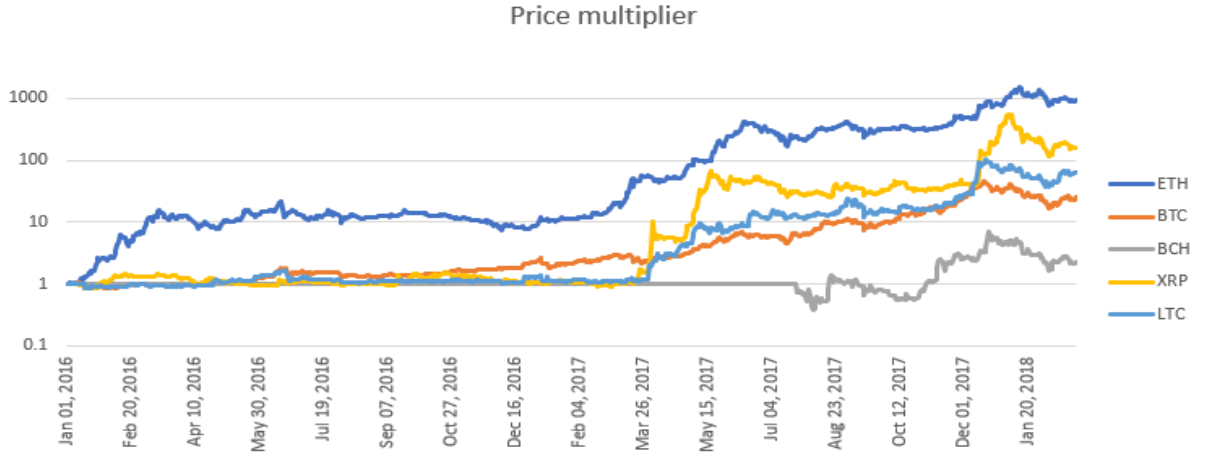


Figure 17: Price multiplier of the analysed cryptocurrencies in 2016 – 2017.

³³ Coin Market Cap, “Currencies”.

As can be seen, the value of the top five cryptocurrencies today has increased tremendously in value over just the last 2 years, and has a result attracted many investors seeking fortune and large payoffs. To illustrate, a quick calculation is made below to show a theoretical case investment made in 2016 in what would become the top five cryptocurrencies as of end 2017 (Table 1). Here a small investment of 100 \$ in each of the top five cryptocurrencies totalling 500 \$ in 01.01.2016 is turned into almost 130,000 \$ as of 01.01.2018.

	Investment 01.01.2016		Price multiplier 01.01.2018		Value 01.01.2018
BTC	\$ 100.00	x	32.76	=	\$ 3,276.42
ETH	\$ 100.00	x	809.41	=	\$ 80,941.45
BCH	\$ 100.00*	x	4.57	=	\$ 456.72
XRP	\$ 100.00	x	380.79	=	\$ 38,079.47
LTC	\$ 100.00	x	66.57	=	\$ 6,657.18
Sum	\$ 500.00				\$ 129,411.25

Table 1: Theoretical case investment of \$500 evenly distributed across the current top 5 cryptocurrencies.

*Bitcoin Cash opened August 2017

In this example, Ether (ETH) is the biggest winner by far with over 800x increase in value compared to 2016 numbers, followed by Ripple (XTC), Litecoin (LTC), Bitcoin (BTC) and then Bitcoin Cash (BCH). It is however important to note that these numbers are only based on the total increase in value per cryptocurrency for the last two years presented as a price multiplier. It is therefore not representative as a value indicator of a cryptocurrency. It is also important to keep in mind that cryptocurrency such as ETH or XRP that experienced the largest growth since 2016 are still relatively new compared to Bitcoin or Litecoin, which have had a longer history of market growth and therefore a longer time to stabilize.

4.3 Adoption of cryptocurrency in society and market distribution

Hileman and Rauchs, (2017) states that estimating the number of cryptocurrency holders and users is difficult seeing how individuals can use multiple wallets from several providers at the same time. Additionally, one single user can own several wallets and exchange accounts for different cryptocurrencies making it possible to overestimate the number. In early 2017, Hileman and Rauchs, (2017) stated that they believed the number to lie between 2.9 million and 5.8 million unique active users of cryptocurrency wallets based on data from study participants (Figure 18).

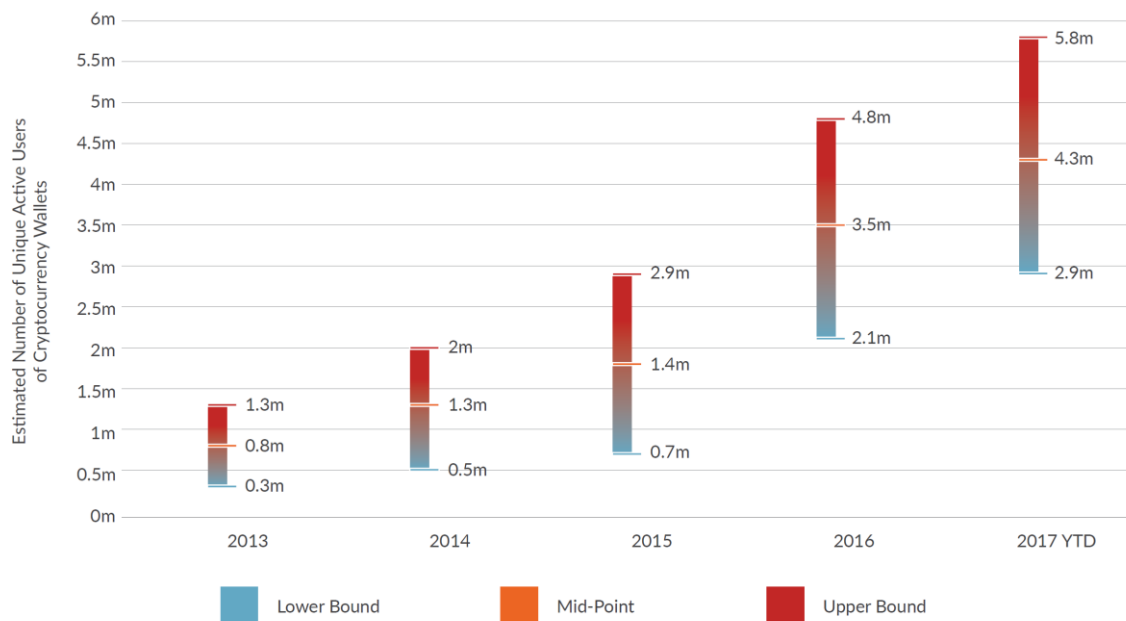


Figure 18: Estimated public adoption by unique active users of cryptocurrency wallets. Source: BENCH 2017

Given the increased popularity of cryptocurrency in 2017, high stream of new users³⁴ and increased public adoption (over 10 million users on Coinbase alone)³⁵. This number is believed to have significantly increased from early 2017 levels.

Rogers, Everet M. (2010)³⁶ proposes that the adoption of a new innovative solutions within a social system can be standardized with the use of five categories:

³⁴ Young, “Exponential growth- Cryptocurrency exchanges are adding 100,000+ users per day”.

³⁵ Cheng, “Bitcoin exchange Coinbase has more users than stock brokerage Schwab”.

³⁶ Rogers, Everett M. “Diffusions of innovations.”

Adopter category **Definition**

<i>Innovators</i>	Innovators are willing to take risks, have the highest social status, have financial liquidity, are social and have closest contact to scientific sources and interaction with other innovators. Their risk tolerance allows them to adopt technologies that may ultimately fail. Financial resources help absorb these failures.
<i>Early adopters</i>	These individuals have the highest degree of opinion leadership among the adopter categories. Early adopters have a higher social status, financial liquidity, advanced education and are more socially forward than late adopters. They are more discreet in adoption choices than innovators. They use judicious choice of adoption to help them maintain a central communication position.
<i>Early Majority</i>	They adopt an innovation after a varying degree of time that is significantly longer than the innovators and early adopters. Early Majority have above average social status, contact with early adopters and seldom hold positions of opinion leadership in a system (Rogers 1962, p. 283)
<i>Late Majority</i>	They adopt an innovation after the average participant. These individuals approach an innovation with a high degree of scepticism and after the majority of society has adopted the innovation. Late Majority are typically sceptical about an innovation, have below average social status, little financial liquidity, in contact with others in late majority and early majority and little opinion leadership.
<i>Laggards</i>	They are the last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little to no opinion leadership. These individuals typically have an aversion to change-agents. Laggards typically tend to be focused on "traditions", lowest social status, lowest financial liquidity, oldest among adopters, and in contact with only family and close friends.

Table 2: Social adaption stages for innovative solutions. Source: Rogers, Everett M. 2010

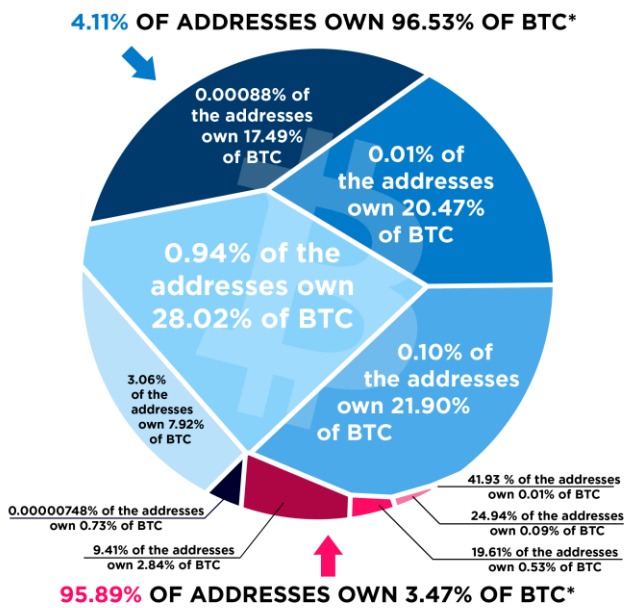
Based on the observations made in the cryptocurrency market, it can be argued that the cryptocurrency market has a relatively low adoption rate in the global market. Following Rogers, Everet M. (2010)'s model, it is likely that the cryptocurrency market is still mainly comprised of innovators and early adopters but has started to reach some early majority adoption.

In the cryptocurrency market today, there exist a huge imbalance in the distribution of market share between the holders. In the Bitcoin market as of late 2017 it is estimated that over 95 % of all Bitcoins are owned by about 4 % of the addresses on the market and that 1% of the addresses control over 50 % of the market³⁷ (Figure 19).

It is however important to keep in mind these numbers are tied to wallet addresses. Meaning that one address might represent more than one individual, but also that one individual might represent more than one address.

This introduces uncertainty regarding any estimates on number of people holding cryptocurrency, but also regarding the market share distribution in the crypto-market.

The bitcoin Wealth Distribution



* Data as of September 12th, 2017
Article and Sources:
<https://howmuch.net/articles/bitcoin-wealth-distribution>
<https://bitcoinprivacy.net/>

howmuch.net

Figure 19: Bitcoin wallet wealth distribution. Source: <https://howmuch.net/articles/bitcoin-wealth-distribution>

³⁷ How much, “This chart reveals the centralization of Bitcoin Wealth”.

4.4 Market drivers, Market history, and Market manipulation

Due to the potential financial profits related to the massive growth that the cryptocurrency market has seen, there is a strong incentive in attempting to predict and influence the future of the market. This is however inherently difficult as the market is prone to speculations, uncertainties, and volatile behaviour. While an analysis will be made of market history and future potential, any detailed market prediction analysis methods will not be covered by this thesis.

Even though the overall market has seen significant growth, there has been several major hurdles and failures for many cryptocurrencies over the years like Paycoin, DAO, GEMS, Dogecoin, etc³⁸. In order to attempt to understand the cryptocurrency market behaviour and drivers, there is value in analysing historical data and events with the corresponding market response.

The cryptocurrency market has historically seen significant changes linked to isolated events or periods over the last years. Due to the speculative nature and relatively unexplored potential in the cryptocurrency market, events of a certain magnitude can impact the market significantly. Examples of such events will be discussed below along with the impacts they had on the market.

For most market observations in the following chapters, Bitcoin has been used as a representative for the cryptocurrency market due to its high market share, market control and for simplicities sake.

³⁸ Faggart, "The top 5 cryptocurrencies failures of all time"

4.4.1 The Mt. Gox incident – Then and Now

Arguably, the incident that has had the biggest impact on the cryptocurrency market is the Mt. Gox incident in early 2014 which's influence lasted for years. The following information has been compiled from Gandal, Neil, et al. (2018)³⁹. According to Gandal, Neil, et al. (2018), Mt. Gox was a Bitcoin currency exchange ecosystem that operated between 2010 and 2014, not very different in nature from many of the exchanges that exists today. From early 2013, the market experienced a period with high price growth followed by a period experiencing rapid price growth. These periods of growth have later been found to be linked to two suspicious “traders”; Markus and Willy (Figure 20). Studies have found it likely that the actions of a single actor running the two fraudulent “traders” dubbed Marcus and Willy, was the reason behind the spike in the Bitcoin price from \$150 to over \$1000 Gandal, Neil, et al. (2018). The days these traders were active, they were responsible for 21% and 18% of the total daily trade volume on Mt. Gox respectfully, acquiring cryptocurrency without paying. The paper concludes that the evidence of this being fraudulent trading with the purpose of artificially inflate the market is overwhelming.

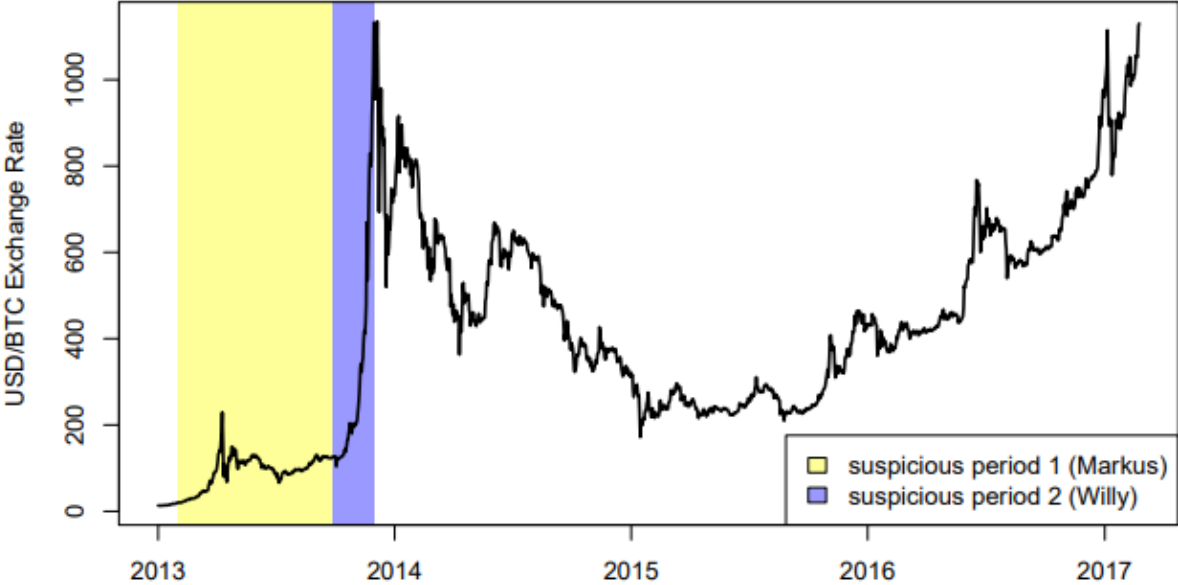


Figure 20: Period of growth linked to suspicious trading activity in 2013 Mt. Gox. Source: Gandal, Neil, et al. 2018

The following crash was prompted by the discovery that Mt. Gox had lost over 850 000 Bitcoins over the period that these traders were active. Mt. Gox later recovered around

³⁹ Gandal, Neil, et al. “Price manipulation in the Bitcoin ecosystem.”

200 000 of these Bitcoins, but 650 000 Bitcoins were still gone. This severely damaged the trust the users had towards the exchanges and in the technology for years. It took Bitcoin more than three years before it was able to match this price again recently in 2017. This example goes to show how it is possible for fraudulent forces to affect the market through artificial inflation.

Comparing the recent price development in the cryptocurrency market in 2018 provides a seemingly matching view to what was observed in 2014 (Figure 21), sparking debates in cryptocurrency forums regarding if similar events as with Mt. Gox may have contributed to the 2017 increase and subsequent decrease⁴⁰.



Figure 21: Side by side comparison of 2013 and 2017 price history. Source: <https://www.tradingview.com/chart/BTCUSD/c9qjrlR-Mt-Gox-Crash-VS-2018-Crash-side-by-side-comparison/>

While no hard evidence for fraudulent transactions have been presented today to explain the extreme increase in 2017, the following crash has of April 2018 been linked to the sell-off of the remaining 200 000 Bitcoins that where recovered during the Mt.Gox Crisis as a

⁴⁰ Trading view, “Mt. Gox crash vs 2018 crash”

part of the bankruptcy legal process to the clients⁴¹. The effect of these huge amounts of cryptocurrency sold as part of this series of sales is apparent when analysing the timing of the sales and the market response (Figure 22). The Mt. Gox trustee sold 35,841 BTC and 34,008 BCH for \$362 million and \$45 million respectively. These numbers are relatively small compared to total market cap, but in such a volatile market with much fear and uncertainty, sales of these proportions can be enough to create a cascade effect when mixed with other factors. The trustee still holds over 165,000 BTC, and while the price has stabilized since the last sale as of writing this thesis, future sales of this magnitude could cause further significant drops in the price ⁴².



Figure 22: Price history and sale events comparison. Source: https://twitter.com/matt_odell/status/971429396174209027/photo/1

⁴¹ Kobayashi, Nobuaki, “Bankruptcy sales report”
⁴² Lewis. “Did Mt. Gox cause the 2018 crypto crash?”

4.4.2 Whales in the Cryptocurrency Market

The trustee discussed in the Mt. Gox case that holds over 165,000 BTC, and other users holding vast amounts of cryptocurrency are often referred to as “whales” by the Bitcoin community. In fact, the media speculates that almost 40% of the entire market is controlled by under 1000 persons⁴³. When controlling such massive amounts of cryptocurrency, it is possible to influence the market with timely and large market transactions. Sales similar to the case described above make it possible to instigate a sell-off effect in the market and then take advantage of this and buy back in when the price is lower. Such operations can be done over the course of days to shake market stability or by splitting large transactions into a series of several smaller transactions over a longer time to stimulate the market⁴⁴.

4.4.3 Market response to regulations

There are several examples where the introduction of regulations has influenced the market significantly, and history has shown that the cryptocurrency market in general is very responsive to any news that could rock the balance in the market. Here are a few examples of noteworthy events from the last year from news and corresponding market responses for Bitcoin as a reference with data from coinmarketcap.com:

5th of February, 2018. Cryptocurrency markets experience a significant price drop after China officially blocked all websites related to cryptocurrency both domestic and foreign. Following this news, Bitcoin dropped 16% in price just over the next 24 hours⁴⁵.

1st of February, 2018. Bitcoin prices drop over 20% in 24 hours following the reports that India aims to take measures towards eliminating the use of crypto-assets⁴⁶.

⁴³ Kharif. “The Bitcoin Whales: 1000 people who own 40% of the market”.

⁴⁴ CCN. “What is a Bitcoin Whale”

⁴⁵ Roh. “China cryptocurrency ban crashes market, again”

⁴⁶ Damiani. “Crypto Watch: Bitcoin Prices Fall Amid Reports Of India Crypto Regulation”

8th of November, 2017. Following a failed suggestion for a hard fork in the Bitcoin ledger system the price for a Bitcoin dropped from almost 8000\$ down to under 6000\$ in a couple of days⁴⁷.

8th of September, 2017. Bitcoin loses 35% value over a week after rumours about Chinese government shakedown against the crypto market and unfavourable statements from Jamie Dimon, CEO of JPMorgan Chase⁴⁸.

10th of March, 2017. Bitcoin drops 15% in minutes after ruling against Bitcoin exchange-traded fund proposal⁴⁹.

As can be seen from some of the examples above, cryptocurrency trading is big business in the Asian markets such as China, Japan and South Korea. Any significant news impacting the Asian market has had a direct impact the cryptocurrency market on a global scale. While other key markets such as Europe and the United States of America have not implemented any significant regulations as of writing this thesis, it is likely that such a situation would cause similar market responses.

Regardless of these reductions in price, the increased popularity, and media attention that cryptocurrency saw in 2017, pushed the price for one Bitcoin from around \$1000 USD in early 2017 to almost \$20000 USD towards the end of 2017 before the following continued decline in 2018.

⁴⁷ Shin. "Bitcoin Hard Fork Called Off, Averting Major Disruptions And Turbulence In Cryptocurrency"

⁴⁸ Clements. "Bitcoin Price Update LIVE: Bitcoin recovers amid China BTCC and exchange shut down"

⁴⁹ Lee. "Why Bitcoin lost 15 percent of its value in a few minutes"

4.4.4 Cyclical markets and psychological barriers regarding round numbers

In addition to regulations, market-manipulations and hype, there are several other factors which play a role in defining the market price of different cryptocurrencies.

By analysing the price history of Bitcoin (Figure 23) around the Lunar new year, it becomes clear that 2-4 weeks before the Chinese New Year, there are usually some noticeable sell-off events. This has also been linked to cultural norms regarding lending and borrowing money in China and liquidation of assets in preparation of the holiday⁵⁰.

Another effect that seems to influence markets such as the cryptocurrency market is the well documented effect of round numbers and the psychological

effect these have on markets⁵¹. By analysing the historical charts, there is an observable resistance to breaking through round numbers. The bigger the numbers are, the more difficult they tend to be to break through. An example is how the Bitcoin price was pushed up to nearly \$20,000 USD before turning around in December 2017 (Figure 24) and similarly experienced resistance at price roofs and floors throughout the month.

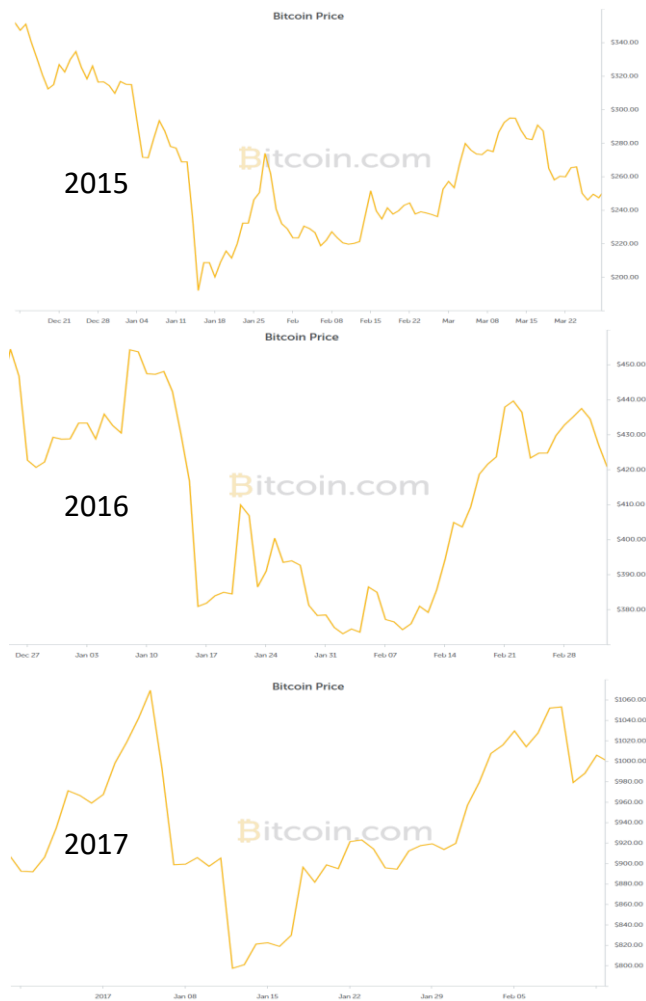


Figure 23: Price history around Chinese new year for 2015, 2016, and 2017. Source: Bitcoin.com

⁵⁰ Venegas. "Bitcoin and the Chinese New Year"

⁵¹ Stanley. "Trading Psychological Whole Numbers"



Figure 24: Price history around of December 2017 depicting price changes around round numbers 18,000, 20,000, and 12,000 USD. Source: Coinmarketcap.com

4.4.5 The cryptocurrency market and bubbles

The behaviour of the cryptocurrency market has been compared to bubble markets since the early days of Bitcoin⁵² and the famous graph for stages in a financial bubble by Rodrigue, Jean-Paul et al. (2016)⁵³ has been thrown around on many occasions where there is a rapid price change/development (Figure 25).

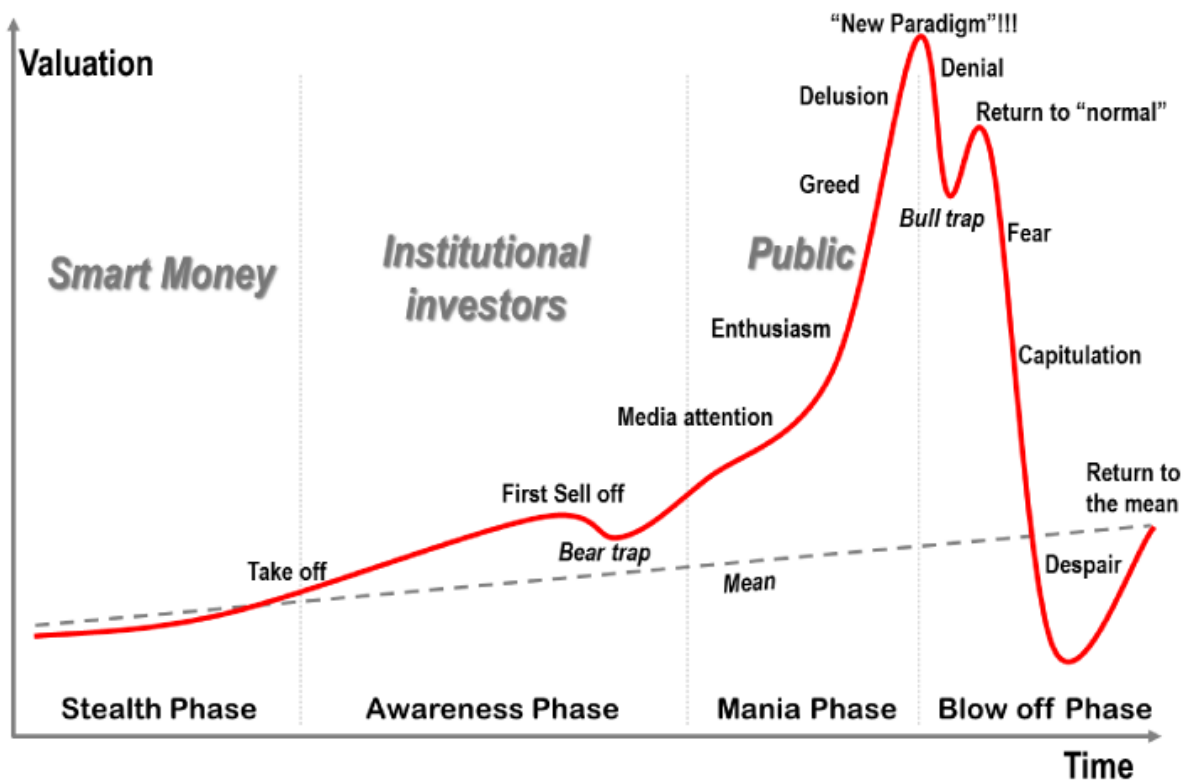


Figure 25: Graph depicting stages in a financial bubble. Source: JEAN PAUL RODRIGUE, https://transportgeography.org/?page_id=9035.

According to Rodrigue, Jean-Paul et al. (2016), the lifecycle of a financial bubble can be divided into four stages:

1. **Stealth.** “Categorized by those who understand the new fundamentals realize an emerging opportunity for substantial future appreciation, but at a risk since their assumptions are so far unproven. The “smart money” is often invested in the asset class, quietly and cautiously. This category of investor tends to have better access to information and a higher capacity to understand the wider economic context that would trigger asset inflation. Prices gradually increase, but often completely

⁵² Steemit. “Bitcoin-Bubbles: A brief history”

⁵³ Rodrigue, Jean-Paul et al. “The geography of transport systems”

unnoticed by the general population. Larger and larger positions are established as the smart money start to better understand that the fundamentals are well grounded, and that this asset class is likely to experience significant future valuations.”

2. **Awareness.** “Many investors start to notice the momentum, bringing additional money in and pushing prices higher. There can be a short-lived sell off phase taking place as a few investors cash in their first profits (there could also be several sell off phases, each beginning at an higher level than the previous one). The smart money takes this opportunity to reinforce its existing positions. In the later stages of this phase the media starts to notice with positive reports about how this new boom benefits the economy by “creating” wealth; those getting in becoming increasingly “unsophisticated”.”

3. **Mania.** “Everyone is noticing that prices are going up and the public jumps in for this “investment opportunity of a lifetime”. The expectations about future appreciation becomes a “no brainer” and a linear inference mentality sets in; future prices are an extrapolation of past price appreciation, which of course goes against any conventional wisdom. This phase is however not about logic, but a lot about psychology. Floods of money come in creating even greater expectations and pushing prices to stratospheric levels. The higher the price, the more investments pour in. Fairly unnoticed from the general public caught in this new frenzy, the smart money as well as many institutional investors are quietly pulling out and selling their assets. Unbiased opinion about the fundamentals becomes increasingly difficult to find as many players are heavily invested and have every interest to keep asset inflation going. The market gradually becomes more exuberant as “paper fortunes” are made from regular “investors” and greed sets in. Everyone tries to jump in and new entrants have absolutely no understanding of the market, its dynamic and fundamentals. Prices are simply bid up with all financial means possible, particularly leverage and debt. If the bubble is linked with lax sources of credit, then it will endure far longer than many observers would expect, therefore discrediting many rational assessments that the situation is unsustainable. At some point statements are made about entirely new

fundamentals implying that a “permanent high plateau” has been reached to justify future price increases; the bubble is about to collapse.”

