



UIS BUSINESS SCHOOL

MASTER'S THESIS

STUDY PROGRAM:

Business Administration

THESIS IS WRITTEN IN THE FOLLOWING SPECIALIZATION/SUBJECT:

Economics

**IS THE ASSIGNMENT CONFIDENTIAL?
(NB! Use the red form for confidential theses)**

TITLE:

An evaluation of performance and levels of risks associated with investments in the cryptocurrency market.

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*An evaluation of performance and levels of
risks associated with investments in the
cryptocurrency market.*

By

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2019

UiS Business School

ABSTRACT

Bitcoin is a decentralized digital currency, invented by Satoshi Nakamoto in the wake of the financial crisis in 2008/09. Since then thousands of cryptocurrencies have been created. We evaluate Bitcoin along with Dash, Litecoin, Dogecoin, Ripple, and for comparison reason, gold. This thesis has two main goals: 1) to study the impact of including cryptocurrency in a standard portfolio and 2) to evaluate which approach is preferred when investing in cryptocurrencies, whether a simple buy-and-hold strategy or a momentum strategy. Our result gives evident proof that the investment percentage of each of the cryptocurrencies should be treated individually. The optimal percentage of investments for the cryptocurrencies/gold are the following: 10% Ripple, 5% Bitcoin, 4% Dash, 1% Litecoin and 0,5% for Dogecoin and gold. Moreover, the results conclude that Dash outperforms all the other investments. In addition, we conclude that the weekly momentum strategy is the most efficient approach when investing in cryptocurrencies.

ABSTRACT.....	III
PREFACE	1
1. INTRODUCTION.....	2
2. BACKGROUND.....	5
2.1 THE STOCK MARKET (SPY)	5
2.2 THE BOND MARKET (AGG)	6
2.3 THE GOLD MARKET (GLD ETF)	6
2.4 THE CRYPTOCURRENCY MARKET	7
2.5 BLOCKCHAIN TECHNOLOGY	8
2.6 PRESENTATION OF THE CRYPTOCURRENCIES	10
2.6.1 Bitcoin (BTC)	10
2.6.2 Litecoin (LTC)	10
2.6.3 Ripple (XRP)	11
2.6.4 Digital Cash (DASH)	12
2.6.5 Dogecoin (DOGE)	12
3. LITERATURE REVIEW.....	13
4. DATA.....	14
5. METHODOLOGY.....	19
5.1 THEORY	20
5.1.1 Sharpe Ratio	20
5.1.2 The Capital Asset Pricing Model (CAPM)	20
5.1.3 Jensen's Alpha	22
5.2 STRATEGIES	23
5.2.1 Momentum Strategy	23
5.2.2 Buy-and-Hold Strategy	24
5.2.3 Random Walk	26
5.2.4 Market Efficiency	26
6. RESULTS.....	26
6.1 COMPOSITIONS OF PORTFOLIOS	26
6.1.1 Annual Excess Return	27
6.1.2 Annual Standard Deviation	28
6.1.3 Sharpe Ratio	32
6.1.4 CAPM & Jensen's Alpha	35
6.1.5 Conclusion Portfolio Performance	38
6.2 STRATEGIES	39

6.2.1 Momentum Strategy.....	40
6.2.2 Momentum Monthly	44
6.2.3 Momentum Quarterly	45
6.2.4 Momentum Annually.....	46
6.2.5 Buy-and-hold Strategy.....	47
6.2.5 Comparison of Momentum and Buy-and-hold Strategy	50
6.3 STRENGTHS AND WEAKNESSES OF OUR APPROACH	51
7. SPECULATIVE BUBBLES	52
8. CONCLUSION.....	54
9. BIBLIOGRAFI	VII

TABLES:

<i>Table 4.1: Percentage of investment in the different portfolios.....</i>	<i>s.15</i>
<i>Table 6.1: Diversification of investments in portfolios.....</i>	<i>s.27</i>
<i>Table 6.1.1: Excess return on cryptocurrencies/gold P1 – P13, annualized.....</i>	<i>s.27</i>
<i>Table 6.1.2: Standard Deviation on cryptocurrencies/gold P1 – P13, annualized.....</i>	<i>s.29</i>
<i>Table 6.1.3: Sharpe Ratio of cryptocurrencies & gold P1 – P13, annualized.....</i>	<i>s.32</i>
<i>Table 6.1.4A: CAPM, Jensen’s alpha and Beta for all of the portfolios.....</i>	<i>s.36</i>
<i>Table 6.1.4B: Correlation with the market.....</i>	<i>s.37</i>
<i>Table 6.2.1A: Calculation of the momentum strategy, for each currency.....</i>	<i>s.40</i>
<i>Table 6.2.1B: Calculating the Sharpe ratio of momentum strategy, all five years.....</i>	<i>s.41</i>
<i>Table 6.2.1C: Overview of measurements of the momentum strategy for each currency.....</i>	<i>s.42</i>
<i>Table 6.2.1D: Beta for each financial asset.....</i>	<i>s.42</i>
<i>Table 6.2.1E: Correlation matrix between each currency and the market.....</i>	<i>s.43</i>
<i>Table 6.2.2A: Monthly momentum.....</i>	<i>s. 44</i>
<i>Table 6.2.3: Momentum quarterly.....</i>	<i>s.45</i>
<i>Table 6.2.4: Momentum annually.....</i>	<i>s. 46</i>
<i>Table 6.2.5A: Calculation of the buy-and-hold strategy for each financial asset.....</i>	<i>s.48</i>
<i>Table 6.2.5B: Calculating the Sharpe ratio of Buy-and-hold strategy, all five years.....</i>	<i>s.49</i>
<i>Table 6.2.5C: Measurements of buy-and-hold strategy.....</i>	<i>s.49</i>
<i>Table 6.2.6A: Annual Sharpe ratio for weekly momentum strategy.....</i>	<i>s.51</i>
<i>Table 6.2.6B: Annual Sharpe ratio for buy-and-hold strategy.....</i>	<i>s.51</i>

GRAPHS:

Graph 6.1.1: Excess return of cryptocurrencies/gold P1 – P13, annualized.....s.28
Graph 6.1.2A: Standard Deviation of cryptocurrencies/gold P1 – P13, annualized.....s. 30
Graph 6.1.2B: Standard Deviation & Excess Return of cryptocurrencies/gold P1–P13,annualized..s.31
Graph 6.1.2C: Standard Deviation & Excess Return of gold P1 – P13, annualized.....s.32
Graph 6.1.3A: Sharpe Ratio for Dogecoin& Ripple P1 – P13, annualized.....s.33
Graph 6.1.3B: Sharpe Ratio for Dogecoin, Ripple & Dash P1 – P13, annualized.....s.34
Graph 6.1.3C: Sharpe Ratio All Cryptocurrencies/Gold: P1 – P13, annualized.....s.35
Graph 6.2.4: Sharpe ratio of the momentum strategies.....s.47
Graph 7: Historical market cap. & price of Bitcoin (Coinmarketcap, May 2019).....s.53

PREFACE

The cryptocurrency market today is a highly discussed topic and has been researched for a long time. Previous studies have mostly focused on Bitcoin, and therefore we were motivated to analyze the performance of other cryptocurrencies. Not only do we investigate Bitcoin, but also four other cryptocurrencies (Dash, Litecoin, Dogecoin and Ripple) with a different price range, market capitalization and behaving patterns.

We hope our findings are appreciated and will contribute to future studies.

We would like to thank our supervisor Peter Molnár at the University of Stavanger for good follow-up and guidance.

1. INTRODUCTION

The last 10 years investors have opened their eyes for what some people call the “evolution of money”; The Cryptocurrency Market. It started out in the wake of the financial crisis in 2008/09 when someone under the alias, Satoshi Nakamoto, invented the first decentralized digital currency called Bitcoin. One of the unique factors with cryptocurrencies, which separate it from traditional currencies, is the possibility to do a peer to peer transaction without the need to be verified by an intermediary.

The aim of Bitcoin was to remove two key elements in the management of finance and money: Trust and centralization. The goal was to create universal cash, a cryptographically secure currency, that could replace all forms of fiat currency in the world.

Since the release of Bitcoin in 2008/09, there have been created thousands of altcoins (alternative variants of Bitcoin) and by the end of May 2019, there are over 2000 cryptocurrencies in the market (Coin Market Cap, 2019). The interests in cryptocurrency investments have blasted over the last few years both from an optimistic perspective, as well as from a pessimistic perspective.

The cryptocurrency market today is seen as a highly unstable market with a high degree of fluctuation, speculations and uncertainty. Due to the high price volatility and the risk for tremendous losses, some financial experts’ do not recommend investing in the cryptocurrency market and some of them are also pointing at bubble tendencies. However, the cryptocurrency market is also seen as a complex market which has led to high profits for several investors. Therefore, it is no surprise that many are attracted to investments in cryptocurrencies even though such investments are extremely volatile.

The cryptocurrency market is complex, containing thousands of currencies with different characteristics. The cryptocurrencies have a diversified price range, market share, behaving pattern and there is no clear correlation between them. Therefore, we found it interesting to not only examine Bitcoin but to look at several of the cryptocurrencies and their investment potentials. Based on these issues we formulated the following research problem:

“An analysis of the effect by adding cryptocurrency in a standard portfolio. In addition, examine which of momentum and buy-and-hold strategy is the ideal approach, when investing in cryptocurrency.”

Our research will contribute to making a wider understanding of how to evaluate performance and levels of risks associated with an investment in the cryptocurrency market.

Cryptocurrencies have a place in financial markets and portfolio management, therefore we evaluate the cryptocurrencies as financial assets. The research problem is divided into two parts; part one consists of evaluating how much percentage of cryptocurrency should be included in a standard portfolio to achieve a valuable portfolio performance. Part two examines what strategy would outperform the other, momentum or buy-and-hold.

Before answering the research question, the first chapter covers the background information of each financial asset we have chosen to analyze, and an explanation of the cryptocurrency market and the blockchain behind it. We describe different underlying theories that have displayed efficient ways to measure the performance of the portfolios and the strategies. Following, we explain how we approach the research problem and what we have accomplished to find a representative answer. We keep our thesis in two parts, whereas when presenting the results, we start with the outcomes for the portfolios, and then exhibit the different strategies for each of the cryptocurrencies/gold. From our results, we concluded which of the portfolios that are optimal for each of the cryptocurrencies, as well as clarifying the ideal strategy when investing in cryptocurrencies. Additionally, we comment on future speculation about the cryptocurrency market.

The results of our research will contribute to giving an outlook for investors on how much percentage of cryptocurrency that should be included in a standard portfolio, based on historical data. The results also illustrate whether weekly-, monthly-, quarterly- or annually momentum strategy or buy-and-hold strategy is the most efficient when investing in cryptocurrencies. After evaluating the performance of the portfolios as well as the cryptocurrencies with different strategies, we found clear answers to the research problem.

The results of the analysis give evidently proof that the different cryptocurrencies need to be treated differently when considering investing in the cryptocurrency market. When finding

the most efficient percentage of the cryptocurrencies to include in a standard portfolio, the results show that what is optimal for one of the cryptocurrencies, could be far from ideal for another. The results also show that the strategy you chose to implement also play an important role in financial investment decisions. Our analysis shows that there is one cryptocurrency that clearly outperforms all of the other financial assets. Most people might think, due to its popularity and market capitalization, that Bitcoin is the leader, but our thesis proves that this is not the case.

2. BACKGROUND

2.1 THE STOCK MARKET (SPY)

The S&P 500 stands for the Standard and Poor's 500 indexes. It is viewed as the most precise gauge of the performance of large capitalization American equities. Basically, it is an index of 505 stocks issued by 500 large companies with a market capitalization of at least 6.1 billion (Icapital Network, 2018).

The S&P 500 was first published in 1957 and it has since then been considered as the single best gauge of large-cap U.S. equity market. The roots go all the way back to 1860 when Henry V. Poor started an investment information service that later became an original company that merged with Standard Statistics (a company founded in 1906 as Standard Statistics Bureau). Today we know it as the S&P 500, which is a financial information and analysis provider (Icapital Network, 2018).

The index represents the large cap-companies from the two largest U.S. exchanges: New York Stock Exchange (NYSE) and NASDAQ. The S&P 500 is claimed to be more representative of the American market than Dow Jones, one of the reasons why is that the index is a market-value-weighted-index. The index is the percentage change from calculating the total market value of the 500 companies and the total market value of the same companies the previous trading day. The S&P 500 is meant to reflect the development of the total stock market in the U.S.

There are multiple different criteria that must be fulfilled to be one of the 500 companies; such as market capitalization, financial viability, sector representation, and there must be a public float of at least 50%.

The biggest stocks in the S&P are Apple, Amazon, Facebook, Microsoft and Google. If you buy into the S&P 500 you are buying into the 500 largest US corporations that have a global reach. This is an asset that has returned 7% inflation-adjusted, 10% non-inflation adjusted on average since 1928 (Investopedia, 2019d).

2.2 THE BOND MARKET (AGG)

iShares Core U.S. Aggregate Bond ETF measures the performance of the total U.S. investment-grade bond market. It seeks to track the index and includes Treasuries, agencies, CMBS, ABS and investment-grade companies. For a single investment, the index provides wide, diversified coverage of the overall bond market.

The ETFs has for investors become a more and more popular method for diversifying investment portfolios. Income from bonds often provides a “safe haven” against downturns from investment in the stock market, and it is therefore highly valued among investors. Moreover, bonds also provide higher protection from bankruptcy compared to stocks. In other words, bonds are considered to decrease the total volatility in investment portfolios.

There are generally two main reasons why investors choose to invest in ETFs; either to obtain a balanced portfolio of fixed income investment or to diversify their investment portfolios. Overall, the ETFs are known for performing well with low expenses ratio and are giving a solid return for investors (Investopedia, 2018a).

2.3 THE GOLD MARKET (GLD ETF)

Gold is one of the most precious and popular metals when it comes to investments. For centuries gold has served as a store of value, as a medium of exchange and at times as a unit for account (Darst D., 2013). Gold is often considered as a “safe haven” for investors, which allows them to diversify risks in their portfolios.

One of the most popular ETFs in the world is GLD. Good reasons exist why investors choose to invest in the GLD market. Some of the most common uses are for short term hedging against equity market volatility, dollar weakness or inflation. Other investors include gold in their portfolios as a part of a long-term investment strategy. The gold market value is determined by the world supply and demand, while currencies depend on governments and the central bank’s monetary policy. Price of gold may, therefore, behave in an entirely different way than traditional currencies (Etfdb, 2019).

The price of the ETF can be expected to move in line with the spot gold prices. The spot gold price refers to the price of gold for immediate delivery. The spot gold market is open for trading close to 24 hours since orders for gold is taken actively all around the world (Kitco, 2019).

In the gold market, there are made contracts where producers and market makers agree upon a certain price that the gold is going to be sold at a specific date. Hedging is common due to security from fluctuations and speculations in the market.

2.4 THE CRYPTOCURRENCY MARKET

There are two ways of participating in the cryptocurrency market, the first one is by buying coins or tokens with an exchange, and the second one is through mining. One of the main characteristics of the cryptocurrency market is that they are typically used for a peer-to-peer transaction. Cryptocurrencies can be exchanged to FIAT currencies or be changed in other tokens (Crypto Currency Facts, 2019).

There are 2143 cryptocurrencies as of 2nd of May 2019, with a total market capitalization of \$ 176 647 606 386. Bitcoin is dominating the market with 54,6% of the market cap (Coin Market Cap, 2019). In 2017 Bitcoin experienced massive growth, growing on a 27 000% rate of return in 12 months. Bitcoins price went from \$700 to almost \$20 000 (Master the Crypto, 2018).

The cryptocurrency market is known as an extremely volatile market. The market crash in 2018 lead to an 85% loss of value in the cryptocurrency market. The last two years, the prices of the cryptocurrencies have been fluctuating a lot, which makes many investors consider the market to be highly unstable and full of uncertainty and speculations (Master the Crypto, 2018).

However, while the cryptocurrency market lost 85% if its value in 2018, the number of users is still rising, and this can be seen as a positive way to measure growth in the industry. A new study published by Cambridge Center for Alternative Finance shows that despite the severe

bear market the last year, the onboarding of new users and cryptocurrency adoption has increased (Invest in blockchain, 2019).

