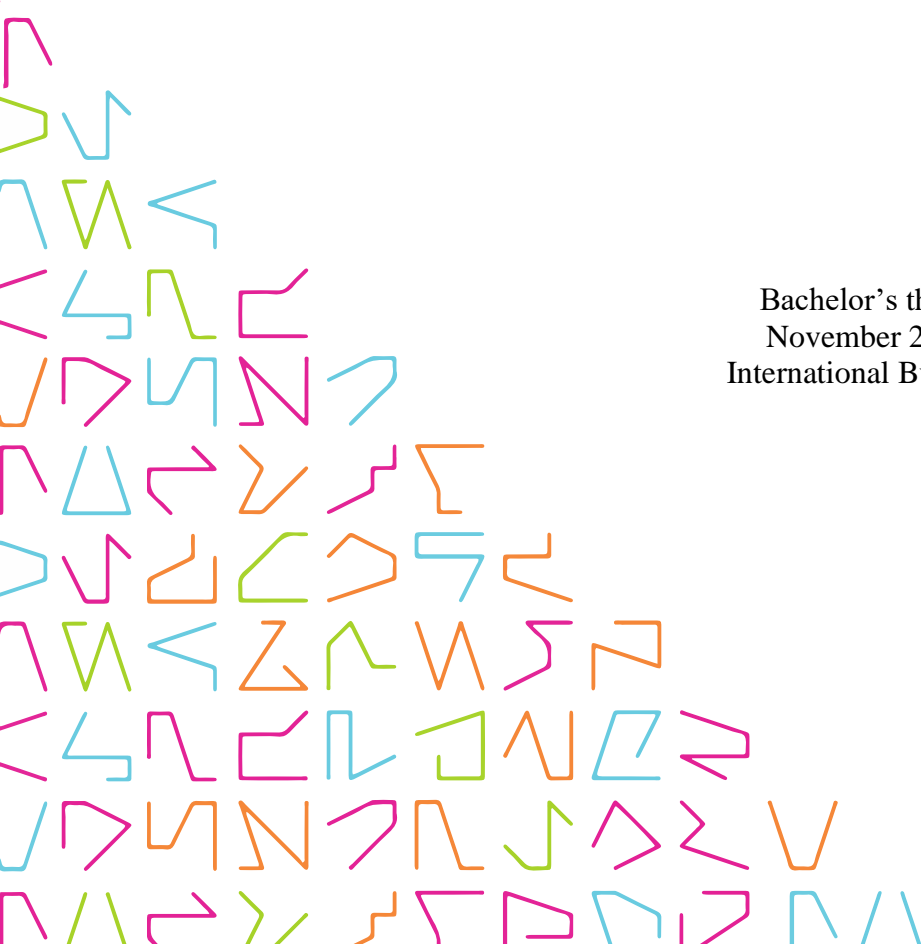


# CREATING A TOKENIZED FUND IN THE ETHEREUM BLOCKCHAIN

Luis Gomez Quintana

Bachelor's thesis  
November 2017  
International Business



## **ABSTRACT**

Tampereen ammattikorkeakoulu  
Tampere University of Applied Sciences  
International Business

Luis Gomez Quintana:  
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Cryptocurrencies are reaching a turning point. As their popularity increases, so do the pertaining opportunities. As the author is cryptocurrency trader and investor, he sees this as the key moment to think about potential business ventures in the area.

The purpose of this study was to gather information on the problems and opportunities that cryptocurrencies have as an investment, and the best way to create a new investment vehicle that tracks the cryptocurrency market.

The data was collected from online databases and from technical white papers. The databases collect and store the daily price of each of the cryptocurrencies in the market. A whitepaper is a technical report on the inner workings of a cryptocurrency.

It was found that many of the problems encumbering cryptocurrencies are related to trust, volatility, and legal risk. It was suggested that an investment structure that can ensure trust, reduce volatility, and remain unaffected by regulation, will prove to be a very successful business opportunity that might get traditional investors into the cryptocurrency market.

It was suggested that the best way to do such an investment vehicle is through the combination of innovative investment structures and traditional ones. A tokenized exchange-traded fund that tracks a cryptocurrency market index, was proposed as the best alternative.

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Key words: Blockchain, Tokenized funds, Cryptocurrencies

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## 1 INTRODUCTION

Cryptocurrencies are a digital medium of exchanging information, build upon the blockchain technology. This information can be of a monetary nature, proprietary nature, represent voting rights, or almost anything else. While the use of cryptocurrencies is only limited by code, its main use has been as an investment vehicle.

During the last three years, cryptocurrencies have become increasingly popular due to the high returns they have historically provided. Investors are rushing into the market attracted by the annual returns of over three hundred percent. But with great profit comes significant risk, investing into cryptocurrencies presents many challenges. Cryptocurrencies are a unique security in many ways, they are barely regulated, are not listed on traditional stock exchanges, are completely decentralized, cryptocurrency traders use a completely different language and mediums to exchange information.

In the following pages, I will describe the challenges that institutional and retail investors will face when trying to invest into cryptocurrencies, how traditional investment vehicles do not work in this new industry, and to discuss how we can create tools that help investors get exposure to cryptocurrencies. I will be presenting a new type of investment vehicle: Tokenized funds. I will talk about what it offers, and about its drawbacks.

The thesis has been written for my peer readers in such a way that the readers, will have a clear view on the topic, regardless of their initial knowledge of blockchain or cryptocurrencies. For those of my peers new to the subject, I have included brief explanations of all the theory that they will need to know to understand this project and understand cryptocurrencies.

### 1.1 Data collection

Information about cryptocurrencies is scarce, there is almost no literature on the topic. This is due to the novelty of the subject; the market changes so fast that virtually any book will be outdated rather quickly, and there is still not enough information to conduct a rigorous academic research. The only information I could recompile was the daily price

changes of all the cryptocurrencies studied, and their respective potential uses. Most of the information that the reader will find in the following pages is extracted from my knowledge as a trader of cryptocurrencies.

## **2 THEORETICAL FRAMEWORK**

Cryptocurrencies and blockchain technology are a relatively new phenomenon and to this day they remain a mystery to the public. Most people have heard news or read articles about Bitcoin or blockchain, but hardly anyone has the sufficient knowledge to give a comprehensive explanation of how they work. To ensure the coherence of this thesis, I will explain the key terms needed to understand the project entirely. Since this thesis is aimed at my peers, international business students, I will try to keep the technicalities to a minimum and will use business-related examples. The explanations will be oversimplifications, but it will provide the reader with the sufficient knowledge to understand the project.

### **2.1 Blockchain**

The potential of a cryptographically secure chain of blocks has been discussed by cryptographers since the nineties, but it was not until 2008 that Satoshi Nakamoto created the first decentralized Blockchain (Satoshi Nakamoto, 2008).