4. **Blow-off.** “A moment of epiphany (a trigger) arrives and everyone roughly at the same time realize that the situation has changed. Confidence and expectations encounter a paradigm shift, not without a phase of denial where many try to reassure the public that this is just a temporary setback. Some are fooled, but not for long. Many try to unload their assets, but takers are few; everyone is expecting further price declines. The house of cards collapses under its own weight and late comers (commonly the general public) are left holding depreciating assets while the smart money has pulled out a long time ago. Prices plummet at a rate much faster than the one that inflated the bubble. Many over-leveraged asset owners go bankrupt, triggering additional waves of sales. There is even the possibility that the valuation undershoots the long-term mean, implying a significant buying opportunity. However, the general public at this point considers this sector as “the worst possible investment one can make”. This is the time when the smart money starts acquiring assets at low prices.”

The stealth phase can be compared to the earliest life of Bitcoin, where the market potential was primarily discussed on forums and within small private communities of initial developers, backers, and investors. The same can be said for many other cryptocurrencies, as the technological potential and market potential is often difficult for the wider public to understand in the initial phases. This stealth phase has traditionally however become shorter for new cryptocurrencies, as a common market model has been to broadly advertise the potential behind the technology or future growth of the cryptocurrency and move into the awareness stage as early as possible. This is often done to get a foothold before any potential competing cryptocurrency or to create hype and rapid growth behind the cryptocurrency. Cryptocurrencies that have been around for a while have often experienced several awareness and sell-off phases before. When Bitcoin started getting traction back in 2011, the media caught on and drove the price up to a \$33 USD high⁵⁴. Examining the price history of Bitcoin and other cryptocurrencies, it is clear that there has been several “mania” and “blow-off” phases. There have been several

⁵⁴ The economist. “The bursting of the bitcoin bubble”

bubble-like events in the life time of most tested cryptocurrencies and Bitcoin has seen many, with major bubble event examples recorded in 2011, two in 2013 and two in 2017 to mention some⁵⁵. It is possible to forcefully fit the price history charts with Rodrigue, Jean-Paul et al. (2016)’s proposed lifecycle of a financial bubble as can be seen in the examples below, which is why this graph is often referred to whenever a cryptocurrency is experiencing bull runs or price shifts.

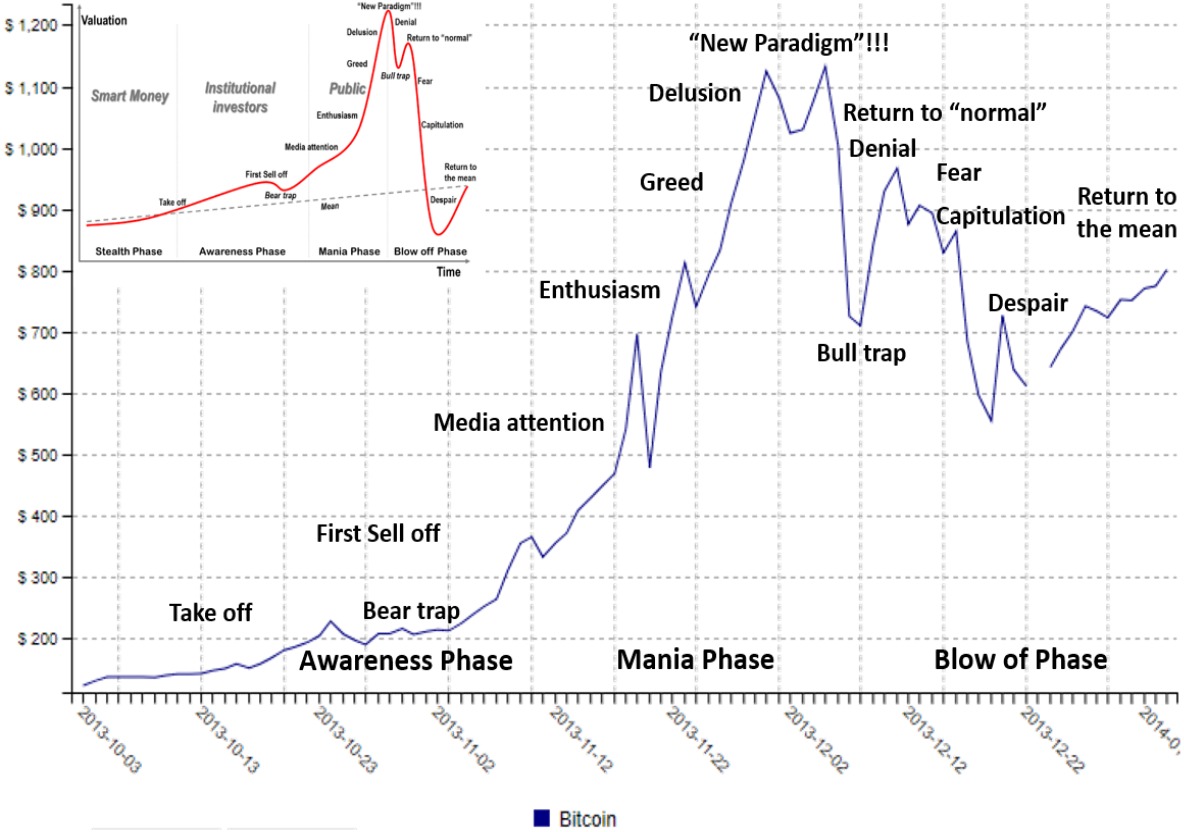


Figure 26: Price history of 2013 crypto-bubble with labels from proposed lifecycle of a financial bubble.

⁵⁵ Steemit. "Bitcoin-Bubbles: A brief history".

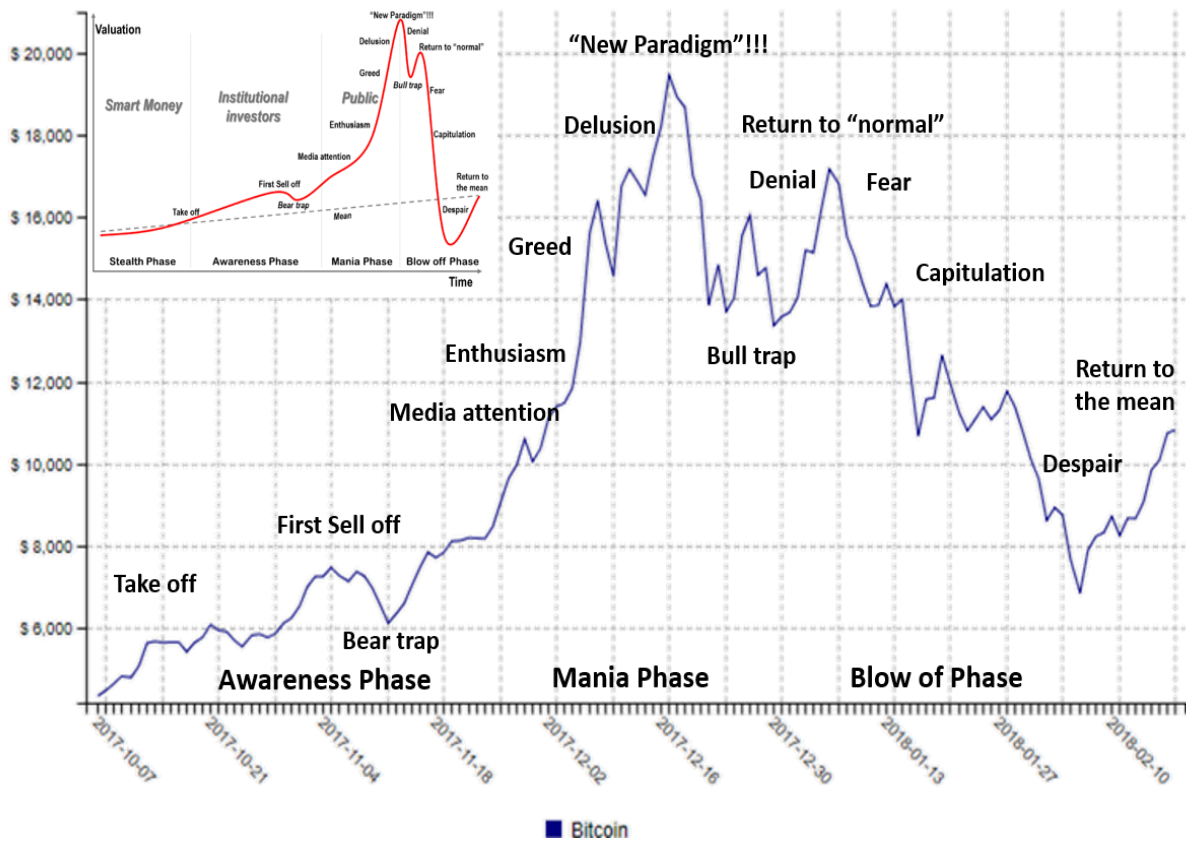


Figure 27: Price history of 2017 crypto-bubble with labels from proposed lifecycle of a financial bubble.

The nature of these bubble-like tendencies that can be seen in the cryptocurrency market, is possible to explain by a customized Gartner Hype Cycle⁵⁶, illustrating Amara’s Law which states that “We tend to overestimate the effect of a technology on the short run and underestimate the effect in the long run.”

A Gartner Hype Cycle states that for anything new, a rapid growth caused by excitement over the potential applications is followed by a correction from realizing the limits of the technology. This is again followed by the slow learning of the what does work and ultimately followed by sustained progress.



Figure 28: Standard Gartner hype cycle. Source: Michael B. Casey 2016. <https://medium.com/@mcasey0827/speculative-bitcoin-adoption-price-theory-2eed48ecf7da>.

⁵⁶ Casey, “Speculative Bitcoin Adoption/Price Theory”.

While the Gartner Hype Cycle could be a good for explaining bull-runs and declines that is often seen in the early life of certain cryptocurrencies, a typical cryptocurrency bubble does not reach a steady state of gradual increase. Instead it tends to follow a volatile rise into the next bull-run sometimes separated by a “plateau” of less volatility. This plateau can be found in all stages of the cryptocurrency lifecycle,

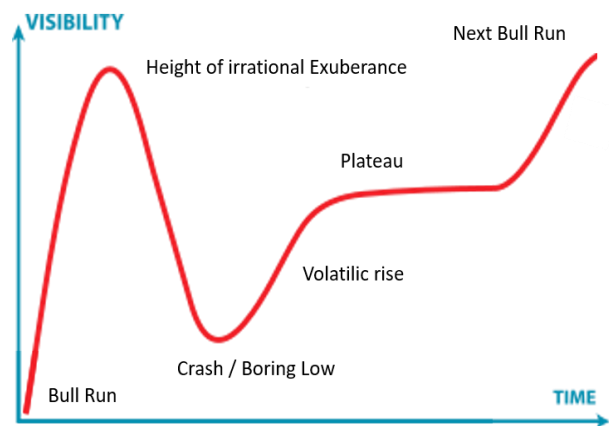


Figure 29: Gartner hype cycle modified from Michael B. Casey 2016. <https://medium.com/@mcasey0827/speculative-bitcoin-adoption-price-theory-2eed48ecf7da>.

but is more often found after a crash / boring low (also called a bear market). The reason for this difference is because the nature of cryptocurrency investment is highly speculative. And speculation is driven in a large measure by hype (Casey. 2016).

By analyzing the relationship between the price of Bitcoin and public interest in Bitcoin through a chart displaying the price of Bitcoin over the years versus the google search index, it is clear that these two graphs are closely related (Figure 30)⁵⁷.

Calculating the correlation between the google Bitcoin search index and the Bitcoin price, shows that there is a strong correlation of 98 %. This information is a strong indication that the public interest shown during many of the bull-runs and crashes have been a strong influencing force for the price movement in the crypto-market. While it is clear that the influence of the public interest is significant for the attributed value of cryptocurrencies, it is also explained earlier that this hype-force is not acting alone, but rather fuels the reactionary market in times of market-changes.

⁵⁷ Data gathered from trends.google.com, and coinmarketcap.com.

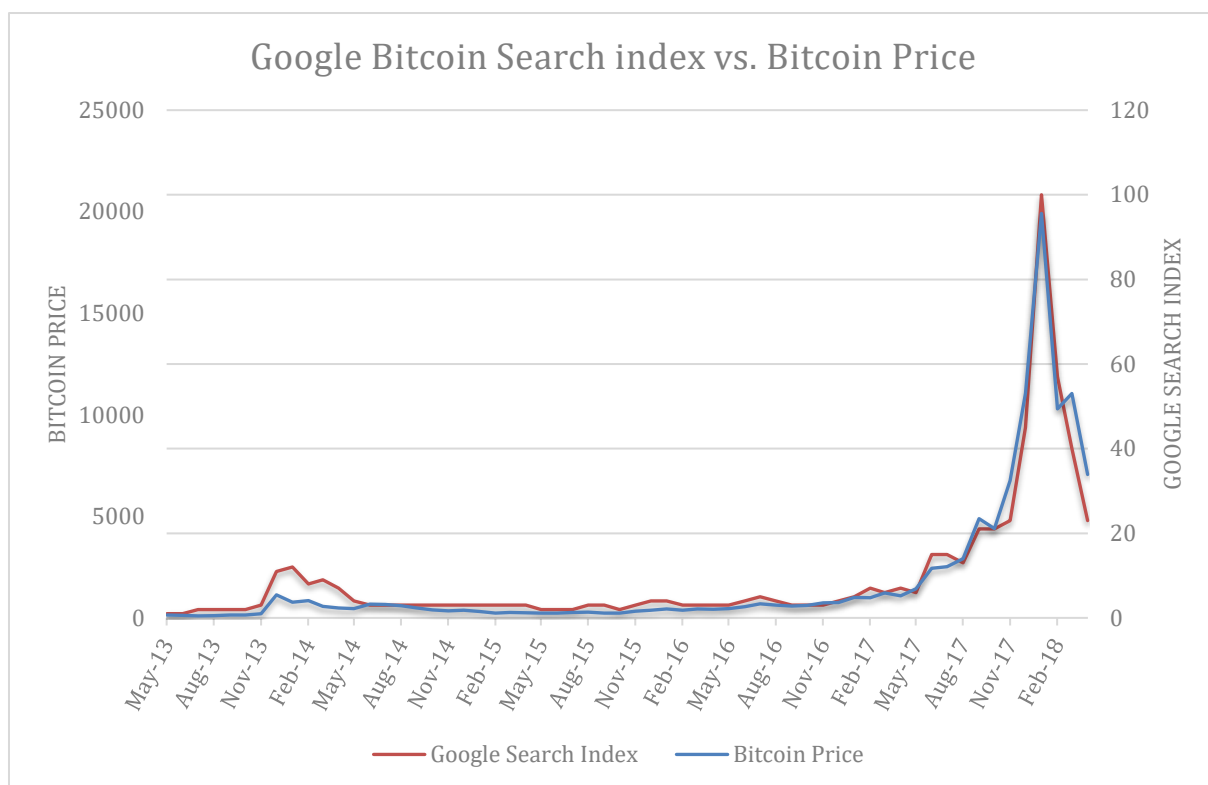


Figure 30: Overlapping graph from google search index for Bitcoin and Bitcoin Price history for the same period. Source: trends.google.com, and data from coinmarketcap.com.

A bubble is essentially an overvaluation (or undervaluation in the case of negative bubbles) of assets. Lux. Thomas. (1995)⁵⁸ argues that this overvaluation or undervaluation of assets occurs because of strong self-amplifying reactions of speculators on small deviations from the equilibrium. To explain this, Lux. Thomas. (1995) argues that this effect is brought on by “herd behaviour” and that this can be explained by several existing microeconomic explanations: “1) They can be seen to act irrationally; 2) contagion can be interpreted as an attempt to draw information from what others do; 3) reputation considerations may urge even smart investors to follow the crowd.” Lux. Thomas. (1995) argues that in reality, it is more complex than this. This is due to the fact that a wide variety of actors with separate agendas and information exist, and that this is rather a good description of the interactions of the general public in a market bubble. Essentially, there exists a macroscopic market outcome based on the delusion and agendas of several individual influencers with micro-motives. This reflects what can be seen in the cryptocurrency market on several occasions and indicates that the cryptocurrency market (if represented by Bitcoin) is inherently bubbly in nature.

⁵⁸ Lux, “Herd behaviour, bubbles and crashes”.

4.4.6 Market manipulation

In addition to previously discussed methods of market manipulations such as the Mt.Gox incident and whales influencing the market, there are other ways that influencers attempt to manipulate the cryptocurrency market to their benefit. One such market manipulation scheme is called “pump and dump” schemes⁵⁹. These kinds of activities are specifically designed to push the price up artificially through buying market forces and then sell or “dump” when the market has been sufficiently “pumped”, hopefully making a good profit in the process. While morally questionable, there exist few laws that outlaw such behaviours in the cryptocurrency market today, and enforcement of such laws are difficult⁶⁰. Although many of these schemes are organized in private forums⁶¹, there exist services such as <https://pumpmycoin.com/> that publicly advertise their pump schemes. <https://pumpmycoin.com/> is advertising that they have as of writing this thesis over 30,000 individual members on their website that are actively co-ordinated in market pumps to make profit.

⁵⁹ Massa. ” Top Regulator Worries That Crypto Markets Could Be Full of Manipulation”

⁶⁰ Irrera. ”U.S. regulator warns of cryptocurrency pump and dump schemes”

⁶¹ Martineau. ” Inside the group chats where people pump and dump cryptocurrency”

5. Analysis of Cryptocurrency markets

5.1 Price Volatility and Returns

Volatility is defined as the variations in prices around the expected value of an asset or option. There exist different methods used to calculate the volatility. However, in this thesis the volatility has been examined by using the historical volatility over a period t . This method has been chosen, as the goal of this thesis is to compare the volatility of the five cryptocurrencies: Bitcoin, Ethereum, Litecoin, Ripple and Bitcoin Cash over a set period. The historical return numbers that are calculated from the opening prices of the currencies are used in the calculations of the standard deviations of the currencies.

The continuous return for a chosen period is given by: $r_t = \ln\left(\frac{P_{t+1}}{P_t}\right)$

where r_t is the return for period t , P is the price at period t and the price at period $t+1$.

By assuming that the volatility over the set period is constant, the volatility can be calculated using the standard deviation.

The given formula for the standard deviation is: $\sigma = \sqrt{\frac{\sum_{t=1}^m (r_t - \bar{r})^2}{n-1}}$

Volatility is expressed as the annualized standard deviation of the compound return, thus the standard deviation has to be annualized by the annual rate d/t , where d stands for the number of days in the year⁶² (Moles and Terry, 2005).

The variance can thus be expressed as: $Variance = \sigma^{d/t}$

And the annualized standard deviation or volatility will be: $An. St.dev. = \sigma\sqrt{t}$

The volatility has been calculated for weekly (7 days), monthly (30 days) and quarterly (90 days) periods for the five chosen cryptocurrencies. This have been done in excel with the formula $STDV.S * \sqrt{356}$. Sample standard deviation has been used because a sample of data from a population has been used. Cryptocurrencies are unlike other currencies traded every day in a year, t is subsequently 365. Historical data spans from 1. January 2017 to the 31. March 2018 has been used and was gathered from coinmarketcap.com.

⁶² Moles, Terry. "The handbook of international finance terms"

The results from the return calculations and the corresponding volatility calculations used in this chapter can be found in 5.1.1 – 5.1.5 Volatility Observations. A comparative table of the average volatility in the study period based on the resulting data presented in 5.1.1 – 5.1.5 is available below (Table 3):

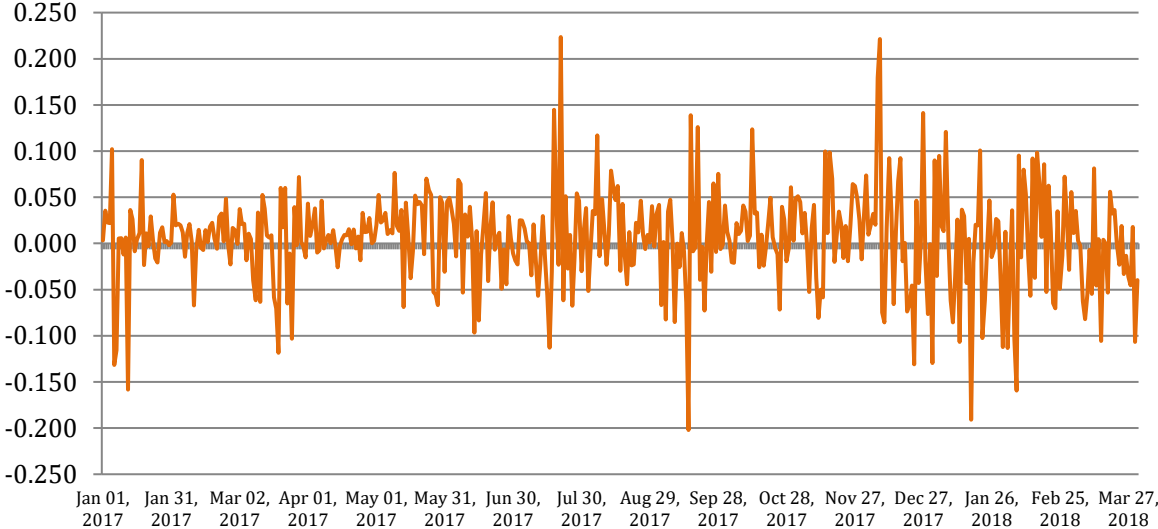
<i>In %</i>	<i>Bitcoin</i>	<i>Ethereum</i>	<i>Litecoin</i>	<i>Ripple</i>	<i>Bitcoin Cash</i>
<i>Max vol. weekly</i>	228,53	367,87	385,65	970,7	500,82
<i>Min vol. weekly</i>	13,52	9,01	2,51	10,88	30,65
<i>Average vol weekly</i>	86,90	110,99	127,65	149,42	176,15
<i>Max vol. monthly</i>	164,44	217,17	252,92	483,5	366,56
<i>Min vol. monthly</i>	29,43	35,92	21,32	35,59	95,72
<i>Average vol. monthly</i>	92,5	122,89	140,95	176,19	198,22
<i>Max vol. quarterly</i>	140,2	168,35	202,48	335,41	245
<i>Min vol. quarterly</i>	62	90,98	123,18	95,97	163,74
<i>Average vol. quarterly</i>	96,56	132,97	159,57	211,67	207,88

Table 3: Results from observed volatility for max, min, average for weekly, monthly, quarterly.

In this table it is possible to observe that the values in weekly, monthly, and quarterly does not match. This is to be expected as calculations are based on the previous week, month, or quarter separately. For example, it is possible to see that the average weekly volatility for Bitcoin is lower than average monthly volatility, which in turn is lower than the average quarterly volatility. Due to the increased resolution with the weekly volatility, there is also a bigger spread in the data, with both higher maximum and minimum values than in the monthly and quarterly. Similar observations can be made from the other analysed cryptocurrencies. Despite the differences, it was decided to base further analysis in chapter 5.3 on the monthly based-volatility calculations as the weekly based-volatility calculations provided unnecessary resolution and the quarterly was too generalized.

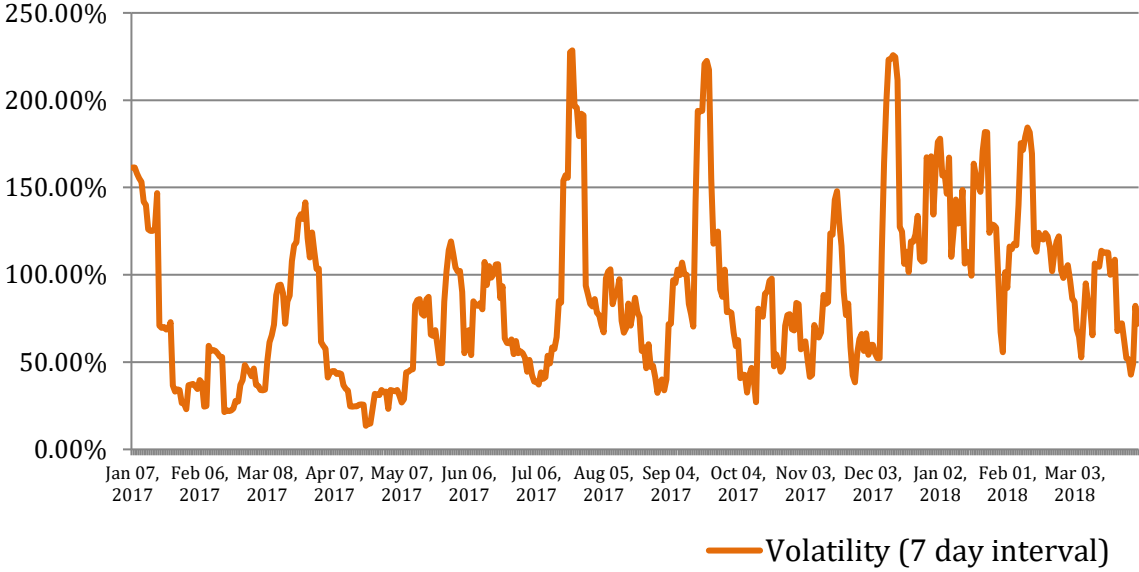
5.1.1 Volatility Observations of Bitcoin

Return Bitcoin



5.1.1.1 Weekly

Volatility (7 day interval)



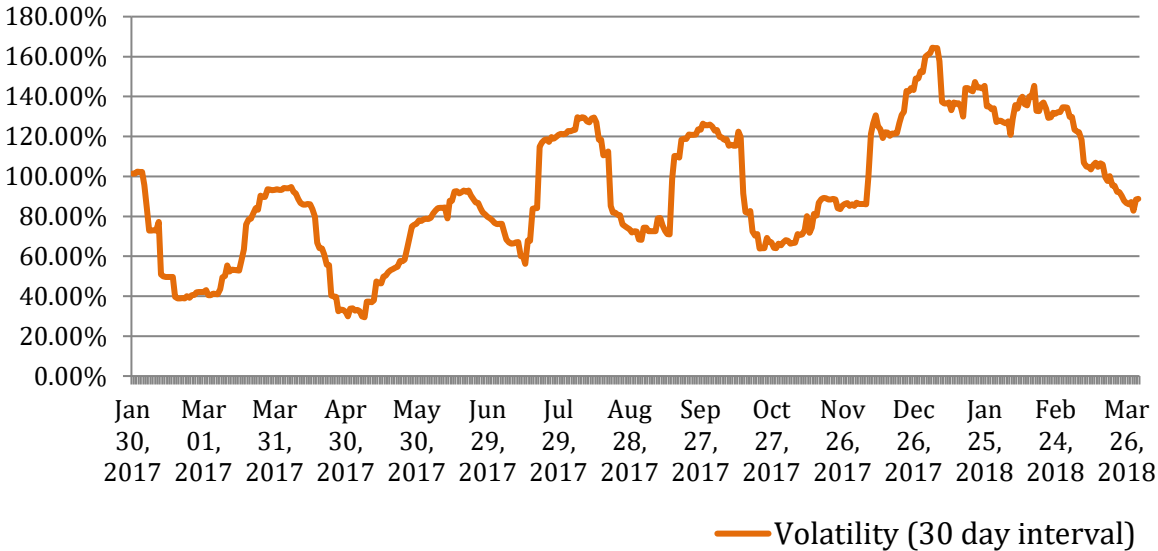
— Volatility (7 day interval)

In general, when looking at the weekly volatility there is no clear trend. This is mainly because the standard deviation is calculated from 7 days, which is a small range, meaning that the graph is providing a more detailed overview of how the volatility fluctuates over time. However, it seems that the overall volatility is higher in December, as there is a high plateau. Besides trends, there are several peaks in volatility present, of which 3 stand out. These three are situated in the end of July, in the middle September and in the middle of December. The peak in the end of July is a result of two high returns of 22% and 5%, as

well as one loss of 6 % that stands out from the range ranging from 5% to -3%. The peak in the middle of September is a result of a wide range of returns, ranging from a loss of 20% to a return of 14%. The peak in the middle of December is a result of days with high returns of 22% and 15% where on other days the return is ranging from -3% to 5%. The maximum volatility of the weekly volatility analysis is 228,53%, and the minimum volatility is 13,52%.

5.1.1.2 Monthly

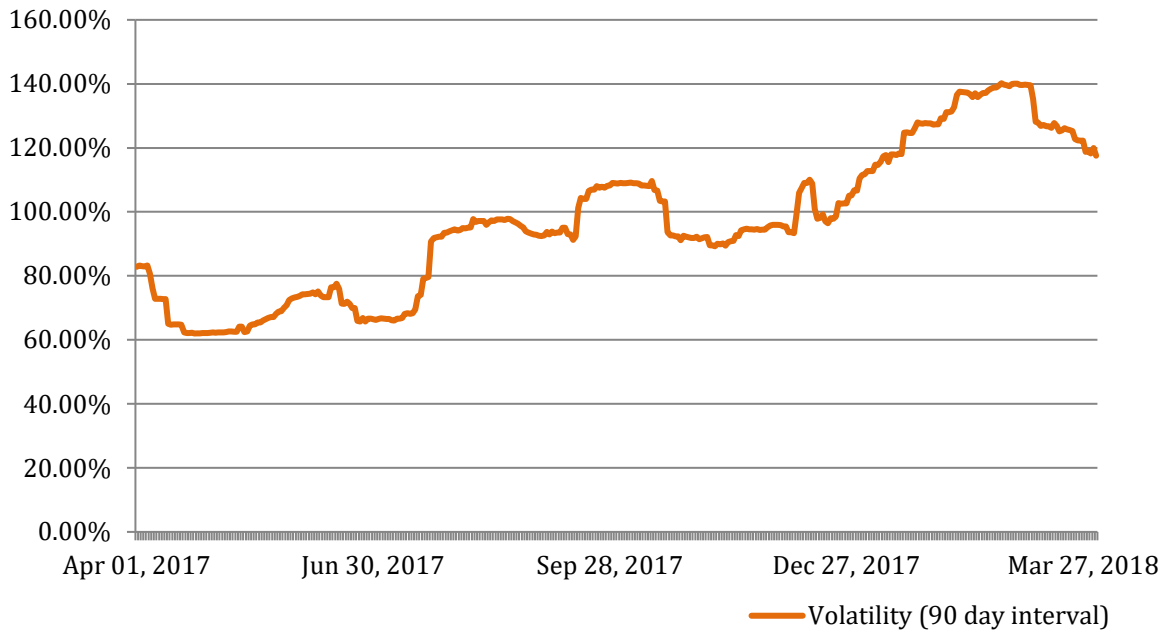
Volatility (30 day interval)



In the monthly volatility, which looks at the standard deviation of 30 days, a trend is starting to appear. The volatility is in general increasing over the study period and the major local increases in volatility overlap with the observations made in the weekly calculations. Compared to the weekly calculations, the maximum and minimum volatilities are brought closer to the mean. The maximum volatility is 164%, the minimum volatility is 29,4%.