The results from the studies show that by the end of 2017 there were 18 million users participating in the cryptocurrency market and by December 2018 the number has increased to over 35 million users. That is a 94% substantial rise in number of users just in one year. The increase in adoption of the market may be a positive sign in the long term (Invest in blockchain, 2019).

2.5 BLOCKCHAIN TECHNOLOGY

To understand the cryptocurrency market, it is important to have an insight and understanding of the technology behind it.

The blockchain technology can be seen as the register of all the cryptocurrencies. It is known for its digital and decentralized characteristics and to erase the double spending problem that has been an issue with prior currencies. Double spending is when there has been tampered with the tokens and the digital code has been duplicated.

The blockchain technology consists of a chain with blocks, where every block holds information about a transaction. The history of blockchain goes many years back in time. In 1991 was the first appearance of this technology and it was originally created to prevent tampering of dates with digital documents. However, the technology first increased its popularity in 2008 when Nakamoto introduced Bitcoin as a digital currency (Bjordal A., 2017).

As mentioned, the blockchain technology can be seen as a record keeper. The properties of the blockchains are very advanced. After the information has been stored in a block it is almost impossible to tamper or change it. Every block contains data, the hash of the block and the hash of the previous block. The Bitcoin block for example stores the detail about the sender of the coins, the receiver and the number of coins the transaction contained. A hash can be compared with a fingerprint, all of them has its own unique coding. The other unique characteristic with a block is that if some changes are happening, the calculation of the hash will also change, and it will make a new “fingerprint” (Tapscott & Tapscott, 2017).

Because of the advanced technology, there is not possible to change the histories of the blocks, you can only add more to it. The blockchains are also known to be highly secure because the hash of the former blocks is stored in the new block that is created. By storing this information, the blockchain is created.

However, with the level of technology and computers nowadays this is still not enough to prevent tampering. Today it is possible to tamper with the blocks by recalculating all the hashes from the previous blocks. However, there also exists a mechanism to prevent tampering, which is called proof of work. Proof of work is a method that makes the creation of blocks longer. In Bitcoins example, when adding a new block to the blockchain, the proof of work will take around 10 minutes. With the proof of work method, it will be much harder to tamper with the blocks because the proof of work needs to be calculated for all the following blocks as well. Proof of work is seen as a security mechanism for the blockchain technology (Tapscott & Tapscott, 2017).

Furthermore, there is also another way to secure the blocks. This method is through the distribution process. There is no central entity involved when conducting a cryptocurrency transaction, instead, the blockchain technology uses something called a peer to peer network, which is open for everyone to sign up for. In the peer to peer network, the members get a copy of the blockchain and the nodes are used to confirm that everything is correct. Every time a new block appears it will be sent to all the members in the network and the nodes can confirm that there has not been tampered with, and in that case, it is safe to add to their own blockchain (Bjordal A., 2017).

As mentioned, the nodes in the network are able to discover if there has been tampered with a block, and if that is the case the nodes will reject the blocks. Therefore, to be able to tamper with a block, you need to tamper with all the blocks in the entire chain. The proof of work needs to be done over for all the blocks and to be able to do that you need control of over 50% of the peer to peer network, which makes tampering almost impossible (Tapscott & Tapscott, 2017).

The blockchain technology is continually evolving. The smart contract is one of the fresh developments. The smart contract is a program that can be used to exchange the coins

automatically. The blockchain technology has awakened a lot of people's interest, and it is not only used for exchanging cryptocurrencies. The technology is also used for storing data like medical records, tax information and notaries.

2.6 PRESENTATION OF THE CRYPTOCURRENCIES

2.6.1 Bitcoin (BTC)

Bitcoin was launched in 2009 and is now one of the most popular cryptocurrencies in the world, with a market capitalization over 50% (Coin Market Cap, 2019). It was one of the world's first decentralized digital currency and does only exist electronically. Through Bitcoins algorithm, the members of the network are keeping a record of the transactions, verifying them and creating new ones.

Bitcoin is not considered to be used for everyday shopping. This is because it takes about 10 minutes for a Bitcoin transaction to be completed and accepted. However, Bitcoin is often being used for online transactions and it is becoming a more and more popular payment method among retailers.

There is a maximum amount of Bitcoin that will be in the market and it sums to around 21 million. Today it is already over 16 million Bitcoins in the market (Coincentral, 2018). When a Bitcoin transaction is completed, the miner who solved the hash will be rewarded with payments in bitcoin. This payment is new generated Bitcoins, so for every miner who solves a hash, there will be more Bitcoins in circulation.

2.6.2 Litecoin (LTC)

Like Bitcoin, Litecoin is a decentralized currency and was created in 2011, by Charlie Lee. Charlie Lee himself calls it "the silver to Bitcoin's gold", in terms of Bitcoin being able to stay secure and move both a large and small amount of money. The transactions would need the same amount of fee, and with that in mind, he created Litecoin which is designed to move a smaller amount of money with lower fees (Meholm, 2018).

All transaction is publicly recorded on a ledger called blockchain, this way the transaction can be verified immediately, and the money can be sent all over the world.

There will only exist 84 million Litecoin. Compared to Bitcoin, Litecoin has both faster transactions and cheaper transactions costs. Litecoin uses only 2.5 minutes for each new block to generate into the blockchain, while Bitcoin uses 10 minutes (Meholm, 2018).

2.6.3 Ripple (XRP)

Originally Ripple was developed in 2004 in Canada, where Ryan Fugger had an idea for a transaction system where one could make own money and use that to pay from one person to another. He launched RipplePay.com which was a decentralized database. In 2013 they announced with blockchain technology and as integration against Bitcoin. What makes Ripple so special is that transmitter and receiver can use any type of currency, such as stocks, gold, silver, international currencies and virtual money from gaming (Meholm, 2018).

Ripple is a privately held company that was co-founded by Chris Larsen and Jed McCaleb. The fact that Ripple is privately owned means that there is no one on the outside that can verify the transactions. Ripple transfer the currency, XRP, from account to account, meaning that this also is a peer-to-peer. At this moment there are 41 billion ripples in circulation, but the company has 59 billion held by Ripple Labs (Meholm, 2018).

There are around 50 banks that have invested in Ripple today, including Santander and UBS, as well as Google. In addition, some banks use Ripple as payment infrastructure, here an example is the Swedish SEB (Meholm, 2018).

One feature that makes Ripple different from Bitcoin is that Ripple has successfully united the old bank system with the new in blockchain, with this being said Ripple does not have any blocks, but the transactions get consensus through algorithm each fifth Second.

2.6.4 Digital Cash (DASH)

Dash is built on Bitcoin's core code and also has a peer-to-peer decentralized digital cash. It has its own blockchain and focuses more on privacy and quick transactions.

Dash was created in 2014 and was originally released as XCoin, then changed it to Darkcoin, before it was rebranded as Dash in 2015.

Dash has a total supply of 18 million coins and the average block mining time is 2.5 minutes. It is based on Bitcoin software but focuses more on anonymous and untraceable transactions (Coinsutra, 2019).

A popular way to buy Dash is by going through Changelly. "Changelly is an instant exchange where you can exchange various cryptocurrencies. Changelly currently supports 55 cryptocurrencies" (Coinsutra, 2019).

2.6.5 Dogecoin (DOGE)

Dogecoin was founded in 2013 by Billy Markus and Jackson Palmer and it was originally founded as a joke. Today it is a digital currency that is rapidly growing. Dogecoin is fully anonymous, decentralized and secure. Dogecoin is often used for trading in other currencies; both other cryptocurrencies, as well as traditional currencies like euros and dollars. It is also used to buy goods and services (Weusecoins, 2018).

Dogecoin is used with a wallet online through their webpage, app or saved on your computer. One of the most popular uses for Dogecoin is to create or share content with real value that can be used across all the internet (Dogecoin, 2019).

3.LITERATURE REVIEW

Last years a new market got attention from investor all over the world, the cryptocurrency market. It started after the financial crises that took place in 2008 when Nakamoto first presented Bitcoin as the first cryptocurrency. Bitcoin is still today ranked as number one in the cryptocurrency market dominating the market with 54,6% of the market capitalization (Coin Market Cap, 2019).

Never has any assets offered such a high level of return on investments that Bitcoin did from October 2016 to October 2017. During this year, Bitcoins market capitalization increased from \$ 10,1 to 79.7 billion and with a price increase from \$ 616 to \$ 4800, which indicate a return at 680% per year (Corbet, Lucey, Urquhart, & Yarovaya, 2019). There have been speculations that cryptocurrencies are a revolution of the currency market and that it has the potential to change the entire money market that we know today.

Due to its increased popularity over the last years, Bitcoin and other cryptocurrencies have fascinated investors, media attention as well as academic researchers. To be able to identify gaps in the existing literature, it is important to first get an overall understanding of the existing knowledge in the cryptocurrency market. In this part, we are going to get an overview of the major topics that have already been researched.

In all available research on cryptocurrency, over 70% has only focused on Bitcoin. This show that there is an under-analysis of the other cryptocurrencies (Corbet et al., 2019). The core research topics that has already been researched in the cryptocurrency market are market efficiency, price dynamics, diversification benefits, regulation and cybercrime.

Due to wide fluctuation in cryptocurrencies prices, this topic has been a popular research area. The vast variations in the price of cryptocurrencies have led to speculations around bubble tendencies with fear for future outlooks. Cryptocurrencies are also proven to be extremely volatile and earlier research shows that this can be correlated with two unfavorable features, which are regulatory disorientation and cyber criminality (Corbet et al., 2019). It is proven that one of the main reasons for price fluctuations is due to regulations. One example is that Bitcoins price was reduced by almost 50% in 2018 due to new regulations in China

and South Korea (Corbet et al., 2019). Another matter is the anonymity of the cryptocurrencies, which have been used to misapplication through money laundering and other cybercrimes. Events like these have led to wide price fluctuations and uncertainty among investors.

When it comes to involving cryptocurrency in a portfolio, earlier research has proven that investing in Bitcoin as well as other financial assets can offer a diversification advantage and hedging opportunities for investors (Trimborn, Mingyang, & Härdle, 2017). Results from research also claim that, compared to only hold stock portfolio, by including Bitcoin and gold reduces a portfolio's variance (Guesmi, Saadi, Abid, & Ftiti, 2019). Previous analysis has discovered that involving cryptocurrency in a standard portfolio not only lead to improving diversification, it also has shown to give a higher Sharpe ratio (Chuen, Lee, Guo, & Wang, 2017).

As mentioned, most of the previous literature on cryptocurrencies consider Bitcoin. Today there exist thousands of altcoins with different behaving pattern, price range and market capitalizations. It is limited whether only analyzing Bitcoin can represent all of them. Therefore, it is necessary to conduct research on several cryptocurrencies to obtain a broader understanding.

4. DATA

In this study we have collected historical data from diverse markets, which are consisting of the stock market *SPDR S&P 500 ETF* (SPY), the Bond Market *iShares Core U.S. Aggregate Bond ETF* (AGG), the gold market (GLD ETF) as well as the cryptocurrency market. All the data are available at finance.yahoo.com, consisting of open, high, low, close and adjusted close prices, as well as dollar volume and market capitalization.

Furthermore, we compared the gathered data from *Yahoo Finance* with other websites such as *Coin Market Cap* and the cryptocurrencies own websites. *Yahoo Finance* provides an easy way of downloading the historical data and gives you a lot of options e.g. when it comes to

the frequency of the data. The data from *Yahoo Finance* goes longer back in time and has less lack of data registration, compared to other websites such as *Coin Market Cap*.

In this study, the dataset covers the period from February 5, 2014, throughout five years up until December 31, 2018. The only exception is Ripple (XRP) which cover the period from February 8, 2015, to December 31, 2018, due to lack of registered data. The data collected is on a weekly basis.

The cryptocurrencies used for our analysis are not selected randomly. Our preconditions for the evaluation of which cryptocurrencies to include was; historical data (minimum four years of records) and high market capitalization. The cryptocurrencies we choose to include in our analysis are: *Bitcoin* (BTC), *Litecoin* (LTC), *Ripple* (XRP), *Digital Cash* (DASH) and *Dogecoin* (DOGE). All the mentioned currencies were among the top thirty cryptocurrencies, relative to the market capitalization, at the starting point of the study (January 2019).

We used the same method when downloading data, for the stocks, bonds, gold and all the five cryptocurrencies. Unlike stock and bonds market, which has limited trading hours, the cryptocurrency market is a decentralized system, which is open for trading 24/7, including the weekends as well as holidays.

To answer our research questions, we started to analyze the performance from the different markets, as well as the individual cryptocurrencies. In part one of our research problem, we wanted to find the optimal percentage of cryptocurrency/gold in a standard portfolio. We used a different weight of stocks, bonds and cryptocurrency/gold in the portfolios, which we later refer to as P1-P13. In *table 4.1* you see the diversification of the investments in the different portfolios. We used a constant ratio between stocks and bonds in each of the portfolios so that the change in performance is caused by the effect of including the different percentage of cryptocurrencies.

Portfolios	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12	P 13
Stocks	59,75 %	59,5 %	59,25 %	59,0 %	58,75 %	58,50 %	58,25 %	58,0 %	57,75 %	57,50 %	55,0 %	52,50 %	50,0 %
Bonds	39,75 %	39,5 %	39,25 %	39,0 %	38,75 %	38,50 %	38,25 %	38,0 %	37,75 %	37,50 %	35,0 %	32,50 %	30,0 %
Crypto/Gold	0,5 %	1,0 %	1,5 %	2,0 %	2,5 %	3,0 %	3,5 %	4,0 %	4,5 %	5,0 %	10,0 %	15,0 %	20,0 %

(Table 4.1: Percentage of investments in the different portfolios)

The first step in the analysis was to calculate the weekly excess return on each asset. The weekly excess return is calculated by taking the logarithm of this weeks adjusted close divided by last weeks adjusted close. Going from weekly data to annual we used the following formula:

$$((1 + r_i)^w - 1) - r_f$$

Where r_i =expected annual excess return, w =number of weeks, r_f =risk-free rate

As for the number of weeks in a year we used 50 weeks for stocks, bonds and gold, and 52 weeks for the cryptocurrencies (since the cryptocurrency market is open 24/7).

When adjusting the weekly data to annual for the weekly momentum strategy, we used the number of weeks where we invest in cryptocurrency/gold, in other words, the number of weeks where the excess return is positive (the same goes for monthly-, quarterly- and annually momentum strategy).

The next step was to calculate the standard deviation of the assets. The standard deviation is a measure of the dispersion of a dataset relative to its mean and is calculated as the square root of the variance (Bodie Z., 2014). Standard deviation is a useful measurement for investigating the historical volatility of an investment. The higher the standard deviation, the more the values deviates from the mean, the more volatile the investment is considered to be. The standard deviation is calculated by using the following formula:

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n - 1}}$$

Where: x_i = Value of the i^{th} point in the data set, μ = The mean value of the data set and n = The number of data points in the data set.

Adjusting the standard deviation from weekly to annual, we multiply the average weekly standard deviation with the square root of the number of weeks. In the case of buy-and-hold, we multiply it with the square root of 50/52.

In addition, we studied the performance of the assets by looking at the Skewness and Kurtosis by taking a descriptive analysis in *Excel*. In situations where the return distribution deviates

from a classic normal distribution, it is important to analyze implications of risk and return. Skewness and Kurtosis are considered to measure the “risk of the risk”, in other words, to make sure the standard deviation does not over- or underestimate the risk and extreme outcomes (Cain M., 2017).

Skewness is used to describe asymmetry from the normal distribution in a set of data. It is a well-known measurement, mainly used because of its possibility to measure the extremes of the data and does not only focus on the average. It is indicating the frequency of return relative to the mean and it distinguishes extreme values in one versus the other tail (Cain M., 2017). Skewness can have a right (positive), a left (negative) or a normal skew to a varying degree. If the mean and the median is greater than the mode, the skewness is positive. Positive skewness means when the tail on the right side of the distribution is longer or fatter. (See figure 4.2). A negative skew is the opposite; where the tail of the left side is longer or fatter than the tail on the right side. The mean and median will be less than the mode.