The term Blockchain was coined in 2016. Blockchain technology is the foundation of cryptocurrencies, enabling cryptocurrencies. A blockchain is nothing more than a decentralized list of records. In a blockchain, all the information generated during a specific period is time-stamped and stored on a block, every single block contains a cryptographic code of the previous block, linking the blocks in chronological order. Linked blocks form a chain (Alex Tapscott, 2016).

To illustrate how Blockchain works, I will compare a traditional payment system, to a payment system using blockchain technology:

Traditionally, a transfer of money between two parties will include an external trusted party: a financial institution, usually a bank. The job of such an institution is to ensure that the transaction takes place and that no fraud is committed. All the transactions will be stored in the main database of the financial institution, leaving the data vulnerable to cyber-attacks and systematic issues, which leads financial institutions to spend fortunes on cybersecurity.



Transferring money through a blockchain is entirely different, there is no need for a trusted third party. This is achieved by the open ledger quality of blockchain, at any given moment users can see all the transactions ever realized. This system prevents users from spending money they do not have, and to double-spend their money. Blockchains are decentralized, this means that the data is not stored in one central server, but in the computers of all the nodes. If one node were to be corrupted, damaged shut down, the rest of the nodes will keep the blockchain functioning. Nodes keep the information updated through a consensus protocol.

There are different consensus mechanism, but the most widely known is the protocol called proof of work. Under Proof of work, nodes compete to find the mathematical solution to a very complex problem. The first node to solve it will create a new block of information and will receive a newly created cryptocurrency. This process is called mining, and it is how new tokens are minted. Once a node finds a solution, the rest of the nodes will verify it; the mathematical problem is challenging to solve, but nodes can quickly confirm the solution. If a proposed solution receives support from more than fifty-one percent of the nodes, the new block will be added to the blockchain.

This method creates a financial barrier and an incentive. Firstly, finding the solution to such mathematical problem consumes energy, a lot of it. Such cost prevents malicious actors from spam-flooding the market and hurting the credibility of the blockchain. Secondly, the no malicious nodes of the system will get a financial reward each time they mine a new block, incentivizing them to keep the blockchain functioning. The combination of the barrier of entry and financial incentives makes blockchain to be a Byzantine fault tolerant system.

Blockchain systems are only vulnerable to a fifty-one percent attack, where a malicious actor owns at least fifty-one percent of the nodes. By owning the majority of the nodes, attackers will be able to alter the blockchain to their will. This is easier said than done, to have at least fifty-one percent of the nodes of a blockchain means to have at least as much computational power as the rest of the nodes. Bitcoin's processing power consumes 0,12 percent of all the energy used in the planet, an individual actor owning fifty-one percent of that amount of computing power is close to impossible.

## 2.2 Cryptocurrency

A cryptocurrency is a decentralized digital asset that serves as a medium of exchange for blockchain systems. A cryptocurrency can be both the means to an end, or the end product. Some cryptocurrencies such as Bitcoin, are simply a decentralized currency that aims to create a worldwide decentralized system of payments, Bitcoin is the end product. Other cryptocurrencies such as Ethereum, designed to be the cohesive force that keeps a blockchain system up and running, the services that the blockchain system provides is the end product. Cryptocurrencies are minted at a specified rate through mining. This process does not require a central authority, and the rates at which **new** currency is created is subject to the code, not to an arbitrary entity. All the code surrounding cryptocurrencies is open sourced, so anyone can see at which rates the currency will be mined, and since the supply of any given cryptocurrency is limited, everyone will be able to know how much currency will be ever be mined.

## 2.3 Cryptocurrency fork

A cryptocurrency fork divides a blockchain into two different entities, creating two different blockchains and two cryptocurrencies. Forks happen as a result of a major software update of the blockchain, or as a result of a dispute between the nodes of the system of how to continue the blockchain. When a blockchain undergoes a major upgrade, the nodes of the system must accept this change, and consequently update their mining software. If some of the nodes do not accept such update, they will not update their system and will keep supporting the old version of the blockchain. This will lead to two different blockchains that have the same records; their only difference will be technological. This has two immediate consequences, there will be two different cryptocurrencies, with the same supply, and the ownership of the new cryptocurrency will be identical to the pre-fork cryptocurrency. Any individual holding one unit of the cryptocurrency before the fork, will retain the same amount of the old currency and receive one unit of the new cryptocurrency.

## 2.4 Ethereum Blockchain

The Ethereum blockchain is an app platform. The Ethereum blockchain is the Appstore of decentralized applications. It serves as a standard to develop new blockchain based software. An individual can use the Ethereum blockchain to program decentralized apps, without having to create a blockchain. All the decentralized apps in the Ethereum blockchain consume a cryptocurrency called Ethereum (White paper, 2017).

#### **2.4.1 Smart contracts**

A smart contract is a protocol that will use code to enforce the terms of a contract. To put it simply a smart contract is an open source, a decentralized program with the terms of a contract encoded. Once a smart contract is triggered, none of the involved parties will be able of stopping it or modifying the contents.

A smart contract can automatically sign papers, authorize transactions, pay for services... If someone were to draft their will in a smart contract, once the person passes away, the smart contract will sign all the needed paperwork and will allocate the deceased's assets among its family and friends, just how the deceased stated on the terms of the contract. This will be done automatically, and it will be impossible to alter; if coded properly a smart contract always delivers. A smart contract is a program that enables any transaction or action, without having to include a third party, enabling any peer to peer transaction to be conducted safely (White paper, 2017).

#### **2.4.2 Decentralized applications**

A decentralized application is a group of smart contracts working together. Each smart contract in a Dapp fulfills a certain role, and all of them together provide a full service, just like the gears of a watch. Decentralized applications provide users with sophisticated peer to peer services (White paper, 2017).

#### **2.4.3 Oracle**

Smart contracts cannot directly receive information from outside the blockchain, and this presents a problem for those contracts that are supposed to automatically trigger when an event in the real world happens. That is why blockchains add a third-party service called oracles. Oracles receive information from the outside world and provide it to the blockchain. In the example of the smart will, the oracle will be the one notifying the blockchain that the user passed away (White paper, 2017).

## **2.5 Initial coin offering**

An initial coin offering, or ICO, it's the first time a new coin is offered to the public. It has a similar structure than an initial public offering, with the difference that both retail and institutional investors can participate in an ICO. An ICO aims at raising funds for the firm, a form of crowdfunding. Usually, the issuing company does not have a finished product by the time they do an ICO. After an ICO is finished, the new tokens are distributed among the participants, and there is usually a period in where the new tokens are frozen, frozen tokens cannot be sold or bought.