5.1.1.3 Quarterly

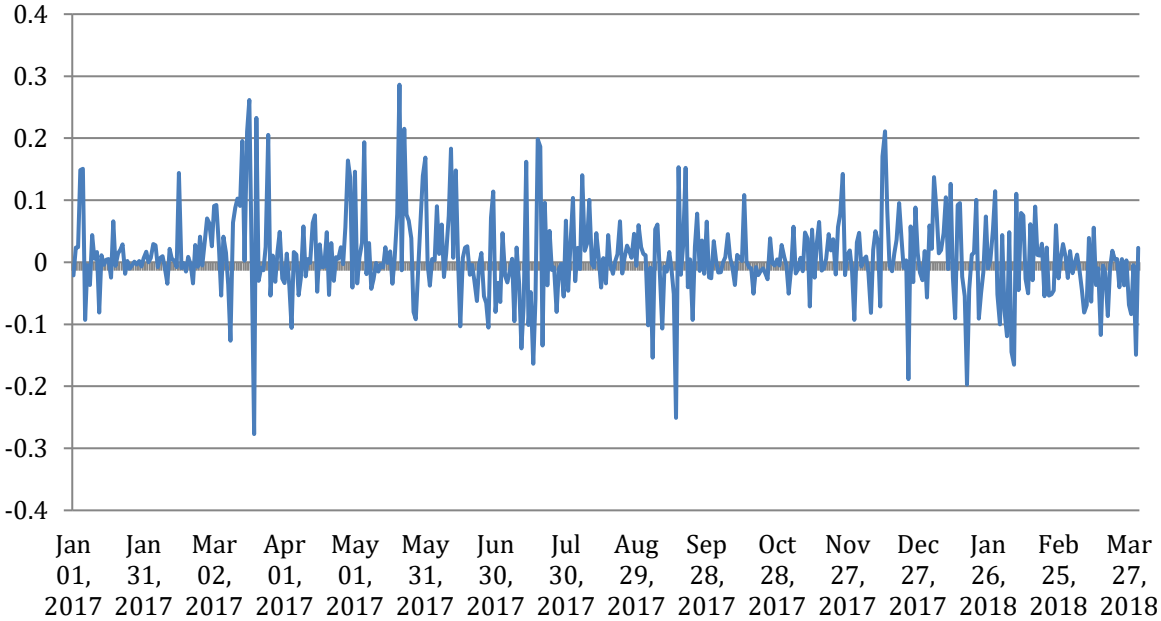
Volatility (90 day interval)



From the quarterly volatility, a clear trend can now be seen and some of the local extremes are now gone. In general, the volatility of Bitcoin is increasing in the study period. The trend towards the end of the study period appears to be of a decreasing nature, but the data-range is set to the end of March 2018, and does therefore not include any data beyond this point. Again, the extremes are brought closer to the mean. The maximum volatility present is 140,4%, while the minimum volatility is 62%.

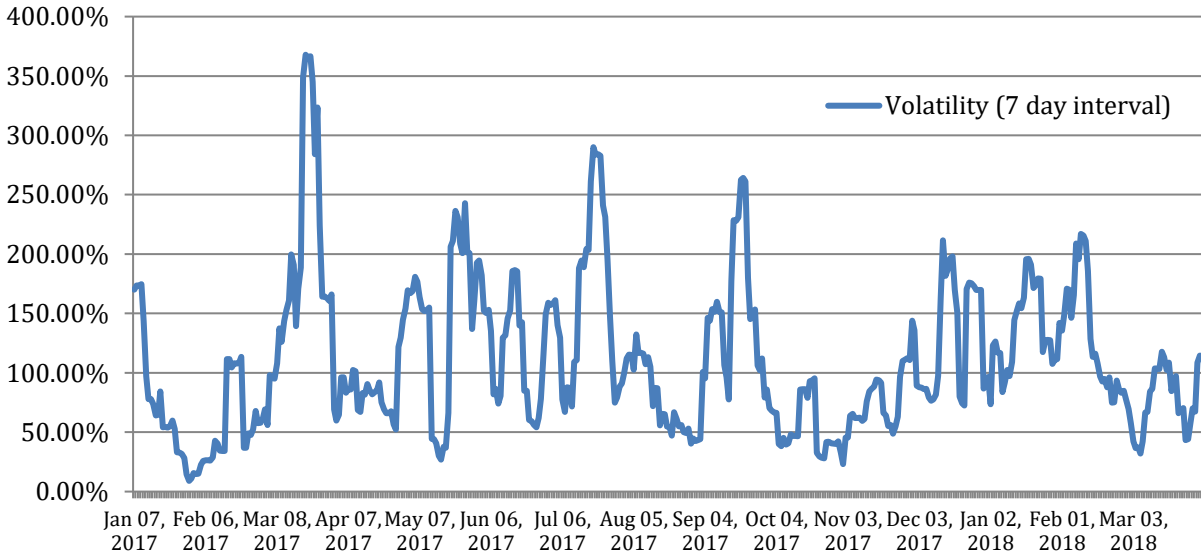
5.1.2 Volatility Observations of Ethereum

Return Ethereum



5.1.2.1 Weekly

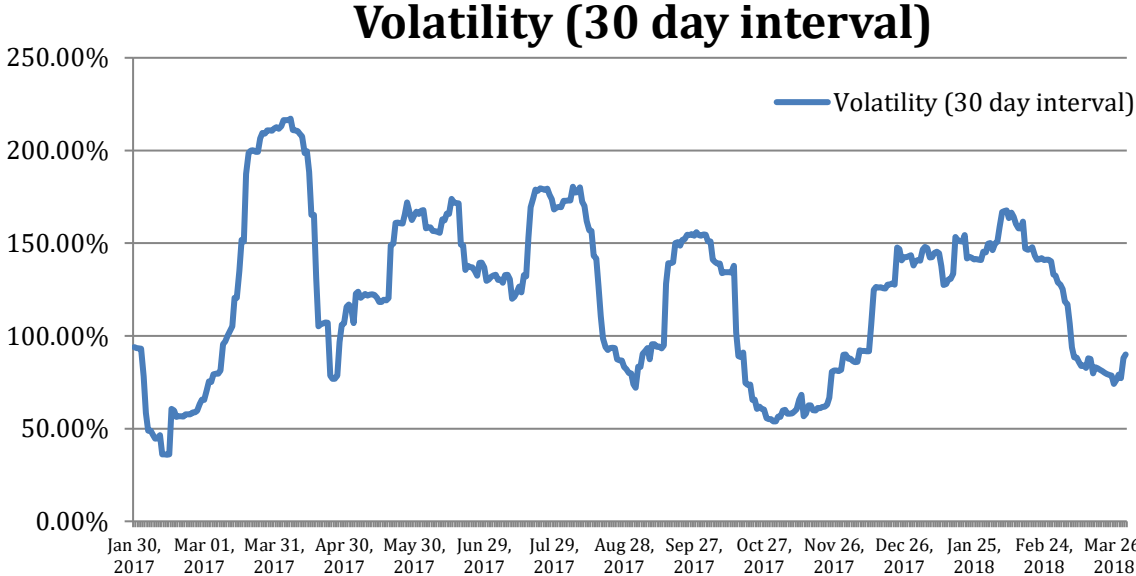
Volatility (7 day interval)



Again, the weekly volatility allows for a higher resolution, displaying many individual peaks and lows in the local volatility over the study period. The weekly volatility of Ethereum has a range from the minimum volatility in the end of January of 9%, and the maximum volatility is 367% which is present in the end of March. The reason for the high volatility in the end of March is two days with a very low return on March the 18th and

March the 15th at around 20%. In the end of July there is a wide range on the return, ranging from 20% return to 10% loss. The main reason for the high volatility are the days with high returns, as most returns are low ranging from 1% return to 1% loss. Again, in the middle to end of September the high volatility is a result from a few days with high returns around 15% and one day with a 25% loss, the rest of the returns in this period ranges from 3% return to 5%. There are as well several peaks present in December, January and February. These are a result from very varying returns.

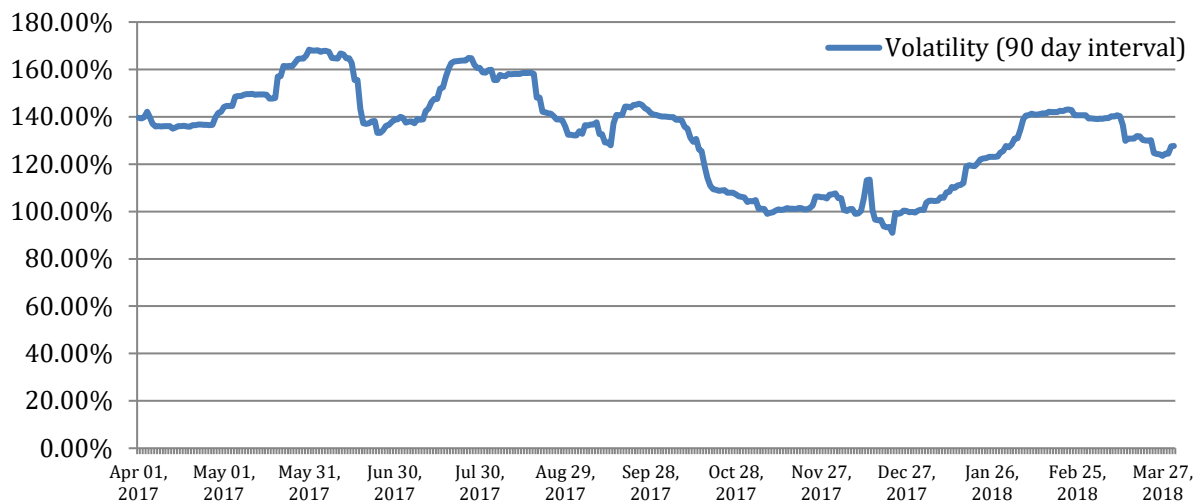
5.1.2.2 Monthly



The monthly volatility has volatility peaks present at similar places as the weekly volatility but has a lower resolution than that on the weekly analysis. Unlike the monthly analysis for Bitcoin, there is no immediately apparent trend in the volatility. As before, the extreme highs and lows are reduced with the reduced resolution. This is because the range is bigger, meaning that there is more data present in each day.

5.1.2.3 Quarterly

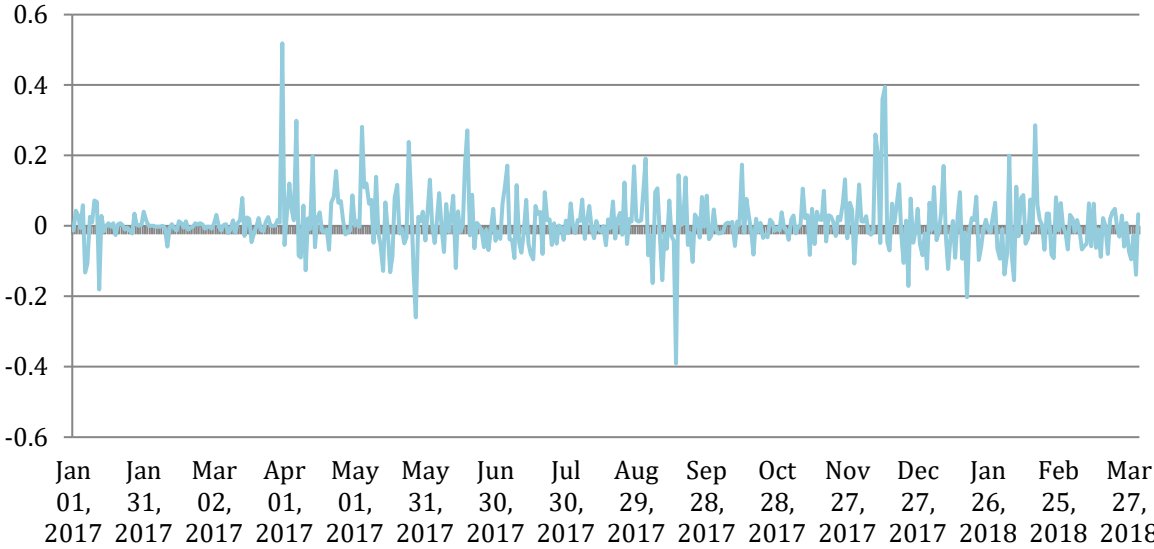
Volatility (90 day interval)



In the quarterly volatility graph a trend of the volatility is appearing. The volatility was high in March, before overall falling until the end of November, but with local peaks with high volatility. In the December the volatility started to rise again, before starting to fall in the end of February. The price of Ethereum over the last 15 months has risen from at around 8\$ at the beginning of the year to 1398\$ at the highest. Due to the low price in the beginning of the year, small changes in the price affected the return a lot, and this again affected the volatility substantially. However, the major price jump and fall of Ethereum happened at the end of 2017. In November the price was around 300\$ dollar before peaking in the beginning at January at 1398\$. After the peak the price started to fall to 400\$ dollar at the end of March 2018. With major price jumps and falls like this comes a high volatility. The maximum quarterly volatility is 168% and the minimum is 90,9%.

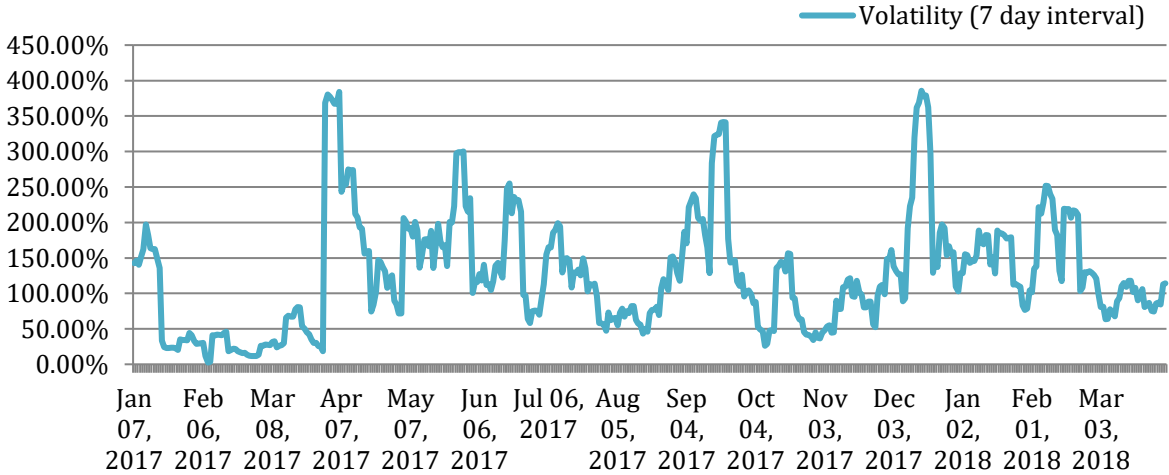
5.1.3 Volatility Observations of Litecoin

Return Litecoin



5.1.3.1 Weekly

Volatility (7 day interval)

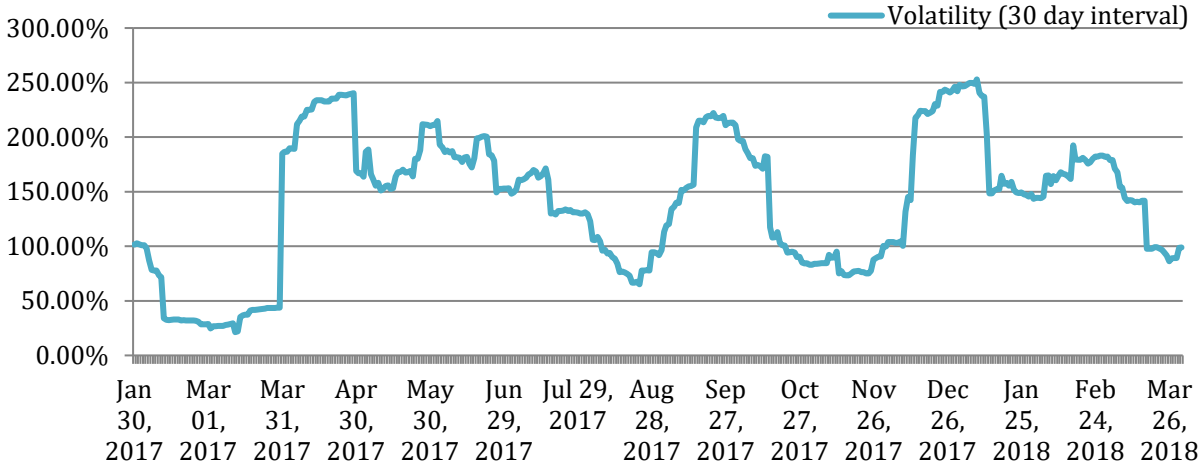


The weekly volatility of Litecoin is at its maximum in December with the value 386% . The minimum volatility is 2,5% and is present in February 2017. The high volatility peak in end of March to beginning of April is mainly a result of one day with an extreme high return of 51% on March the 31st. Generally, before this day the return ranged from 2% to -2%. After this period the return becomes unstable ranging at some occasions from 19% return and 13% loss, this is resulting in a higher volatility. The peak in the middle of September is mainly a result from unstable returns, on September 15th the loss is as high as 39%, while on the 16th of September the return is at 15%. Generally, the return is

varying a lot, with the main range being from a 16% loss to a 15% return. Another high volatility peak is present in the middle of December. This peak occurs as a result of a few days with a high return ranging from 20% to 40%. Other days in this period has a loss of around 2% to 7%, with some days in-between with a low return of 1% to 2%.

5.1.3.2 Monthly

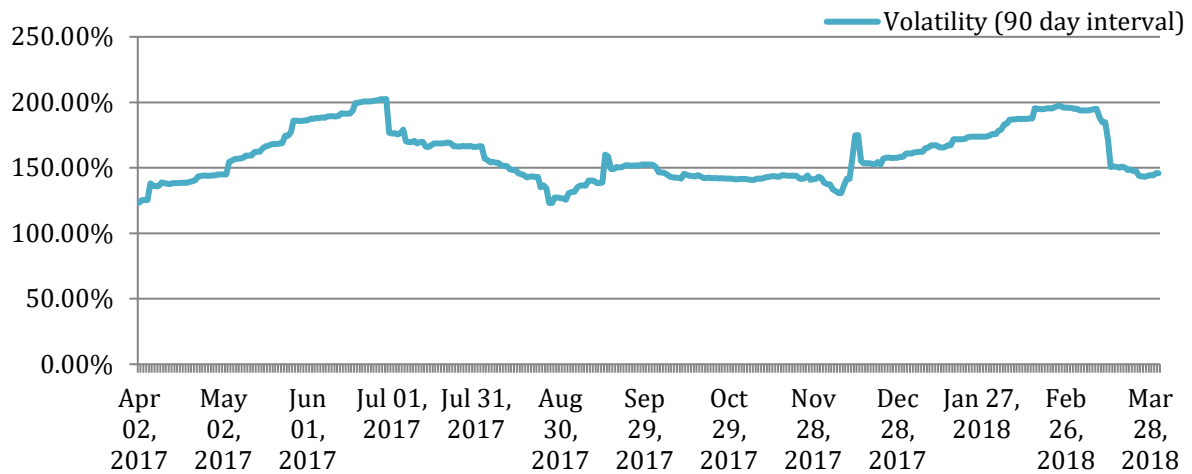
Volatility (30 day interval)



The monthly volatility has its peaks located at similar places as the weekly volatility graphs. Again, the graph shows more of a trend and the volatility is more average; the low volatilities are generally higher, while the volatilities at the peaks are lower. The maximum volatility in the monthly volatility graph is 253%, and the minimum volatility is 21,3%.

5.1.3.3 Quarterly

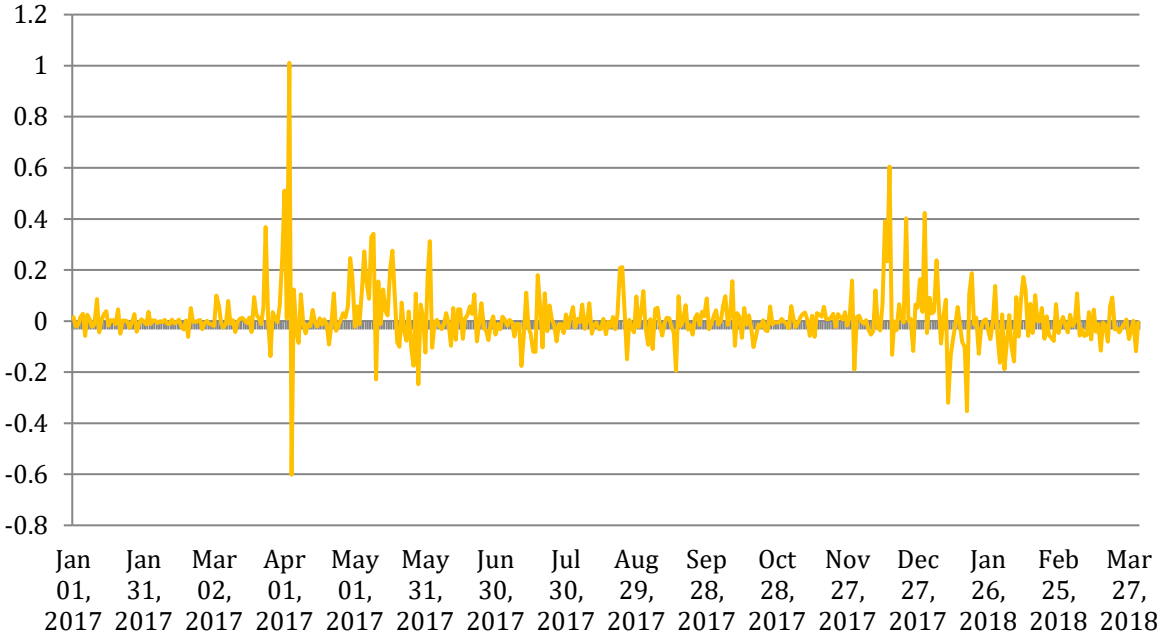
Volatility (90 day interval)



In the 90-day interval volatility or the quarterly graph a trend has appeared in the volatilities. From April to the beginning of July the volatility rose, from the beginning of July to the end of August the volatility fell. The volatility was quite stable at 150% until the middle/end of December, before it rose again until the end of February. Overall the price of Litecoin rose a lot in 2017. In the beginning of the year the price was around 3\$-4\$, and at in the end of December it reached its peak price of 359\$. In the end of March 2017, the price rose to the almost doubled of what it used to be, before overall continuing to rise. This created a large return, which again created a more volatile currency. The volatility continued to rise while the price of Litecoin rose until the end of June. The price of Litecoin continued to be stable with a few major changes, which resulted in less changes in the returns, which again resulted in the volatility decreasing. Until the end of November the price of Litecoin continued to rise steadily with some price falls, resulting in a steady volatility. In the beginning of December there is a major price jump for Litecoin. As of November 30th, the price was at 86\$, but at December 19th the price had risen to 359\$. During this time the price of Litecoin fluctuated a lot resulting in major differences in returns, which again resulted in the volatility increasing. The price continued to rise and fall substantially until the end of March 2018, where it looks like it has become more stable. The maximum volatility seen is 202%, and the minimum volatility is 123%.

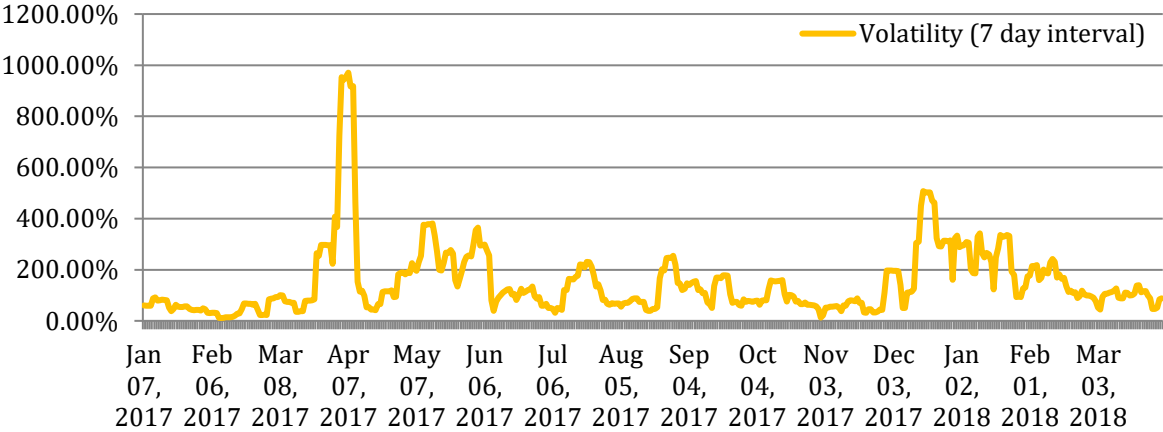
5.1.4 Volatility Observations of Ripple

Return Ripple



5.1.4.1 Weekly

Volatility (7 day interval)



The weekly volatility of Ripple has especially one prominent peak that is located in the beginning of April. There is as well a larger peak located in the end of December to the beginning of January. In the beginning of April, the return ranged from a 60 % loss on one day to a return of 101% on another day within the very short time period of one week. During the middle of December, the return again fluctuated with a range from a 60%

return to -14% loss. This again left a high volatility. The maximum volatility was found in the beginning of April at 971%, while the lowest volatility is 10,9%.

5.1.4.2 Monthly

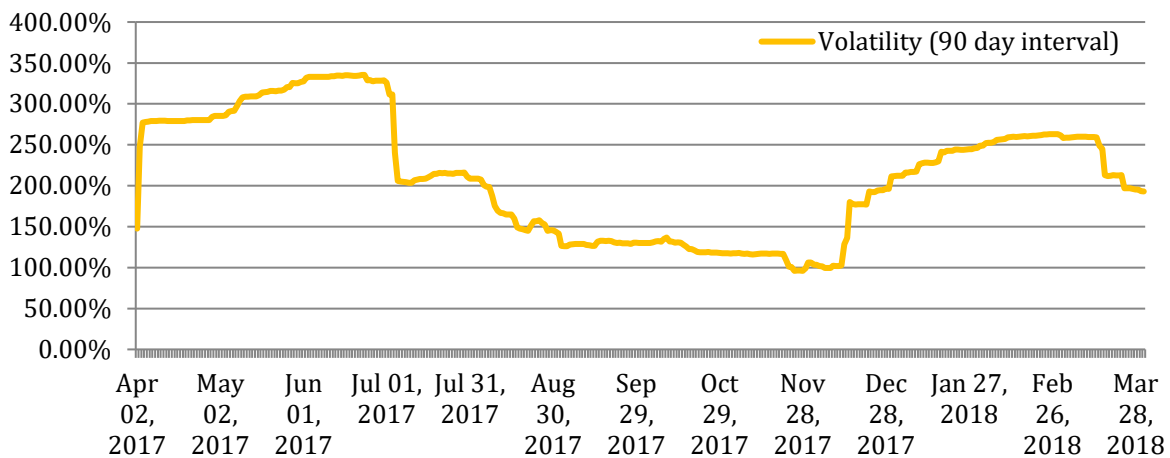
Volatility (30 day interval)



The monthly volatility graph shows the same peaks as the weekly graph. The peaks are more profound, especially the peak that is present in the end of May. This peak is a result of a large range of returns that spans from a 25% loss to a 27% return. Overall the volatility is lower than the weekly volatility, mainly because more data is compared leaving fewer returns to stand out. The maximum volatility is 483%, the minimum volatility is 35,6%.