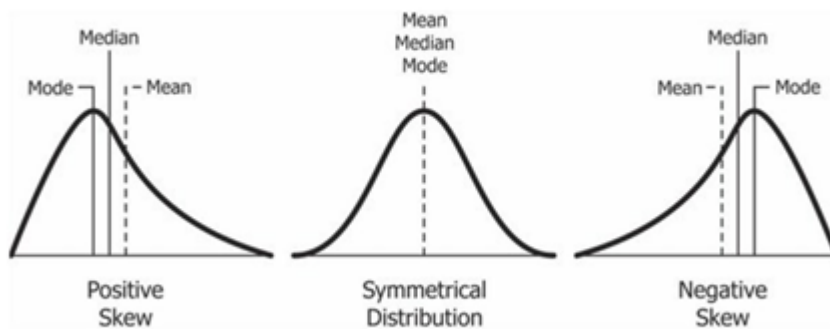


Figure 4.2: Negative and positive skewness explained (Codeburst, 2018)

The formula for sample skewness where n is the number of observations, X_i is the i^{th} random variable, X_{avg} is the mean of the distribution and $S = \sigma$ is the standard deviation:

$$s = \frac{n\sqrt{n-1}}{n-2} \frac{\sum_{i=1}^n (X_i - X_{avg})^3}{(\sum_{i=1}^n (X_i - X_{avg})^2)^{3/2}}$$

(Macroption, 2019)

Like skewness, kurtosis is also a well-known measurement that is used to describe the distribution. It is often stated as “volatility of volatility”. Kurtosis is calculating the peaks of the distributions and it is a measure of the combined weight of a distribution’s tails relative to the rest of the distribution (Investopedia, 2019b). Kurtosis signalizes where the volatility is situated and the likelihood of extreme outcomes. There are three kinds of kurtosis (Towards Data Science, 2018):

- *Mesokurtic*: Kurtosis = zero. Similar to normal distribution.
- *Leptokurtic*: Kurtosis > zero. Higher than the normal distribution (outlier).
- *Platykurtic*: Kurtosis < zero. Less than the normal distribution (no outlier).

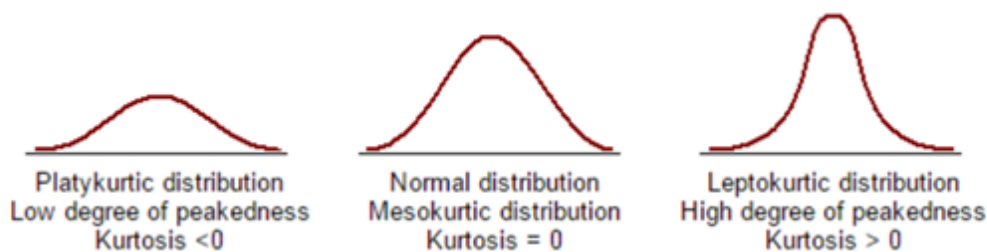


Figure 4.3: The different types of kurtosis

(Chaudhari, 2018)

The formula for sample kurtosis, where n is the number of observations and $S = \sigma$ is the standard deviation:

$$K = \frac{n(n+1)}{(n-1)(n-2)(n-3)} \frac{\sum_{i=1}^n (X_i - X_{avg})^4}{s^4} - \frac{3(n-1)^2}{(n-2)(n-3)}$$

(Chaudhari, 2018)

Measurements like standard deviation will not discover the potential risk for the assets in situations where the skewness and kurtosis values deviate from the normal distribution.

Therefore, to be able to get a more accurate picture of the risk, it is essential to also consider both the occurrence and size of extreme outcomes.

Furthermore, for investors considering including cryptocurrencies in their portfolio, it is important to look at the correlation with other assets. In this thesis, we have been analyzing thirteen different portfolios with different weight of stocks, bonds and cryptocurrencies/gold. Theory suggests that Bitcoin belongs to a unique asset class and it has been found to be largely uncorrelated with both other risky financial assets, as well as “safe haven” assets (Codeburst, 2018). We will analyze the correlation between the different cryptocurrencies with the other markets: stocks, bonds and gold, to see if our results match the theory.

5. METHODOLOGY

To answer our research problem, we divided our analysis into two parts. As mentioned, in part one we evaluate how much percentage of cryptocurrencies included in a standard portfolio is optimal and compared it to gold. We started by looking at the excess return associated with its risk for each asset so that we later could include the findings in thirteen different portfolios. Our main measurement was Sharpe ratio and based on this index we found out how much percentage of cryptocurrencies should be involved.

We used a deductive approach to make sure that the gathered data aligns with existing theory. To evaluate the data collected we conducted regression analysis. We completed the regression analysis by adjusting the weights of the different assets within each portfolio, to see how the Sharpe ratio would change when including more or less percentage of cryptocurrencies.

In part two we analyzed momentum- and buy-and-hold strategy, which are two different and popular approaches within financial markets. In this part, we evaluated all of the currencies isolated for each of the strategies and compared the results.

5.1 THEORY

5.1.1 Sharpe Ratio

Sharpe Ratio is a risk-adjusted measurement of a financial portfolio. The ratio examines the performance of an investment, by looking at its risk, excess return and the risk-free rate. Investors are interested in the expected return they gain by replacing the T-bill with a risky portfolio. To analyze the effect on the excess return of including cryptocurrencies in a standard portfolio, we started with calculating the Sharpe ratio. The higher the Sharpe ratio the better the investment.

Using the standard deviation of the portfolio, we can calculate the Sharpe ratio:

$$\text{Sharpe Ratio} = \frac{\text{Risk premium}}{\text{SD of excess return}} = \frac{r_p - r_f}{\sigma}$$

(Bodie Z., 2014)

To calculate the Sharpe ratio, we divide the risk premium by the standard deviation of the excess return. After calculating the excess return, we used 2,49% as the risk-free rate. We used 2,49% throughout the whole thesis. When calculating the Sharpe ratio on weekly excess return, we used 50 weeks for stocks, bonds and gold, and 52 weeks for the cryptocurrencies for buy-and-hold. We found the risk premium with this formula: $((1 + r_i)^{50} - 1) - r_f$

Where r_i = expected annual excess return, r_f = risk-free rate

After we obtained the risk premium, we took the square root of the variance and multiplied it with the square root of 50/52 (buy-and-hold) weeks to get the standard deviation of excess return. The Sharpe ratio was used to evaluate both individual assets, all the portfolios and for each currency with the two strategies.

5.1.2 The Capital Asset Pricing Model (CAPM)

Another way to evaluate the performance of an asset is with The Capital Asset Pricing Model (CAPM). This model was co-founded by Sharpe, Lintner and Mossin. It is a calculation of the expected return and the risk of an investment. The capital asset pricing model shows that

the expected return on an asset is equal to a risk premium and the risk-free rate, where the risk premium is based on the beta of that asset (Kane, 2014).

How to use CAPM to find the expected return of the portfolio:

$$E(R_i) = R_f + \beta(E(R_m) - R_f)$$

(Bodie Z., 2014)

Where $E(R_i)$ = expected return of investment, R_f = Risk-free rate, β_i = Beta of the investment and $E(R_m)$ = Expected return of the market.

By using the result of CAPM as an estimation of the expected return of an investment we have to consider assumption about the market. These assumptions vary from excluding the transaction cost and personal income tax to assumptions that deal with homogeneity of expectations. To summarize the statements one can divide them into two key assumptions; that the market is efficient and the risk premium on a risky asset is corresponding to its beta (Bodie Z., 2014).

We included this equation to evaluate our investment strategies as support to confirm that our findings from the Sharpe ratio are representative. For the expected return of the market, we used the S&P 500.

In part one we used the beta between each of the portfolios with the market, in other words, we used the weighted beta of the assets included in our portfolios, and in part two we used beta between each currency and the market. Since CAPM mostly takes into consideration the association of an asset with the market, we applied the Jensen's alpha as well.

5.1.3 Jensen's Alpha

Jensen's alpha is another way to measure the performance of an asset and is expressed by risk and average return. Jensen's alpha evaluates if an investment receives an excess return that is genuine compared to its risk. The alpha measures excess over the CAPM expected return and is a measurement often used by investors (Jensen, 1969)

$$\text{Alpha} = R(i) - (R(m) + \beta(R(m) - R(f)))$$

Where $R(i)$ = realized return of the investment, $R(m)$ = realized return of the market index,

$R(f)$ = Risk-free rate of return and β = beta of the investment.

(Bodie Z., 2014)

The alpha gives a good interpretation of the cryptocurrencies related to the market. As mentioned, the beta for cryptocurrencies is close to zero, so when calculating its alpha, the risk premium has a low effect on the expected return.

With the excess return of each financial assets, risk-free rate, the excess return of the market and beta between the assets and the market, we calculated the Jensen alpha for all the investments both in part one and part two of our thesis.

There are other propositions on how to measure the expected return based on market value and volatility. For example, the information ratio and the reward-to-volatility ratio (Treyner ratio). The information ratio measures the risk that could be excluded by holding a diversified market index portfolio.

$$\text{Information ratio: } aP/s(eP) = \frac{\text{Portfolio return} - \text{benchmark return}}{\text{tracking error}}$$

(Bodie Z., 2014)

Tracking error from the calculation of the information ratio is the standard deviation of the difference between benchmark and portfolio returns. Comparable with the other equations, the information ratio tells us how much a fund has beaten a benchmark.

After analyzing different formulas, we decided to conduct Sharpe ratio, CAMP, Jensen's alpha, Skewness and Kurtosis.

When examining the calculations of the investment's performance, we wanted to identify optimal strategies for the assets. Throughout the analysis, we kept well-diversified portfolios, and with this in mind it was necessary to address research to find the most efficient investment strategy. After reading relevant literature we decided to analyze momentum- and buy-and-hold strategies. This led to part two where we calculated the performance for both momentum and buy-and-hold strategy to determine the ideal excess return considering its risk. Based on the results we could see which of the strategy outperformed the other.

5.2 STRATEGIES

Financial investments strategies can be divided into two approaches: fundamental- and technical. The fundamental strategy is widely used among private investors, especially when trading stocks, bonds and alternative investments. The basis of a fundamental strategy is to buy an asset if it is undervalued. Technical strategy, on the other hand, is when investors analyze movements to evaluate trading opportunities. We engage in a technical strategy when evaluating our investments in cryptocurrencies. These methods distinguish categories of analyzing trading in investments over all sorts of assets. There are different approaches on how to analyze investment based on these methods, where momentum strategy and buy-and-hold strategies are widely used when trading assets.

5.2.1 Momentum Strategy

A momentum strategy is based on the return over the previous year. The momentum strategy advises to buy short term "winners" and sell short term "losers". You buy the top decile of stocks that have risen the most over the past period and finance your purchases by (short) selling the bottom decile that have risen the least. The logic behind this strategy is that assets that have risen in the past tend to keep rising in the future. This strategy has existed for over 200 years and is a well-known financial approach when trading assets (Forbes, 2019). One disadvantage with momentum strategy is that if it has a bad month it usually is a really bad month. By selling an asset when the price is declining investors is ahead of the market and

with this, they maximize the return of investment. Since this is a technical method, investors look at different financial indicators, for instance, trend lines and moving average. A momentum strategy is also known as a relative strength strategy (Cuthbertson & Nitzsche, 2014).

The strategy goes against the efficient market hypothesis, it shows that people tend to overreact or underreact on new important information. The main idea behind the strategy is to invest in securities that have recently obtained the highest rate of return (Kosc K., 2019).

When examining the financial investment strategy, momentum strategy, our first initiative was to use the *IF function* in excel, using weekly data. To get a good interpretation of the momentum strategy we also use the *IF function* on a monthly, quarterly and annually basis. The function was that if the excess return for each cryptocurrency was positive we wanted to invest, and if not, we did not want to invest. As an example: we had the weekly excess return of Bitcoin, our statement was if Bitcoin is higher than 0 we wanted to invest in Bitcoin, if not we wanted 0: $IF(\text{Bitcoin} > 0, \text{Bitcoin}, 0)$. We did this with each of the cryptocurrencies, as well as stocks, bonds and gold. In part two of our thesis, we studied each financial asset individually and not as a portfolio. The purpose was to see whether it would be efficient to use a momentum approach when investing in cryptocurrencies and compare the outcomes with the performance of more traditionally assets with the same strategy.

The cryptocurrency market is a relatively new financial market. After the emerge of Bitcoin it has been debated in multiple articles and papers on how to interpret the currency appropriately (Cheah & Fry, 2015). There are a lot of questions about the underlying technology, and investors have a fair amount of legal and ethical doubts. The mainstream media displays new reports every day predicting a speculative bubble to appear soon (Kosc K., 2019). Concerning the momentum strategy, all mentioned has an impact on investors actions continuously.

5.2.2 Buy-and-Hold Strategy

Position trading is an investment strategy where one invests in assets or securities in a long time period. Investors who trade based on the buy-and-hold strategy has a belief that return

will not happen if they bail out after a decrease. This passive strategy is an approach where the investors keep the assets regardless of how the market moves. The buy-and-hold strategy may be the optimal investment strategy for loss averse investors. Loss aversion is when “losses loom larger than gains” - (Kahneman, 1979). It is human nature that the pain of a loss is twice as powerful as the pleasure of a gain.

When it comes to cryptocurrencies there is a lot of variation in price. Investors who bought Bitcoin after the startup, and still own today, has observed an overall high increase in price. The buy-and-hold strategy tells us to invest in the long run and if one were able to overlook all the variations in the last couple of years, it is clear that this strategy shows a good result. Studies has shown that for given a long enough time period the buy-and-hold strategy works, the key is to have a long holding period. If investors implement this strategy it is important to hold the assets in a 10-20-year period, due to market fluctuations.

We evaluate the performance of the buy-and-hold strategy and the momentum strategy by using the same functions on each strategy. For each of the strategies, we calculated the average- annual excess return, the volatility, Sharpe ratio, CAPM, Jensen’s alpha, Skewness and Kurtosis. After finishing the calculations, we compared them to one another and present them graphically.

The long-time existence of Gold has led to multiple financial analysis to find a strategy to help predict the future value, among those are market timing and buy-and-hold. The gold market has a lot of professional investors (ex. hedge fund managers and money managers), which makes it a highly liquid asset. Therefore, it is important to implement multiple strategies to find the most efficient (Baur, Dichtl, Drobetz, & Wendt, 2018). For comparison, we carried out both the momentum strategy and the buy-and-hold strategy for gold additionally to the other securities.

When deciding on which strategies to go forward with, we studied different theories that have to be considered when evaluating financial investments. There exists a lot of theories regarding financial analysis, so we chose to include a couple in our thesis, which we have had in the back of our minds when evaluating our findings. Two of them are random walk and market efficiency.

5.2.3 Random Walk

The random walk is a theory that indicates that stocks are independent of each other and that the stock prices have the same distribution. This means that the past trend or movement of an asset cannot be used to predict the future movement. In other words, the random walk theory suggests that the future path of assets is random and unpredictable (Investopedia, 2019c).

5.2.4 Market Efficiency

Market efficiency theory refers to the degree to which market prices reflect all available and relevant information. In an efficient market, all information will be incorporated into the prices, which will make it impossible to “beat the market”. The market efficiency theory was developed by Eugene Fama. He argued that stocks always trade at their fair value and therefore making it impossible for investors to either purchase undervalued stocks or sell stocks for inflated prices (Investopedia, 2018b).

6. RESULTS

6.1 COMPOSITIONS OF PORTFOLIOS

In part one of the analysis, we examined different compositions of portfolios, where the bulk of the investments are in the stock- and bond markets. Furthermore, we analyze what happens when adding a different percentage of various cryptocurrencies and gold, and how it affects the result on return and risks in the investments. The goal was to discover what might be the optimal percentage of cryptocurrency/gold in a standard portfolio.

The cryptocurrencies we analyzed was: Bitcoin, Dash, Litecoin, Dogecoin and Ripple. We separately researched each cryptocurrency and gold in thirteen different portfolios, where the percentage of investment were diverse.