There are different types of ICOs; we can differentiate ICOs depending on their security level and their level of restriction. Depending on their security standards ICOs will conduct a process called know your customer or KYC, in where they will ask the future investors to provide their data and the pertinent evidence. This information aims at restricting access to the citizens of countries where such an investment is forbidden by law. Imposing such restrictions will clear the company of any legal responsibility. Other ICOs have no such process and are therefore at risk of legal action. Depending on their openness, an initial coin offering will either be public, private or a mixture. Private coin offerings use a whitelist. Only those in the whitelist will be able to invest on the ICO. The requirements to join such whitelist will vary. Public ICOs do not have a whitelist, allowing any investor to invest. Mixed ICOs have a period where only whitelisted customers will be able to participate, and later on, the remaining tokens will be sold in a public manner.

## **2.6 Transactions on the blockchain**

To understand cryptocurrencies is crucial to understand how cryptocurrencies exist. Cryptocurrencies do not physically exist in any location, or in any file. The only thing that blockchains store is the records of all the transactions ever done. In a traditional banking system, a database will store in a file the amount of money any person owns, and any transaction will just modify that number. On blockchain, is the sum of all the transactions that give a user ownership of a certain amount of cryptocurrency. Ownership on the blockchain is given by public key infrastructure, a version of asymmetric cryptography (Alex Tapscott, 2016).

Asymmetric cryptography or public key cryptography is a popular way to encrypt data using a public key and a private one. Each of these keys has a different function that is why it is called asymmetric cryptography. The public key is designed to be disseminated widely, and the private key should remain unknown by everyone except the owner. The public key encrypts the information, while the private key decrypts it. This design allows for any individual to send encrypted data while making sure that solely the receiver will be able of decoding the information.

Transactions in the blockchain work similarly, every single transaction in the blockchain records three key elements: The amount of cryptocurrency transferred, the public key of the sender, and the public key of the receiver. The public key is basically how ownership of a cryptocurrency is bestowed, transactions in the blockchain change the public key linked to a certain amount of cryptocurrency for another, essentially swapping the possession of the cryptocurrency from one user to the other.

For an individual to conduct a transaction in the blockchain, he must use his private key. While the public key assigns ownership, the private key is the one that allows users to conduct transactions. If a seller were to receive a bitcoin payment done by a client, the client would use his private key to send Bitcoins to the public key of the seller, and the seller will have to use his private key to access the newly obtained Bitcoins. A helpful way to picture how public key cryptography works is to compare to how a bank account works. Anyone that knows your bank account number will be able of sending money to your account, but only those that know the pin code and passwords will be able of retrieving the money located inside the account or generating transactions.

## 2.7 Wallets

Wallets are a piece software connected to a specific blockchain and provide the user with a public key and private key where to store their cryptocurrencies. Any individual with the private key will be able of accessing the wallet and generating new transactions. It is important to notice that transactions done in the blockchain cannot be stopped, once a transaction starts there is no way to reverse it, does not matter if the transaction was sent to the wrong recipient or if someone hacked into the wallet and stole the funds. This feature of the blockchain makes security to be of adamantium importance, if someone were to acquire the private key of someone, he would be able of stealing all the cryptocurrency inside the wallet without repercussion (Cryptocurrency Facts).

There are different kinds of wallets, in this paper, I will classify them into two separate groups: digital wallets and physical wallets. Digital wallets are purely software based; addresses are generated at random by a webpage, a program, or even a mobile app. The safety of this wallets can vary tremendously, with wallets being produced by web pages tending to be less secure than those generated by software installed in a computer. Digital wallets have the risk of being hacked and must be used carefully. Physical wallets are wallets that store the private keys either on a piece of hardware, such as a USB or physically on a piece of paper. These wallets are sometimes referred to as cold wallets, meaning the wallet is not connected to the internet, making it impossible for a hacker to hack into the wallet. These wallets are only connected to the internet momentarily, to execute transactions. This kind of wallet is the perfect way of storing large amounts of cryptocurrencies, while not incurring the risk of being hacked.

### 3 CRYPTOCURRENCIES AS AN INVESTMENT

Cryptocurrencies present themselves as one of the most lucrative investment opportunities. Bitcoin, the spearhead of cryptocurrencies, arguably has been the best performing financial asset in history, seven years ago Bitcoin was worth less than 10 cents, and today is worth more than six thousand dollars. As the price of Bitcoin rose, more and more users embraced this new technology. It is important to notice that the growth in popularity of cryptocurrencies, was not only due to their speculative power, but many users are also believers in the system. Cryptocurrencies and blockchain technology might help us create a more decentralized and just world, and such a dream has attracted a lot of attention all over the globe. These dreamers were the first adopters, the ones that have made cryptocurrencies a discussion topic all over the world.

#### 3.1 The opportunities of investing into cryptocurrencies

Cryptocurrencies are a unique investment. They have historically provided returns that are unmatched by any other asset class; they are one of the quickest growing markets in the globe, and they are still untouched by financial institutions (Figure 1). Usually, financial institutions such as investment banks and large hedge funds find the next investment opportunity before retail investors; they have the knowledge, the talent, and the means to do so. But with cryptocurrencies is different, big financial institutions cannot directly invest into cryptocurrencies. And they will not be able if regulation regarding cryptocurrencies remains the same. Cryptocurrencies currently offer a unique opportunity for retail investors, for the first time they can invest in an asset before the big money managers.

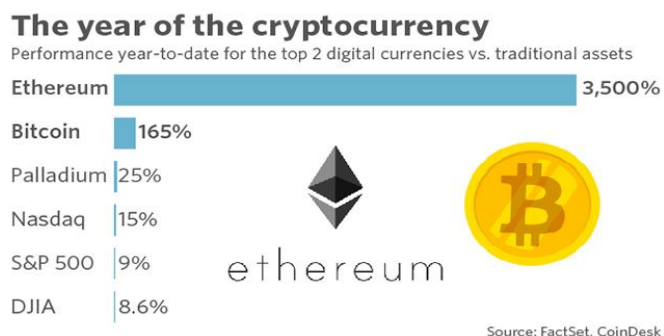


Figure 1, Cryptocurrency growth in the first half of 2017 compared to traditional assets. (Ryan Vlastelica, 2017)

Blockchain technology and cryptocurrencies have the potential to shape part of our future. Currently, they are emerging technologies, but they are gaining traction. In the image below you can see the amount of funding blockchain start-ups (Figure 2). In the future, they will be a part of our daily lives. Early adopters will have an information lead in this industry.