5.1.4.3 Quarterly

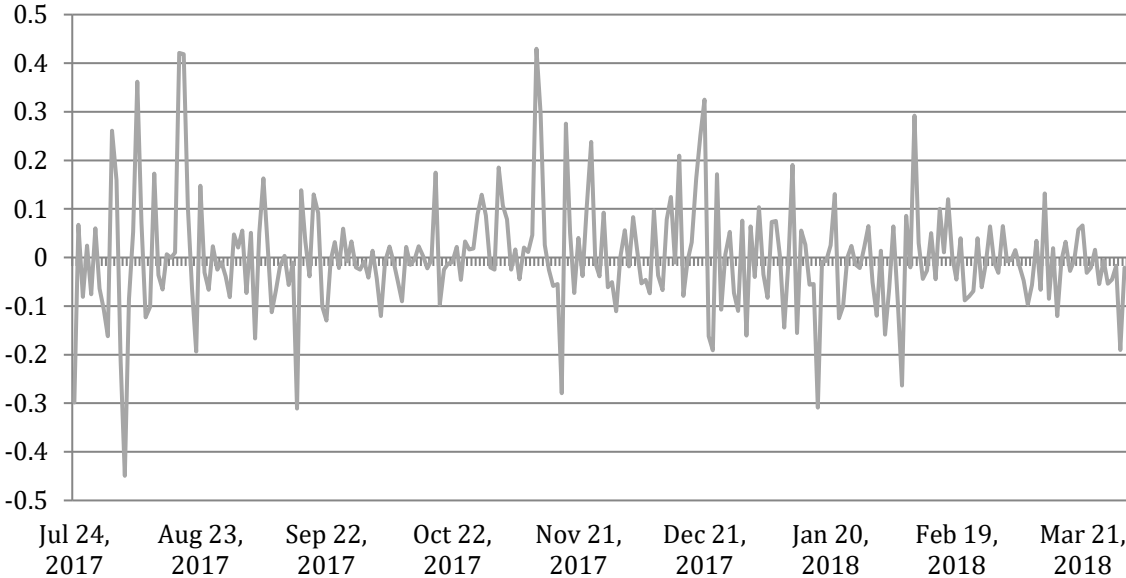
Volatility (90 day interval)



In the depicting the 90-day interval volatility a trend is starting to form. The volatility is high in May, June and the beginning of July. The volatility decreases from the beginning of July until the beginning of December. From the end of August throughout November the Volatility was quite stable ranging from 130% to 100%, however as mentioned it is decreasing from August until the beginning of December. In the beginning of December, the volatility starts to increase, reaching a peak point in the beginning of March before starting to decrease. During the year the price of Ripple has had a substantial rise. In the beginning of 2017 the price was around 0,006\$, while at it highest in the beginning of January 2018 the price was 3,36\$. During the period with the high volatility in January 2017 until the end of June 2017 the price increased fast from 0,006\$ to 0,3\$. This left some days with large returns, but as the price also had periods where it fell, it as well resulted in some negative returns. This resulted in high volatilities. From July until November the price fluctuated around 0,2\$-0,3\$, leaving less variations in the return, which again resulted in a lower volatility than in the beginning of the year. In the December the price again started to increase fast, reaching its peak in the beginning of January. During this period the price ranged from 0,25\$ to 3,36\$, this left high returns on some days. After the peak price the price started to decrease until the end of March, where the price was 0,5\$. In this period there were large fluctuations the price of Ripple which lead to varying returns. This resulted in the peak volatility. The maximum volatility is 335%, the minimum volatility is 96%.

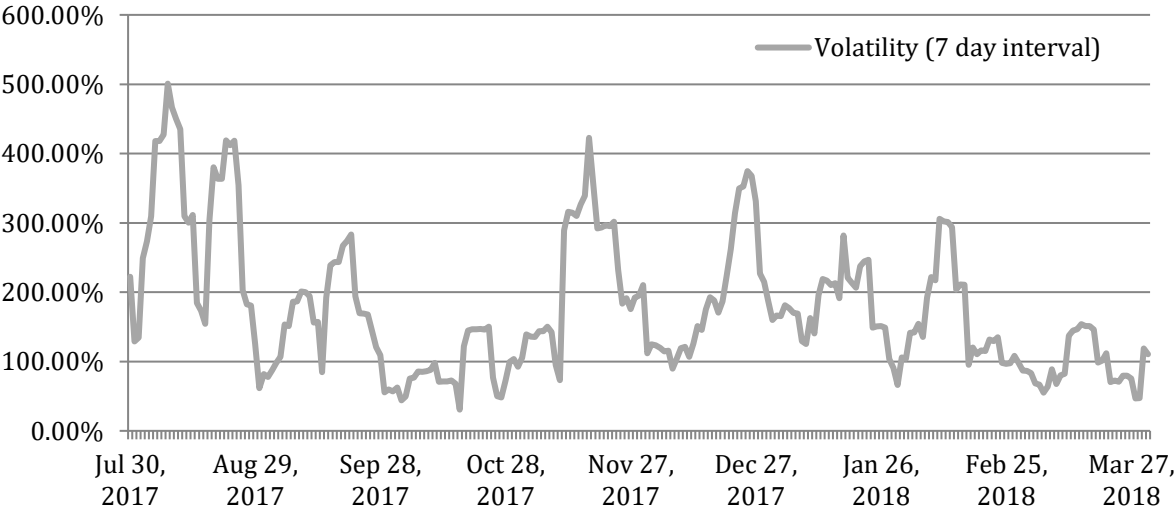
5.1.5 Volatility Observations of Bitcoin Cash

Return Bitcoin Cash



5.1.5.1 Weekly

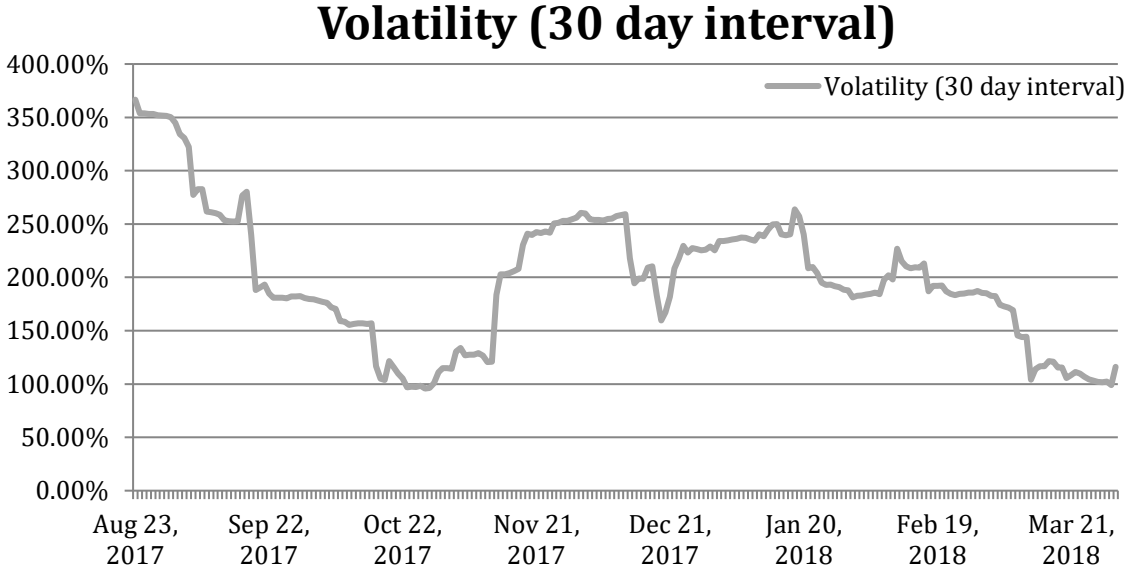
Volatility (7 day interval)



The weekly volatility of bitcoin cash shows two peaks in the beginning and end of August, as well as peaks in the middle of November, end of December, in the middle of January and end of February. In both the beginning and end of August the price of bitcoin cash increases a lot, making a large return as high as 40% on three different days. This comes in addition to one day where the return actually drops 40%. This makes the volatility high. In the middle of November, the return ranges from 27% to a 27 % loss, making the volatility peak again. During the end of December, the volatility again starts to fluctuate,

ranging from a return of 35% to a loss of 20%. In the beginning of February, the return again has a big range; ranging from a return of 29% to a loss of 26%. The maximum volatility is 500% and it's present in the beginning of August. The minimum volatility is 30,7%.

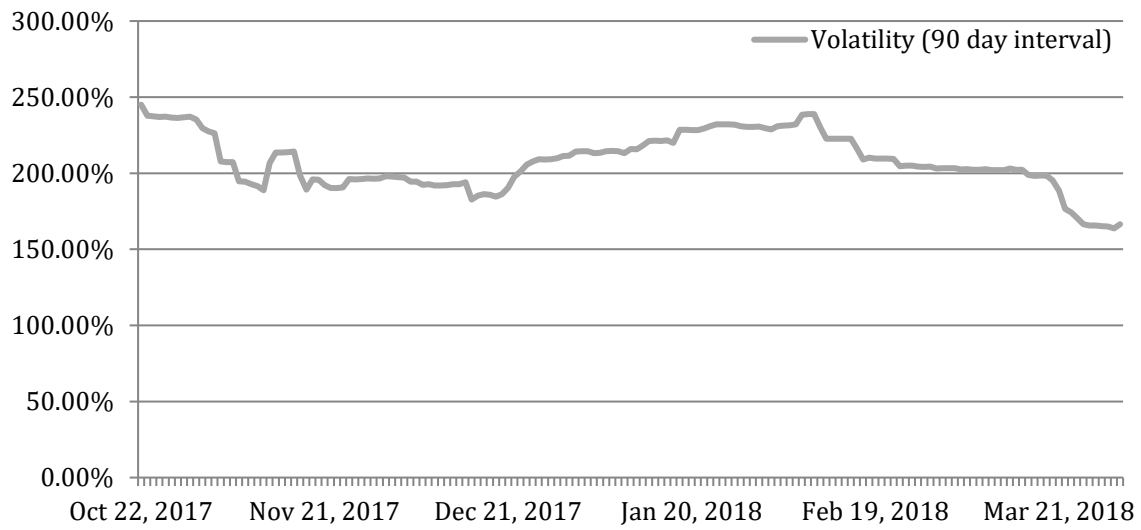
5.1.5.2 Monthly



In the monthly graph a trend is starting to appear. The volatility is high in the end of August before it decreases until the beginning/middle of October where it again starts to increase. In the middle of January, the volatility starts to decrease. The price of Bitcoin Cash increased substantially through 2017. From July to the beginning of November the price fluctuated a lot, starting at 555\$, before going as low as 212\$ ending at 651\$ before another big jump in price happened. These fluctuations in the price influenced the return and made it very volatile. In the middle of November, the price of Bitcoin Cash increased a lot, and had 43% return, meaning that the price jumped from 651\$ to 1001\$. The price continued to rise until it reached its peak price at 3909\$ in the end of December. Afterwards the price overall started to decrease, but with some fluctuations before ending at a price of 697\$ in the end of March 2018. From the middle of February 2018, the price fluctuated less, resulting in less variations in the returns, which led to the volatility decreasing.

5.1.5.3 Quarterly

Volatility (90 day interval)



From the quarterly volatility graph, it seems like the volatility is quite stable. There is however an apparent decreasing trend in volatility during the study period. The maximum volatility is 245% and the minimum volatility is 164%,

5.1.6 Comparison of Volatility Observations

5.1.6.1 Monthly

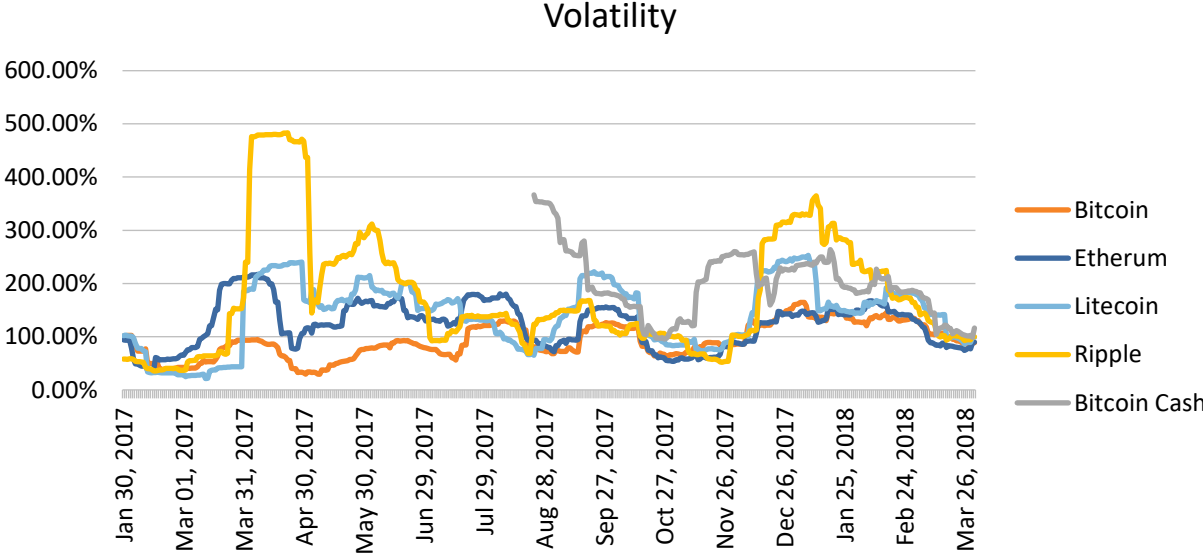


Figure 31: Monthly volatility for all cryptocurrencies in the study.

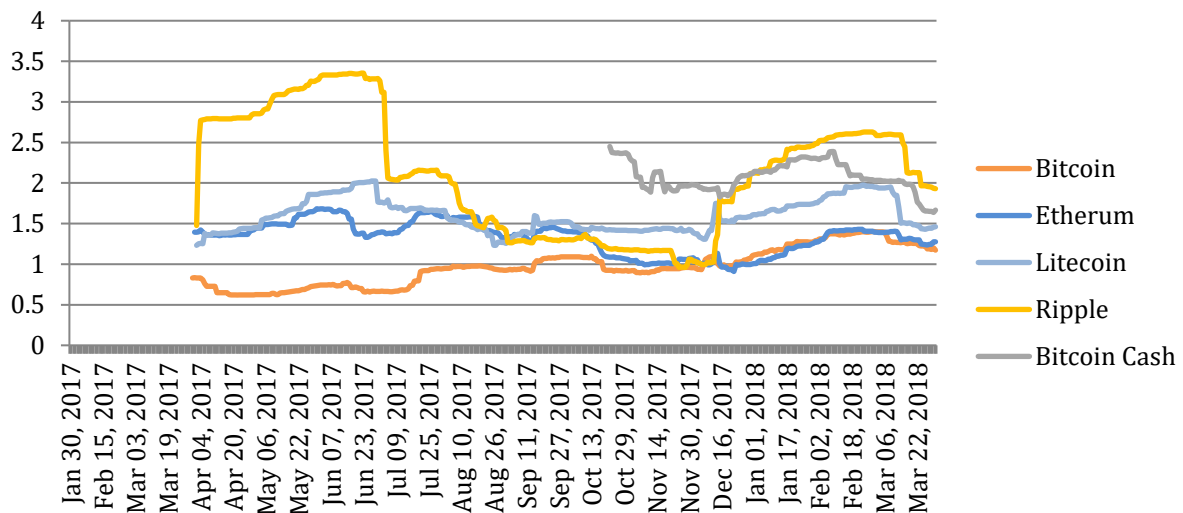
When comparing the volatility of the five different cryptocurrencies the weekly volatility graphs weren't used due to the high resolution, making it hard to differentiate the graphs from one another. Figure 31 shows the monthly volatility of the five cryptocurrencies Bitcoin, Ethereum, Ripple, Litecoin and Bitcoin cash. Overall Bitcoin is the cryptocurrencies with the lowest volatility, followed by Ethereum and Litecoin.

Detailed comparative observations (used as input in chapter 5.3):

In the beginning of the year 2017 the volatility of the four cryptocurrencies present (Bitcoin, Ethereum, Ripple and Litecoin) was low. In the beginning of March, the volatility started to increase for the three cryptocurrencies Bitcoin, Ethereum and Ripple. Litecoin on the other hand continued to be stable until the end of March before it started to increase. Both Bitcoin and Ethereum reached their peak volatility for the period in the end of March, unlike Ripple and Litecoin where the volatility continued to increase until the end of April. Ripples volatility becomes extremely high, while Litecoins volatility is in the same levels as Bitcoin and Ethereum. In regards of Bitcoin and Ethereum the volatility starts to decrease in the beginning of April, while the volatility starts to decrease for Litecoin and Ripple in the end of April. Ethereum and Bitcoin have the lowest volatility in the end of April, before it again starts to increase. Ripple and Litecoin's volatility decreases until the beginning of May. In the beginning of May the volatility of Ripple increases a lot,

contrary to Litecoin, Bitcoin and Ethereum. Ripple, Litecoin and Ethereum reaches their next peak volatility almost at the same time; in the end of May. Bitcoin reaches its next peak volatility later in the middle of June. Through July the volatility moves similar for Bitcoin, Ethereum and Ripple where the volatilities increases a bit in the end of July before starting to decrease in the beginning of August. This is unlike Litecoin, which overall only decreases. In the end of August, the volatility of Bitcoin Cash is becoming available. It starts out with a high volatility that decreases until the end of October. The volatility of Bitcoin, Ethereum, Litecoin and Ripple increases until the end of September, where all the volatilities start to decrease. In the beginning of November, the volatility of Bitcoin Cash is increasing. This is in contrast to the volatility of Bitcoin, Ethereum, Litecoin and Ripple that are all pretty consistent. However, in the end of November the volatilities of these four cryptocurrencies start to increase and continue to increase until the end of December. In Ripples case the volatility continues to increase until the beginning of January. The volatility of Bitcoin and Ethereum is increasing at almost the same rate, while the volatility of Ripple and Litecoin increases by fare more, especially in the case of Ripple that increase fare more than Litecoin as well. The volatility of Bitcoin Cash follows another pattern where the volatility starts to decrease in the beginning of December. This before it starts to increase until the beginning of January. The volatility of Ripple, Litecoin and Bitcoin cash starts to decrease in the beginning of January. In the case of Ethereum and Bitcoin the volatility is quite stable and does not start to decrease by a lot before the beginning of March. The volatility of all the five cryptocurrencies continues to decrease until the end of March.

5.1.6.2 Quarterly



The quarterly volatility graph shows the overall trend of the volatility better than the monthly. Generally, the volatility of the four cryptocurrencies Bitcoin, Ethereum, Litecoin and Ripple increases and decrease at similar times. Ripple has larger fluctuations, and overall higher volatility than the others when the volatilities peak. Litecoin is more or less, less volatile than Ripple. Bitcoin is the cryptocurrency with the lowest volatility, followed by Ethereum. However, Ethereum has similar volatility as Bitcoin from December and throughout March. Bitcoin Cash has less data but shows similar fluctuations as the other cryptocurrencies in regard to volatility. In the end of October until the end of November however the volatility decrease. This contrasts with the others that are more or less stable in this period.

5.2 Market Correlation Between Cryptocurrencies

To analyse how the different cryptocurrencies in the market are correlated, a correlation analysis was done on the price history between the five cryptocurrencies Bitcoin, Ethereum, Litecoin, Ripple, and Bitcoin Cash. The methodology used for this work is described below:

Correlation is essentially a measure of the dependencies between variables, and thus is used to test the relationship between them. It is worth to keep in mind however, that a high correlation does not mean that a relationship is present. In frameworks such as the cryptocurrency market, it can however be a good indicator that there is such a relationship.

The formula used to calculate correlation coefficient: $r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}}$

where $r_{x,y}$ is the correlation coefficient, n the number of elements in the sample, x_i the i -th element of the variable x and y_i the i -th element of the variable y .

The correlation coefficient can span from 1 to -1. When there is no correlation between the variables the correlation coefficient is 0. When the correlation coefficient has a value between 0,1 and 1 the variables are positive correlated, at 1 they are perfectly positive correlated. If the correlation coefficient has a value between -0,1 to -1 the variables are negative correlated, at -1 they are perfectly negative correlated (Mari et al, 2001) ⁶³. When values are negative correlated as one value increases the other one decreases, and if one value decreases the other one increases. If values are positive correlated they both increases, or they both decreases.

Detailed observations regarding the correlation between all cryptocurrencies can be found in Appendix – Correlation observations as optional reading. This is however condensed and used as input to chapter 5.3 Matching Market History with Volatility, Correlation, and Price.

⁶³ Mari and Kotz. "Correlation and dependence". 7-20

5.3 Matching Market History with Volatility, Correlation, and Price

The observations made from the presented data in the previous sub-chapters raise some questions regarding clear trend outliers and the nature of these observations. To understand what can cause the data outliers presented above and market responses, it is important to analyse how both the general and specific market situation was at the time of these events. In light of this, the Volatility analysis, correlation between the selected cryptocurrencies (Bitcoin, Ethereum, Ripple, Bitcoin Cash, Litecoin) and market price history in the form of price multiplier increase will be used in this discussion. As Bitcoin is generally the least volatile cryptocurrency according to our analysis, and traditionally has been a huge market driver, it was chosen as a correlative reference currency to the other cryptocurrencies discussed in this thesis. This was done in order to determine the points where cryptocurrencies deviate from the “market norm” or where Bitcoin deviate from the market norm. Lastly, to make the analysis more comprehensible, it was decided to split the analysis into quarterly sections.

The graphs that will be used as foundation in this analysis is gathered from monthly (30 day) calculations from Volatility Observations, Correlation Observations, and an extended price multiplier graph from 4.2. Below in Table 4 and Table 5 it is possible to see the average quarterly calculated volatilities and correlation between the analysed cryptocurrencies as reference for the quarterly based analysis conducted below.

<i>Volatility%</i>	<i>Q1 (2017)</i>	<i>Q2 (2017)</i>	<i>Q3 (2017)</i>	<i>Q4 (2017)</i>	<i>Q1 (2018)</i>
<i>Bitcoin</i>	82,39	65,87	107,32	108,79	116,87
<i>Ethereum</i>	139,93	138,94	140,2	99,87	127,93
<i>Litecoin</i>	123,35	176,62	151,73	159,93	144,96
<i>Ripple</i>	109,84	327,62	129,93	211,93	173,85
<i>Bitcoin Cash</i>			273,15	212,30	163,95

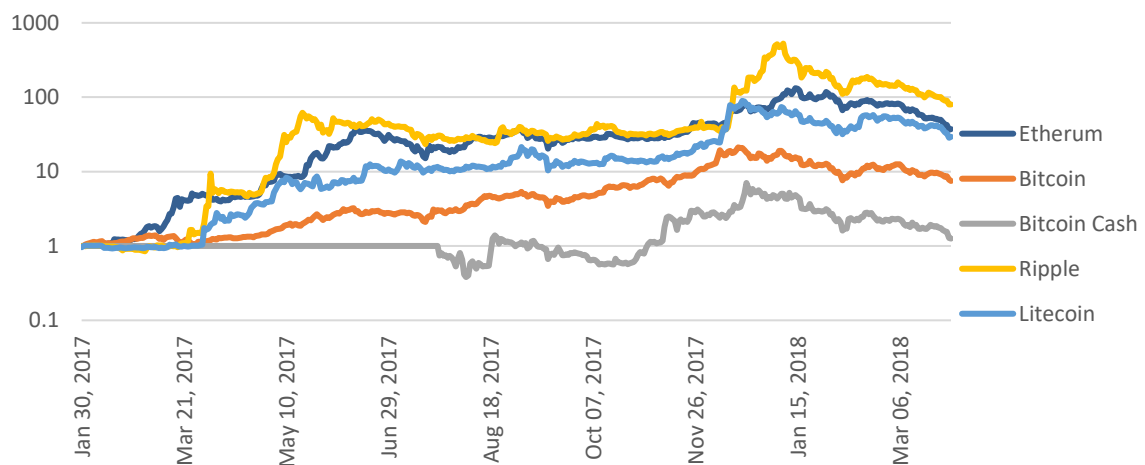
Table 4: Quarterly based analysis of average quarterly calculated volatilities.

Correlation	Bitcoin	Ethereum	Litecoin	Ripple	Bitcoin Cash
Bitcoin	1	0,47*	0,51*	0,24*	0,29*
Ethereum	0,47	1	0,46*	0,25*	0,44*
Litecoin	0,51	0,46	1	0,3*	0,36*
Ripple	0,24	0,25	0,3	1	0,28*
Bitcoin Cash	0,29	0,44	0,36	0,28	1

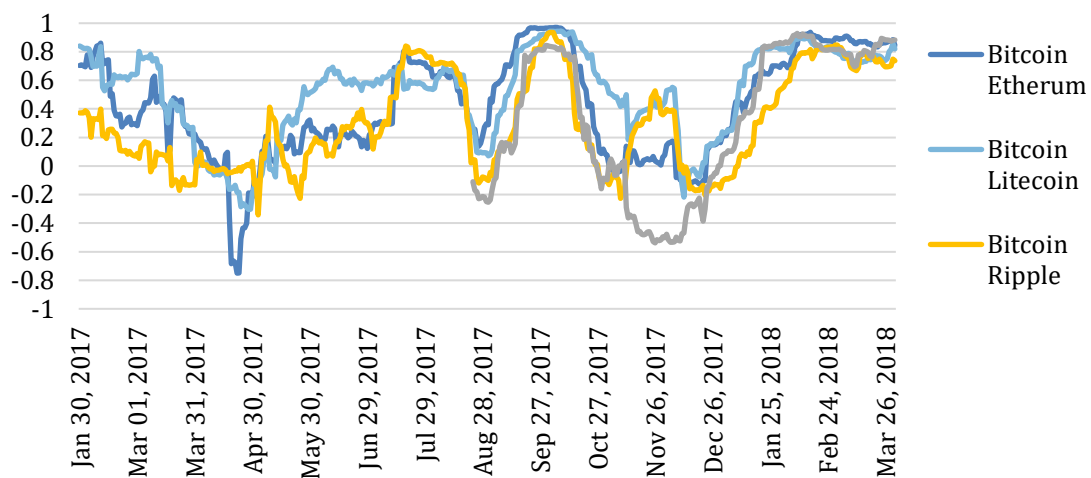
Table 5: Average correlation between the analysed cryptocurrencies.

*Note that the correlation is the same regardless of in which order it is correlated.

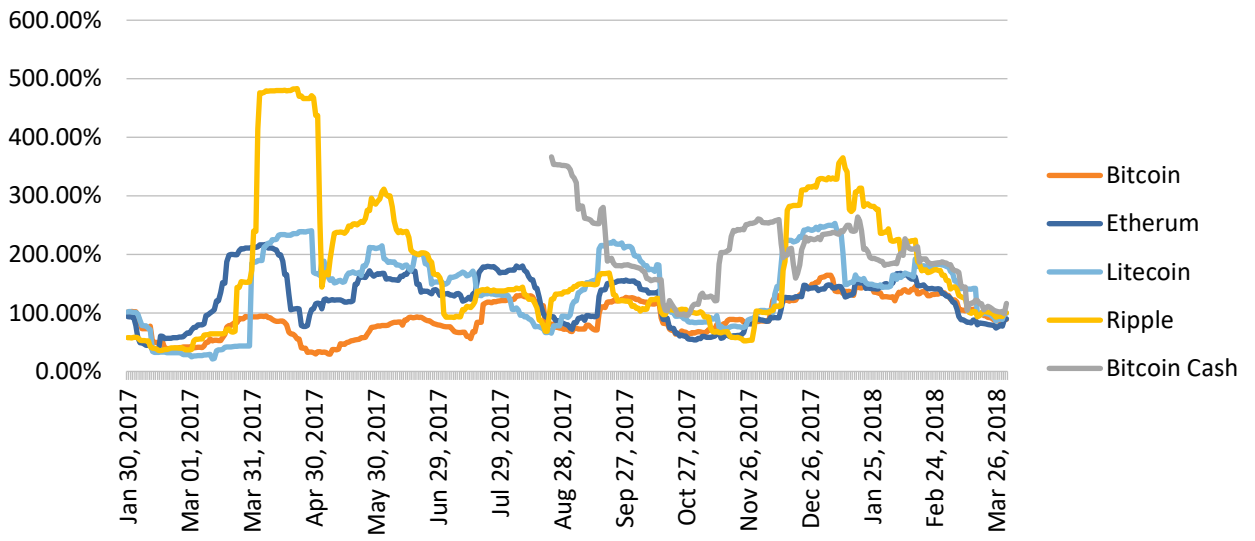
Price multiplier



Correlation Bitcoin

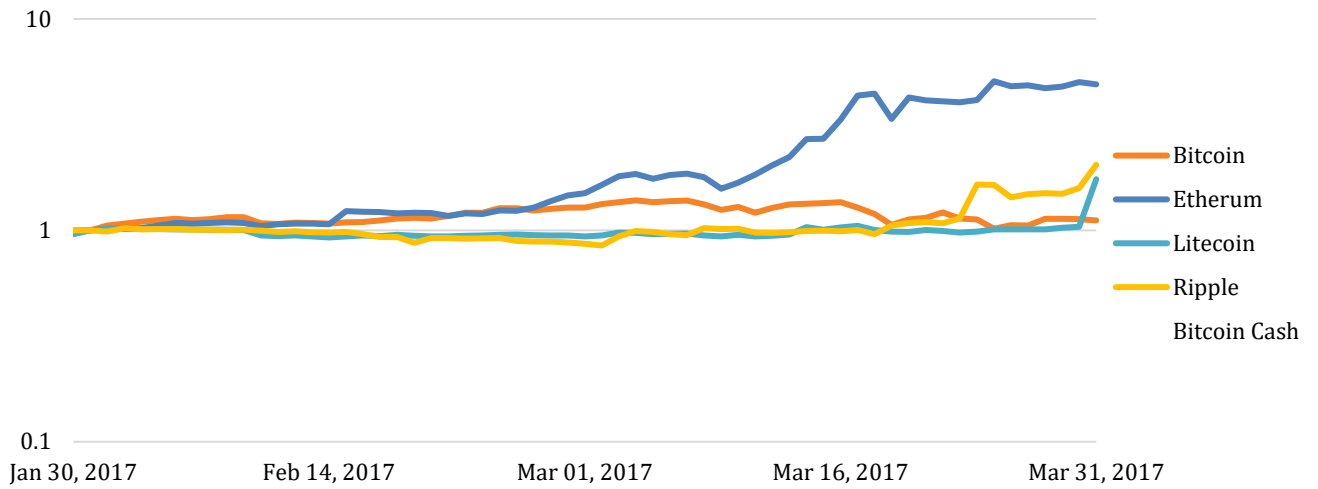


Volatility

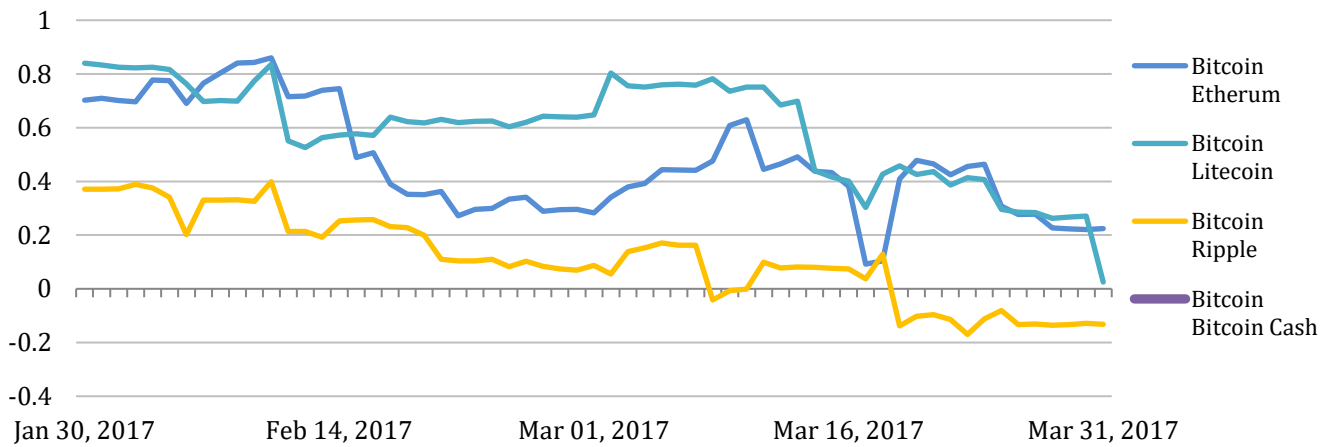


5.3.1 2017 - Q1

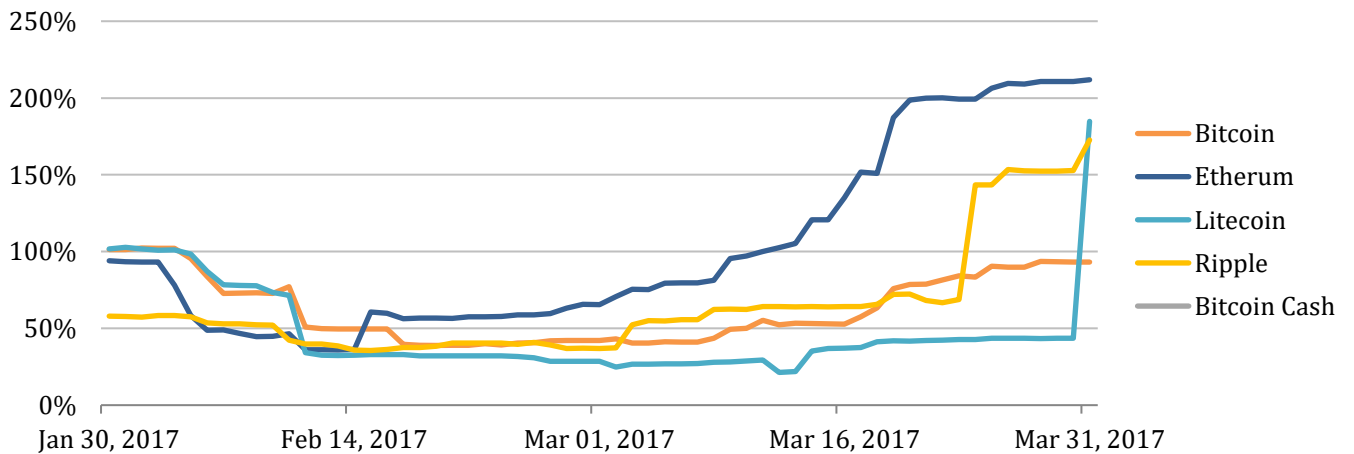
Price multiplier - Q1 2017



Correlation Bitcoin - Q1 2017



Volatility Q1 - 2017



Early Q1 2017, there is a relatively high correlation between Bitcoin and the other cryptocurrencies, low volatility, and steady price increase across the five cryptocurrencies until mid-February. A crash followed in early-January ⁶⁴, this period was also relatively uneventful regarding any market-news.