In *table 6.1* below you find information about the thirteen different portfolios and the percentage of investments in the different markets. (Stocks, bonds, cryptocurrency/gold).

Portfolios	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12	P 13
Stocks	59,75 %	59,5 %	59,25 %	59,0 %	58,75 %	58,50 %	58,25 %	58,0 %	57,75 %	57,50 %	55,0 %	52,50 %	50,0 %
Bonds	39,75 %	39,5 %	39,25 %	39,0 %	38,75 %	38,50 %	38,25 %	38,0 %	37,75 %	37,50 %	35,0 %	32,50 %	30,0 %
Crypto/Gold	0,5 %	1,0 %	1,5 %	2,0 %	2,5 %	3,0 %	3,5 %	4,0 %	4,5 %	5,0 %	10,0 %	15,0 %	20,0 %

(Table 6.1: Diversification of investments in portfolios)

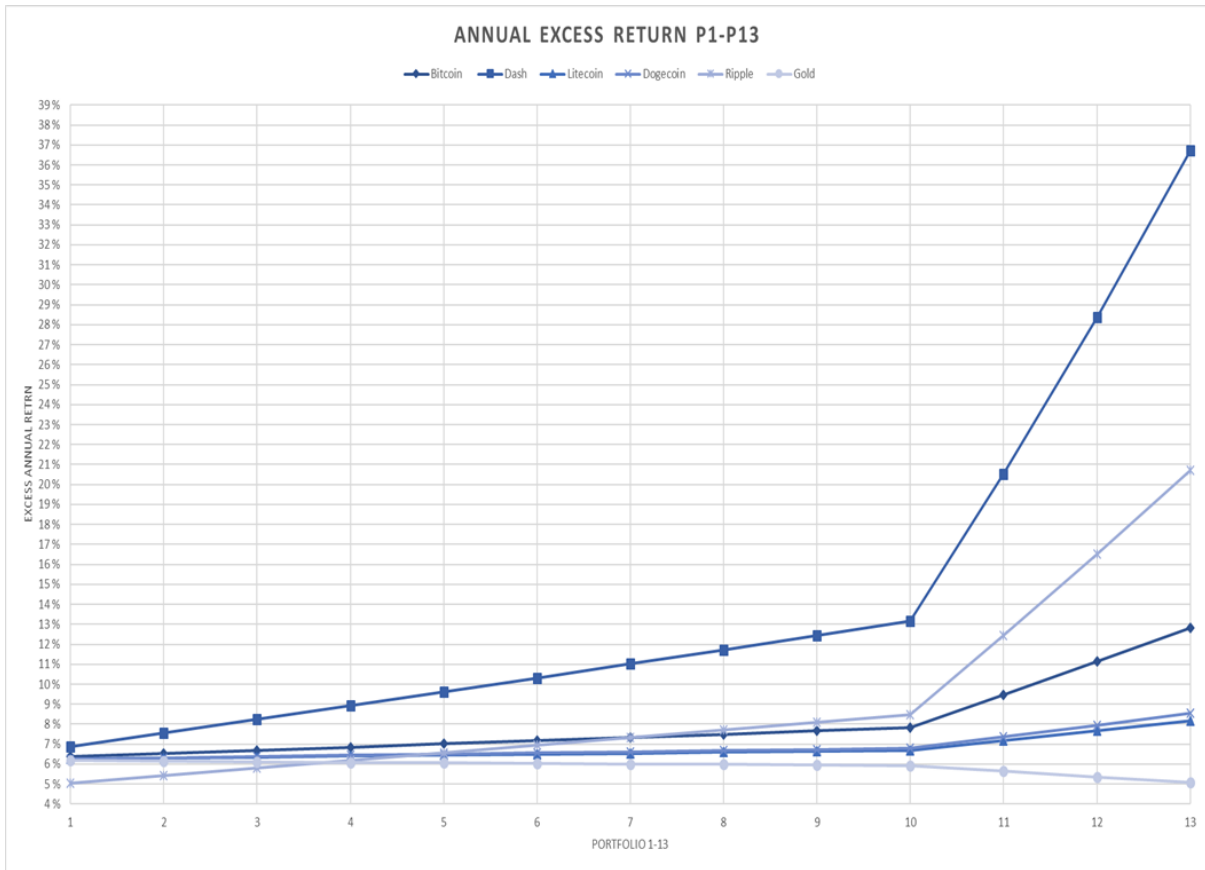
6.1.1 Annual Excess Return

The annual excess return shows the investment returns from the portfolios, that exceed the risk-free rate. In table 6.1.1 we see the results on the excess return for the different cryptocurrencies and gold in the diverse portfolios. The results show that for all the cryptocurrencies, the more percentage you add to the portfolio, the higher the excess return you can expect. On the other side, we find that gold moves in the other direction: the more percentage of gold added to the portfolio, the lower the excess return you can expect.

EXCESS RETURN ANNUAL	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Bitcoin	6,37 %	6,53 %	6,69 %	6,85 %	7,01 %	7,17 %	7,34 %	7,50 %	7,66 %	7,83 %	9,47 %	11,14 %	12,84 %
Dash	6,88 %	7,56 %	8,24 %	8,93 %	9,62 %	10,32 %	11,02 %	11,72 %	12,43 %	13,15 %	20,53 %	28,39 %	36,74 %
Litecoin	6,25 %	6,30 %	6,35 %	6,40 %	6,45 %	6,50 %	6,55 %	6,60 %	6,65 %	6,70 %	7,19 %	7,68 %	8,18 %
Dogecoin	6,26 %	6,32 %	6,38 %	6,44 %	6,49 %	6,55 %	6,61 %	6,67 %	6,72 %	6,78 %	7,36 %	7,95 %	8,53 %
Ripple	5,06 %	5,43 %	5,81 %	6,19 %	6,57 %	6,95 %	7,33 %	7,71 %	8,10 %	8,48 %	12,42 %	16,50 %	20,72 %
Gold	6,18 %	6,15 %	6,12 %	6,09 %	6,06 %	6,03 %	6,01 %	5,98 %	5,95 %	5,92 %	5,64 %	5,36 %	5,08 %

(Table 6.1.1: Excess return on cryptocurrencies/gold P1 – P13, annualized)

In graph 6.1.1 (below) we clearly see the results on annual excess return on the different cryptocurrencies/gold in the portfolios. There are two cryptocurrencies that stand out from the rest. Dash is in all the portfolios, the cryptocurrency with the highest excess return. In P1 Dash's excess return is at 6,88%, and it increases all the way up to 34,25% in P13. The other cryptocurrency that stands out is Ripple, which has a changing pattern. From P1 to P4 it is the cryptocurrency with the lowest excess return of all the cryptocurrency, but then from P5 the excess return start rising, and from P8 to P13 it is the cryptocurrency with the second highest return and reaches 16,50% in P13. The three other cryptocurrencies; Bitcoin, Dogecoin and Litecoin have an excess return between 6-7% from P1 to P10 and from 7-12% from P11-P13. As mentioned, another interesting finding is that gold excess return decreases, the more percentage of investment you put in the portfolio. In P1 gold has an excess return at 6,18% and in P13 it is as low as 5,08%.



(Graph 6.1.1: Excess return of cryptocurrencies/gold P1 – P13, annualized)

However, it is not sufficient to only look at the excess return when considering an investment decision. The cryptocurrency market is extremely volatile, with huge up and downs. Therefore, it is essential to analyze the volatility of diverse investments.

6.1.2 Annual Standard Deviation

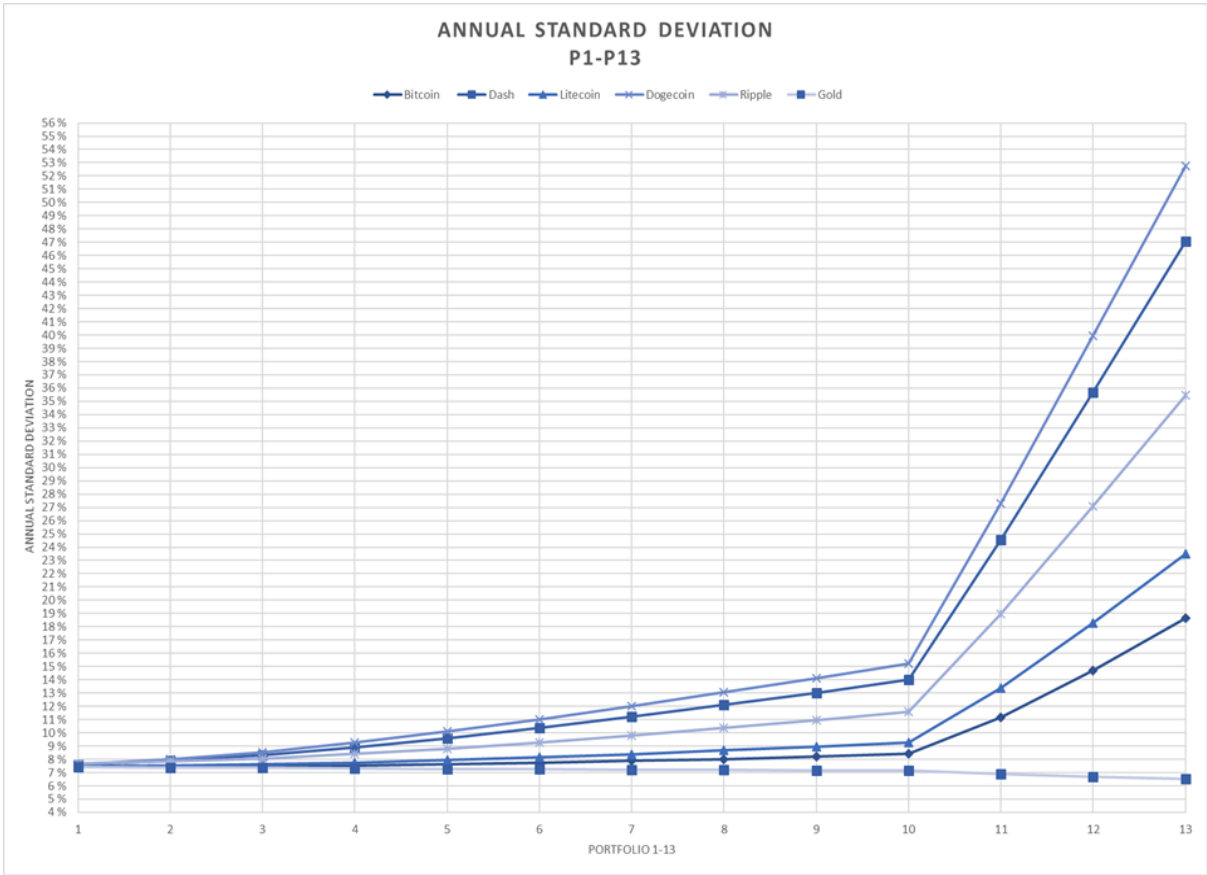
Standard deviation is a useful measurement for investigating the historical volatility of an investment. The standard deviation is measuring the dispersion of a dataset relative to its mean. The higher the standard deviation, the more volatile the investment is considered to be. The results are not unexpectedly: the more percentage of cryptocurrency invested in the portfolio, the higher the standard deviation. In other words, the more percentage you choose to invest, the higher the risk you are taking. In *table 6.1.2* you see the results on the standard deviation for the different cryptocurrencies and gold in the different portfolios.

STANDARD DEVIATION ANNUAL	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Bitcoin	7,43 %	7,44 %	7,48 %	7,54 %	7,63 %	7,74 %	7,87 %	8,03 %	8,20 %	8,40 %	11,14 %	14,71 %	18,63 %
Dash	7,58 %	7,89 %	8,34 %	8,92 %	9,60 %	10,37 %	11,21 %	12,09 %	13,02 %	13,99 %	24,54 %	35,70 %	47,05 %
Litecoin	7,47 %	7,52 %	7,62 %	7,76 %	7,94 %	8,15 %	8,39 %	8,66 %	8,96 %	9,28 %	13,38 %	18,27 %	23,47 %
Dogecoin	7,61 %	7,99 %	8,55 %	9,26 %	10,09 %	11,01 %	11,99 %	13,04 %	14,12 %	15,24 %	27,32 %	39,97 %	52,78 %
Ripple	7,67 %	7,83 %	8,08 %	8,41 %	8,81 %	9,28 %	9,80 %	10,36 %	10,96 %	11,60 %	18,97 %	27,10 %	35,46 %
Gold	7,41 %	7,38 %	7,35 %	7,32 %	7,28 %	7,25 %	7,22 %	7,19 %	7,16 %	7,13 %	6,88 %	6,68 %	6,55 %

(Table 6.1.2: Standard Deviation on cryptocurrencies/gold P1 – P13, annualized)

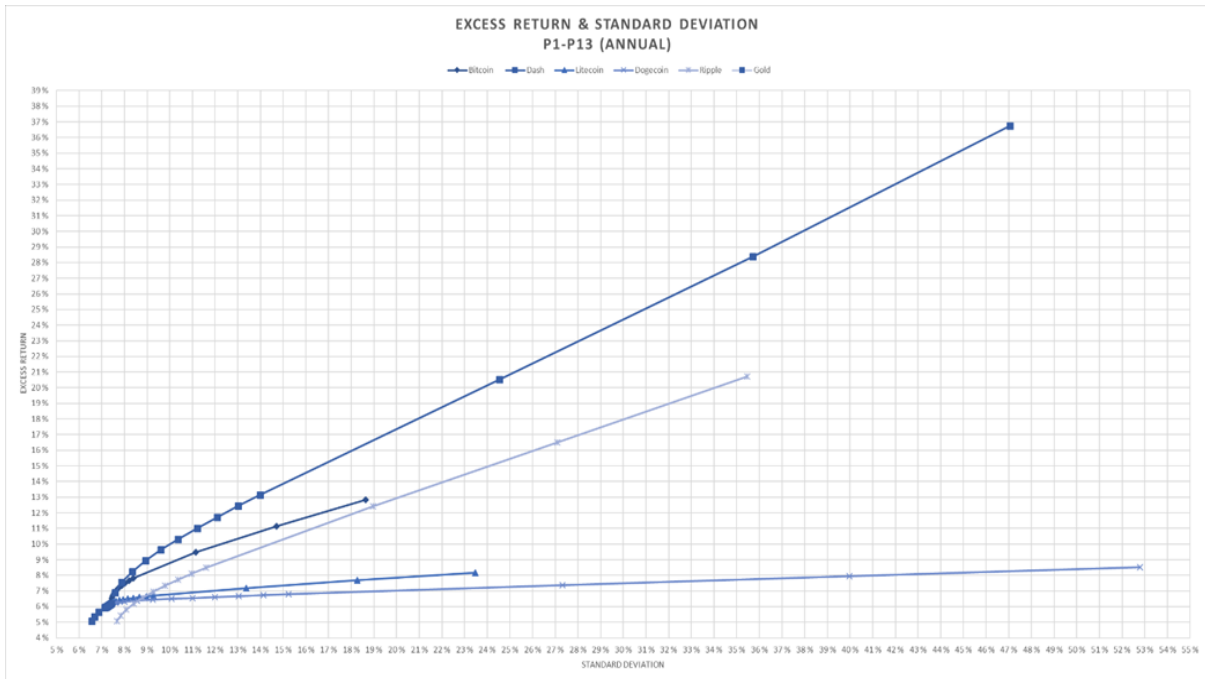
In graph 6.1.2A we see the results on the standard deviation of the diverse cryptocurrencies/gold in the different portfolios. All the cryptocurrencies have a linear increase in standard deviation the more percentages invested. The cryptocurrency with the overall highest standard deviation, in all portfolios (except P1) is Dogecoin which goes from 7,61% in P1 and increases to over 50% in P13. Moreover, Dash, which has the highest overall excess return in all portfolios, also has a remarkably high standard deviation with 7,58% in P1 and rises to 47,05% in P13. The results indicate that Dogecoin, Dash and Ripple are currencies which have data points spread out over a wider range of values, and therefore also are more volatile investments. Bitcoin and Litecoin are the ones with the lowest standard deviations among the cryptocurrencies with between 7-9% from P1-P10 and rises to between 11-23% from P11-P13.