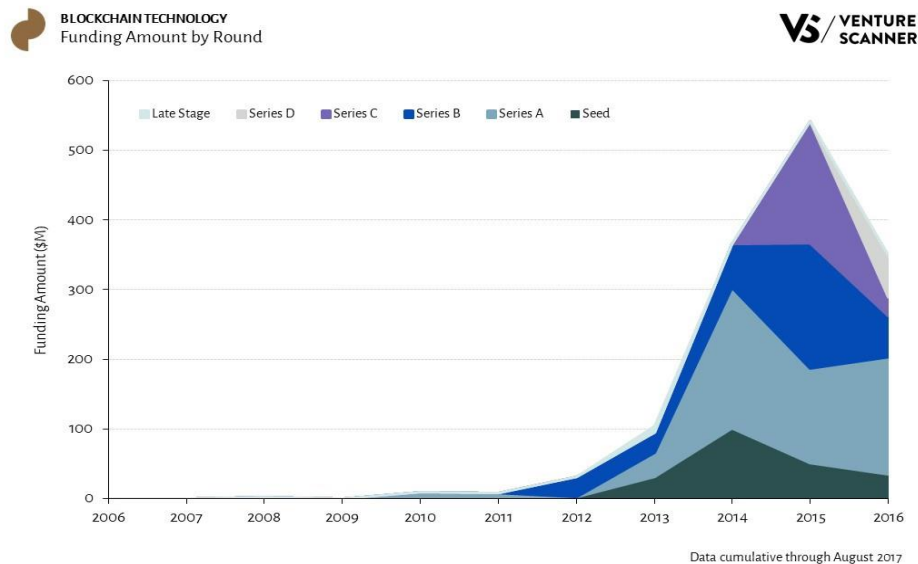


Figure 2, Amount of investment done by venture funds into blockchain startups. (VentureScanner, 2017).

Cryptocurrencies happen to retain their value in times of market turbulence, making cryptocurrencies an effective hedge against stock market crashes. As you can see in the graph Bitcoin prices have a positive correlation with the volatility of the S&P500 (Figure 3). As market uncertainty raises, investors start investing in cryptocurrency.



Figure 3, Bitcoin price compared with the volatility of the SP500. (Ian King, 2017).



### 3.2 The difficulties of investing in cryptocurrencies

For the average person investing in the stock market is relatively easy, a brokerage account can be opened in mere minutes, financial experts are not hard to find, and information on the topic is readily available and popularly known. For the professional investor, there is unlimited data and much academic research about the stock market to help them make decisions. The financial sector has faced very little change over the years, the mainstream financial theories such as modern portfolio theory were created over fifty years ago, and many of them remain unchanged. Stock markets are inherently changing averse, since by nature those in leading positions tend to be well past fifty, and age makes it harder and harder to adapt to new technologies. This is a significant problem for all the mainstream investors who try to invest into cryptocurrencies; everything works differently but yet similarly.

Cryptocurrencies and blockchain are very new; most people do not truly understand the very basics of blockchain and cryptocurrency, let alone it's potential. And there is little to none literature on the topic, and very few professional experts, forcing the average investor to educate himself. Information about cryptocurrencies usually come in the format of a tweet or a meme, not from a centralized news source as newspaper or any other trusted third party. As anyone can write articles or tweets, it is very hard for the beginner to distinguish the relevant information from fake news. As well the slang used in cryptocurrencies is derived from Wall Street but combined with the new trends in communication, social media and memes.

For an investor unfamiliar with new technologies and social media, all of this might present itself as an impenetrable barrier. Traditional investors might face some of this issues when attempting to enter a foreign market, especially emerging ones. But they have many tools at their disposal; an investor does not need Yen to invest in the Japanese stock market, he can buy a mutual fund that trades Japanese stock, while being listed on its home country exchange. If the investor does not know which sector of the Japanese economy is more likely to succeed, or he simply does not know if he can trust mutual fund managers, he can buy an exchange-traded fund that tracks the Japanese economy as a whole. Buying into this investment vehicles is relatively easy and have no minimum cash requirements. A retail investor does not have this opportunity when it comes to cryptocurrencies; no publicly traded fund invests into cryptocurrencies. The only funds that trade

cryptocurrencies are trust funds and hedge funds, every single other type of fund are forbidden by law to invest into cryptocurrencies. Regulation is one of the major problems cryptocurrency faces.

Cryptocurrencies face many legal challenges, regulation changes abruptly from country to country, some countries see a future in them, while others have forbidden its use. In the image below you can see how each country regulates cryptocurrency (Figure 4).

Major economies tend to regulate cryptocurrencies very loosely; lawmakers are letting the technology unfold before regulating. This has led to publicly traded cryptocurrencies funds not being accepted by the respective financial regulators, most famously by the United States Securities and Exchange Commission (SEC).

Legally it is currently impossible to get a fund that trades cryptocurrencies to be listed on a public exchange, only a small amount of trust and hedge funds are currently trading cryptocurrencies. This kind of funds have a minimum buy-in that can fluctuate from a thousand to a million dollars, as well only accredited investors can participate. Investing in cryptocurrencies through funds is extremely restricted, such limitations make it extremely hard for traditional investors to get started in cryptocurrencies and are hampering the adoption of the technology.

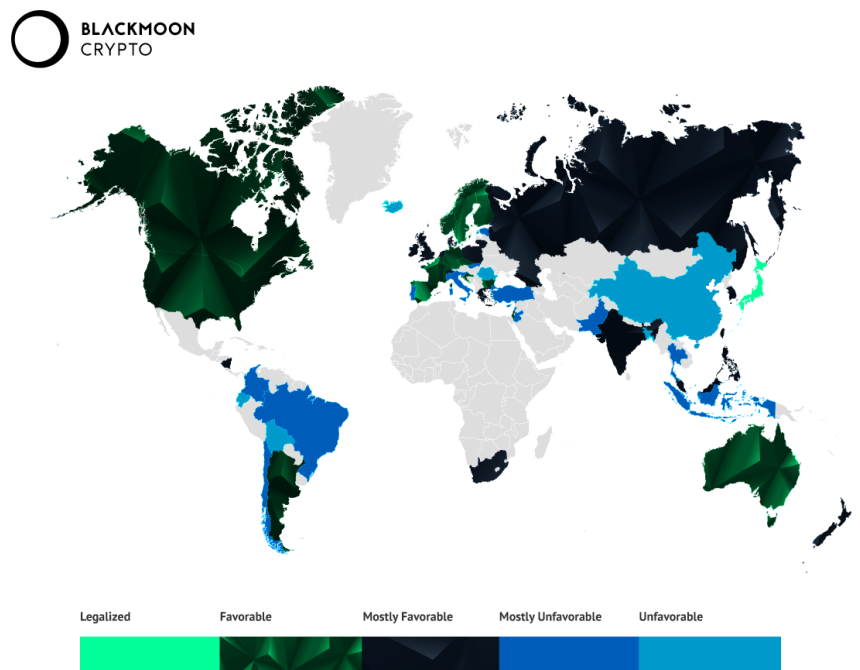


Figure 4, Differences in cryptocurrency regulation by countries. (Sergey Vasin, 2017).