Over the course of Q1 2017 Ethereum is outpacing Bitcoin and the rest of the top five cryptocurrencies in terms of growth, this is followed by an increase in the volatility for Ethereum and causes a reduced correlation to Bitcoin. The reason for Ethereum's market response in this period can possibly be attributed to public backing as a result of the announced backing from Business giants⁶⁵.

The volatility of Litecoin is relatively low during this period and the correlation to Bitcoin is stable at a relatively high level until the middle of March where the price of Bitcoin is decreasing compared to Litecoin, causing a decrease in correlation followed by a price spike in the end of March causing a huge increase in volatility. This price spike was likely caused by investors driving up the price of Litecoin with support from the following public excitement⁶⁶.

Similar to Litecoin, Ripple also experience a huge price increase in the later part of March, increasing while Bitcoin is decreasing, causing a negative correlation and increased volatility. This market response was likely caused by news that several banks were looking into the best practices of Ripple implementation into their services⁶⁷.

Overall, using the top five cryptocurrencies as a representation of the cryptocurrency market situation in Q1, the market volatility increases towards the end of Q1 2017 for all cryptocurrencies. The same can be said for the price of the cryptocurrencies, except Bitcoin which experience a slight decrease towards the end of Q1. This is a natural response to the rapid increase in the value of the altcoin cryptocurrencies as owners shift their holding from Bitcoin to Altcoins and causes a decrease in Bitcoin market dominance.

⁶⁴ Høgseth. " Slik forklares Bitcoin fallet"

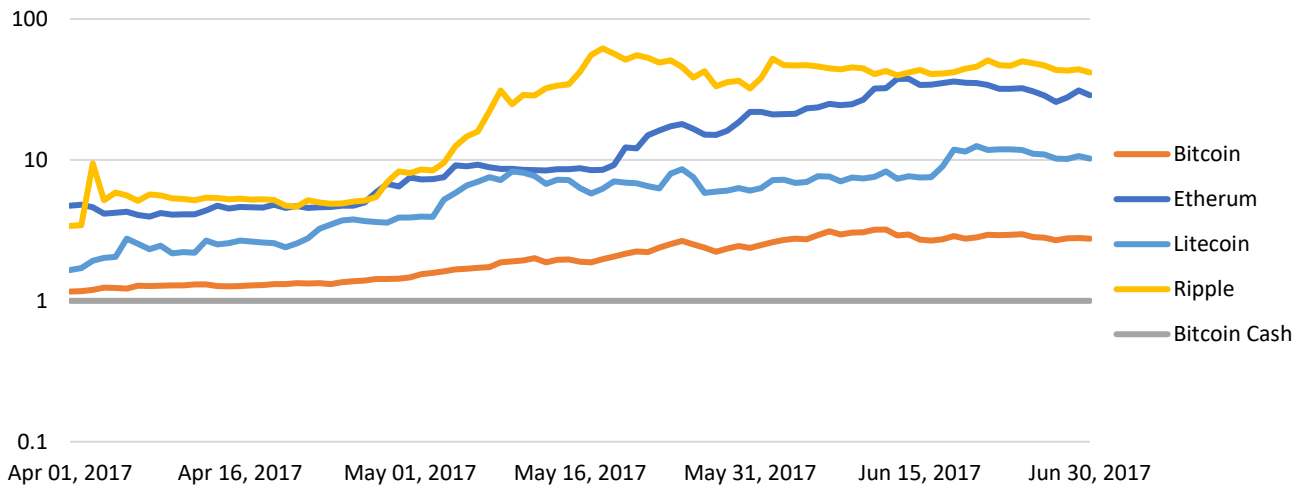
⁶⁵ Hackett. "Big Business Giants From Microsoft to J.P. Morgan Are Getting Behind Ethereum"

⁶⁶ Buntinx.. "Chinese investors start to drive up the Litecoin price"

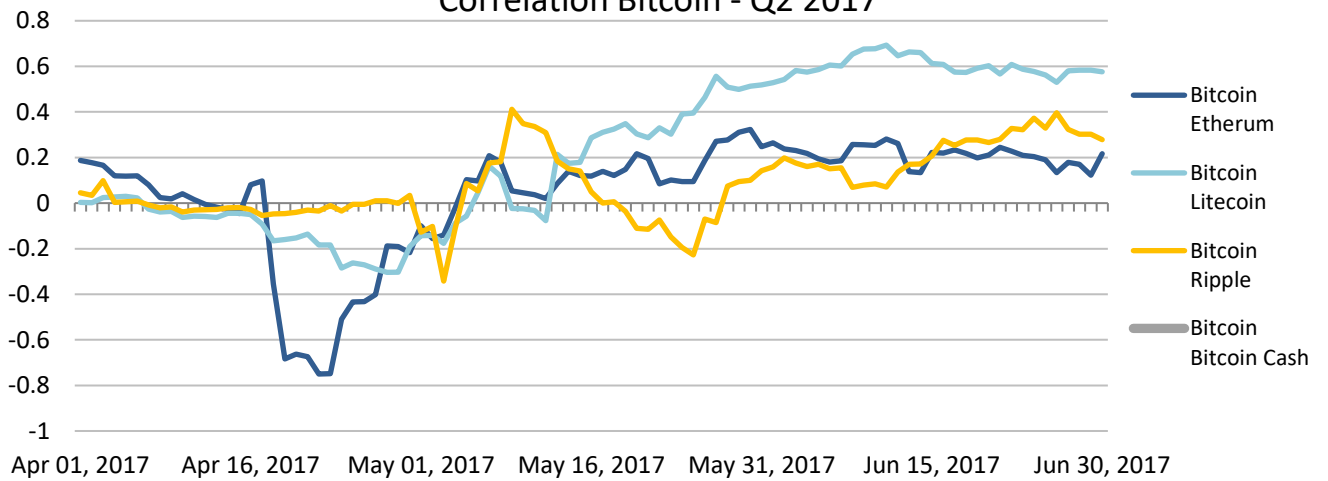
⁶⁷ Suberg. "Ripple Price Jumps 101% As It Surpasses Dash to Become Number 3 Crypto"

5.3.2 2017 – Q2

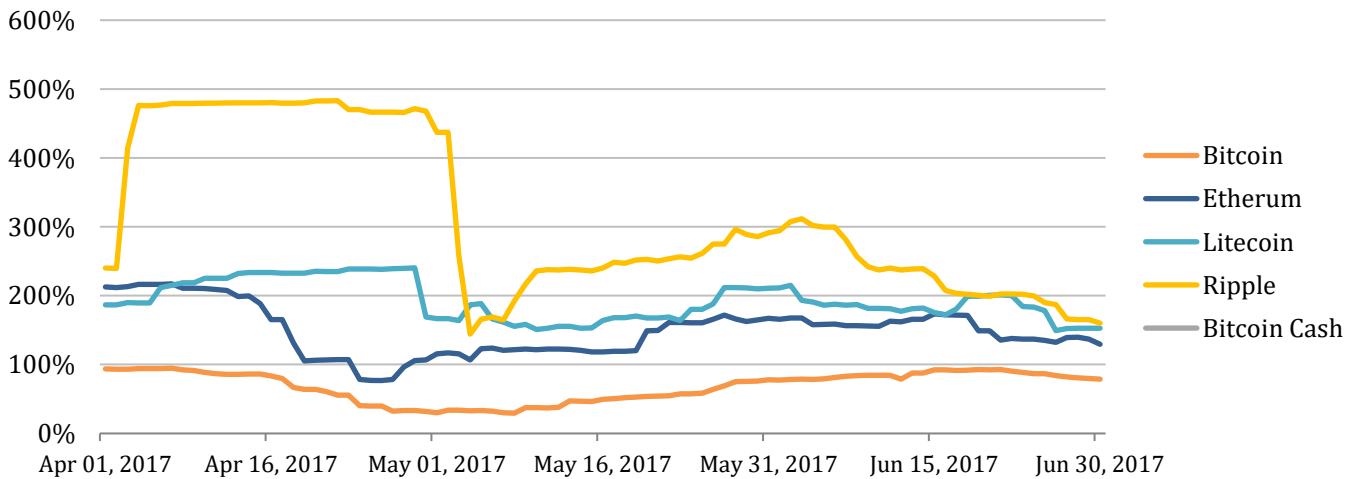
Price multiplier - Q2 2017



Correlation Bitcoin - Q2 2017



Volatility Q2 - 2017



Early Q2 shows low correlation between all the other main cryptocurrencies and Bitcoin. When looking at the price multiplier, the growth of all the other cryptocurrencies is outpacing the growth of Bitcoin leading to low correlation and higher volatility.

Ethereum is experiencing a steady high growth with low correlation to Bitcoin throughout Q2, except for a period with high negative correlation where the price of Bitcoin is decreasing compared to the increase of Ethereum. The increase of Ethereum in this period can be attributed to the continued momentum from Q1 and increased backing in the community⁶⁸. Towards the end of June, Ethereum has a short price crash as fake news regarding the death of its creator spread on the internet ⁶⁹.

Litecoin has a relatively high correlation to Bitcoin towards the end of Q2 as, and a high growth throughout Q2. In early May there is a price jump as Litecoin gets listed on South Korea's largest exchange⁷⁰ and Litecoin adds SegWit⁷¹ (a code update to battle scalability issues).

Ripple saw the biggest changes of the cryptocurrencies in Q2 and had extremely high volatility in early April. This high volatility can be attributed to a divide in the market after the sudden price increase between latest Q1 and earliest Q2 followed by a significant market correction (Appendix 1.4). From the end of April, Ripple experiences a huge increase in valuation with less volatility, due to the announcement of new financial institutions joining the Ripple global payments network^{72 73}.

⁶⁸ Kahrpal. "Ethereum hits another record high after bitcoin and is now up over 5,000% since the start of the year"

⁶⁹ Lant.. "Ethereum lost \$4 billion in market value due to fake "fatal car crash""

⁷⁰ Young,. "Litecoin Price Surges to \$30 as South Korea's Largest Exchange Adds Support"

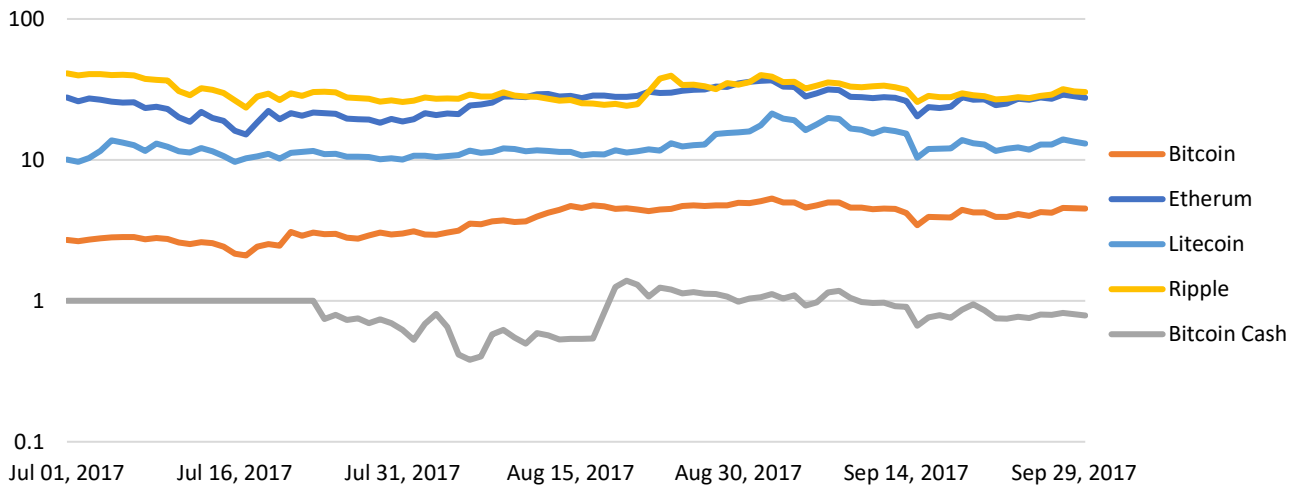
⁷¹ Ngo."Litecoin Price Spikes Amid SegWit Activation"

⁷² Mavadiya. "Blockchain boom begins: Ripple locks in 10 more financial institutions."

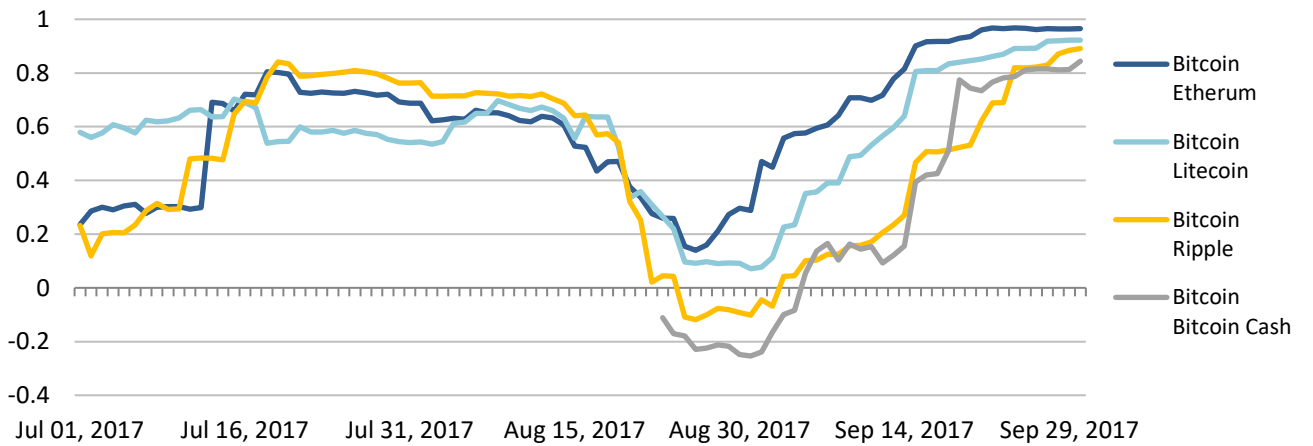
⁷³ Roberts. "More than 75 banks are now on Ripple's blockchain network."

5.3.3 2017 – Q3

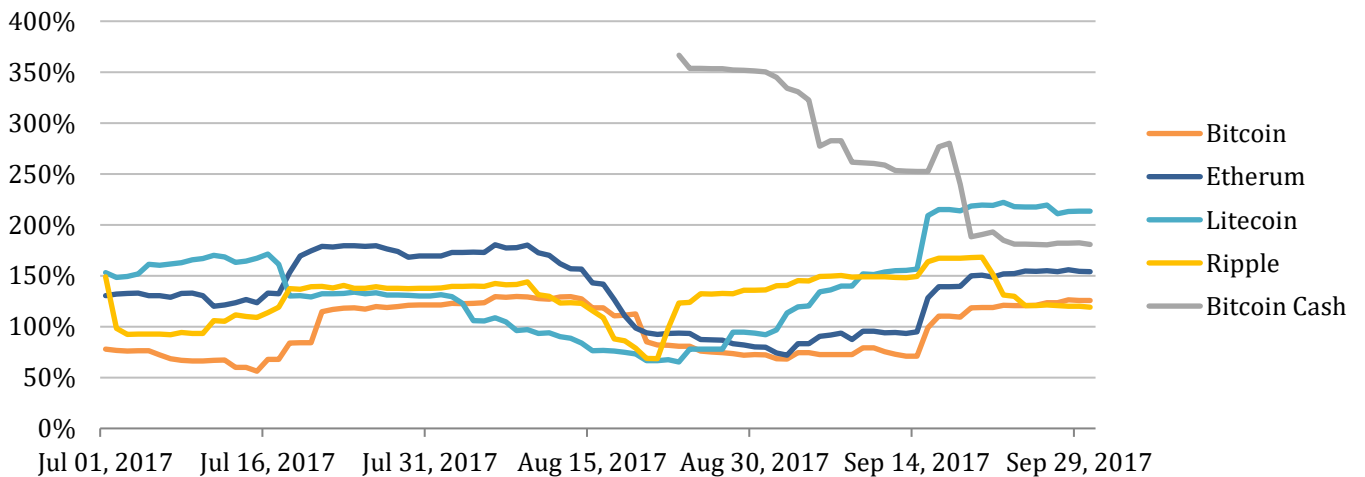
Price multiplier - Q3 2017



Correlation Bitcoin - Q3 2017



Volatility Q3 - 2017



Early Q3 shows increased correlation between the different cryptocurrencies and Bitcoin towards late July, as the market experience a devaluation from the increase in late Q2 due several factors such as fear, doubt and talk of bubble like tendencies ⁷⁴. During this devaluation of the market in early Q3, there is a relatively low volatility across the market.

Ethereum follow the market trend closely in most of Q3, but experience price and volatility responses to market events such as a hacking event in July ⁷⁵, exchange crackdowns in China⁷⁶ and unfavourable statements from Jamie Dimon, CEO of JPMorgan Chase⁷⁷ in mid-September. The correlation to Bitcoin is reduced late August and early September due to split in the Bitcoin network and introduction of Bitcoin Cash. In this period, Bitcoin experience a decrease in price as many holders are acquiring BCH.

Litecoin is like Ethereum following the market trends closely in this period, but experiencing an increase compared to the market norm in early July and early September as a response to the effects that took place back in May 2017 ⁷⁸ The correlation to Bitcoin is again stable but is also decreased with the launch of Bitcoin Cash as the rest of the market.

Ripple follows the market-trend closely in July and most parts of August, until the price soars as a result of rumours of Chinese market entry and favourable wins⁷⁹ ⁸⁰. Beside the outliers of the price increase in August, Ripple keeps a high correlation to the rest of the market and follows the crash in mid-September.

With the introduction of Bitcoin Cash as a split from the highest valued cryptocurrency Bitcoin, there is an extremely high volatility in the first weeks of Bitcoin Cash's lifetime before it levels with the rest of the cryptocurrencies. During this time, the price development does however somewhat follow the general market trends.

⁷⁴ Garber. "Ethereum is getting crushed".

⁷⁵ Quereshi. "A hacker stole \$31M of Ether—how it happened, and what it means for Ethereum"

⁷⁶ Omkar." Ethereum Drops Below \$250 as Price Hits Inflection Point".

⁷⁷ Monaghan." Bitcoin is a fraud that will blow up, says JP Morgan boss."

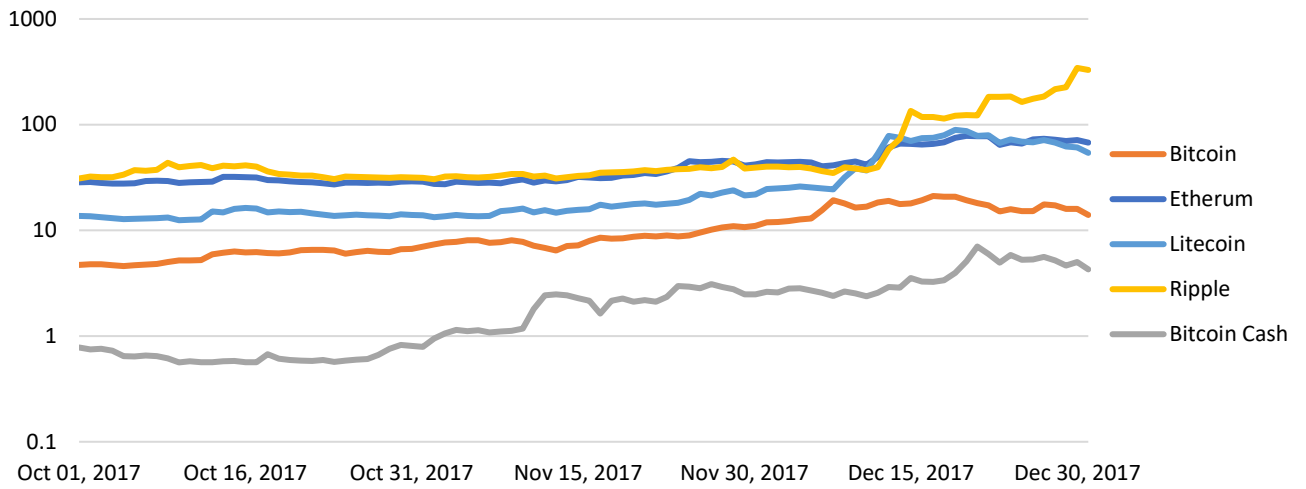
⁷⁸ Palmer. " Litecoin Prices Surge Above \$70 as Crypto Market Tops \$175 billion".

⁷⁹ Acheson. "Hints and Rumors? How Ripple Might Really Enter China's Market"

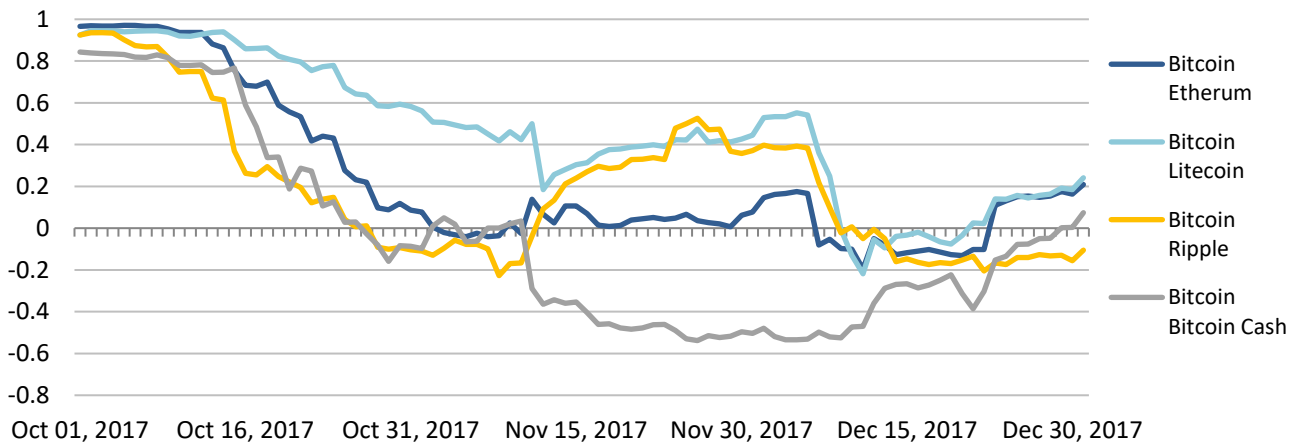
⁸⁰ Roberts. "Digital Currency Soars 70% Overnight."

5.3.4 2017 – Q4

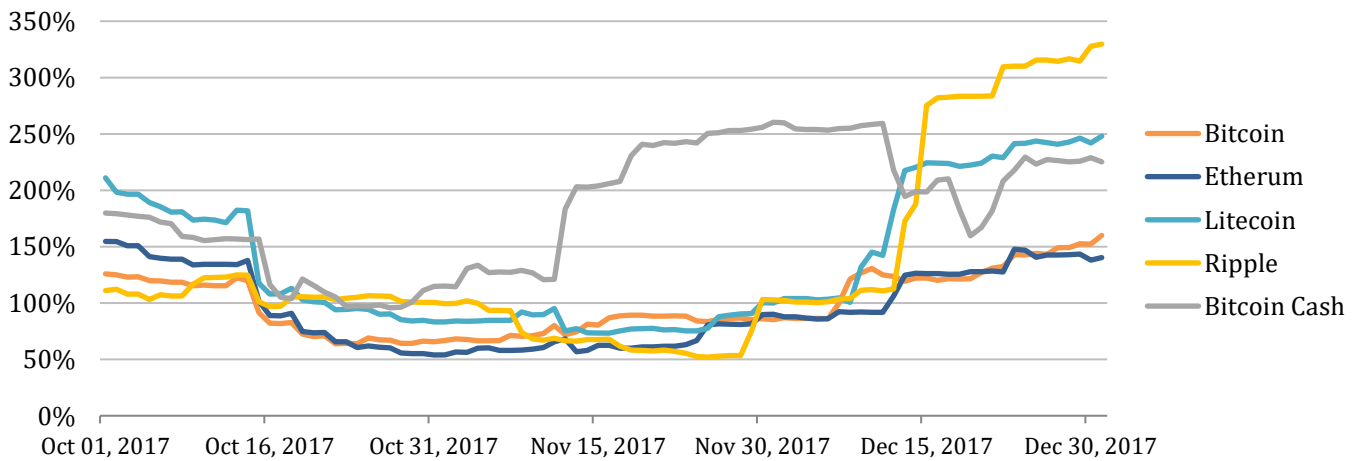
Price multiplier - Q4 2017



Correlation Bitcoin - Q4 2017



Volatility Q4 - 2017



Early Q4 has high correlation between Bitcoin and the other cryptocurrencies and is experiencing strong price growth and relatively high but declining volatility. Towards the end of Q4 2017, the price of all the cryptocurrencies experience a huge price increase, and the volatility in the market picks up and becomes very high. The market then experiences a correction amidst a series of volatile sell-off events in latest December, bringing down price of most cryptocurrencies from the top in mid-late December. While the market increase is big for Bitcoin, the increased value of the altcoins is comparatively larger in late December.

Ethereum experience a reduced correlation to Bitcoin compared with the rest of the market and an increase in price in mid-October with the “Byzantium” code upgrade ⁸¹. Like the rest of the market, Ethereum experience a huge price increase in the latter half of Q4 riding the wave caused by increased public enthusiasm and adoption.

Litecoin follows the market trend with a steady increase over the later half of Q4 with a strong increase in the beginning of December. This price increase was followed by a price decrease and increased volatility in late December, which while steered by general negative market trends, were worsened by the news of Litecoin funder Charlie Lee selling his Litecoin holdings ⁸².

Ripple follow market trends in most parts of Q4 but is generally underperforming compared to the other currencies with generally low volatility in mid-late October to Early December. Although the price increase was rapid, it appears to be no singular reason for Ripple’s price increase in late December. The growth has been attributed to good market decisions from the developers in the previous months, increased public awareness, rumours of exchange adoptions etc. These factors could all contribute to create public hype at a time in the market where many other cryptocurrencies are reducing after reaching all-time highs ⁸³.

⁸¹ Herting. “Hours to Go: How to Watch Ethereum's Fork as It Happens”.