Portfolios with gold performed opposite, the more percentage of gold, the lower the standard deviation and the less risk. Gold has a standard deviation of 7,41% in P1 and decreases to 6,55% in P13.



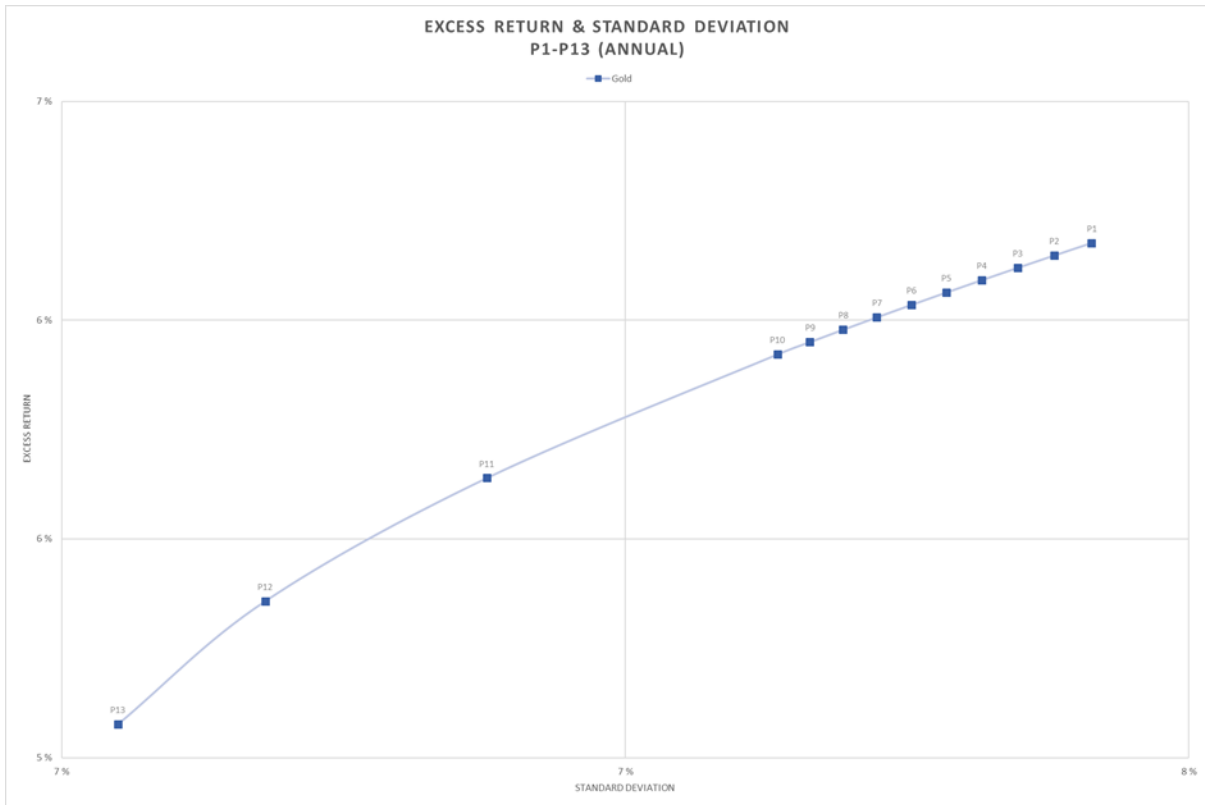
(Graph 6.1.2A: Standard Deviation of cryptocurrencies/gold P1 – P13, annualized)

By looking at the relationship between the excess return and standard deviation of the portfolios, it is observable that the higher percentage of cryptocurrency added in the portfolio, the higher the excess return is expected to be. Though, it is worth noticing that the risk also increases considerably.



(Graph 6.1.2B: Standard Deviation & Excess Return of cryptocurrencies/gold P1 – P13, annualized)

In graph 6.1.2C you get a closer look at the relationship of the excess return and standard deviation of gold. As mentioned, gold moves in the other direction, compared to cryptocurrencies. The higher percentage investment of gold in the standard portfolio, the lower excess return, and the lower standard deviation. In P1 gold has an excess return at 6,18% and standard deviation at 7,41%. In P13 the measurements are 5,08% in excess return and 6,55% in standard deviation.



(Graph 6.1.2C: Standard Deviation & Excess Return of gold P1 – P13, annualized)

6.1.3 Sharpe Ratio

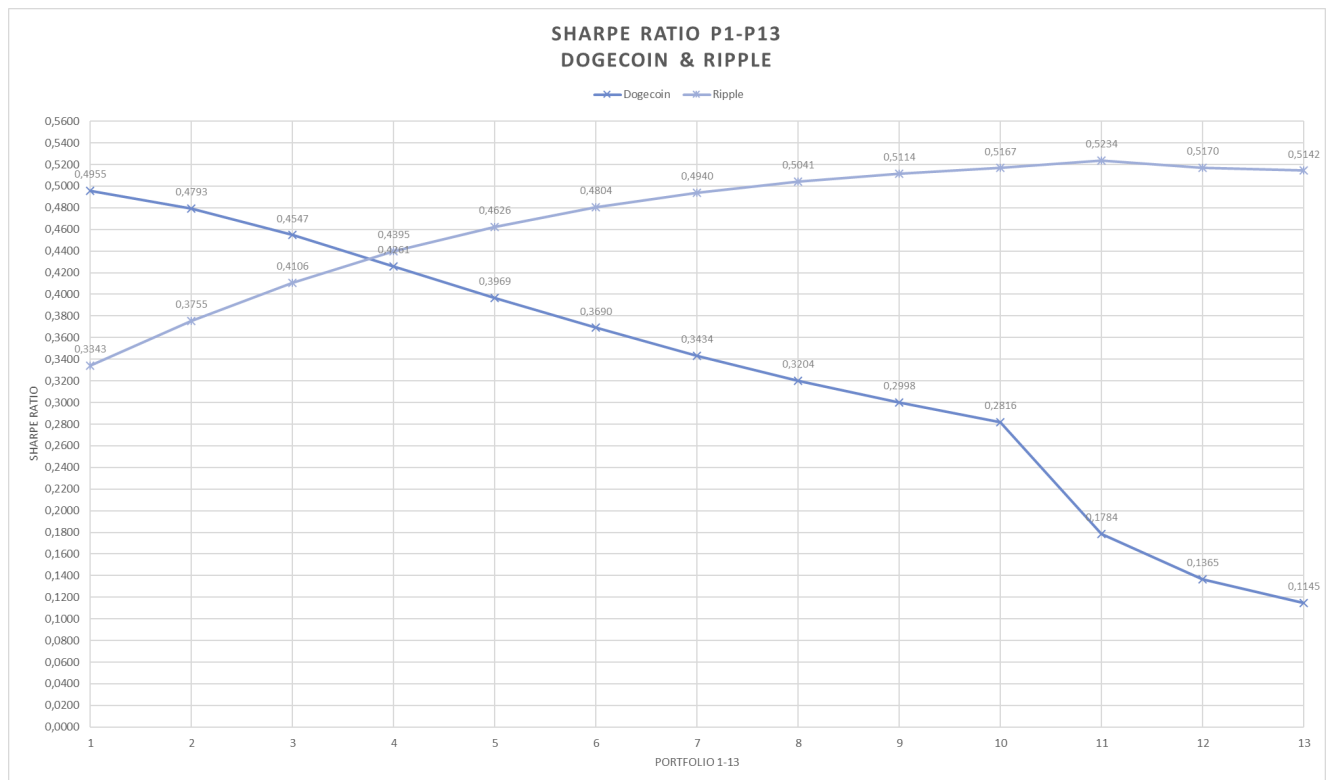
One of the main measurements we used to evaluate the portfolios performances was the Sharpe Ratio. The ratio makes it possible to calculate the risk-adjusted return of investment by looking at the risk, excess return and risk-free rate. The higher the Sharpe Ratio, the better the investment is considered to be.

Table 6.1.3 presents the results of the Sharpe Ratio for all the cryptocurrencies and gold in the different portfolios. The results show that all the cryptocurrencies have more or less the same ranking between “winners and losers” in all the portfolios.

SHARPE RATIO	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Bitcoin	0,5215	0,5425	0,5614	0,5783	0,5929	0,6054	0,6158	0,6242	0,6306	0,6354	0,6266	0,5883	0,5555
Dash	0,5789	0,6428	0,6898	0,7219	0,7425	0,7546	0,7609	0,7634	0,7634	0,7619	0,7352	0,7253	0,7280
Litecoin	0,5042	0,5067	0,5065	0,5038	0,4988	0,4920	0,4837	0,4742	0,4639	0,4532	0,3512	0,2841	0,2424
Dogecoin	0,4955	0,4793	0,4547	0,4261	0,3969	0,3690	0,3434	0,3204	0,2998	0,2816	0,1784	0,1365	0,1145
Ripple	0,3343	0,3755	0,4106	0,4395	0,4626	0,4804	0,4940	0,5041	0,5114	0,5167	0,5234	0,5170	0,5142
Gold	0,4973	0,4957	0,4940	0,4923	0,4905	0,4887	0,4869	0,4849	0,4830	0,4810	0,4579	0,4292	0,3949

(Table 6.1.3: Sharpe Ratio of cryptocurrencies & gold P1 – P13, annualized)

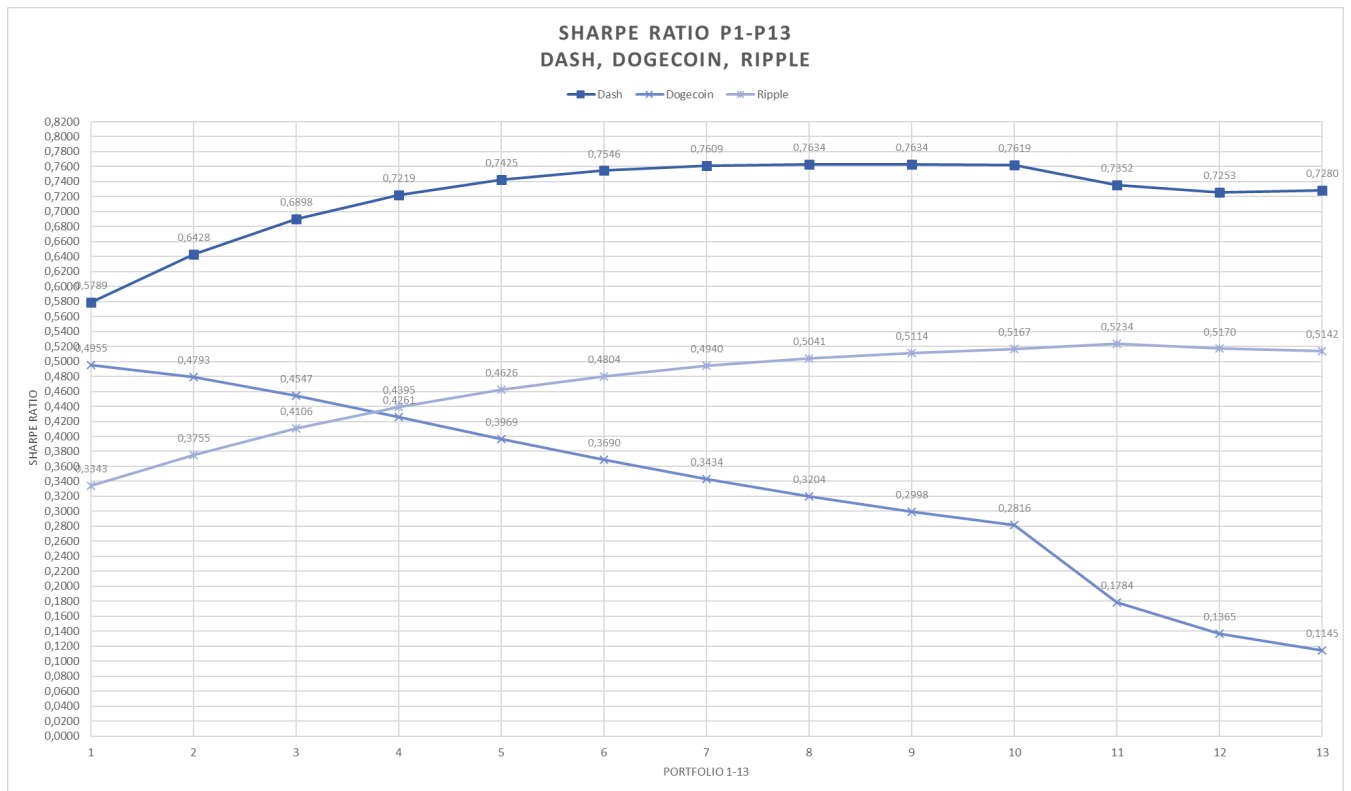
On the bottom in P1 to P3 we find Ripple, however from P4 and up to P13 it is Dogecoin that has the overall lowest Sharpe Ratio. The lowest Sharpe Ratio for Dogecoin is in P13 with a value at 0,1145. Based on the result, Dogecoin is the least promising investment judged by calculations from past performance of standard deviation and excess returns. *Graph 6.1.3A* show pattern of Dogecoin and Ripple’s Sharpe Ratio from P1 to P13.



(Graph 6.1.3A: Sharpe Ratio for Dogecoin & Ripple P1 – P13, annualized)

On top, with the highest Sharpe Ratio in all the portfolios and with the highest excess return, is Dash. Dash’s Sharpe Ratio has the lowest value in P1 with 0,5789 and the highest value in P8 with 0,7634.

If we compare the top, Dash, and the bottom, Dogecoin and Ripple (P1-P4), the results clearly show there is a vast difference between the Sharpe Ratio between them. *See graph 6.1.3B*. This demonstrates that when considering including cryptocurrency in an investment portfolio, it is important to do proper research on the different cryptocurrencies and how they perform in the market.



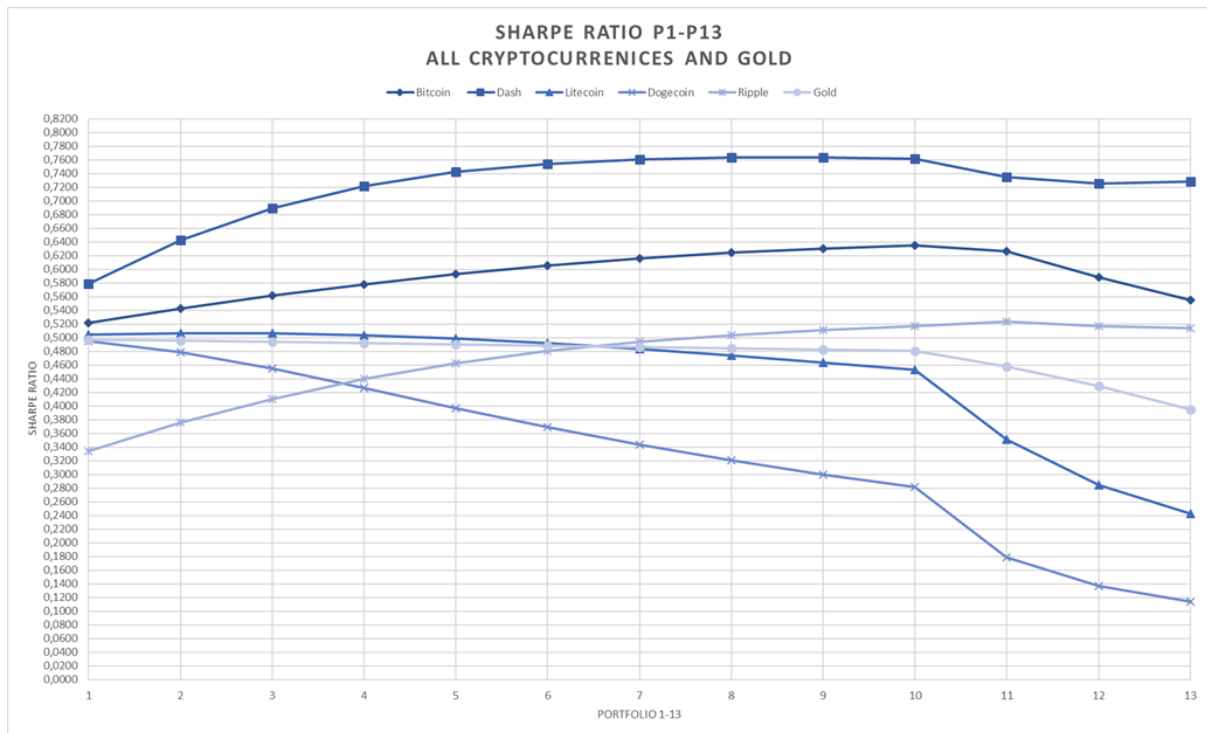
(Graph 6.1.3B: Sharpe Ratio for Dogecoin, Ripple & Dash P1 – P13, annualized)

In graph 6.1.3C below we see the result of the Sharpe Ratio of all the cryptocurrencies and gold, in all the portfolios. As mentioned, we find Dash as an obviously “winner” and Dogecoin as a clear “loser”. On the second-ranking from the top, we find Bitcoin which also has a notable Sharpe Ratio. An unpredictably finding is that gold has higher Sharpe Ratio measurements than Dogecoin.