Many investors as well fear the possibility of a bubble. As the price of cryptocurrencies increases without showing any sign of stopping, many wonder if the price truly corresponds to the inherent value of the technology. Many people are comparing the current state of the cryptocurrency to the Dotcom bubble. This argumentation is not without a basis, the inherent value of most cryptocurrencies is somewhat hard to determine, most tokens are yet to be used in the real world, so their current price is not a measure of their use but their potential.

Critics argue that cryptocurrencies will never live to their expectations, as currently both blockchain technology and cryptocurrencies are being overrated by both users and the media. Gartner's hype cycle ranks the hype surrounding an emerging technology during its five initial phases: Innovation trigger, peak of inflated expectations, trough of disillusionment, slope of enlightenment, and plateau of productivity. Blockchain technology is currently rated at almost the height of its hype, while cryptocurrencies are already well through its hype peak, as you can see in the graph below (Figure 5). The possibility of a bubble that could implode at any time is undoubtedly scaring many risk adverse investors, and any sensible investors should be wary of it.

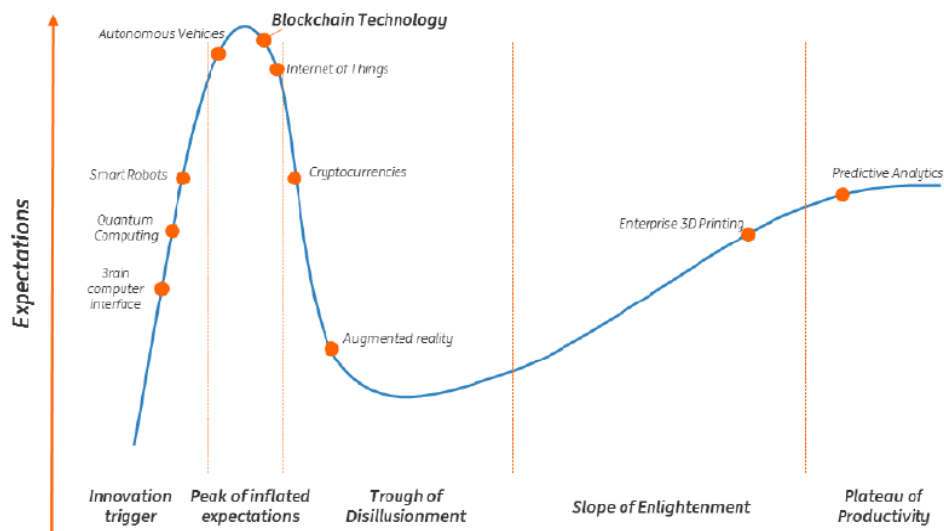


Figure 5, Garner's hype cycle (Mark.Buitenhek, 2017).

Entering into the cryptocurrency market can be challenging, but staying on it, has shown to be equally as challenging. The levels of volatility in the traditional stock market are overshadowed by the volatility of cryptocurrencies, compared in the graph below (Figure 6). The event known as The Black Monday which started The Wall Street Crash of 1929,

was the result of the stock market collapsing 22,61 percent on one day. This led to the Great Depression. Such collapses have historically created panic and havoc among investors, leading to massive sellouts. In cryptocurrencies, such breakdowns are a regular occurrence. Bitcoin, arguably the less risky cryptocurrency, in the last year has had six occasions in where it collapsed over 10% in just a day.

OmiseGO, one of the major altcoins, this year alone had four days in where it collapsed more than 22 percent. This level of liquidity has proven to be too much for many investors that have closed their positions in the middle of crash, leading many investors to lose enormous sums of money. Investors that want to add cryptocurrencies to their portfolio must be aware that occasional collapses are to be expected, and panic selling is the worst possible reaction.



Figure 6, Bitcoins volatility when compared to the SP500 and the Euro. (Radoslav Albrecht, 2017).

### 3.3 The potential of easily accessible cryptocurrencies funds

The number of investors that is interested in cryptocurrencies increases by the day, people want exposure to Bitcoin and other cryptocurrencies. This growing need is yet to be satisfied, and many believe the most efficient way will be an exchange-traded fund (ETF). There have been numerous attempts at developing a cryptocurrency ETF, but none has

received approval from the relevant financial regulators. Many firms are currently working on producing a cryptocurrency ETF once regulation allows it. Analysts at the Meryl Lynch Bank of America, estimate a potential 1,6 billion-dollar market for cryptocurrencies ETF's (Kelso, 2017.) Such figures are gaining a lot of attention, some of the largest financial firms are currently trying to create a Bitcoin ETF based on Bitcoins futures. Holding Bitcoin futures in reserve over Bitcoins will provide financial institutions with a way to circumvent cryptocurrency regulation. Nevertheless, this ETF has a flaw, it will only allow investors to get exposure to Bitcoin, leaving all the other cryptocurrencies out.

As well such investment structure still needs to be approved by the SEC and will be subject to all its rules, it is yet to be seen if such idea will succeed in the short term. Nevertheless, such attempts at creating cryptocurrencies exchange-traded funds only prove the unsatisfied demand there is for such products, the first companies to satisfy such demand will have found a gold mine.

## **4 TOKENIZED FUNDS**

There is still no traditional fund that can fulfill the demand for a Bitcoin ETF, but as new technologies emerge, so do new ways of investing. I am presenting the idea of a tokenized fund as a solution to the lack of exchange-traded funds in the cryptocurrency market.

To understand the potential of tokenized funds we need to understand the similarities between legislation, and open source decentralized through a blockchain. An individual only buys a company stock, because he knows that by doing so he legally owns a part of a company. The legislation provides stockholders with a legal claim over the company; it ensures that the shareholders will not be scammed; without such legislation, no individual will invest in a firm. Up to this day, we needed a central authority that will ensure the trustworthiness of contracts and investments.

The beauty of the blockchain technology is that it decentralizes such trust, it can replace legislation with open source code. Open source code means that the code is public and anyone can access it and read it. Therefore the limitations and uses of the code are known by everyone. Programs can only do what they are coded for if you know the code; you can trust that the program will always deliver. The decentralized structure of blockchain technology prevents any central authority to make unilateral changes to the code, allowing in theory to create an immutable code. A smart contract cannot be legally enforced, but once the code is triggered no one can stop it.

### **4.1 What is a Tokenized fund**

A tokenized fund is an investment vehicle based on blockchain technology; it uses code to mimic the functionalities of a traditional fund. A tokenized fund replaces shares with cryptocurrency. Instead of a centralized trusted third party, tokenized funds decentralize trust, using blockchain technologies such as smart contracts. You can make both passive and active tokenized funds, tokenized passive funds such as tokenized exchange-traded funds are much more reliable. Passive funds just follow a set of pre-selected rules and leave no space open for personal arbitrage, and this is much easier to code in a way that ensures trust.