⁸² Browne. “ Litecoin founder Charlie Lee says he’s sold all his holdings in the cryptocurrency”

⁸³ Damiani. “ 5 Reasons Why The Ripple (XRP) Price Continues To Surge In The Face Of Crypto Market Corrections”

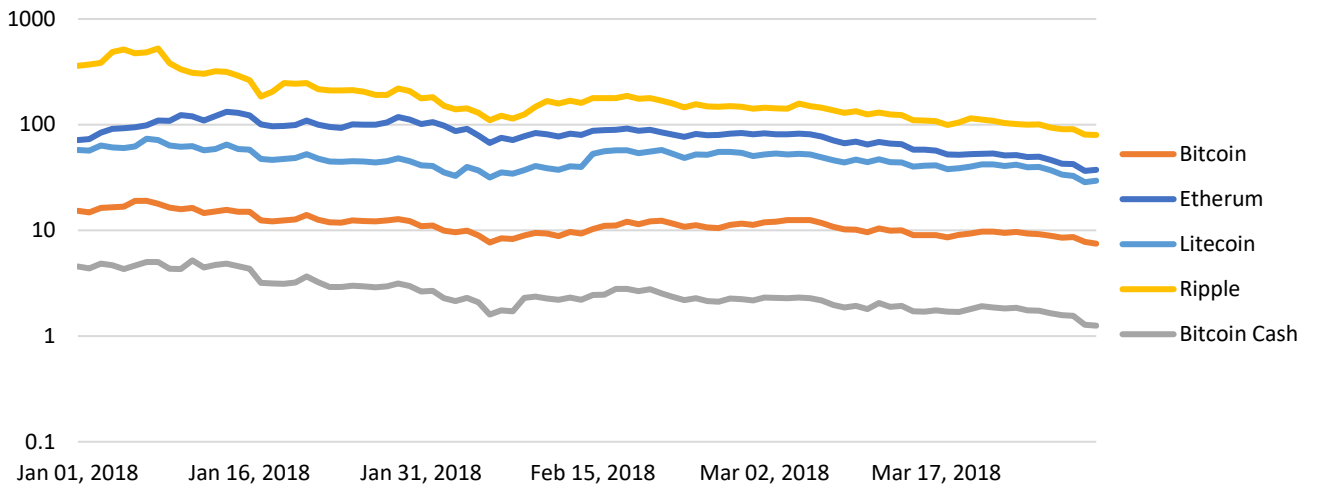
Bitcoin cash experience a negative price development in early Q4 and reduced correlation to Bitcoin but started seeing support in the late October and early November. Additionally, there was a huge price increase in mid-December as a direct consequence of Coinbase, one of the markets largest exchanges, listing Bitcoin Cash without any warning⁸⁴. This listing of Bitcoin Cash caused a huge sell-off in Bitcoin, possibly due to fear of missing out on potential growth and panic selling due to the lack of any warning. Generally, when there is an increase of the price of Bitcoin Cash in Q4 with low market correlation, there is also a negative correlation to Bitcoin as many customers are adjusting their holdings into Bitcoin Cash, often from their Bitcoin wallets to diversify. The volatility of Bitcoin Cash is also generally high in November and December compared to the rest of the market. This high volatility is to be expected when there is a hard fork, creating a new cryptocurrency from the highest valued cryptocurrency on the market (Bitcoin).

Generally, in Q4 all cryptocurrencies saw a huge increase and previous records are broken in terms of both individual cryptocurrency pricing and total cryptocurrency market capitalization. Volatility is relatively lower in middle Q4 with low correlation between Bitcoin and the rest of the cryptocurrency market. December is however a highly volatile month as transaction volume and trading (chapter 2.1) is skyrocketing, with a huge bull-run in early December followed by a market correction in late December.

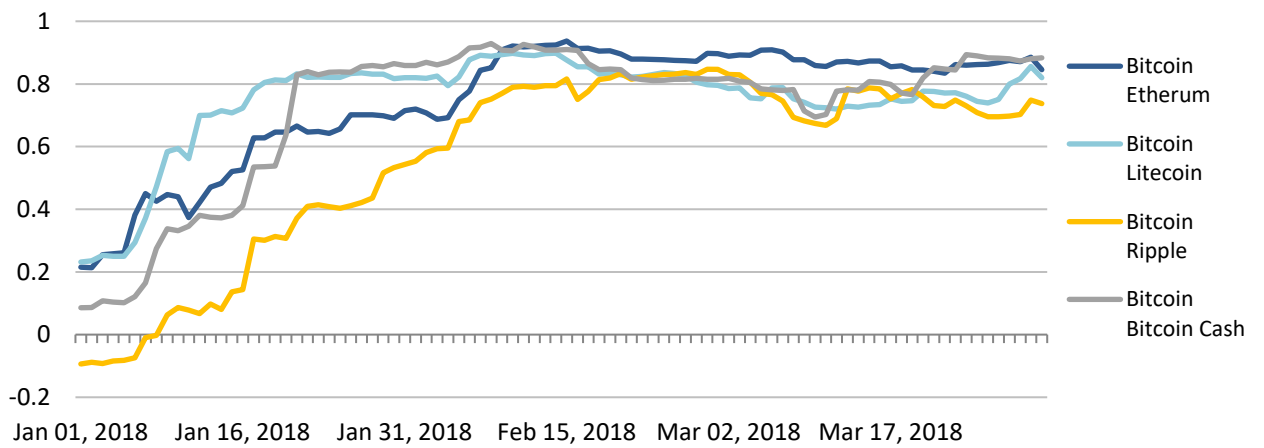
⁸⁴ Lee, Timothy. " Bitcoin rival Bitcoin Cash soars as Coinbase adds support"

5.3.5 2018 - Q1

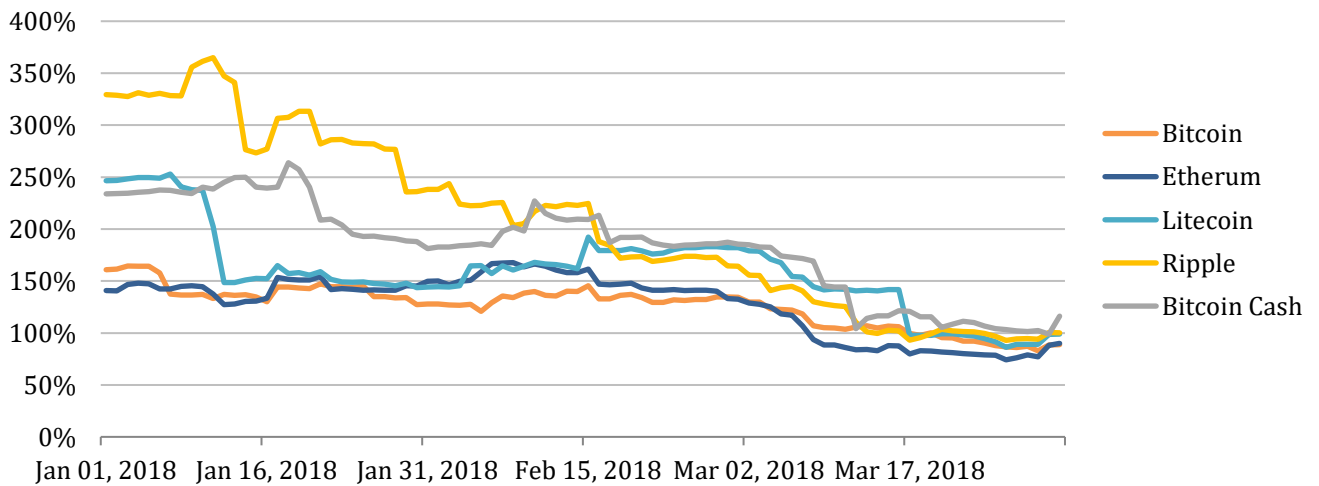
Price multiplier - Q1 2018



Correlation Bitcoin - Q1 2018



Volatility Q1 - 2018



Early Q1 2018 is experiencing a small recovery in the cryptocurrency market from the crash in late December 2017. This recovery is however followed by a new reduction which generally continue throughout Q1 with some small exceptions where the price is shortly recovering. The market trends in Q1 is very similar for most of the cryptocurrencies in this study, especially from the middle of January. As the price continues to decline for all cryptocurrencies, the correlation to Bitcoin increases and stays at a high level for most of Q1. The volatility of the cryptocurrency market is also significantly reduced as the price continues to drop. This can be seen as result of reduced transaction volumes as the market goes into a low activity period in wait of the next price surge. This type of “boring low” market behaviour and potential reasons for the price and market development were discussed in detail back in chapters 4.4.1 and 4.4.5.

5.4 Liquidity

Liquidity describes how easy an asset can be sold in the market without affecting its market-price. The most liquid assets are considered to be cash and currency, but gold is also considered to be a relatively liquid commodity. The liquidity of the five cryptocurrencies was calculated using the coefficient of elasticity of trading. This method suggests that the liquidity is similar to the price elasticity of trading volume. Subsequently the coefficient of elasticity also called CET can be calculated by dividing the percentage change in trading volume by the percentage change in price⁸⁵.

$$CET = \frac{\% \text{ change in trading volume}}{\% \text{ change in price}} = \sum_{t=1}^T \frac{\ln\left(\frac{V_t}{V_{t-1}}\right)}{\ln\left(\frac{P_t}{P_{t-1}}\right)}$$

The CET value ranges from negative infinity to positive infinity. If the CET value is high, this is a result from the price changes being accompanied by a large change in volume transaction. Therefore, if the change in volume is large while the change in price stays small, the CET value will approach a positive or negative infinity. Subsequently the cryptocurrencies are highly liquid if their absolute CET value is big. The sign of CET value does not have any impact on the liquidity (Loi, 2017).

	<i>Bitcoin</i>	<i>Ethereum</i>	<i>Litecoin</i>	<i>Ripple</i>	<i>BTC</i>	<i>Gold</i>
<i>CET</i>	226	764	5030	1977	1939	127 221

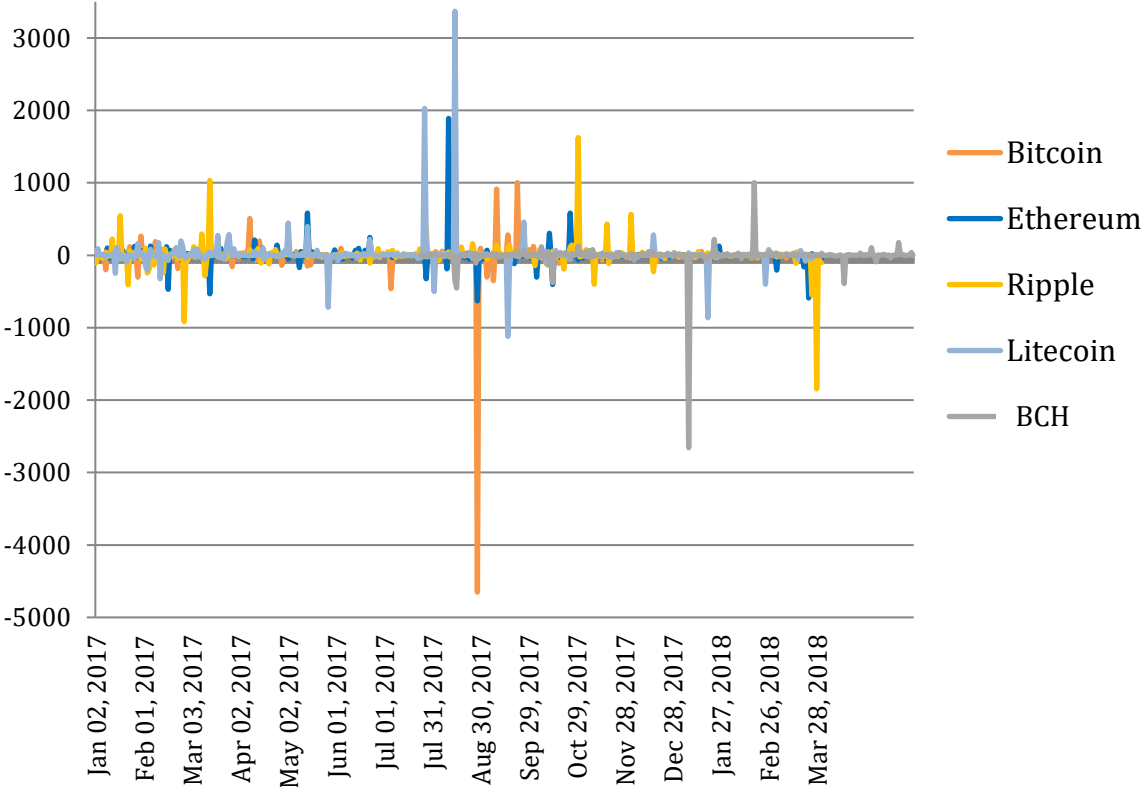
Table 6: Average liquidity for the analysed cryptocurrency and gold based on liquidity observations.

Table 6 shows the CET values for the cryptocurrencies and gold from January 2017 to the end of March 2018⁸⁶. The most liquid cryptocurrency is Litecoin, followed by Ripple, BTC, Ethereum and Bitcoin. The liquidity will be dependent on transaction volume of the commodity analysed. When comparing the liquidity to the liquidity of gold, it becomes clear that the cryptocurrencies are not comparatively liquid. The most liquid cryptocurrency is over 25 times less liquid than Gold. This means when compared to gold, cryptocurrencies are much less easy to sell in the cryptocurrency market without affecting the market price.

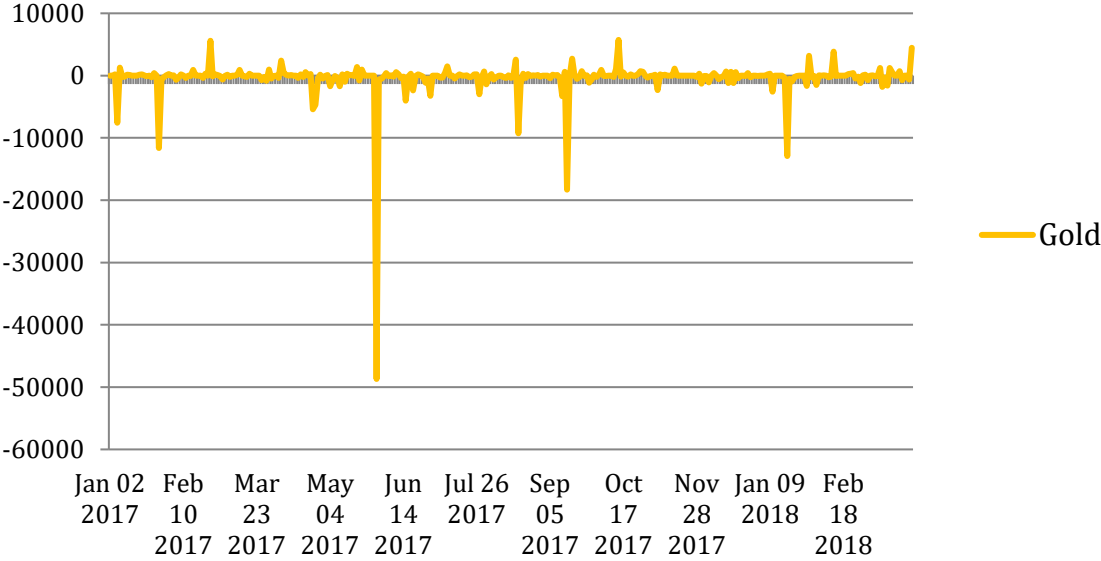
⁸⁵ Loi. "Liquidity of Bitcoin"

⁸⁶ Investing.com – Gold historical data

Beneath it is possible to see the graphs for liquidity of the analysed cryptocurrencies and for gold. The results from the figures below show that the liquidity for gold is much higher than that of cryptocurrency. Even at times of locally high liquidity for cryptocurrency, it is possible to see that gold has much higher peaks, often by a ten-fold. Gold is also traded in 5 days intervals and cryptocurrency is traded all week.



Gold



5.5 Cryptocurrency as an alternative to fiat currencies and gold

5.5.1 Volatility of Gold vs Volatility of Cryptocurrency

The volatility of gold has been calculated in the same period as for the cryptocurrencies and is used to compare the difference in volatility between these. This was done in order to analyse how volatile the cryptocurrencies actually are. It is worth mention that Gold is only traded 5 days a week, Monday to Friday when the stock exchanges are open⁸⁷. This means that gold is traded fewer days in a year compared to cryptocurrencies.

IN %	BITCOIN	ETHEREUM	LITECOIN	RIPPLE	BITCOIN CASH	GOLD
MAX VOL. WEEKLY	228,53	367,87	385,65	970,7	500,82	16,69
MIN VOL. WEEKLY	13,52	9,01	2,51	10,88	30,65	2,4
AVERAGE VOL WEEKLY	86,90	110,99	127,65	149,42	176,15	8,5
MAX VOL. MONTHLY	164,44	217,17	252,92	483,5	366,56	13,28
MIN VOL. MONTHLY	29,43	35,92	21,32	35,59	95,72	6,07
AVERAGE VOL. MONTHLY	92,5	122,89	140,95	176,19	198,22	9,84
MAX VOL. QUARTERLY	140,2	168,35	202,48	335,41	245	11,35
MIN VOL. QUARTERLY	62	90,98	123,18	95,97	163,74	8,23
AVERAGE VOL. QUARTERLY	96,56	132,97	159,57	211,67	207,88	9,99

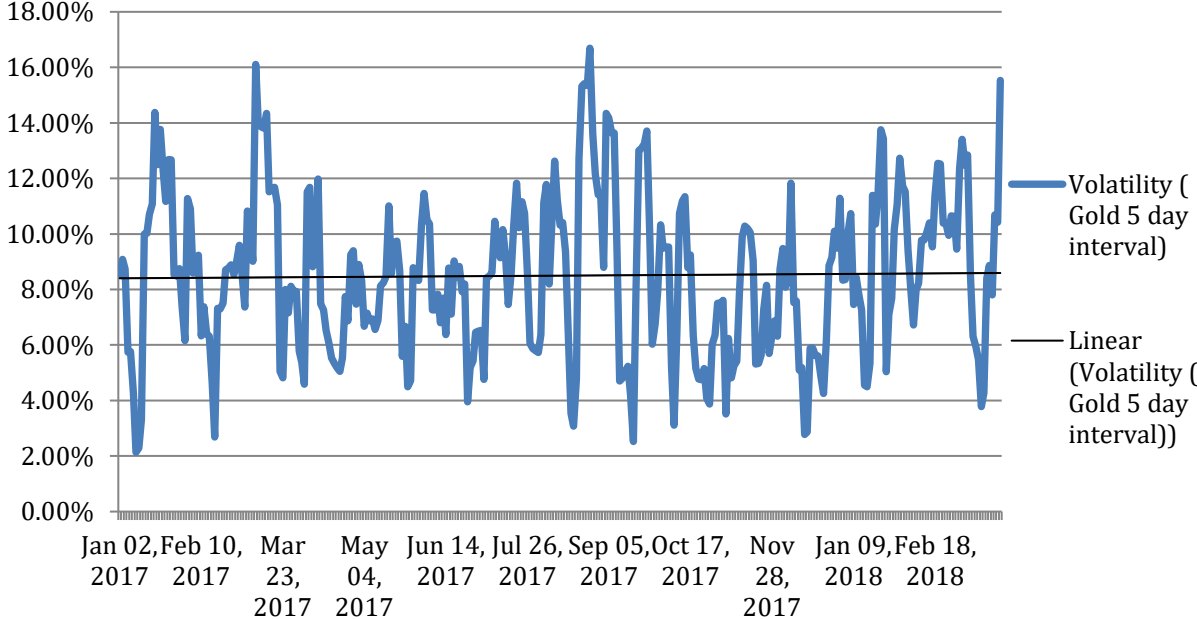
Table 7: Volatilities of analysed cryptocurrencies and gold in max, min, average for weekly, monthly, and quarterly.

From the table above, it can be seen that the average volatility of the least volatile cryptocurrency (Bitcoin) is almost 10 times as high as the volatility of gold. The most volatile cryptocurrency is Ripple, and it has an average volatility almost 18 times higher than gold. When looking at the weekly volatility of Bitcoin and compare it to the weekly

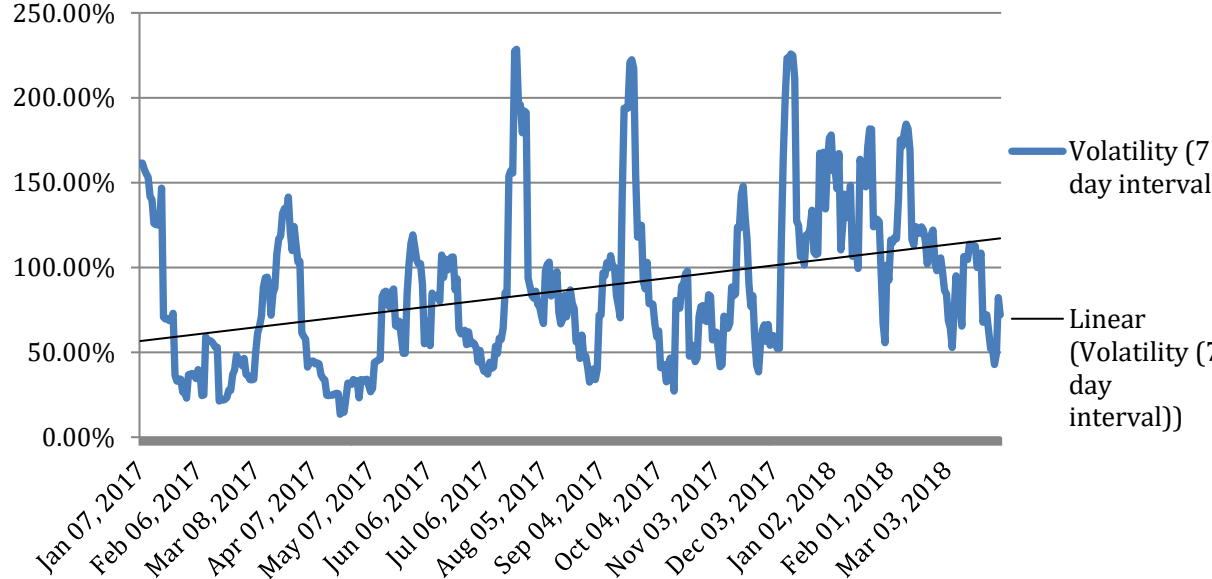
⁸⁷ Investing.com – Gold historical data

volatility of gold, it can be noticed that the even though the volatility of gold has peaks and lows, it is overall stable. Gold does not have these extreme periods with high volatility as for example Bitcoin has. In the period looked at in this thesis, gold has had a stable volatility, while Bitcoin has had an increase in volatility.

Gold Volatility (5 day interval)



Bitcoin Volatility (7 day interval)



Arguably, one of the reasons for the high volatility in the cryptocurrency market is the speculations regarding uncertain future public adoption in established financial cultures, and strong market responses. Resulting in limited options for spending and trading cryptocurrency in society⁸⁸.

It is common that newcomers to any market experience relatively higher volatility than the rest of the market. It can be argued that the cryptocurrency market is in its entirety a newcomer, which leads to a naturally high volatility. Cryptocurrency have no intrinsic value as it exists only in the virtual world. Gold however has intrinsic value as it is a limited physical object that have real world applications such as computer electronics, jewellery, engineering etc. Another reason, which can impact the volatility of the cryptocurrencies, is the lack of regulations, and the anticipation that regulations at some time will be coerced. Press has as well an impact on the cryptocurrencies which has been shown in chapter 5.3. When the press writes positive articles about the cryptocurrency market more people are likely to be drawn to invest, while when the press writes negative articles less people would want to invest.

The cryptocurrencies do also have a few things in common with gold. They do not have a central authority that makes both of them shielded. Both cryptocurrencies and gold are durable; meaning that they do not have an expiring date, like for example paper money. There is also a finite amount of both, in Bitcoins case it only exists 21 million. Some people may even speculate that bitcoin at one point may take over gold's position as a world leader in store of value⁸⁹.

5.5.2 Money substitutes and cryptocurrencies

A money substitute can be defined as an asset that can be converted into spendable money with different degrees of convertibility. Most often people turn to money substitutes when the currency of the country they are living in starts to fail. Cryptocurrencies have mostly been seen as assets, but some have started debating if it is a currency. Some even have the

⁸⁸ Steemit. " Why Are Cryptocurrencies So Volatile? When Will Prices Stabilize?"

⁸⁹ Shen. " Forget the Stock Market. Investors Are Trading in Gold for Bitcoin"

idea that cryptocurrencies will replace cash entirely. The ideal advantages of using cryptocurrency as a currency is that it can't be as easily manipulated as fiat currency because it's unregulated and decentralized. Cryptocurrencies could also better support the debated concept of a universal basic income⁹⁰. The disadvantages of using not only cryptocurrencies as currency but also to use money substitutes as currency is that they are subject to volatility that can disrupt their use. By paying with a money substitute as a cryptocurrency like bitcoin or a general money substitute as gold, it could be difficult to know how much a transaction is worth in comparison standard daily transactions. Cryptocurrencies also loses to gold as a money substitute when it comes to store of value due to its volatility. The store of value is what makes gold an important money substitute. Most people want to safely place their money in a way they can accumulate wealth, and have it hold its value. When looking at history of gold, silver, diamonds etc. has been seen as a place to store value⁹¹.

5.5.3 Bank issued digital currencies

Bank issued digital currencies is the digital form of fiat money. Meaning that it is a currency established as money by government regulation or law. These digital currencies will make transactions happen faster and more efficient. There is a debate if bank issued digital currencies will be able to replace and take over the role of cryptocurrencies. The main reason for this to happen is the pressure of certain governments on for example Bitcoin and other cryptocurrencies. In China regulators have moved to ban initial coin offerings that allow start-ups to raise funds by flogging of new cryptocurrencies⁹². But the nature of the decentralized currency market, with cryptographic transactions over a blockchain were developed to keep central banks and governments out of the private economy of the citizens. This will make it hard for centralized entities to take over the market. The anonymity given when using cryptocurrencies in addition to the how easily people can exchange value with each other, can be a threat for the traditional banking industry ⁹³.

⁹⁰ Reiff. "Could Cryptocurrencies Replace Cash?"

⁹¹ Katok. "Gold Has Just One Of The Three Characteristics Of A Functional Currency"

⁹² Browne. "Central bank-issued digital currency is the future, not cryptocurrency, economist says

⁹³Hall. "will centralized bank issued-digital currency replace crypto?"

5.6 Other Market Challenges

5.6.1 Security

The security that cryptocurrencies can provide through their decentralized blockchains is perceived as one of the greatest attractions that the technology can provide. The security of a blockchain is as discussed briefly in chapter 3.1.2, based on the unstructured simplicity of the network. In a blockchain based on the founding technology that Nakamoto presented with Bitcoin, it is computational impractical to conduct attacks on the network as long as honest nodes control the majority of CPU power. There have however, been cases where cryptocurrency has been obtained through illegal means such as hacking, phishing and scamming.

Most of these cases is a result from attacks on exchanges rather than the cryptocurrency blockchain itself. The Mt. Gox incident described in chapter 4.4.1 is the biggest example of such an attack on an exchange where over 850,000 Bitcoins were stolen. Other examples of such exchange attacks include the Bitstamp attack in January 2015 where 19,000 Bitcoins was stolen⁹⁴, the Bitfinex hack where 120,000 Bitcoins was stolen from the users segregated wallets, and the NiceHash hack where the exchange was hacked in 2017 for over 4,000 Bitcoins⁹⁵. All these attacks were made possible due to weaknesses in the exchange security measures rather than in the technology behind the cryptocurrencies themselves.

While exchange attacks have resulted in the most damage to the cryptocurrency industry, there are also other types of security issues that the cryptocurrency face:

In 2016 there was an incident regarding an original Ethereum smart contract dubbed the DAO incident that resulted in a loss of 3.6 million Ether ⁹⁶. Following this event, the Ethereum network voted on whether to annul this event through a hard fork of the block chain. This resulted in a hard fork and the creation of the Ethereum blockchain that exist today and Ethereum Classic⁹⁷. It is however important to note that this was not a fault in

⁹⁴ Wikipedia. "Bitstamp"

⁹⁵ Suberg. "NiceHash CEO Quits After 4,000 BTC Hack, Service To Continue Work"

⁹⁶ Castillo. " The DAO Attacked: Code Issue Leads to \$60 Million Ether Theft"

⁹⁷ Madeira. " The DAO, The Hack, The Soft Fork and The Hard Fork".

the Ethereum network, but rather a third-party application that was running on the Ethereum platform.

There have also been fraudulent operations such as the GAW Miners and ZenMiner in 2014 pyramid scheme⁹⁸, and the 2018 lawsuits against Bitconnect, an open source cryptocurrency suspected of being a Ponzi-scheme⁹⁹.

There have also been several incidents where malware has been used from everything from stealing CPU power from computers to mine the cryptocurrency Monero, stealing private passwords for personal cryptocurrency wallets through keystroke tracking, providing fake wallet-addresses for transactions etc. Additionally, a special type of malware called ransomware has been used to encrypt personal hard drives and demand a certain amount in cryptocurrency in return for decrypting the hard drives¹⁰⁰.

While the technology behind the different cryptocurrencies have been proven to be robust against any forms of targeted malicious attacks, the system around the cryptocurrencies such as wallet services, exchanges, personal computers and user data is not. This support system is vulnerable to hacking and malicious software from a technical point of view, but also against frauds that target the gullible and naïve potential customers. These types of security risks are not necessarily exclusive to the cryptocurrency industry, but experience has shown that exchanges that are not equipped or experienced to fend off malicious attacks pose the greatest security risk for the cryptocurrency market at this point.

⁹⁸ Higgins. " SEC Wins \$11 Million Default Judgment Against GAW Miners."

⁹⁹ The next web. "How BitConnect pulled the biggest exit scheme in cryptocurrency"

¹⁰⁰ Wikipedia. "Cryptocurrency and security."