Moreover, one of the most interesting results to take further from this graph is that all the cryptocurrencies and gold have their highest value of Sharpe Ratio in different portfolios. For both Dogecoin and Gold, the optimal percentage of investment is in P1 with 0,5% investment in cryptocurrency/gold. Litecoin has its highest Sharpe Ratio in P2 with the value 0,5067, Ripple in P11 with 0,5234 and Bitcoin in P10 with a value of 0,6354. As mentioned, Dash is the cryptocurrency with the highest Sharpe Ratio in all portfolios and the optimal percentage of Dash in a standard portfolio, based on Sharpe Ratio, is in P8 with 4% investment in cryptocurrency.

Another interesting finding is that the lowest value of Sharpe Ratio among the cryptocurrencies is also spread in different portfolios. Dash has its lowest Sharpe Ratio in P1

with 0,5789, while Dogecoin has its lowest value in P13 with 0,1145. Moreover, this means that there is no notable relationship between the measurements of the Sharpe Ratio for the different cryptocurrencies and how they are performing in the different portfolios. In other words, by considering adding cryptocurrency or gold to a standard portfolio, each cryptocurrency and gold need to be analyzed individually based on their level of risk and return.



(Graph 6.1.3C: Sharpe Ratio All Cryptocurrencies/Gold: P1 – P13, annualized)

Based on the Sharpe Ratio, the results indicate that 4% investment in Dash is optimal to add in a standard portfolio with stocks and bonds. If investing 4% in Dash (P8), you can expect to get an excess annual return at 11,7%.

6.1.4 CAPM & Jensen's Alpha

Furthermore, we analyzed the Capital Asset Pricing Model (CAPM) and Jensen's Alpha. To calculate CAPM and Jensen's alpha we first calculated the beta on each portfolio based on their weights on investment in the different markets: stocks, bonds, cryptocurrency, and gold. The beta tells us the volatility of the systematic risk of the assets compared to the

unsystematic risk of the entire market. The beta can help us to understand how the assets, or in this case the different portfolios, moves in the same direction as the rest of the market, and how volatile or risky it is compared to the market. The benchmark we used for the beta calculation is the S&P 500.

A beta of 1 means that the portfolios respond to the market volatility in tandem with the market, on average. A beta less than 1, means that the portfolios are less responsive to market risks. In table 6.1.4A we see the results of the betas for the overall portfolio with the different cryptocurrencies and gold.

CAPM	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Bitcoin	0,04016	0,04014	0,04013	0,04012	0,04010	0,04009	0,04008	0,04006	0,04005	0,04004	0,03990	0,03977	0,03964
Dash	0,04016	0,04015	0,04013	0,04012	0,04011	0,04010	0,04009	0,04007	0,04006	0,04005	0,03993	0,03980	0,03968
Litecoin	0,04016	0,04015	0,04014	0,04012	0,04011	0,04010	0,04009	0,04008	0,04007	0,04005	0,03994	0,03982	0,03970
Dogecoin	0,04016	0,04015	0,04013	0,04012	0,04011	0,04010	0,04008	0,04007	0,04006	0,04005	0,03992	0,03980	0,03968
Ripple	0,04016	0,04015	0,04014	0,04012	0,04011	0,04010	0,04009	0,04008	0,04007	0,04005	0,03994	0,03982	0,03970
Gold	0,04012	0,04006	0,04001	0,03995	0,03990	0,03985	0,03979	0,03974	0,03968	0,03963	0,03909	0,03855	0,03801

JENSENS	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Bitcoin	0,0540	0,0556	0,0572	0,0588	0,0604	0,0620	0,0637	0,0653	0,0669	0,0685	0,0848	0,1014	0,1182
Dash	0,0592	0,0659	0,0728	0,0796	0,0865	0,0935	0,1005	0,1075	0,1146	0,1217	0,1954	0,2739	0,3573
Litecoin	0,0529	0,0534	0,0539	0,0543	0,0548	0,0553	0,0558	0,0562	0,0567	0,0572	0,0620	0,0668	0,0717
Dogecoin	0,0536	0,0541	0,0547	0,0553	0,0558	0,0564	0,0570	0,0575	0,0581	0,0639	0,0696	0,0753	-0,0101
Ripple	0,0409	0,0447	0,0484	0,0522	0,0560	0,0598	0,0636	0,0674	0,0712	0,0751	0,1144	0,1550	0,1971
Gold	0,0521	0,0517	0,0514	0,0511	0,0507	0,0504	0,0501	0,0497	0,0494	0,0490	0,0457	0,0423	0,0390

BETA	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Bitcoin	0,2322	0,2320	0,2318	0,2316	0,2314	0,2312	0,2310	0,2308	0,2306	0,2304	0,2283	0,2263	0,2243
Dash	0,2322	0,2320	0,2318	0,2316	0,2315	0,2313	0,2311	0,2309	0,2307	0,2305	0,2287	0,2268	0,2250
Litecoin	0,2322	0,2320	0,2319	0,2317	0,2315	0,2313	0,2311	0,2310	0,2308	0,2306	0,2288	0,2270	0,2253
Dogecoin	0,2322	0,2320	0,2318	0,2316	0,2314	0,2313	0,2311	0,2309	0,2307	0,2305	0,2286	0,2267	0,2249
Ripple	0,2322	0,2320	0,2318	0,2317	0,2315	0,2313	0,2311	0,2310	0,2308	0,2306	0,2288	0,2270	0,2252
Gold	0,2316	0,2307	0,2299	0,2291	0,2283	0,2274	0,2266	0,2258	0,2250	0,2242	0,2159	0,2077	0,1995

(Table 6.1.4A: CAPM, Jensen's alpha and Beta for all the portfolios)

Overall, in all portfolios and for all the different cryptocurrencies and gold, the beta is under 1. In other words, this means that the portfolios are less responsive to the benchmark (S&P 500) risk. There are none of the cryptocurrencies that particularly stands out, and the beta is more or less the same for all in the different portfolios. However, it is worth noticing that gold has an overall lower beta compared to the cryptocurrencies.

In this part of the thesis, we calculated the weighted beta for each of the portfolios. In table 6.1.4B we see the results on the different financial assets correlation with the S&P 500. As we can see from the table, there is a weak positive correlation between the stock market and Dash, Litecoin, Dogecoin, and Ripple, but it is close to zero, so we would evaluate them to be more or less non-correlated with the market. The same applies to Bitcoin, who has a weak negative correlation. However, the Bond market and the gold market has a more significant negative correlation with the stock market, which means that if the stock market increases by

1, the bond market (AGG) decreases by 0,21 and the gold market decreases by 0,11 in average.

Correlation with S&P 500	
Bonds	-0,2104
Bitcoin	-0,0013
Dash	0,0602
Litecoin	0,0423
Dogecoin	0,0578
Ripple	0,0626
Gold	-0,1194

(Table 6.1.4B: Correlation with the market)

Beta is used in the capital asset pricing model (CAPM), which calculated the expected return of an asset using beta and expected market returns.

CAPM describes the relationship between systematic risk and expected return for assets. The model is calculating the expected return on an asset based on its level of risk. The required rate of return is the increase in value you should expect to see based on the inherent risk level of the assets (Investopedia, 2019a). Using this measure of risk can, in theory, allow investors to improve their portfolios to find their required rate of return. Based on the results in *table 6.1.4A* Litecoin and Ripple are the assets that perform best in all the portfolios with the CAPM model, and gold is the one with the lowest overall scores.

To more precisely analyze the performance, we also need to take a look at the risk of the portfolios to see if the investments return compensates for the risk it takes. Jensen's Alpha is one of the measurements who determine if a portfolio is earning the proper return for its level of risk. It is a risk-adjusted performance measure, who represents the average return on the portfolios, above or below that predicted by the capital asset pricing model (CAPM) (Investopedia., 2019).

If the value for Jensen's alpha is positive, it means that it has "beaten the market", and the higher alpha, the better the investment is. Based on the result in *table 6.1.4A* Dash is the asset with the highest alpha in all portfolios. The alpha increases the more percentage of Dash that is put into the portfolios and the results go from 0,0592 in P1 to 0,3573 in P13. Other assets who perform well in all portfolios are Ripple and Bitcoin. In the middle we find gold, and on

the bottom are Dogecoin and Litecoin. These results are consistent with the results of the Sharpe Ratio, where we also found Dash as the top performer.

6.1.5 Conclusion Portfolio Performance

Some investors mistakenly base the success of their portfolios on returns alone. It is an essential part when doing an investment decision, to also consider the risks involved by achieving those returns. In this part of the thesis, we have been analyzing thirteen different compositions of portfolios and measured both risks and return together. We have been studying how the results on return and risk are changing when adding a different percentage of various cryptocurrencies and gold to the portfolios. The purpose was to discover what might be the optimal percentage of cryptocurrency/gold, and which asset would be the most favorable one.

Today, there are diverse measurement models that are used to measure risk and return performance into a single value. In this part, we have been using Sharpe Ratio, CAPM and Jensen's alpha. The Sharpe Ratio examine average return for the total period under the consideration for all variables in the formula (the portfolio, market, and risk-free rate) (Sharpe, 1964). However, CAPM and Jensen's alpha calculate risk premiums in terms of beta (systematic, undiversifiable risk), and therefore, assumes the portfolio is already sufficiently diversified. Since CAPM and Jensen's only take in consideration the systematic risk, we find the Sharpe ratio as the most representative model, when evaluating the portfolios, because it considers the volatility associated with the excess return.

Based on the different models that have been studied and the results, we will conclude that each cryptocurrency and gold have different optimal portfolios. For two of the cryptocurrencies and gold, we recommend following a low percentage of investment. P1 with 0,5% is optimal for Dogecoin and Gold, and P2 with 1% for Litecoin. However, for Bitcoin, Ripple and Dash it is better to invest a higher percentage of cryptocurrency. Bitcoin has its optimal portfolio in P10 with 5% and Ripple in P11 with 10%. The optimal portfolio for Dash is P9 with a 4% investment.

Furthermore, the asset who is the best performer based on Sharpe ratio measurement is Dash. In all portfolios, Dash has a remarkable high Sharpe Ratio compared to the other assets. Dash

is also scoring highest in the Jensen's alpha measurements. To sum up, we will conclude that the optimal portfolio is P8 with a 4% investment in Dash. The reason for this conclusion is that we have considered Sharpe Ratio to be the most representative model of calculating the risk-adjusted returns.

However, there is no huge difference in the Sharpe Ratio for Dash from P1-P13, which makes it possible for risky investors to also consider investments with a higher percentage of cryptocurrency. Yet, the cryptocurrency market is still a speculative market with a high degree of uncertainty for the future, so precautions should be considered.

Moreover, research done by Brauneid and Mestel finds that by diversifying the investments with several cryptocurrencies in the same portfolio, reduces the risks of the investments (Kajtazi A., 2018). We have not been analyzing this in our thesis, but in part two, we will take a closer look at the risk associated directly with the different cryptocurrencies and gold, as well as analyze different investment strategies.

6.2 STRATEGIES

To analyze each cryptocurrency as well as gold and evaluate how they would perform compared to the market, we interpret momentum strategy and a buy-and-hold strategy. These strategies are widely used in the currency market. We used weekly data here as well, and for comparison reasons, we calculated on the momentum strategy on monthly, quarterly and annually additionally.

In this segment of the thesis we answer this part of the research problem:

“Examine which of momentum and buy-and-hold strategy is the ideal approach, when investing in cryptocurrency.”

To address the research problem, we apply a technical approach to evaluate the two strategies. By looking at the relationship between volatility and excess return we analyze the different strategies for each cryptocurrency, gold, stocks and bonds. We investigate all securities in isolation and compare them with each other to find the most efficient investment strategy for each of them individually.

6.2.1 Momentum Strategy

Momentum strategy is one of the most investigated investment strategies within the financial field. The essence of the strategy is to hold the assets that have remarkable historical return and shorting those who had a low historical return. Momentum is a strategy that has existed in a long time and has proved to be very efficient, not only for traditional assets, but also for currencies (Rohrbach, Suremann, & Osterrieder, 2017).

After implementing the momentum strategy, we evaluated the performance of the historical return, by finding the excess return, volatility and Sharpe ratio. To find the expected return we calculated Jensen's alpha and CAPM, and to confirm that the results are representative we looked at the Skewness and Kurtosis. With the momentum analysis, we figured out when the investment was positive and when it was negative. In this case, we only wanted to invest in the cryptocurrencies/gold if they presented a positive return.

MOMENTUM								
2014	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,018	0,002	0,039	0,234	0,035	0,190	-	0,007
Annual return	0,638	0,057	1,297	53,379	0,798	31,431	-	0,174
Variance	0,0001	0,00001	0,009	0,183	0,005	0,191	-	0,0001
St.dev Annual	0,058	0,013	0,439	1,866	0,283	1,953	-	0,047
Sharpe Ratio	0,206	-1,787	1,241	53,366	0,710	31,418	-	3,137
2015	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,008	0,002	0,037	0,079	0,058	0,039	0,048	0,006
Annual return	0,286	0,051	2,189	5,174	3,894	1,397	1,778	0,155
Variance	0,0001	0,00001	0,002	0,035	0,013	0,004	0,010	0,0001
St.dev Annual	0,056	0,013	0,262	0,920	0,615	0,295	0,470	0,050
Sharpe Ratio	4,666	2,062	8,245	5,598	6,294	4,656	3,727	2,588
2016	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,007	0,002	0,031	0,053	0,023	0,063	0,035	0,009
Annual return	0,270	0,056	1,749	3,061	0,915	2,408	1,295	0,274
Variance	0,0001	0,00001	0,002	0,009	0,001	0,019	0,004	0,0002
St.dev Annual	0,051	0,013	0,247	0,486	0,179	0,618	0,302	0,067
Sharpe Ratio	4,815	2,344	6,976	6,249	4,966	3,858	4,201	3,747
2017	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,005	0,002	0,087	0,129	0,115	0,147	0,167	0,008
Annual return	0,170	0,061	19,169	61,182	31,361	45,231	34,066	0,270
Variance	0,00003	0,000004	0,009	0,027	0,032	0,052	0,119	0,0001
St.dev Annual	0,032	0,012	0,563	0,953	1,006	1,202	1,657	0,051
Sharpe Ratio	4,528	2,951	33,978	64,200	31,137	37,617	20,543	4,784
2018	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,008	0,002	0,034	0,037	0,036	0,055	0,056	0,004
Annual return	0,234	0,043	1,150	1,004	1,269	1,350	2,524	0,105
Variance	0,0001	0,00001	0,003	0,007	0,005	0,017	0,016	0,00005
St.dev Annual	0,059	0,014	0,282	0,372	0,346	0,514	0,599	0,034
Sharpe Ratio	3,544	1,308	3,993	2,635	3,597	2,577	4,172	2,365

(Table 6.2.1A: Calculation of the momentum strategy, for each financial asset)

When calculating the annual excess return, we used the average number of weeks that were positive (when we invest) throughout the five years. To annualize the standard deviation, we multiplied it with the square root of the number of weeks.