## **4.2 The potential of tokenized funds**

Tokenized funds have one clear advantage, they issue cryptocurrencies and not shares. These cryptocurrencies have all the functionalities of a share, with one significant difference: It is not currently regulated. To create a fund, a financial institution must get approval and follow a myriad of laws and rules. But anyone can create their blockchain and issue a cryptocurrency. A tokenized fund can use smart contracts and other forms of code to ensure the same level of trust than a traditional fund, but without requiring approval from regulators. Simplifying the creation of a fund, and does not leave investors unprotected.

This investment vehicle will one day get regulated, but even then it will prove to be a great system. For central authorities to monitor tokenized funds, they will have to regulate which code is considered acceptable and which code is not. Once the appropriate code is defined, companies could create their own tokenized funds incredibly fast; they would only need to copy the code and change which assets it tracks. Enterprises could download the whole financial and legislature structure of their business.

## **4.3 Downsides of tokenized funds**

Consumer ignorance is the most prominent challenge tokenized funds face. New investment vehicles that are not currently regulated are hard to trust, even if a program ensures that trust. This is especially true, since most investors are not able of reading the code of the program, and have no way of knowing if there is any bugs, loopholes, or any other kind of threat to their money. This problem could be resolved in the future if trusted auditors were to exist since they could audit the code and ensure customers that the code is what they are advertising; just like how financial auditors ensure that the financial statements of a company are correct and lawful.

#### 4.4 How to create a tokenized fund

The easiest way to create a tokenized fund is to build it as decentralized application on the Ethereum blockchain. In other words, it will be a compilation of smart contracts which will be deployed into the Ethereum network. This has several implications: The Ethereum network is the most significant marketplace for decentralized applications in the world, it is extremely trusted. As well tokens based on Ethereum technology follow the same basic criteria, such basic criteria makes Ethereum based tokens or ERC20 tokens, easy to store and to keep secure. But, every single action that the smart contracts perform will incur a small fee; this fee is the payment done to the miners. This means that all the smart contracts need to be fully optimized, to bear the least possible cost.

The smart contracts which will create the fund must code every single process that the fund will partake. In the case of a close ended fund, the code must ensure that no more shares will ever be created. For an open-ended fund, the code must include the process of buying and selling shares to the fund directly. In the case of an exchange-traded fund, it must include the creation and redemption process done by authorized participants. In the case of a passive index fund, the smart contracts must code all the rules that the fund follows, which index will it track, how often will it be restructured, and which rules will be followed in such restructuring. Since passive funds, conduct all their process based purely on rules, they are the best kind of fund to be tokenized. It is easy to code rules of conduct, but active funds use ever-changing strategies that cannot be coded.

After the smart contracts have been coded, a tokenized fund will have to create their cryptocurrency. This cryptocurrency will be the only form of buy in the fund will offer investors. Such cryptocurrency must have a built-in system, which allows trading the token for its proportional share of the goods the fund holds. Such system will prevent the price of the token to fall below the net asset value of the fund. After the cryptocurrency is created, it's time for the initial coin offering or ICO. The funds raised through the ICO will be used to buy the underlying basket of goods that the fund will hold. As the price of the basket of goods changes over time, so will the token the fund issued. Since the token cannot fall below the net asset value of the pool of goods, the sum of all tokens will always be worth at least as much as the underlying pool of goods.



Once the initial coin offering period ends, the fund's cryptocurrency will be distributed among the ICO participants. At this point, the fund will launch, and the participants will be free to do as they wish with the tokens, they will be able of buying and selling them on different cryptocurrencies exchanges. Investors who decide to hold the cryptocurrency will earn profit once the underlying pool of goods increases on price, and will lose money when it decreases.

## **5 CRYPTOCURRENCIES**

We have conducted a quantitative and qualitative analysis of the forty biggest cryptocurrencies as of the 31<sup>st</sup> of October 2017.

To provide a comprehensive picture of the uses of each of the cryptocurrencies, we have created seven different categories: Payment system, privacy-focused, Dapps, decentralized exchanges, financial services, reward system and other. The functions of various cryptocurrencies in the same group can be hard to distinguish, many times the only difference between two cryptocurrencies is a pure technicality. We compared the strengths and weakness of each of the currencies, to the leader of their respective group. The differences which are not self-explanatory will be further described. Hopefully, this will allow the reader to distinguish between the different cryptocurrency.

### **5.1 Payment system**

Coins classified under the Payment system category, aim at being the worldwide currency for payments across borders. This type of cryptocurrency allows users to pay for any service or good instantly, across the globe, regardless of location. Payments done through these cryptocurrencies are decentralized and do not require any middlemen such as a bank, which in turn reduces the fees of transaction. The coins that fall into this category are:

#### **5.1.1 Bitcoin**

Bitcoin is the first cryptocurrency based on a decentralized blockchain. It was released as open software in 2009 and was created by the anonymous programmer (or group of programmers) that goes by the name: Satoshi Nakamoto. It is the symbol and the spearhead of all cryptocurrencies (Satoshi Nakamoto, 2008).

#### **5.1.2 Bitcoin cash**

Bitcoin cash is the result of a hard fork of bitcoin this past August.

Improvements over Bitcoin	Disadvantages over Bitcoin
Emergency Brake Scalable	Less secure Low acceptance level Centralized development Less trusted

The mining difficulty of Bitcoin gets adjusted every two weeks to match the mining computing power. Overall this change prevents that mining Bitcoin becomes too easy or too hard. But as it only gets adjusted every two weeks, Bitcoin faces the threat of chain death spiral. Chain death spiral happens when the mining processing power of a cryptocurrency falls dramatically, but its mining difficulty level does not. This will prevent miners from creating new blocks, forcing the blockchain to stop working until the difficulty gets adjusted. This could drop the price of any cryptocurrency to zero and destroy it. Bitcoin cash has measures to drop its difficulty level instantly in case of an acute drop of mining processing power.

### 5.1.3 Litecoin

Litecoin is popularly described as the silver to bitcoin's gold. Litecoin is essentially an improved version of Bitcoin.

Improvements over Bitcoin	Disadvantages over Bitcoin
Bigger market capitalization Faster transactions Limited mining Cheaper	Less secure Limited mining

Bitcoin can be mine through a computer, a graphics card, or hardware exclusively designed for mining. Litecoin can only be mined with a regular computer, this severely limits the mining processing power. This can prove to be both beneficial and a disadvantage. In one hand it will prevent the accumulation of power into the hands of professional mining farms, creating a more democratic system. On the other hand, many miners will reject to mine Litecoin, since it will not be profitable for them.