5.6.2 Regulations

There are four main objectives of regulation; securing price stability (macro), financial intermediaries stability (micro), disclosure and fairness and developing competition and markets¹⁰¹. The governments can mainly regulate a market, commodity, or currency by using taxes, laws and licensing. The questions related to the regulations of cryptocurrencies are regarding who is going to regulate them and how they are going to be regulated. Regulators are concerned about digital currency being used in money laundering, terrorist financing, tax evasion and fraud. One issue in regard to most cryptocurrencies is that they do not operate within set geographical borders, meaning that regulations imposed by one government may not be valid in another country. Many governments are divided on how they should regulate cryptocurrencies. Most governments have chosen to view cryptocurrencies as an asset or commodity rather than a currency. By doing this they have avoided problems in relations to regulating a currency. When classified as an asset it is as well possible for governments to tax them. Another reason to classify cryptocurrencies as an asset is that it's easier to track its performance for investors in a portfolio setting.

Even when categorized as an asset, different countries have different views on how the taxation of cryptocurrencies as an asset should be handled. A few examples on how different countries has solved this: Australia and the US have classified cryptocurrencies as property assets; by doing this there is capital gain tax. The US has also stated that certain cryptocurrencies should be treated as commodities. This has resulted in that fraud and manipulation involving cryptocurrencies traded in interstate commerce and the regulation of commodity features is under the authority of the commodity futures trading commission. The Internal Revenue Service (IRS) has stated that Bitcoin must be treated as property for tax purposes. As a result of this capital gain or loss should be recorded as an exchange involving property. If cryptocurrencies are used as payment it should be treated like currency and converted to its fair market value checked on an exchange. Until now Germany has viewed cryptocurrencies as foreign money. There is no capital gain tax, but if it has been owned under a year, a progressive income tax of up to 45% of all gains. Switzerland has classified cryptocurrencies as a foreign currency with no capital gain tax

¹⁰¹ Hall. "The international handbook on financial reform."

and no sales tax. In Japan cryptocurrencies are a legal tender and is a subject to capital gain tax but is exempt from consumption tax. In Norway virtual currencies are seen as assets subjected to capital gains taxes and are not seen as money or currencies¹⁰².

There are divided opinions on the issue of using cryptocurrencies as a tender. When this thesis was written countries like Japan and Switzerland allowed the use of Bitcoin as a legal tender. On the opposite, countries like the US, China, India, Singapore and various countries within the EU have not fully legalized Bitcoin and many other cryptocurrencies as a tender¹⁰³. When it comes to exchanges there are as well different opinions on the legality of these. In Japan the cryptocurrencies exchanges are legal if they are registered with the Japanese Financial Service Agency. In a same manner cryptocurrencies exchanges have to be registered with the Financial Conduct Authority in the UK. Cryptocurrencies exchanges are legal in the US, various countries in the EU and Singapore, while corporate cryptocurrencies exchanges are illegal in China¹⁰⁴.

In 2019 EU plans to introduce different measures to help regulate cryptocurrencies. The biggest challenges EU will have when trying to regulate cryptocurrencies is in the relation to anonymity. The promise of anonymity attracts money laundering, drug money and the funding of terrorism. Ultimately the new legislation that EU will propose aims to end the anonymity of wallet addresses and make the exchanges and their users more transparent (Business world, 2018). This is however not an easy task for EU, as it will be nearly impossible for EU to force a change in the ledger of most cryptocurrencies that coerce the users identity to be known. In comparison the US government has not been able to force tech giants like Apple to decrypt a single iPhone, even if they belonged to known terrorists¹⁰⁵. Cryptocurrencies values are heavily tied to speculation and optimism. When drastic policy changes are imposed on them it can have an impact on the short-term value. However, regulations can lead to a more stable market in the future, but it is difficult to assess how effective these implementations will be.

¹⁰² Mckenna, "Here's how the US and the world regulate Bitcoin and other cryptocurrencies".

¹⁰³ Arner. "The Evolution of Fintech: A New Post-Crisis Paradigm."

¹⁰⁴ Rooney, Kate. "Your guide to cryptocurrency regulations around the world and where they are headed"

¹⁰⁵ Contributor. "Will EU regulation of bitcoin and other cryptocurrencies succeed?"

5.6.3 Scalability

One challenge that cryptocurrencies like Bitcoin has been facing since the beginning is the scalability issue. The scalability is used to describe the limits of the transactional network, or the adaptability to change with regards to the amount of transactions that a blockchain network can process at any given time. The effective scalability factor will naturally bottleneck the potential of the network for any cryptocurrency aiming to expand, and it is therefore an actively discussed topic.

In the Bitcoin community, the scalability problem has been heavily debated as it has traditionally been one of the more challenging aspects for the cryptocurrency. The blockchain that Bitcoin is using today has an estimated >10 minutes transaction processing time and has a maximum transaction processing capacity of around 7 transactions/second (Croman, Kyle et al. 2016)¹⁰⁶. As a comparison, VISA credit card confirms transactions within seconds and process roughly 2000 transactions/sec with peak rates of 56,000 transactions/sec (Croman, Kyle et al. 2016). These problems were discussed briefly with regards to bitcoin back in chapter 4, and it clear by analysing these numbers for transaction capacity along with transaction costs discussed in chapter 4 that Bitcoin is not optimized to act as a transactional medium in its current state. This has been the basis for the discussion regarding the Bitcoin scalability debate. The side debating for increased scalability through a rethinking of the fundamental technical approaches behind Bitcoin argues that the cryptocurrency will never become the transactional medium it was imagined to be if the scalability issue is not overcome. One result from this discussion was the hard fork that resulted in Bitcoin Cash, a new cryptocurrency based on the Bitcoin protocol but increasing the maximum block size to 8 MB¹⁰⁷ versus Bitcoins 1 MB limit. This means that a higher number of transactions should fit in each block and as a result increase the rate of transaction/block.

The Ethereum network is facing similar issue with scalability, and while it currently supports more than twice the amount of transactions compared to Bitcoin. It is still low compared to the transaction capacity of VISA. Ethereum's creator Vitalik Buterin has

¹⁰⁶ Croman, Kyle et al. "On scaling decentralized blockchains."

¹⁰⁷ Wikipedia. "Bitcoin Scalability Problem"

come up with a new solution dubbed “Sharding”, allowing the network to solve problems in a parallel manner. This has the potential to increase the capacity of the network, meaning that the transaction processing capacity will be much faster than before¹⁰⁸. If the sharding solution is accepted into the Ethereum blockchain in the future it could help a great deal with Ethereum’s scalability issues.

Ripple has been called the most scalable blockchain on the market¹⁰⁹, and outcompete the other cryptocurrencies when it comes to transactions capacity. As of writing this thesis, Ripple has the capacity to handle around 15,000 transactions per second with relative ease¹¹⁰. This is due to Ripples design, and it was designed to be as efficient as possible and to handle high transaction volumes with low transaction cost. The reason that Ripple is design in a way that allow this, is because Ripple has a goal to compete with established services such as VISA.

Litecoin faces similar issues to Bitcoin and Ethereum when it comes to scalability but is generally much faster than Bitcoin with an average 2.5 minutes transaction time compared to Bitcoins 10 minutes¹¹¹. Beside the transaction time, the transaction cost is also relatively low with around 1/1000 of the value of the transaction. Litecoin was however quick to utilize the new system called SegWit or Segregated Witness, allowing for better transactability alongside lower fees for Litecoin and Bitcoin. It is however important to note that while the consensus is that Litecoin appears more scalable than Bitcoin is today, it has not been tested at the volumes that Bitcoin experience each day, and it is therefore difficult to accurately compare the two.

As can be seen above, scalability is one of the most important issues for any cryptocurrency, as any increase to public adoption will create much higher transaction times and transaction costs than today. If the cryptocurrencies cannot overcome this impractical transaction limit, it will be difficult to compete against market presence from more established forms of transactions such as VISA. As shown, Ripple has a system that is most suited to handle the high transaction volumes that comes with increased public

¹⁰⁸ Watson,. Ethereum’s Scalability Issues Will Be Solved By Mastermind Vitalik Buterin’s Sharding Solution”

¹⁰⁹ Travis. “Ripple: The most (demonstrably) scalable blockchain.”

¹¹⁰ Buntinx.”Ripple’s new Rippled client improves ledger scalability.”

¹¹¹ Libekind. ”Meet Litecoin, a faster Bitcoin that gamers love”.

adoption. It is however important to keep in mind that Ripple is not decentralized, unlike the other cryptocurrencies analysed. There are however new technologies and fixes that are being worked on all the time with regards to scalability. This means that while the situation today is as described above, it is likely that significant changes will be implemented in the blockchain of the different cryptocurrencies. Any cryptocurrency that cannot overcome its own scalability issues is in an immediate danger of being replaced by more suited cryptocurrencies down the line.

5.7 Strategic Market Analysis

As a step to further understand the market situation and the challenges that cryptocurrencies have and face in the market situation today, a strategic market analysis was conducted. The strategic market analysis was done in the form of a PESTEL analysis and a Porters Five Forces analysis, is based on pervious discussions and is conducted with a broad market focus.

5.7.1 PESTEL analysis

In the analysis of the external influencers on the cryptocurrency market, it is possible to apply a PETSEL analysis. This analysis focus on macro-environmental influencers and factors in context to the market (Political Economical Social Technology Environmental Legal). As many of the legal factors are yet to be decided or is closely related to political factors, these two sections were merged into political for this analysis.

PESTE(L) Analysis				
Political	Economical	Social	Technology	Environmental
Challenging to established systems	Volatile prices	Adoption rates	Technological innovations	Increasing energy demands for mining
Strong incentives to regulate and control	Exchange and comparative market value	Social and cultural influencers	Accessibility	Pollution
Taxation and legalities	Macro-economics and geopolitical influencers		Competing cryptocurrencies	
			Scalability	

Table 8: PESTEL analysis key words and topics for the cryptocurrency market.

5.7.1.1 Political

Regulations has been highlighted previously in chapters 4.4.3 and 5.6.2, but it is included in the PESTEL analysis to summarize and expand upon previous information. With cryptocurrencies becoming more widespread in the global economy, it is natural with the increased presence of political stakeholders and influencers that can impact the cryptocurrency market. As cryptocurrency in most forms are decentralized and digital, it is traditionally available to most people across the world independently of country borders and local law. This is challenging the control that governments have on taxation, creating a strong incentive to regulate and control the cryptocurrency market. An increasing amount of countries have started to actively regulate the use of cryptocurrency by its citizens, and there are different approaches on how to do this. Some examples with how countries have chosen to handle cryptocurrencies as of writing this thesis. ¹¹²:

- Belgium has similarly to many other European countries like Latvia, Lithuania and Poland used to take a stance towards cryptocurrency yet and is waiting for European wide guidance.
- Brazilian government has classified cryptocurrency as an asset, taxing on capital gains above a certain threshold. Similar adoptions with a VAT (Value Added Tax) on circulations of cryptocurrency with local variations has been adopted in countries such as United Kingdom, Denmark, Czech Republic, Finland, Germany, Italy, The Netherlands, Norway etc.
- Ecuador has banned all use of cryptocurrency in hopes of promulgating its own digital currency based on the blockchain technology. Mexico is working on a similar solution but has not yet banned cryptocurrencies outright.
- India has along with other countries such as Indonesia, Taiwan not provided any clear regulations yet, providing no clear law regarding the legality of cryptocurrency.
- Iceland has banned cryptocurrency to combat potential capital flight in times of economic turmoil.
- Cryptocurrencies are legal and exempt from VAT in Spain, and the country has been actively lobbying to establish a cryptocurrency regulatory.

¹¹² Thomsonreuters. "Cryptocurrencies by country"

- United States has a state-by-state situation where some states are favourable towards cryptocurrency and others are not favourable.
- In China, financial institutions are banned from trading in Bitcoin, but individuals are free to trade as they wish.

As can be seen, there are several different ways that countries have chosen to handle the cryptocurrency market, and these are just some of them, complicating the use of cryptocurrency as a global payment option. It is however notoriously difficult to regulate the cryptocurrency market, and in many cases, it has shown to be difficult to enforce local laws and regulations¹¹³. There is also the question on how to regulate the market where anonymity is valued among its customers. This has led to “wild west” tendencies in the crypto market today and while this could arguably be seen as a part of the original vision behind Bitcoin, it represents a major hurdle for global-scale public adoption¹¹⁴.

5.7.1.2 Economical

One big challenge for the use of cryptocurrency as a medium for payments is the high volatility that cryptocurrency traditionally is subject to. Based on observations from previous chapters it is shown that the cryptocurrency market is exceptionally volatile. With volatile prices, it is difficult to correctly assess the value in cryptocurrency of a product over time. In market such as the market today, it is likely that an exchange rate would set the price for any commerce, anchoring the value in the rate of the currency exchanged instead of the cryptocurrency used for the transaction. Cryptocurrency has also historically experienced unequal valuation in different exchanges, making it even more difficult to “correctly” assess the value of the cryptocurrency¹¹⁵. Even though cryptocurrency can seemingly act independently from the global economy, cryptocurrency is as all other assets and currencies part of the greater global economy. This means that as cryptocurrency grows and becomes more connected to established financial institutions it will have the potential to significantly be affecting and affected by macroeconomic market forces¹¹⁶.

¹¹³ Liao. “ US regulators are struggling to rein in illegal cryptocurrency offerings”

¹¹⁴ Pisani. “ Here's why bitcoin prices are different on each exchange”.

¹¹⁵ Haselton, “Here’s why bitcoin prices are different on each exchange”.

¹¹⁶ Sen.” Cryptocurrencies Are Starting to Affect the Real Economy”.

5.7.1.3 Social

Cryptocurrency is a relatively new trend and has only recently over the last few years started to really captivate the interest of the greater public. It is however still seen by some as a trend that will likely die, with many sceptics calling it a financial bubble that is doomed to burst, often compared to famous bubbles like the tulip crisis or the famous dot-com bubble¹¹⁷. There are also however many who believe in the technology and expect it to recover into new market highs¹¹⁸.

The average cryptocurrency-investor is younger than the average stock investor and cryptocurrency has seen more awareness in the younger population ¹¹⁹. Due to the apparent technological aspect of the cryptocurrency market, it can also appear overwhelming for less tech-savvy older generations. This is serving to increase the age-gap that is currently seen in the investors and users. As discussed previously, market adoption has been limited, and will play a role in determining the future of cryptocurrency. As long as it is mainly used as a speculative medium, it is difficult to accurately predict the social trends and cultural impact cryptocurrencies will have in the future. The trends over the last years have however shown that the industry has been seeing increased adoption into the main public, indicating that it is likely to keep increasing if there is no fundamental change in the market.

5.7.1.4 Technology

Cryptocurrencies that are successful is often strongly linked with the technological potential or foundation that it can provide compared to its competitors. Therefore, in the cryptocurrency market all cryptocurrencies risk losing market dominance to competing technology if it cannot provide better technological solutions than its competitors. Naturally this produce a strong incentive for cryptocurrencies to be adaptive to market development and evolution. The mining sector is also influenced by the technological development and limitations of graphical processing units, meaning that the profitability

¹¹⁷ Monaghan. "Bitcoin biggest bubble in history, says economist who predicted 2008 crash".

¹¹⁸ Carey. " Bitcoin price: Cryptocurrency could reach \$100,000, investor claims"

¹¹⁹ Arnold. " 30% Of Millennials Would Rather Invest In Cryptocurrency: Here Are 3 Tips To Help You Do It Smarter.

is strongly linked to the cost-effectiveness of the processing units and the rate of electricity needed to run them ¹²⁰.

5.7.1.5 Environment

The mining sector of the cryptocurrency market requires huge amounts of electricity as the solutions for the blockchains are getting increasingly difficult. In 2017 it was estimated that mining Bitcoin alone uses about 32 terawatts every year, enough to power around 3 million U.S. homes. The future potential increase of cryptocurrency adoption also means a future potential in increased electricity demand¹²¹. In 2018, that number has gone up to 70 TWh per year. Combining this with the fact that Bitcoin only represents less than half of the market, it is likely that the total energy consumption of cryptocurrency is much higher. Energy levels such as this is getting close to the demands of whole countries. As a comparison, the entire energy demand of Norway was 134,1 TWh in 2017 ¹²². The source of the electricity used in the mining process therefore plays a huge role in the environmental footprint of the cryptocurrency mining industry. China has a big cryptocurrency mining industry, and inefficient coal power-plants are delivering much of the required energy to this industry leading to a high carbon footprint. The high energy demands from the cryptocurrency industry also leaves them vulnerable to climate regulations, as these can severely reduce the already small profit margin.

¹²⁰ Martindale. "Recent data suggest that GPU supply might be stabilizing and prices falling."

¹²¹ Shane. "Bitcoin boom may be a disaster for the environment."

¹²² NTB. "Norge brukte rekordmye strøm I fjor".

5.7.2 Porters five forces analysis

Porter, Michael (2008)¹²³ argues that no matter how different industries might appear on the surface, the underlying drivers of profitability is the same. To understand the underlying drivers in a competitive market, Porter, Michael (2008) defined five competitive forces that shape the market strategy as: the threat of new entrants, threat of substitutes, bargaining power of customers, bargaining power of suppliers, and industry rivalry. To understand the competitive situation in the cryptocurrency market, the porters five forces approach is applied:

Threat of new entrants:

Any profitable industry that is experiencing high growth will attract new entrants which can reduce the profitability of other firms in the same industry. This is a very real threat internally to any established cryptocurrency today. Any new cryptocurrency that enters the market which is technologically superior and able to outperform similar cryptocurrencies can potentially outcompete established cryptocurrencies. As discussed previously, there exist over 1600 different cryptocurrencies and 10000 markets¹²⁴ with many of these having yet to reach their full potential. There are however also many copies, frauds and Ponzi-schemes with new cryptocurrencies appearing all the time, making it difficult to have full control of all potential competitors. While Bitcoin has been losing market dominance to new entrants such as Ethereum, Ripple, Litecoin and Bitcoin Cash it is unlikely that it will be dethroned from the top as long as the news outlet keep using Bitcoin as the go-to cryptocurrency. There has been more competition for market dominance among some other cryptocurrencies, and the top cryptocurrencies has changed positions many times. Lately, the top cryptocurrencies have been losing market dominance in favour of other the remaining cryptocurrencies, but the top ten cryptocurrencies still hold over 75% of the total market cap as of writing this thesis (:). While this describes the situation for entrants within the cryptocurrency market, it is possible to imagine the potential of other future technologies that is not crypto-based to be developed externally of the cryptocurrency market.

¹²³ Porter. "The five competing forces that shape strategy."

¹²⁴ Coinmarketcap.com

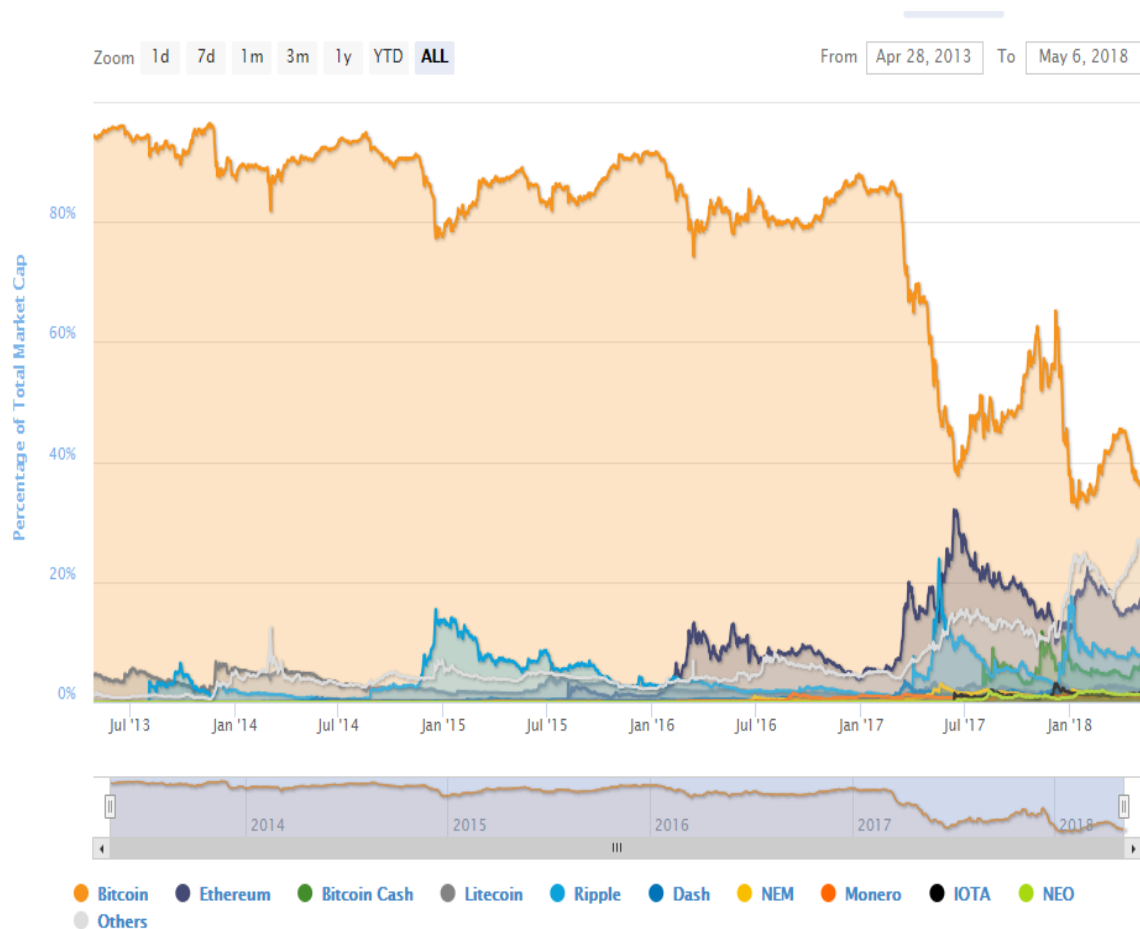


Figure 32: Market capitalization percentage for the cryptocurrency market. Source: <https://coinmarketcap.com/charts/>

Threat of substitutes:

If considering the cryptocurrency market as a substitute to standard currency and money, then the threat of substitutes comes from the established currencies and monetary systems globally. If for example global banks or transaction support-systems such as Visa would start providing or supporting similar features to cryptocurrencies, it could represent a viable option to the systems that cryptocurrency provides. However, cryptocurrency is a very broad umbrella term for cryptocurrencies with separate functions and design, providing very specific features. It is therefore very difficult to accurately assess the threat of substitutes to the cryptocurrency market. It is however, possible to imagine that if established monetary systems are able to provide technology outcompeting or simply matching the attractive aspects of cryptocurrency market, it would provide significant competition.

Bargaining power of customers:

Most costumers in the cryptocurrency market have limited influence and bargaining power when it comes to the market price of cryptocurrency as the price is mainly controlled by the free market. There exist some cases however, as discussed previously, where there has been apparent market manipulation by some of the users holding big portions of the market. There is however no way to directly control the price of the separate cryptocurrencies by any individual without controlling the blockchain behind it, and the possible influence of any individual costumer is therefore limited. The costumers do however have a certain bargaining power in the cryptocurrency market as it is likely they will invest in cryptocurrencies they expect to experience growth. This means that it is in a cryptocurrencies best interest to provide a solid option to other cryptocurrencies in order to capture market share.

Bargaining power of suppliers:

The suppliers are streamlining the process of trading the different cryptocurrencies through exchanges, and thus increases the traded volume. This traded volume is also strongly linked to price and the suppliers therefore have a certain control over the market by controlling trade volume, transaction limits, which cryptocurrencies to provide etc. When Coinbase listed Bitcoin Cash in December 2017 without prior informing its customers, the price increased with more than a two-fold in just under two days as a response, before experiencing a correction over the following days (Figure 33). However, by attempting to control the market, any exchange puts itself in risk of losing customers to competing exchanges. Due to the high number of available exchanges on the market, a potential situation where one exchange would attempt to directly influence the market, the free market forces would likely prevent direct control.

Bitcoin Cash Charts

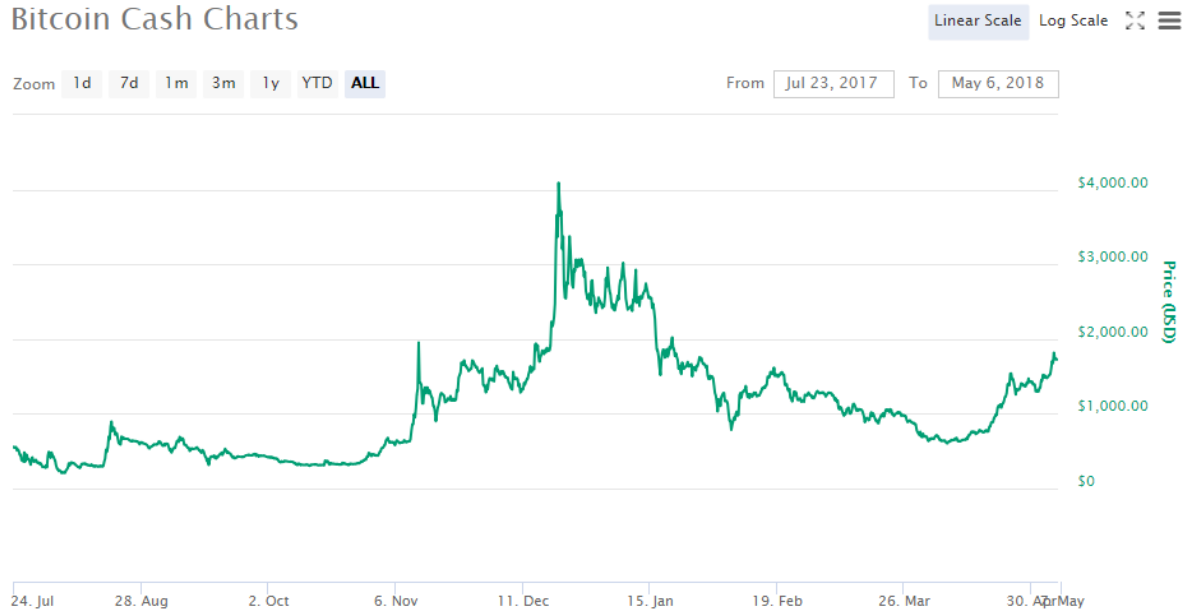


Figure 33: Price history of Bitcoin Cash in the period studied. Source: <https://coinmarketcap.com/currencies/bitcoin-cash/>

Industry rivalry:

There is as discussed, a strong industry rivalry in the cryptocurrency market, with a vast number of cryptocurrencies competing for market dominance. While the top ten cryptocurrencies control over 75% of the market, the remaining >1600 cryptocurrencies compete over the remaining 25% of the market. Even though the competition is strong amongst the top cryptocurrencies, this industry rivalry is as a result of the high market density even more intense for the remaining >1600 cryptocurrencies.

6. Summary

This thesis has analysed several key components and provided insight to the inner workings of the cryptocurrency market, with a foundation in market history and financial market analysis. The objective was to form a comprehensive and thorough market analysis by focusing on several cornerstones (chapter 1.1 - Objectives) and conveying the findings. In this chapter, each of the cornerstones and corresponding findings will be summarized.

The history of money and how cryptocurrencies can be related to money:

The history and nature of money was examined in detail in chapter 2 by looking at how the idea of money formed to meet a need in a developing civilization. This was then used as a parallel when explaining the nature of digital currencies and money. It was found that cryptocurrency can be classified as a variety of digital currencies and an asset used as a means of exchange. As a continuation of the relation between cryptocurrencies and other commodities such as gold and money, this was further analysed in detail in chapter 5.5 – Cryptocurrencies as an alternative to fiat currencies and gold.

The underlying technology and history of cryptocurrencies:

The technological foundation and rationale behind cryptocurrencies was examined in chapter 3 - What is cryptocurrency?, by analysing the origins and history of the original cryptocurrency Bitcoin. Additionally, it is shown how it solved several key issues for decentralizing digital cash transactions such as the double-spending problem. It was however, decided that focusing on Bitcoin alone would not capture the current diversity in the cryptocurrency market, and instead it was decided to focus the market analysis on the top five cryptocurrencies Bitcoin, Ethereum, Ripple, Bitcoin Cash and Litecoin.

The fundamental components of the cryptocurrency market:

In chapter 4 – The cryptocurrency market, different market components such as acquiring, trading, investing, and market forces such as public adoption, market drivers, market history, and market manipulation were examined in detail. Additionally, it was made clear that the cryptocurrency industry can be divided into four main categories: Exchanges, Wallets, Payments, and Mining. Several observations were made with regards to market interactivity, and the main cryptocurrency industry sectors were inspected. From the market observations, it was shown that the majority of cryptocurrency users

are primarily trading and investing in the cryptocurrency market through the use of exchanges, and that the public adoption has likely increased significantly from the early 2017 estimates while still being in its early adoption phases. Observations from market wealth distribution also show that there is a significant apparent imbalance in the market share distribution in the cryptocurrency market. This is also a natural effect of the incredible price increase, since the early adopters would easily acquire much more volume that one would be able to today for the same price. This imbalance is expected to be reduced with time as the market becomes more mature.

Market drivers and market history:

Observations from chapter 4.4 – Market drivers, market history, and market manipulation show that there have been times where the market is displaying strong responses to singular events, some of which can affect the entire market for many years (example the Mt. Gox incident). Additionally, it is shown that singular users can have a strong influence on the market if their holdings are large enough, and that the market has in the past shown strong responses to regulations. In this chapter, it is also concluded that human psyche has a strong effect on the price of cryptocurrencies through cyclical markets and round number bias. This was also observed to play a part in the bubbly behaviour of the cryptocurrency market. Analysing the market history and the finance bubble theorems also showed that the cryptocurrency market has likely been through several bubble periods, meaning that the market is inherently bubbly in its behaviour. Combining all of these effects, emphasizes that when a rapid market response is occurring in the cryptocurrency market, strong reactions may amplify this effect as the specific reasons behind the market reaction often is unknown until a later stage. This amplification can again often be attributed to the human psyche and based on FOMO or FUD.