The Sharpe ratio for the cryptocurrencies has an interesting development throughout the five years. Starting with bonds which have had a gradual increase in the Sharpe ratio until the end of 2017. Not surprisingly bonds, as well as the other securities, has a substantial decrease in Sharpe ratio in 2018, caused by various macroeconomic factors (more details in 7. *speculative bubbles*). The low-interest rate and America's conflict with China are two of many explanatory factors that affected the downturn in the U.S. Aggregate bonds. All of the cryptocurrencies have a significant increase in both the excess return and volatility in 2017. This increase led to outstanding Sharpe ratios, where the excess returns of each cryptocurrency have a record high number of positive weeks, compared to the other four years. When analyzing this momentum strategy for each of the securities, it is noteworthy to recognize the variance and standard deviation. The volatility is extremely low for the S&P 500, U.S. Aggregate bonds and gold, compared to the cryptocurrencies. When evaluating these outcomes, it is important to remember that investors' interpretations differ as regards to if they are risk-averse or risk seeking.

Momentum	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,007	0,002	0,046	0,105	0,054	0,097	0,077	0,007
Annual return	0,243	0,054	2,676	10,537	2,833	6,292	4,508	0,192
Variance	0,00009	0,00001	0,005	0,054	0,012	0,057	0,040	0,0001
St.dev Annual	0,053	0,013	0,394	1,155	0,560	1,102	0,958	0,051
Sharpe Ratio	4,124	2,188	6,732	9,100	5,014	5,686	4,680	3,247

(Table 6.2.1B: Calculating the Sharpe ratio of momentum strategy, all five years)

With momentum strategy, the annual excess return for bonds is at 5,4% throughout the five years. Bitcoin has the lowest excess return of the cryptocurrencies, with an annual return at 267,6%. All of the cryptocurrencies have a much higher excess return compared to the traditional assets. Dash has the highest overall annual excess return, at 1053,7%.

As represented in table 6.2.1B and 6.2.1C it is clear that the cryptocurrencies, based on the Sharpe ratio, outperformed both bonds and gold overall in the five years. The main reason is that they yield a much higher expected return compared to standard investments such as stocks and bonds. From the few currencies we have used in our thesis there is a clear

difference between them. Based on William Sharpe's theory, the higher the Sharpe ratio is, the better, so by looking exclusive at the results from Sharpe ratio we can determine that the cryptocurrency Dash has outperformed all of the other financial assets with an overall Sharpe ratio at 9,1 (*table 6.2.1B*). All of the investments have acceptable Sharpe ratio.

MOMENTUM	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Excess return	0,243	0,054	2,676	10,537	2,833	6,292	4,508	0,192
Standard deviation	0,053	0,013	0,394	1,155	0,560	1,102	0,958	0,051
Sharpe Ratio	4,124	2,188	6,732	9,100	5,014	5,686	4,680	3,247
CAPM		-0,175	0,025	0,02562	0,02595	0,0255	0,0259	-0,002
Jensen's		-0,172	2,651	10,513	2,809	6,268	4,484	0,140
Skewness	2,089	-0,012	2,746	3,436	3,498	4,700	5,398	1,748
Kurtosis	6,320	2,163	11,578	12,933	15,163	29,030	38,281	2,851

(Table 6.2.1C: Overview of measurements of the momentum strategy for each currency)

When Jensen's alpha is positive it means that the investment is performing better than the market. All the cryptocurrencies and gold have positive alphas, but alpha for bonds is negative. The clearest explanation for this is that the beta for bonds over the past five years is -0,919. The beta is estimated for each of the cryptocurrency, bonds and gold separately, with buy-and-hold. We calculated the beta by using the slope function, *in excel*, between the market and each currency:

Security	Beta
Stocks	1
Bonds	-0,9190
Bitcoin	-0,0002
Dash	0,0033
Litecoin	0,0048
Dogecoin	0,0028
Ripple	0,0047
Gold	-0,1241

(Table 6.2.1D: Beta for each financial asset)

Jensen's alpha is a systematic risk-adjusted measurement, which gives us a representative evaluation of the expected return. Not only has Dash the highest Sharpe ratio with momentum strategy it also has the highest alpha and highest expected return of the investment. CAPM is a measurement of the ratio between the excess return and systematic risk. We included this index to back up our findings from Jensen's (*Table 6.2.1C*). This formula calculates the expected return of an investment with the market risk premium, risk-free rate and the beta of the investment. An important part of CAPM is beta since the rest of

the formula consists of measurement of the market, it is important to include the correlation of the investment with the market. As showed earlier (*table 6.2.ID*) it is clear that the cryptocurrencies have a very low beta, which means they are barely correlated with the market.

	<i>Stocks</i>	<i>Bonds</i>	<i>Bitcoin</i>	<i>Dash</i>	<i>Litecoin</i>	<i>Dogecoin</i>	<i>Ripple</i>	<i>Gold</i>
<i>Stocks</i>	1							
<i>Bonds</i>	-0,2104	1						
<i>Bitcoin</i>	-0,0013	0,0481	1					
<i>Dash</i>	0,0602	0,0382	0,0737	1				
<i>Litecoin</i>	0,0423	0,0447	0,5871	0,1112	1			
<i>Dogecoin</i>	0,0578	0,0489	0,3012	0,0771	0,2920	1		
<i>Ripple</i>	0,0626	-0,0578	0,0130	0,0044	0,0620	0,0683	1	
<i>Gold</i>	-0,1194	0,4824	-0,0604	0,0502	-0,0350	-0,0042	0,0886	1

(*Table 6.2.IE: Correlation matrix between each currency and the market*)

As assurance we calculated the correlation of each cryptocurrency and gold with the market, to make sure our assumption about beta being near zero were realistic. Cryptocurrencies have such a high risk and because of this, it is important for our analysis that they are uncorrelated with our standard portfolio. Since CAPM and Jensen’s alpha does not take into consideration investments unsystematic risk, we put most of our focus on the Sharpe ratio.

As a reward for taking a high risk, you get a higher return. The excess return for especially Dash and Dogecoin is impressive, but with great excess return comes great volatility. The Skewness for every investment is above zero and even here the cryptocurrencies are proven to be the most profitable purchase. A positive Skewness means that the tail is on the right side and that the median is greater than the mode. In other words, a Skewness higher than zero represents that the expected excess return is most likely to be higher than the mean return. Kurtosis with value zero shows that the data is normally distributed. In our calculations, the Kurtosis is positive on all financial assets. This indicates that the distribution has heavier tails than a normal distribution. The higher the Kurtosis, the steeper the curve is, which means higher variation in the volatility. In *table 6.2.IC* we can see that Ripple has the largest uncertainty when evaluating volatility, which is represented by the large measurement of Kurtosis.

6.2.2 Momentum Monthly

In addition to evaluating the momentum strategy for weekly data, we calculated on monthly, quarterly and annually as well, to find out to which degree of momentum strategy is the most efficient for investors. We start by looking at the monthly momentum strategy.

Momentum Monthly	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,016	0,004	0,102	0,226	0,118	0,166	0,196	0,014
Annual return	0,126	0,028	0,867	1,884	0,670	1,154	1,044	0,078
Variance	0,0004	0,00003	0,020	0,161	0,056	0,107	0,194	0,001
St.dev Annual	0,054	0,014	0,356	0,915	0,507	0,731	0,882	0,056
Sharpe Ratio	1,888	0,186	2,364	2,031	1,271	1,546	1,156	0,942

(Table 6.2.2A: Monthly momentum)

When calculating on the monthly momentum strategy we used the weekly data on a monthly basis, in other words, we calculated the average monthly return and then used the *if function* in *excel* where we wanted to invest in the cryptocurrencies/gold if they gave a positive return the month before.

If the cryptocurrencies/gold delivered a positive excess return the month before, we wanted to invest, and if not, we did not want to invest (zero value). After finding when the average excess return was positive, we calculated the annual return over the five years, the volatility and Sharpe ratio. We investigated when the excess return was positive and used the number of weeks positive to calculate the return and volatility from monthly to annually, for all five years.

By looking at the excess return of monthly momentum the average annual return is positive for all of the assets. The cryptocurrencies have higher excess return than standard financial investments. *Table 6.2.2A* shows that Dash has the highest excess return, like the results from weekly momentum, but there is a significant difference between the excess return on a weekly and monthly basis. In weekly momentum Dash has an excess return at 1053,7% and in monthly the excess return drops to 188,4%. A drop is common for all of the cryptocurrencies; Dogecoin with the second highest excess return in weekly with 629,2% drops to 115,4%, Ripple goes from 450,8% to 104,4% with monthly momentum. For the more traditionally assets the excess return for stocks drops from 24,3% to 12,6%, bonds from 5,4% to 2,8% and gold drops from 19,2% to 7,8%.

The volatility increases for stocks, bonds and gold from weekly to monthly. Not only does the excess return decrease, but the risk of the investments also becomes higher. Stocks volatility increases from 53% to 54%, bonds from 13% to 14%, and gold from 5,1% to 5,6%. Volatility for the cryptocurrencies, on the other hand, declines; Dash goes from having a standard deviation of 115,5% to a standard deviation of 91,5%.

From *table 6.2.2A* when comparing the Sharpe ratios of the investments, it is clear that cryptocurrencies still outperform the standard investments. When trading cryptocurrency with monthly momentum strategy it is Bitcoin that comes out as the best, with a Sharpe ratio at 2,36. All of the financial investments have a decline in Sharpe ratio when investing based on monthly momentum compared to weekly, and Dash has the steepest drop from 9,1 to 2,0. Even the traditional investments have a downturn in Sharpe ratio, where stocks drop from 4,1 to 1,9, bonds from 2,2 to 0,2 and gold from 3,2 to 0,9.

6.2.3 Momentum Quarterly

Momentum Quarterly	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Annual return	0,00911	0,00177	0,02915	0,14000	0,04020	0,04803	0,04770	0,00405
Variance	0,00001	0,000001	0,00067	0,00507	0,00178	0,00300	0,00374	0,00001
St.dev Annual	0,00443	0,00269	0,03472	0,11476	0,05654	0,07348	0,07232	0,00416
Sharpe Ratio	-3,56432	-8,60208	0,12242	1,00295	0,27053	0,31483	0,31524	-5,00823

(Table 6.2.3: Momentum quarterly)

In this chapter, we investigated quarterly momentum strategy. Like in 6.2.2 and 6.2.3 when evaluating the momentum strategy, we proceeded from weekly data. With help from the *IF function* in excel, we found how often the quarterly excess return was positive and from here chose to invest when the currencies gave a positive return. When comparing quarterly with monthly and weekly the excess return decreases even more. When using quarterly momentum strategy Dash has an annual excess return of 14%, Litecoin, Dogecoin and Ripple has around 4% and Bitcoin has only 2,9%. As for the traditional assets, stocks have the highest excess return, 0,9%, gold has 0,4% and bonds have 0,18%.

As for the volatility, the risk decreases even more in quarterly momentum compared to monthly and weekly. For comparison, we see that Dash has 11,5% in weekly standard

deviation, whereas in monthly the standard deviation was 91,5%. With quarterly momentum strategy Dash has the highest Sharpe ratio, the only currency with a ratio higher than 1. The Sharpe ratio for stocks, bonds and gold are negative. A negative Sharpe ratio is usually caused by an excess return lower than the risk-free rate used in our thesis (2,49%).

6.2.4 Momentum Annually

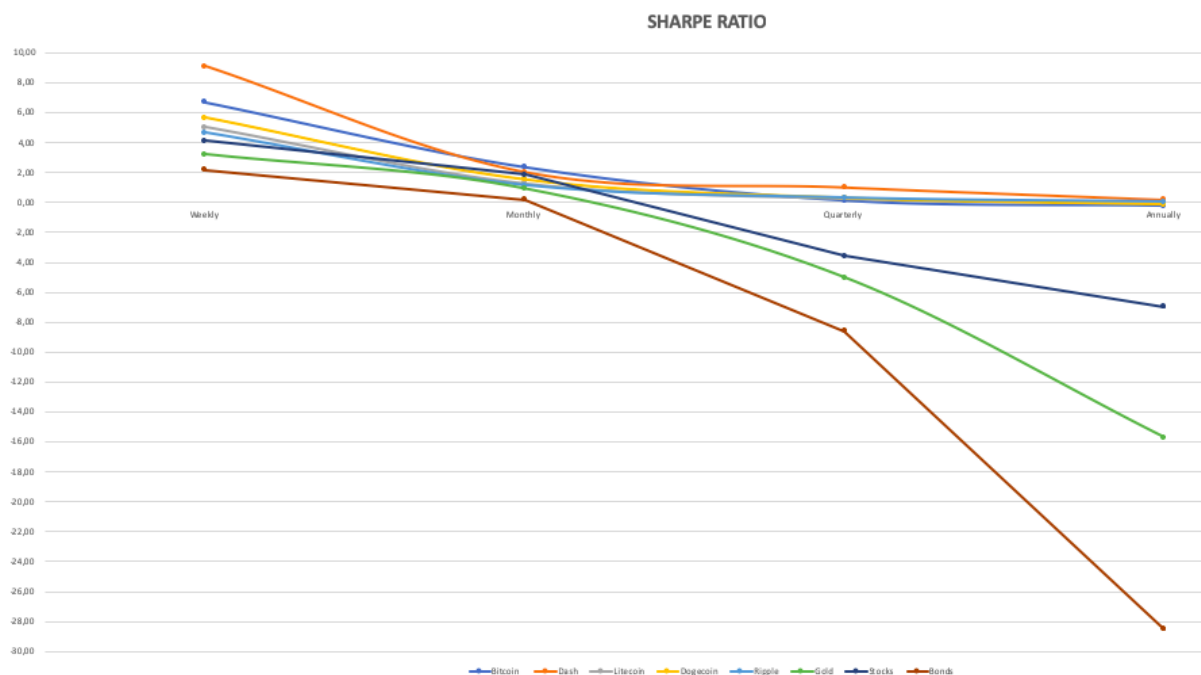
Momentum Annually	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Annual return	0,00200	0,00043	0,01583	0,03687	0,01961	0,01797	0,02857	0,00074
Variance	0,0000027	0,0000002	0,00053	0,00124	0,00124	0,00134	0,00298	0,000001
St.dev Annual	0,00329	0,00086	0,03989	0,07041	0,06089	0,06345	0,07723	0,00154
Sharpe Ratio	-6,95950	-28,49425	-0,22739	0,17000	-0,08696	-0,10923	0,04749	-15,71762

(Table 6.2.4: Momentum annually)

With annually momentum strategy the excess return for each of the currencies, as well as stocks, bonds and gold, is less than with quarterly, monthly or weekly momentum. The volatility keeps decreasing further and the Sharpe ratio is negative for all of the assets, except Dash and Ripple.

Comparing this with quarterly and annually it is clear that if investors want to use the momentum approach, they should use it on a weekly basis (*see graph 6.2.4*). Not only does the cryptocurrencies have a decline in the Sharpe ratio when investing with longer time in between the investments with momentum, but so does the standard assets. Even though there is a significant drop in the standard deviation per investment, the excess return, in all of them, has a drastic drop as well.

Looking at the Sharpe ratio, Dash stays at the top throughout all of the momentum strategies except in monthly, where it is beaten by Bitcoin by a small number. The explanation of why Bitcoin here is higher than Dash is in the volatility. In monthly momentum, the standard deviation for Bitcoin is 0,356, and 0,915 for Dash.



(Graph 6.2.4: Sharpe ratio of the momentum strategies)

As a conclusion concerning the momentum strategy, the most efficient approach is to apply this strategy on a weekly basis, whereas all of the investments have acceptable Sharpe ratios. Ripple has a good average excess return in the annual approach, but after involving the volatility, the Sharpe ratio lands at 0,05. Dash has proven to outperform the other financial investments in momentum strategy, with a remarkable excess return, whether we are evaluating it weekly, monthly, quarterly or annually. The optimal approach is Dash with weekly momentum strategy, whereas the average excess return is so high that even if the standard deviation is at 115,5%, the Sharpe ratio is still positive and at 9,1.

6.2.5 Buy-and-hold Strategy

Unlike the momentum strategy, the buy-and-hold strategy is a passive- long-lasting investment approach. Investors who act based on this strategy hold on to their securities regardless of market fluctuations and invest in the long-term.