### 5.1.4 Iota

Improvements over Bitcoin	Disadvantages over Bitcoin
Tangle Fee less Quantum resistance Microtransactions	Tangle Not trusted

Iota is a cryptocurrency that allows for almost instant transactions and has no transaction fees. It aims to be the standard cryptocurrency for all mini transactions, making it possible to trade almost any technological resource. One of its key features is the tangle, a new way of distributing the data, eliminating the need for the traditional blocks of a blockchain. These new blockchains are known as block-less blockchains. It competes in a different market to Bitcoin, Iota aims at being the standard currency for microtransactions. This can be done thanks to its tangle technology, but this new technology is complicated, untested and untrusted. As the technology gets older and it proves its strengths, Iota might fulfill its goals (Serguei Popov, 2017).

Quantum resistance means that the blockchain is protected from a quantum computer trying to overtake the system. Quantum computers have yet to be developed, but once they are, they will present a risk for cryptocurrencies. Blockchains are exposed to the so-called fifty-one percent attack, in where one malicious party has at least fifty one percent of the mining computing power of the blockchain. Quantum computers will be so powerful, that with them it would not be hard to achieve such computing power. Iota's mining algorithmic shields its system from quantum computers (Post-Quantum).

## 5.2 Privacy focus

Privacy-focused cryptocurrencies provide the users with the chance to do untraceable transactions. Any transaction conducted on the blockchain is open for the public to see, everyone can see the amount of cryptocurrency transacted and the public key of all the

users involved in the transaction. You can even track any individual Bitcoin to the moment when it was mined. Privacy-focused cryptocurrencies mask this information, making it virtually impossible to trace any transaction. This type of cryptocurrency are subject to a lot of controversies, they have been heavily used for criminal porpoises. The coins that fall into this category are:

### 5.2.1 Monero

Monero is an open source privacy-focused cryptocurrency. Currently is the biggest privacy focused cryptocurrency and our benchmark when analyzing the rest of the privacy focused cryptocurrencies. Monero's developers are unknown, they remain in the anonymity (Fluffypony, 2016).

### 5.2.2 Zcash

Zcash is a decentralized, open-sourced cryptocurrency that allows customers to do encrypted transactions.

Improvements over Monero	Disadvantages over Monero
Bigger mining profitability	Bigger fees
Known developers	Riskier cryptographic algorithmic
Open source	
Optional privacy	
Theoretically better	

Zcash uses high end cryptographic algorithmic, which theoretically provides extra privacy, but as well presents a bigger risk. Cryptographers tend to not use new cryptographic algorithmic, new algorithmic carry the risk of having unknown loopholes and bugs that can be exploited. Zcash provides users with the option of masking the transactions or not (Eli Ben-Sasson, Alessandro Chiesa, Christina Garman, Matthew Green, Ian Miers, Eran Tromer, Madars Virza, 2014).

### 5.2.3 Dash

Dash is an extremely user-friendly coin. It is non-fungible, this means that one Dash token, cannot be completely replaced by another Dash token. Cryptocurrencies such as Bitcoin are non-fungible, you can track each individual Bitcoin to its creation, and know who used it and for what. This means that one Bitcoin used for criminal activities could be marked, and its current owners might suffer the consequences. Fungible cryptocurrencies cannot be tracked, so each token can be exchanged for another. Dash has a self-governing system in where the nodes decide the future of the coin through a voting system (Eva Duffield & Daniel Diaz, 2017).

Improvements over Monero	Disadvantages over Monero
User-friendly Faster transaction time Optional privacy Self-governing system	Longer block time Nonfungible

### 5.2.4 Bytecoin

Improvements over Monero	Disadvantages over Monero
Very easy to mine There are no transaction fees	Unknown team low trust Very low liquidity Too many coins in circulation

Bytecoin has too many coins in circulation, its price is almost zero, and its liquidity is extremely low. The team is formed by people without any reputation, and the project is not trusted by the community (Priyabrata Dash, 2017).

### 5.2.5 Hshare

Hshare, or Hash, it's a payment cryptocurrency that implements an important technological advancement: It works as a link between block based blockchains and block less blockchains, as well it has a hybrid open governance model (Hcash Team, 2017).

Improvements over Monero	Disadvantages over Monero
Blockchain and blockless use Hybrid open governance model	Slower transactions Lower mining profitability

#### 5.2.5.1.Pivx

Pivx was launched earlier this year, and it has many advantages over other privacy cryptocurrencies, but it is still being developed (Pivx Team, 2017).

Improvements over Monero	Disadvantages over Monero
User-friendly Proof of Stake Instant transaction Low transaction fees	Less private Most of its features are under development

Proof of stake is a different consensus algorithmic used to mine coins. Bitcoin uses proof of work, where the miners compete to solve a mathematical problem. Proof of stake is not as energy-hungry as proof of work and does not require a certain amount of computing power.

### 5.3 Dapps

Dapps cryptocurrencies are those which serve as a cohesive force for a blockchain system that aims at being a common space where to deploy decentralized applications and smart contracts. The coins that fall under this category are:

### 5.3.1 Ethereum

Ethereum is the second largest cryptocurrency in the world. Ethereum keeps the Ethereum blockchain up and working. The Ethereum blockchain aims at being the supercomputer of the world. Currently is the second biggest cryptocurrency and the biggest marketplace for decentralized applications. It will act as the benchmark when we compare decentralized application cryptocurrencies (White paper, 2017).

### 5.3.2 Nem

Nem is a not for profit platform that allows users, to create multipurpose, highly customizable, and safe blockchains. Blockchains created with NEM are highly flexible as it allows companies to implement a blockchain into their system without altering its databases (NEM Team, 2015).

Improvements over Ethereum	Disadvantages over Ethereum
Easy to adapt to existing business Built-in services Mainstream smart contract programming language	Less flexibility when creating smart contracts

To create smart contracts in Ethereum, users need to learn Solidity. Solidity is a programming language specifically created for smart contracts. On the one hand, this language is beneficial since it offers a lot of flexibility and options to create the smart contract, coding smart contracts in solidity is much more efficient than in mainstream programming languages. On the other hand, developers need to learn this new language, which represents a learning curve.

### 5.3.3 Neo

Neo is popularly described as China's Ethereum. Neo is supported by the Chinese government, but it's hard to access its services if you are not a citizen of China.



Improvements over Ethereum	Disadvantages over Ethereum
Biggest Dapp coin in China-Backed by the Chinese government Proof of stake Faster Quantum resistant Governing system	Usage of Gas Pre-mined Hard to access its information with- out knowing Chinese.

The key concept with Neo is Gas. Blockchain requires the users to spend a small fee each time a smart contract is used. This fee is known as gas price. But gas on the Ethereum blockchain is nothing more than a system designed to detach Ethereum's price from the fees. As Ethereum increases in price the amount of gas required to make a smart contract function reduces, in such a way that in terms of dollars, the fee is always the same. With Neo Gas is different. In the Neo blockchain Gas is its own cryptocurrency. How it's produced and how fees are paid is more complicated. As well Neo cannot be divided, a user cannot send half a neo, only one Neo or two Neos. Never an amount with decimals (DocksNeo).