Financial analysis based on market history:

Examining market history from 2017 and Q1 2018, a comprehensive volatility, correlation and liquidity analysis were conducted for Bitcoin, Ethereum, Ripple, Bitcoin Cash, and Litecoin. Through the volatility analysis, it was shown that the volatility of most cryptocurrencies was exceptionally high in the period analysed, especially when compared to other commodities such as gold. This volatility was however closely linked with periods of exceptionally high density of high or low returns, often in correlation with market events or incidents. Bitcoin was shown to have the lowest volatility of the analysed

cryptocurrencies, which is to be expected as it has had a longer time to solidify its market presence. As the cryptocurrency with the lowest volatility, it is also the most attractive for storing value, hence the nickname “cryptocurrency gold”.

The correlation between the separate cryptocurrencies and Bitcoin was shown to be high in periods governed by general market forces. Whenever a cryptocurrency experience individually positive or negative market-news, the correlation does however decrease significantly, indicating high individuality between the different cryptocurrencies at certain times. The results from the liquidity show that all the cryptocurrencies analysed has a relatively low liquidity when compared to gold, meaning that it is more difficult to sell in the cryptocurrency market without affecting the market price than it is for other established commodities such as gold.

Challenges in the cryptocurrency market:

Besides public adoption and the high market volatility, there are other challenges for the cryptocurrency market. In this thesis, scalability, security, and regulations were discussed as some of the main challenges that cryptocurrencies must overcome. The regulation issue is probably the most pressing challenge that the cryptocurrency industry face today. If key markets and governing force decides on regulations that will negatively impact the use, trading, or purchase of cryptocurrencies, it could have massive consequences for the future of the cryptocurrency market. The observations show that there are several different ways governing systems have chosen to deal with cryptocurrencies, some banning them, some supporting them, and some that have still not decided. There has been no official decision yet from EU, but the future decision and guidelines will likely have a huge impact on the cryptocurrency market. Scalability is the other major hurdle that most decentralized cryptocurrencies today must overcome to be practical in the future, and it is something that most cryptocurrencies are working hard on. Observations from market history and scalability updates show that the scalability issue will likely be a deciding factor for which cryptocurrencies will thrive in the future. Finally, the observations from historical market data with security event has shown that singular incidents have the potential to change the entire market value of a cryptocurrency and bankrupt exchanges. This is likely making it the single greatest threat towards services such as exchanges and wallet services.

Strategic market analysis for the future of the cryptocurrency market:

The strategic market analysis includes a Porter's five forces and a PESTEL analysis based on the observations done the previous chapters. In the Porter's five forces analysis, the weaknesses of the cryptocurrency industry is highlighted through the analysis of the competitive forces. It concludes with that following the methodology of porters five forces, the major challenges for any cryptocurrency in the cryptocurrency industry is external and internal competition through new and better technology being developed by competing established cryptocurrencies or new entrants. Additionally, it is also stressed that there is a threat from potential substitute products, which may provide advantages great enough that it becomes impractical to operate on blockchain technology. There is also the possibility that potential substitute products will have a superior technological foundation that can outcompete the cryptocurrency blockchains that exist today. The PESTEL analysis looks at the external marketing environment for the cryptocurrency industry and highlights the factors which may have a macro-environmental impact. It was found that there exist several potential strong influencers in all of the five sub-factors. The regulatory aspect is still a huge potential influencer from a political and legal perspective, but there are also several economic factors that play a part. It was found that one such economical factor the can play a role in a macro-economic perspective is the potential interaction between anchored exchange rates and commerce and inconsistencies in assessed value across exchanges. Additionally, it also raises questions on how the increased interaction between cryptocurrencies and established financial institutions will play out. It was found that the several social aspects such as age and culture may also prove to impact the global adoption and acceptance of the cryptocurrency industry. Ultimately it was suggested that it is difficult to predict how the socio-economic trends will develop as long as the cryptocurrency market keeps its low adoption trend and remains speculative. The technological aspect touched upon some of the same key points made in the porters five forces analysis, but also highlight that the cost-effectiveness of the mining industry is getting slimmer due to increased difficulty and increased energy demands. Without dedicated miners to back the system, the decentralized structure of the blockchain cannot exist. Another issue that was identified is the high energy demand that the cryptocurrency market has, which represents a serious environmental challenge.

7. Conclusion

The cryptocurrency market has been shown to be exceptionally volatile, difficult to regulate, have a significant security risk tied to its exchange and wallet services, have deep-rooted issues with scalability in many of the operating blockchains, and produce challenges for the environment due to its high power demand. It has however also shown to facilitate the potential of huge economic growth and rapid expansion within short periods of time, provide new innovative versatile technological solutions that can change the current established financial market, and act as a platform for other technologies.

There is a divide among the public, some claiming that cryptocurrencies are nothing but a trend and a financial bubble, while others are claiming it will replace the global financial market structure in the future. What is certain however, is that the cryptocurrency market ultimately has the potential to go both ways. Which way the market is heading in the future, depends on future interactions with potential regulatory forces, and how well the developers can solve the issues of power consumption, scalability, and security to increase the practicality of cryptocurrency as a transactional medium. This will potentially allow cryptocurrencies to be used as intended, instead of primarily being used as a speculative opportunity.

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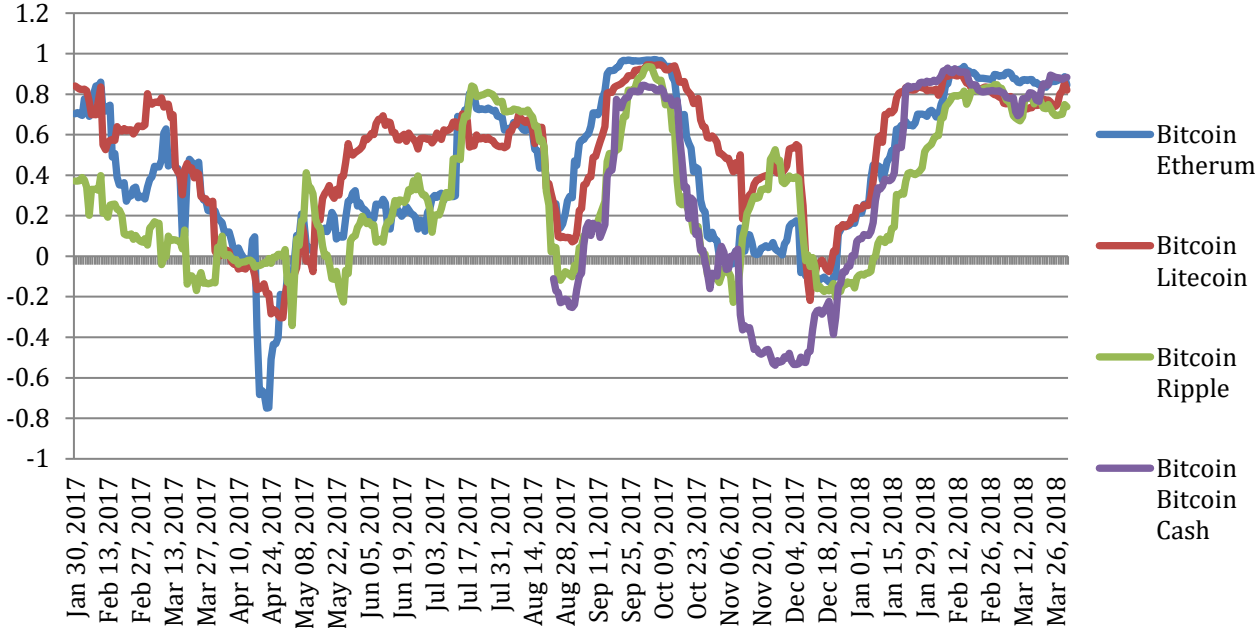
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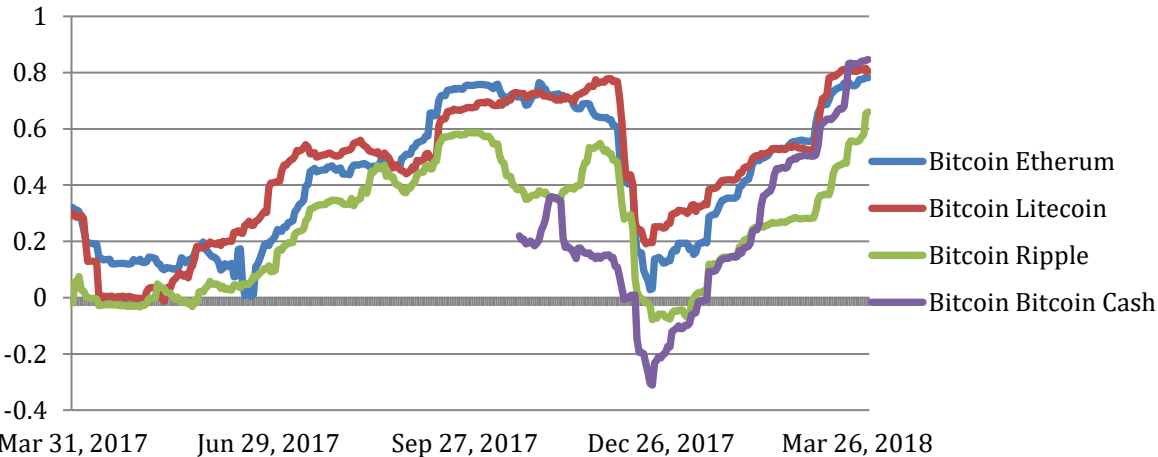
Appendix - Correlation Observations

Bitcoin Correlation



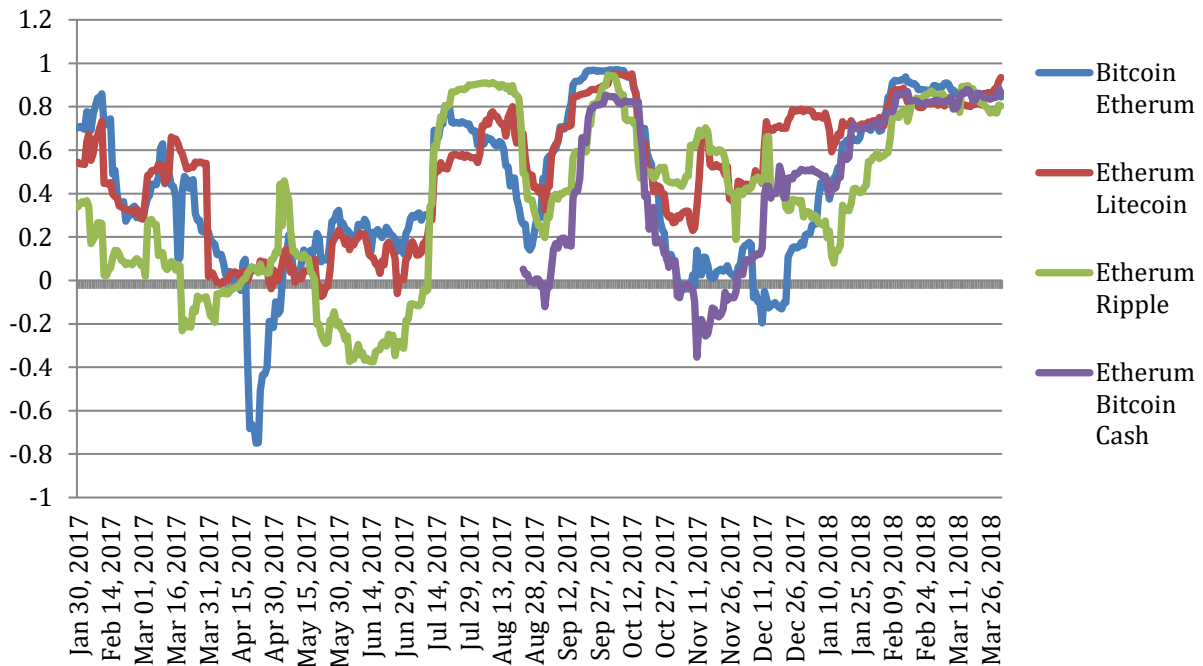
The graph above shows how the return of Bitcoin correlates with the four other cryptocurrencies Ethereum, Litecoin, Ripple and Bitcoin cash over a monthly (30 day) interval. In the beginning of the year both Ethereum and Litecoin had a high correlation with Bitcoin, where the correlation coefficient was above 0,8. Ripple had as well a positive correlation with Bitcoin, however the correlation coefficient was lower at around 0,4. The correlation of all three of the cryptocurrencies decreased until the Middle of April, where all the three cryptocurrencies had a negative correlation with Bitcoin. This means that at the days the return of Bitcoin was positive, the return was negative for Ethereum, Litecoin and Ripple, and vice versa. In the end of April, the correlation started to increase until the end of August. At this point the correlation coefficient was above 0,6 for all the cryptocurrencies. In the end of August there was a sudden drop in correlation for the correlation of Bitcoin with the three other cryptocurrencies. This drop happened at the exact same day for the three cryptocurrencies. At this stage Bitcoin Cash was introduced to the market, and it had a low to negative correlation with Bitcoin in the beginning. In the beginning of September, the correlation coefficient increased for the now four cryptocurrencies. This increase lasted until the beginning/middle of October. In the end of September all the cryptocurrencies had a correlation coefficient above 0,8 with bitcoin. In the middle of October, the correlation decreased again for the four cryptocurrencies.

Bitcoin Cash is especially standing out as it has a negative correlation with Bitcoin from the end of October to the end of December. Ethereum has a correlation under 0,1 with Bitcoin the same period. Ripple has a low to negative correlation with Bitcoin in a short period in the end of October, before it starts to increase. From the end of December to the beginning of February the correlation with Bitcoin for the four cryptocurrencies increases. In the beginning of February, the correlation became more stable, and the correlation coefficient of all fluctuates around 0,8.



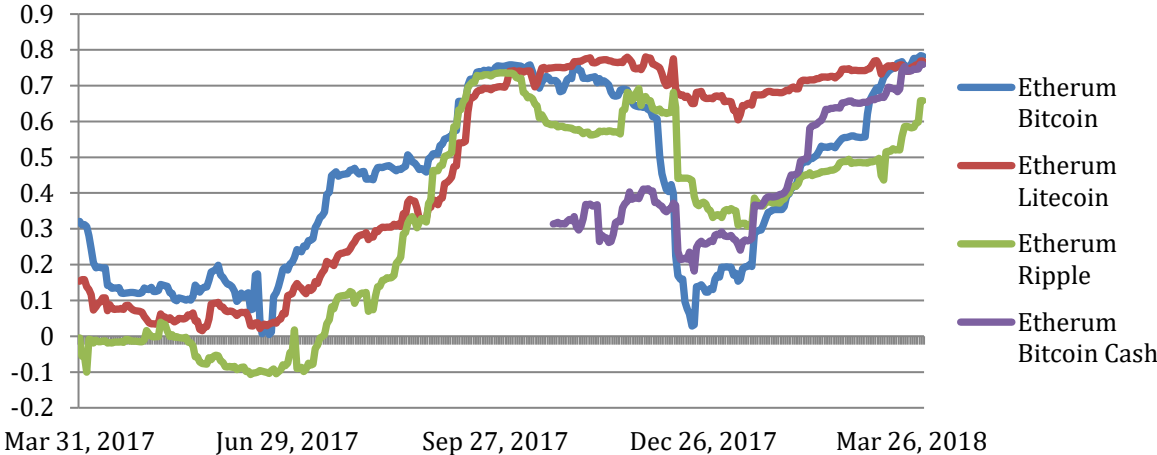
From the 90 day interval graph it can be noticed that overall the correlation between Ethereum and Bitcoin, Litecoin and Bitcoin, and Ripple and Bitcoin increases until the end of December. However, Ripples has a small decrease in correlation in October before it starts to increase again. The correlation of the four all drops in the end of December before it again start to increase.

Ethereum Correlation



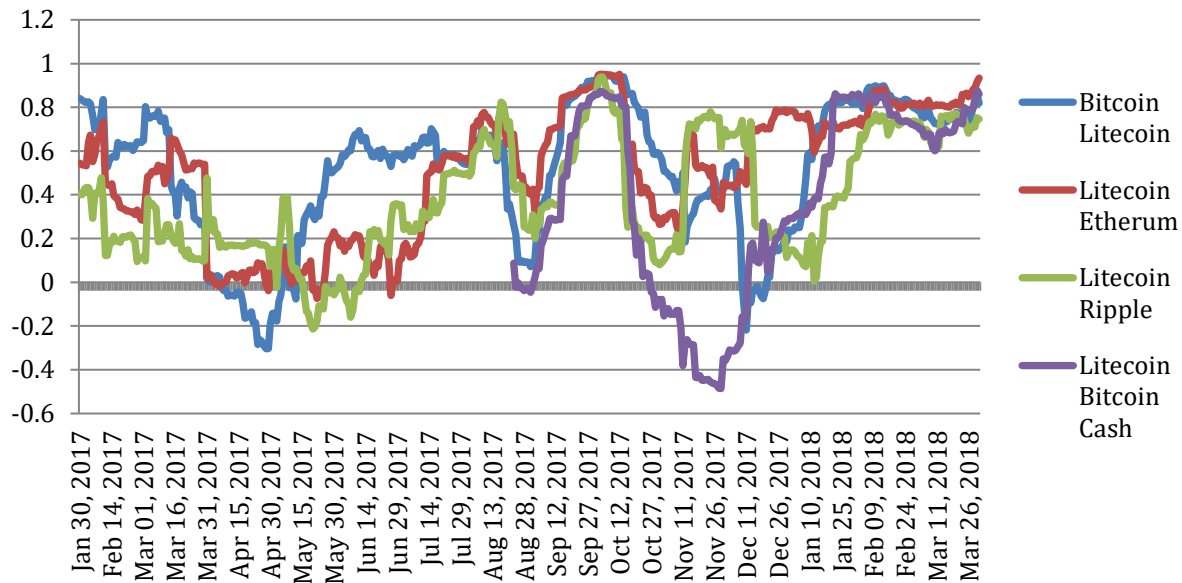
In the beginning of the year Ethereum and Bitcoin and Ethereum and Litecoin was well correlated, with a correlation coefficient fluctuating at around 0,7. Ripple and Ethereum had a correlation coefficient fluctuating at around 0,2-0,3. All three of correlations decrease until the beginning of April. In the case of Ripple and Ethereum there is a negative correlation from the end of March until the beginning of April. Ethereum and Bitcoin have a negative correlation from the beginning of April until the beginning of May. The correlation coefficient spans as negative as -0,7. There is almost no correlation between Ethereum and Litecoin from the beginning of April until the middle of May, as the correlation coefficient fluctuates around 0-0,1. Ripple and Ethereum has another period of negative correlation from the end of May until the beginning of July. In the beginning of July, the correlation increases for all the three cryptocurrencies until the end of August. In the end of August Bitcoin Cash is introduced. From the end of August until the beginning of October the correlation again increases, where the correlations coefficient at its highest is at around 0,8 for all the four cryptocurrencies correlations with Ethereum. In the beginning of October, the correlation decreases, this is especially true for the correlation of Ethereum with Bitcoin and Bitcoin Cash as this correlation falls into a no correlation to a negative correlation in the period from the beginning of November to beginning of December for Bitcoin Cash, and for Bitcoin from the beginning of November until the end of December. In this period for the correlation of Ethereum with Ripple and Litecoin is stable at around 0,5 for Ripple and 0,4 for Litecoin. The correlation

between Ethereum and Ripple decreases from the middle of December until the middle of January. This separates it from the others where the correlation between the others and Ethereum increases until the beginning of February. In the beginning of the correlation becomes more stable. From the beginning of January until the beginning of February the correlation between Ethereum and Ripple increases, before it as well becomes stable in the beginning of February.



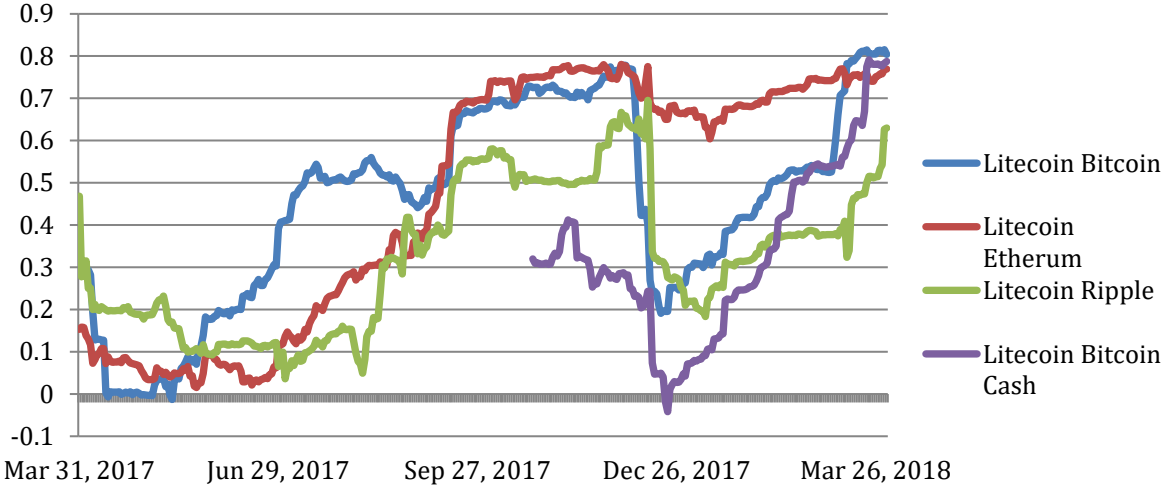
From the quarterly interval graph of the correlation between Ethereum and the four other cryptocurrencies the correlation can be looked at in a “bigger picture”. From March until the beginning of July the correlation is not at its highest. The correlation between Ethereum and Bitcoin, Ethereum and Litecoin and Ethereum and Ripple increases until the beginning of December. In the beginning of December until the end of March the correlation between Ethereum and Litecoin is quite stable fluctuating at around 0,7 to 0,8. The correlation between Ethereum and the Ripple and Bitcoin decreases from the beginning of December until the end of December. In the end of December, it increases. The correlation between Ethereum and Bitcoin Cash fluctuates at around 0,3 until the beginning of January, where the correlation between these two also starts to increase.

Litecoin Correlation



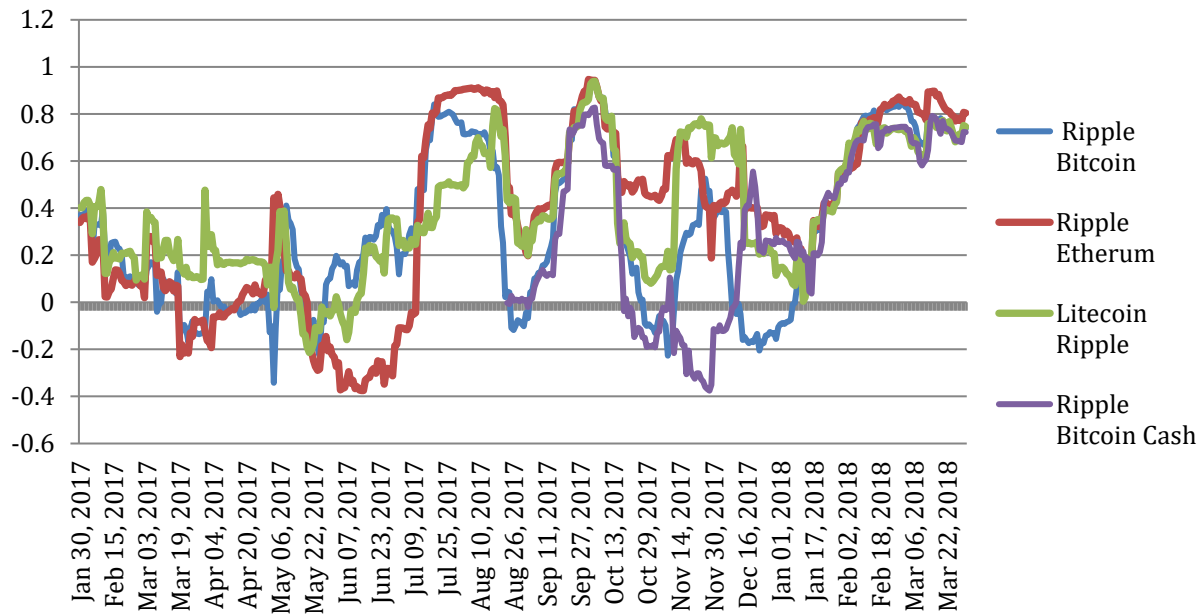
From January until the beginning of April the correlation between Litecoin and the three cryptocurrencies Bitcoin, Ethereum and Ripple decreased. From the beginning of April until the beginning of May Litecoin had a negative correlation with Bitcoin. In the same period there was virtually no correlation between Litecoin and Ethereum as the correlation coefficient fluctuated around 0, and spanned from -0,1 to 0,1. Ripple had a negative correlation with Litecoin from the middle of May until the middle of June. From the middle of June, the correlation between Litecoin and the two cryptocurrencies Ethereum and Ripple started to increase. The correlation with Bitcoin started to increase in the beginning of May. In the end of August, the correlation started to decrease for all the three cryptocurrencies. In the beginning of September, the correlation again started to increase, now for the four cryptocurrencies as Bitcoin Cash was introduced in the end of August. In the Middle of October, the correlation between Litecoin and the four cryptocurrencies started to decrease. From the end of October until the middle of December Bitcoin Cash had a negative correlation with Litecoin. The correlation between Litecoin and Ripple decreased until the beginning of October, before it increased until the beginning of December. In the beginning of December, it started to decrease until the beginning of January. The correlation between Bitcoin and Litecoin decreased until the middle of December before it increased until the end of January. The correlation between Ethereum and Litecoin decreased until the end of November, before it again started to increase. The correlation coefficient fluctuates a bit but is overall increasing. From the

beginning of February, the correlation between Litecoin and the other cryptocurrencies are stable, and the correlation coefficient is around 0,8.



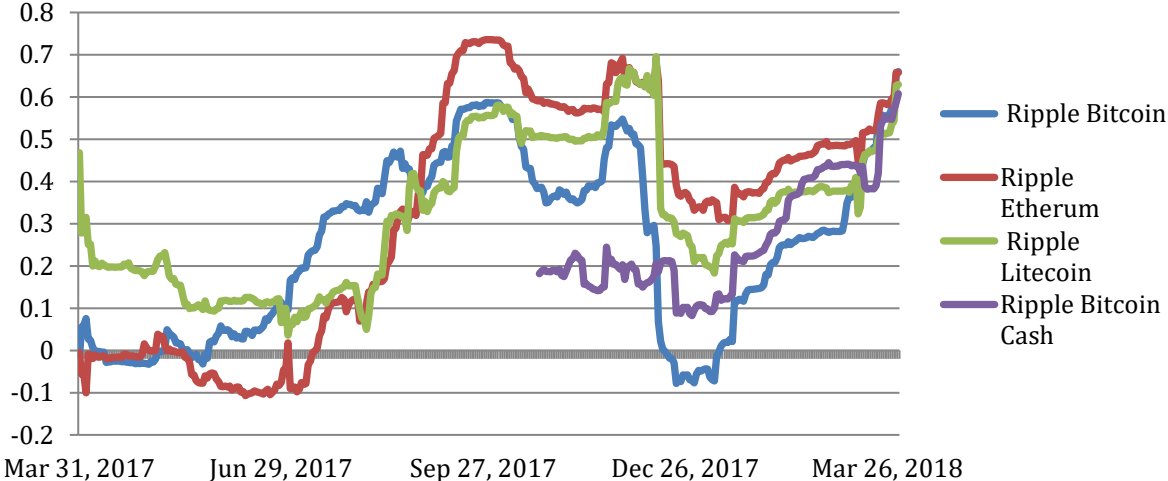
When looking at the 90 day interval graph it can be seen that from March 2017 until the end of December the correlation between Litecoin and the three cryptocurrencies Bitcoin, Ethereum and Ripple increases. In the case of Bitcoin Cash, the correlation decreases from the beginning of November until the end of December. In the end of December, it starts to increase. The correlation between Litecoin and Ethereum decreases a bit in the middle of December, before increases until the end of March. The correlation between Litecoin and Bitcoin and Litecoin and Ripple is reduced in the middle of December, before it increases until the end of March 2018.

Ripple Correlation



In the beginning of the year the correlation between Ripple and the three cryptocurrencies Bitcoin, Ethereum and Litecoin decreased. In the beginning of March until the end of April the correlation between Ripple and Ethereum was negative. From the end of April until the beginning of May the correlation increased, before it again was a period with negative correlation from middle of May until the beginning of July. The correlation between Ripple and Litecoin fluctuated a lot in this period, and there was a negative correlation from the end of June until the beginning of July. The correlation between Bitcoin and Litecoin followed the same pattern as the correlation between Litecoin and Ethereum until the end of May, where the correlation between these two started to increase. The correlation between these and all the three cryptocurrencies increased until the middle of August. In the end of August, the correlation of all started to decrease before again starting to increase in the middle of September. In the end of August Bitcoin Cash was introduced, and the correlation between this cryptocurrency and Litecoin followed a similar pattern as the other correlations. From the end of October until the beginning of December the correlation between these two cryptocurrencies was negative. In the beginning of December, the correlation between them increased until the end of March. The correlation between Litecoin Ethereum decreased until the middle of January before it started to increase. In regard to the correlation between Ripple and Litecoin the correlation decreased from the end of October, before it increased into a peak in the middle of November. In the beginning of December, the correlation started to decrease again until it started increasing in the middle of January. The correlation of

Bitcoin and Litecoin followed a similar pattern as the correlation between Litecoin and Ripple, however the correlation is overall lower. It can also be mentioned that there is a negative correlation between these two in beginning of November, and from the middle of December to the end of December.



From the quarterly graph it can be seen that both Bitcoin and Ethereum has little to no correlation with Ripple from the end of March until the end of May. From the end of May until the beginning of July Ethereum has a negative correlation with Ripple. The correlation between Ripple and the three cryptocurrencies Ethereum, Bitcoin and Ripple increases until the end of December. In the end of December there is a fall in correlation for all of them, before they become more correlated until the end of March 2018. Bitcoin Cash has a fluctuating but stable correlation until the beginning of January, before the correlation with ripple starts to increase.