When looking at the results from the buy-and-hold strategy for each currency, we used the same formulas as for momentum, so we could easily compare them. In this strategy, we used weekly data and started by calculating the excess return, volatility, Sharpe ratio, CAPM,

Jensen's, skewness and kurtosis. Like in the momentum strategy we investigated each of the currencies and standard investments isolated and compare them to one another.

BUY-AND-HOLD								
2014	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,003	0,001	-0,019	0,056	-0,050	-0,038	-	-0,001
Annual return	0,169	0,053	-0,631	16,356	-0,932	-0,869	-	-0,033
Variance	0,0003	0,00001	0,029	0,408	0,023	0,528	-	0,0003
St.dev Annual	0,124	0,025	1,219	4,605	1,099	5,242	-	0,127
Sharpe Ratio	1,159	1,141	-0,538	3,546	-0,871	-0,171	-	-0,457
2015	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,001	-0,0001	0,010	0,013	0,015	0,002	-0,024	-0,002
Annual return	0,027	-0,004	0,681	0,958	1,115	0,126	-0,720	-0,115
Variance	0,001	0,00002	0,007	0,062	0,024	0,010	0,025	0,0003
St.dev Annual	0,160	0,031	0,587	1,802	1,122	0,719	1,143	0,130
Sharpe Ratio	0,016	-0,941	1,118	0,518	0,971	0,140	-0,652	-1,078
2016	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,003	0,0005	0,014	0,027	0,002	0,004	0,004	0,001
Annual return	0,137	0,024	1,010	3,093	0,108	0,240	0,220	0,068
Variance	0,0002	0,00002	0,005	0,013	0,005	0,040	0,008	0,0005
St.dev Annual	0,107	0,034	0,484	0,825	0,501	1,446	0,636	0,151
Sharpe Ratio	1,040	-0,024	2,035	3,718	0,165	0,149	0,306	0,285
2017	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,004	0,001	0,056	0,087	0,082	0,083	0,110	0,002
Annual return	0,207	0,031	15,671	77,219	57,946	63,509	231,168	0,127
Variance	0,00004	0,00001	0,020	0,047	0,043	0,087	0,152	0,0003
St.dev Annual	0,047	0,025	1,016	1,560	1,501	2,122	2,815	0,113
Sharpe Ratio	3,894	0,253	15,403	49,495	38,594	29,916	82,125	0,905
2018	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	-0,001	0,00004	-0,026	-0,050	-0,037	-0,039	-0,032	-0,001
Annual return	-0,058	0,002	-0,752	-0,930	-0,860	-0,870	-0,816	-0,031
Variance	0,001	0,00002	0,015	0,025	0,020	0,042	0,042	0,0001
St.dev Annual	0,165	0,030	0,891	1,147	1,023	1,486	1,472	0,080
Sharpe Ratio	-0,506	-0,759	-0,872	-0,832	-0,865	-0,602	-0,571	-0,707

(Table 6.2.5A: Calculation of the buy-and-hold strategy, for each financial asset)

If we look closer at the expected return for the investments with the buy-and-hold strategy we see that in this strategy there is a lot closer race between the financial assets, but also here Dash outperformed the others, followed by Ripple, Bitcoin, Dogecoin, Litecoin and Gold (table 6.2.5A).

The Sharpe ratio has shown to be very representative when evaluating the performance of the different securities for each investment. Throughout 2014 to 2016 Litecoin and Dogecoin has a gradual increase in the Sharpe ratio, followed by a drastic jump in 2017 before falling to a negative Sharpe ratio in 2018. Overall there is a lot of fluctuation in the development through the five years. By analyzing each financial asset in total over the five years we get the following results.

Buy-and-Hold	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Average return	0,002	0,0004	0,007	0,026	0,003	0,003	0,015	0,000002
Annual return	0,091	0,021	0,448	2,884	0,163	0,183	1,179	0,0001
Variance	0,0003	0,00002	0,015	0,107	0,025	0,135	0,060	0,0003
St.dev Annual	0,127	0,029	0,894	2,357	1,139	2,652	1,761	0,122
Sharpe Ratio	0,518	-0,149	0,473	1,213	0,122	0,060	0,656	-0,203

(Table 6.2.5B: Calculating the Sharpe ratio of Buy-and-hold strategy, all five years)

Not surprisingly Dash outperforms all of the other securities, both with the excess return isolated and in regard to the volatility associated with the excess return. Throughout the years both bonds and gold have a negative Sharpe ratio, mostly because of their low excess return. Stocks perform better than Bitcoin, Litecoin and Dogecoin when evaluating the whole period with a buy-and-hold strategy. Ripple has a Sharpe ratio at 0,66, which is the second best, only beaten by Dash.

BUY-AND-HOLD	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
Excess return	0,094	0,021	0,448	2,884	0,163	0,183	1,179	0,000
Standard deviation	0,129	0,030	0,894	2,357	1,139	2,652	1,761	0,124
Sharpe Ratio	0,538	-0,118	0,473	1,213	0,122	0,060	0,656	-0,199
CAPM		-0,039	0,02489	0,02513	0,02523	0,02510	0,02522	0,016
Jensen's		-0,067	0,423	2,860	0,139	0,159	1,155	-0,033
Skewness	-1,544	-0,352	-0,812	0,285	1,065	-0,668	3,124	-0,008
Kurtosis	8,691	1,898	7,845	7,773	4,505	17,276	19,386	0,309

(Table 6.2.5C: Measurements of buy-and-hold strategy)

Calculating on the CAPM for each financial asset with a buy-and-hold strategy, all of the cryptocurrencies end up at approximately 0,025, gold at 0,02 and bond with a negative estimate, -0,04. Jensen's alpha, on the other hand, has a more diverse estimation of the securities. Here the alpha of Dash is the highest, followed by Ripple, Bitcoin, Dogecoin and then Litecoin, at the bottom we find gold and bonds.

Skewness is included to measure the extremes of the data so that we do not solely focus on the mean. The more skewness, the less accurate the data is. The skewness for stocks, bonds, Bitcoin, Dogecoin and gold is barely below zero. It is said that a skewness between -0,5 and 0,5 the data is relatively symmetrical. For data with skewness higher than 1, the data are highly skewed, in this case for Litecoin and Ripple. Positive skewness means that many of the securities of Ripple and Litecoin are traded for a lower price than the average value.

Kurtosis is an evaluation of how diverse the distribution is between the extremes, whereas normal distribution is a Kurtosis at 3. All of the cryptocurrencies and stocks have a kurtosis higher than 3, which means that there is a higher probability of extreme values to occur.

6.2.5 Comparison of Momentum and Buy-and-hold Strategy

To answer our research question, we have to compare the two strategies with each other, where our main measurement was to evaluate the risk associated with the excess return of the different currencies. Our research problem in part two of our thesis was:

“Examine which of momentum and buy-and-hold strategy is the ideal approach, when investing in cryptocurrency”

We found a clear answer to our research problem. The weekly momentum strategy outperformed the buy-and-hold in all of the financial assets throughout all five years. This is the reason why we wanted to investigate the momentum strategy even further and calculated the data on a monthly, quarterly and annually basis for comparison. We found out that the buy-and-hold strategy is more efficient than the momentum strategy on a quarterly and annually basis. The buy-and-hold even had a better Sharpe ratio than almost every security in monthly momentum, except for Ripple.

Based on our calculation; excess return, volatility, CAPM, Jensen's, Sharpe ratio, Skewness and Kurtosis, on the two different approaches, we conclude that the momentum strategy is the most efficient, but only on a weekly or monthly basis.

After analyzing the data, it is clear that Dash has the highest reward-to-volatility. This means that looking at the Sharpe Ratio, Dash is the cryptocurrency who has the overall highest expected return after risk, both with momentum strategy and buy-and-hold strategy.

The overall annual Sharpe ratio of the investments is shown below (table 7.8 and 7.9). Here the momentum strategy is based on weekly data.

Momentum	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
2014	0,206	-1,787	1,241	53,366	0,710	31,418	-	3,137
2015	4,666	2,062	8,245	5,598	6,294	4,656	3,727	2,588
2016	4,815	2,344	6,976	6,249	4,966	3,858	4,201	3,747
2017	4,528	2,951	33,978	64,200	31,137	37,617	20,543	4,784
2018	3,544	1,308	3,993	2,635	3,597	2,577	4,172	2,365

(Table 6.2.6A: Annual Sharpe ratio for weekly momentum strategy)

Buy-and-hold	Stocks	Bonds	Bitcoin	Dash	Litecoin	Dogecoin	Ripple	Gold
2014	1,159	1,141	-0,538	3,546	-0,871	-0,171	-	-0,457
2015	0,016	-0,941	1,118	0,518	0,971	0,140	-0,652	-1,078
2016	1,040	-0,024	2,035	3,718	0,165	0,149	0,306	0,285
2017	3,894	0,253	15,403	49,495	38,594	29,916	82,125	0,905
2018	-0,506	-0,759	-0,872	-0,832	-0,865	-0,602	-0,571	-0,707

(Table 6.2.6B: Annual Sharpe ratio for buy-and-hold strategy)

6.3 STRENGTHS AND WEAKNESSES OF OUR APPROACH

In our thesis, we examine five different cryptocurrencies, as well as gold. We chose cryptocurrencies with a diverse price range and market capital so that we could study a greater diversity of the market. We evaluate Bitcoin, Dash, Litecoin, Dogecoin and Ripple in thirteen portfolios each, whereas each portfolio has a different percentage of cryptocurrency and rest of the portfolios contains of stocks and bonds. By evaluating thirteen different portfolios for each cryptocurrency, our thesis provides results that have not been researched before. We evaluate five diverse cryptocurrencies and not only Bitcoin. In addition, to find which portfolio that is ideal for each cryptocurrency, we examine four different strategies (weekly-, monthly-, quarterly-, annually- momentum strategy and buy-and-hold strategy), where the outcome shows that every cryptocurrency should be evaluated individually, and that Bitcoin cannot represent all of the other cryptocurrency.

The theories and methods we chose to examine have some weaknesses. The calculations that include the volatility is Sharpe ratio, CAPM and Jensen's. When evaluating the performance of a portfolio with the Sharpe ratio, the ratio assumes that the return is normally distributed. As for the volatility, the Sharpe ratio includes standard deviation, but this measurement of

risk assumes that the movement for the price to go up or down is equally risky. In financial markets, the return is skewed away from the average, because of many unpredictable drops. Using CAPM to evaluate an investment there are several assumptions about the market one has to take into consideration. Even though all these assumptions are necessary, CAPM is still a widely used formula. Because of its simplicity, it makes it easy to compare investments. CAPM only measure volatility with the beta of an asset and does not take notice of the unsystematic risk. Because these models assume that the volatility is normally distributed we interpret Skewness and Kurtosis.

In our calculations, we have assumed that the risk-free rate is constant throughout all five years, and we have not included the cost of the transactions. When buying and selling stocks there is a transaction cost that pays the broker's commission. Buying or selling cryptocurrency one has to pay for the miners (the less you pay the lower priority your transaction will have and the longer time it will take), you have to pay a "wallet fee" which is where you store your cryptocurrency, and a commission (Motley, 2018). We consider that the biggest weakness of our approach is that we used the same risk-free rate for all the five years, and we did not include the transaction costs in our calculations.

7. SPECULATIVE BUBBLES

Cryptocurrencies have been called a revolution of money. Since the cryptocurrency market is a new, upcoming industry, investors speculate on when the bubble will burst or if it already has. Bitcoin has had several crashes from the start up until now, whereas the most recent was in 2018. After a market price of \$19,511 in December 2017, Bitcoin lost 82% of its value the following months (Bloomberg, 2019).



Graph 7: Historical market cap. & price of Bitcoin (Coinmarketcap, May 2019)

As the cryptocurrency that has existed the longest, and are the most valuable one, the majority of previous research and evaluations of future outcomes investigate Bitcoin and no other cryptocurrencies. Chalvatzis et al., 2019 wrote an article about different factors that had an impact on the crash in 2018; the Mt. Gox hack (Mt. Gox was an exchange company that handled over 70% of all Bitcoin transactions, before the hack) and cyberattacks and regulations in China, where Chinese banks were imposed against Bitcoin investments. They also point out that exogenous events like the financial crisis of Cyprus and the British EU referendum has had a high impact on Bitcoin prices.

Today the cryptocurrency market is still a small market compared to the stock market. Many fears that if the stock market crashes, this will affect the cryptocurrency market. One situation that affected the drop of the stock market in 2018 was when the president of the United States, Donald Trump, interfered with the central bank after they increased the interest rate. Trump then publicly called out Chairman Jerome Powell by saying he had gone crazy. This situation led to a lot of uncertainty among investors, mostly because earlier presidents have avoided commenting on Fed policy, in a sign of respect and trust for the bank's independence. Same as the stock market, the cryptocurrency market also has one dictator factor that drives the market price; human psychology. Even though the two markets are not correlated, human emotions, fear, and anger will always be a mutual complication in regard to market prices.

Roughly every day that passes a new cryptocurrency is invented and approximately every cryptocurrency has a limited edition. The fact that cryptocurrency relies on so much energy and modern technology, makes it questionable for investors, especially in the long run. It is impossible to predict the future. Compared to the cryptocurrency market that has only existed for ten years, the stock market has existed for thousands of years. No matter how long of a historical record, we cannot predict the future (black swan theory), especially for a new, innovative financial asset like the cryptocurrency market.

As for the future of cryptocurrency market, the population has a very diverse opinion when it comes to whether the bubble burst in 2018 was the big fall or if there will occur a larger bubble crash in the near future. Cryptocurrencies are such a volatile investment, some investors are optimistic, and some are pessimistic. There are always two sides of the coin.

8. CONCLUSION

The cryptocurrency market has significant volatility, it is difficult to regulate and there exist a lot of speculations around its future outlooks. However, the market is rapidly growing globally, and some investors state it is the “evolution of money”.

In this study, we have been evaluating the performance and levels of risks associated with investments in the cryptocurrency market. We have completed quantitative methods on a various dataset from *Yahoo Finance* to obtain an answer to our research problem.

The datasets consisted of information about each of the financial asset chosen; Bitcoin, Dash, Litecoin, Dogecoin, Ripple, gold, stocks, and bonds. The preconditions for choosing these cryptocurrencies were that they had available data for more than four years and had a high degree of market capitalization.

When calculated on the historical data we took into consideration that the cryptocurrency market is a decentralized system that is open 24/7, unlike standard investments. In part one each cryptocurrency/gold is evaluated in thirteen different portfolios. Portfolio 1 includes 0,5% cryptocurrency/gold and we increased the percentage with 0,5% for each portfolio up to 5%. After portfolio 10, with 5%, we expanded the inclusion of cryptocurrency/gold with 5%; 10% in portfolio 11, 15% in portfolio 12 and 20% in portfolio 13. Rest of the percentage in the portfolios consisted of stocks and bonds, where the majority were stocks. We kept the ratio between stocks and bonds constant throughout all the portfolios.

We investigated the excess return and its volatility for the cryptocurrencies/gold, in thirteen different portfolios for each of them. After comparing the performance of all portfolios, we determined that Dash gave the greatest excess return compared to its risk. Thus, our conclusion is that the optimal portfolio, based on Sharpe ratio, would be to invest 4% in Dash, we are aware of that investors have a different opinion on how much risk they are willing to compensate for the return.

In part two we interpret the momentum strategy weekly, monthly, quarterly and annually and compare them with the buy-and-hold strategy. Our analysis showed that the weekly momentum strategy is the most efficient when trading in the cryptocurrency market. After evaluating each of the cryptocurrencies/gold it was clear that Dash outperformed the others, both in momentum strategy and buy-and-hold. However, this result should not be interpreted as investment advice or as a profitable trading strategy, since we did not consider the transaction costs. The correct interpretation is that there is a quite strong reversal in cryptocurrency prices at a horizon of one week.

The conclusion is that Dash outperforms all the other financial assets both in part one and part two of our analysis. Dash has the highest excess return relative to its risks for all the diverse portfolios and regardless of which strategy chosen.

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