#### 5.3.4 Ethereum classic

Ethereum classic is the result of the DAO hard fork of the Ethereum blockchain. The DAO hard fork followed the massive hacking of the biggest decentralized application ever, with millions being stolen. The fork was aimed at recovering the funds, so everyone will have the same amount of Ethereum as they had before the hack. The only differences between Ethereum classic and Ethereum are the user size and value. Ethereum will be having a software upgrade soon next year, this will further differentiate the two blockchains (White paper, 2017).

#### 5.3.5 Qtum

Qtum is a platform that allows users to create smart contracts and decentralized applications. It is pretty similar to Ethereum, but it allows the decentralized applications to work for mobile devices (Qtum Foundation).

Improvements over Ethereum	Disadvantages over Ethereum
Proof of stake Common programming language You can create Dapps for mobile phones	Slower blocktime Less flexibility when creating smart contracts

### 5.3.6 Lisk

Lisk allows users to create smart contracts using JavaScript, making it easy for developers to create new applications, since they will not have to learn a new programming language. Its key features are how dapps are stored in the blockchain, the storage is off chain every single dapp has its own side chain. This has yet to be proven beneficial or hurtful.

Improvements over Ethereum	Disadvantages over Ethereum
Forging Proof of stake Every Dapp has its own side chain Easy to program smart contracts	Mildly unknown team Every Dapp has its own side chain Less trusted Less flexibility when creating smart contracts

### 5.3.7 Cardano

Cardano is a recently launched cryptocurrency that provides users with access to an open source blockchain that allows creating more complex smart contracts than their competitors (Cardano Hub).

Improvements over Ethereum	Disadvantages over Ethereum
Advanced version of Proof of stake More or less common programming language Technologically superior	Very low liquidity Not entirely trusted

### 5.3.8 Stratis

A platform that allows users to create different applications based on blockchain, its unique selling point, is that developers can create the applications through C#, a very well-known programming language (Chris Trew, Guy Brandon, Nicolas Dorier).

Improvements over Ethereum	Disadvantages over Ethereum
Proof of Stake Scalable Easy to program smart contracts	Less flexibility when creating smart contracts Sidechains

### 5.3.9 Eos

Eos is a blockchain platform that allows users to easily create fully scalable Dapps.

Improvements over Ethereum	Disadvantages over Ethereum
Proof of stake Human readable code Community can fix your code	Less flexibility when creating smart contracts Less trusted Ahead of its time

Eos has several improvements over Ethereum, some of which are a bit strange, and even go against common blockchain practices. Only time will tell if they are going in the right direction (Thomasbcox, 2017).

### 5.3.10 Ardor

Ardor does not have a stellar track record. Their initial coin offering did not go as planned and remained very unpopular. Today it is still overlooked by the community.

Improvements over Ethereum	Disadvantages over Ethereum

Proof of stake People can easily create their own tokens Governing system Phased transactions	Low volume Overlooked by the community Bad track record
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Phased transaction is a system that allows the users to set conditions for a transaction to take place. Such conditions can be anything, an example would be sending money the first day of the month (Jelurida, 2017).

## 5.4 Decentralized exchanges

Decentralized exchanges are those in where users trade peer to peer. All the trading is done through smart contracts, removing the need for any third party. Currently, most decentralized exchanges only trade between cryptocurrencies, but in the future, more services and goods will be added. This exchanges are not always direct competitors, and cannot be directly compared, therefore its strengths and weaknesses are not compared. The coins that fall under this category are:

### 5.4.1 Waves

With Wave's platform, users can trade any cryptocurrency and create their own tokens. Currently, it is one of the biggest decentralized exchanges, and arguably the most famous and more trusted (Wavesplatform, 2016).

### 5.4.2 Kyber

Kyber network is both a decentralized exchange that runs on smart contracts and a decentralized payment system that allows for clients to pay with their preferred cryptocurrency and sellers receiving their preferred one. Kyber tokens are used to pay for fees (Loi Luu & Yaron Velner, 2017).

### **5.4.3 Komodo**

Komodo is a decentralized marketplace for ICOs. It provides trust and transparency to ICOs. Komodo's token is used as payment for the fees (jl777, 2017).

## **5.5 Financial services**

Under this category I have included the cryptocurrencies which serve as a cohesive force for those blockchain systems that provide with financial services, other than a direct decentralized payment system. These currencies cannot be compared since they serve completely different purposes. The coins that fall under this category are:

### **5.5.1 Ripple**

Ripple is currently one of the biggest cryptocurrencies out there. Like many other currencies, it is only used to pay for the transaction fees of its blockchain. Ripple blockchain enables financial institutions to transfer money at a fraction of the cost and hundreds of time faster. With ripple, transferring money across the world is just as easy as transferring it to your neighbor. Ripple is currently working with some of the biggest banks on the planet (The Ripple Lab,2014).

### **5.5.2 Bitconnect**

Bitconnect is a platform in where users can lend money and get returns back from it. These returns are achieved by a trading bot. Every single owner of bitconnect will get returns back no matter if they are lending it or not.

### **5.5.3 Omisego**

The omisego network allows users to accept and send payments through their digital wallet on the Ethereum blockchain (Joseph Poon, 2017).

#### **5.5.4 Stellar lumens**

Stellar lumens is a platform that allows financial companies to transact money instantly and allows people in regions without access to credit, the ability to access it (David Mazieres).

#### **5.5.5 Salt**

Salt is a loan platform. Users can receive loans by giving their cryptocurrencies as collateral, their cryptocurrencies will be locked away until payment of the principal is completed. Users need to hold salt tokens to use the platform (Salt foundation).

#### **5.5.6 Iconomi**

Iconomi is a tokenized fund. It provides customers with an index fund and diverse mutual funds in where to invest. This investment is done through buying iconomi tokens (Tim M. Zagar, Jani Valjavec, Zenel Batagelj, Ervin U. Kovac, Ales Lekse, 2016).

#### **5.5.7 Tenx**

Tenx is a company that provides credit cards, which allow the user to pay for any service with cryptocurrencies. Users will pay with cryptocurrencies but the recipient will receive fiat currencies such as dollars or euros. Holders of Tenx tokens will get rewards for each transaction done in the system (TenX, 2017).

### **5.6 Reward system**

Certain cryptocurrencies serve as a monetary reward for the people using their respective blockchain service. The coins that fall under this category are:

### **5.6.1 Steem**

Steem cryptocurrency is a currency that serves as a reward for the users of Steem. Steem is a social media platform, users can post news, create blogs, guides... The creators of the content will get financial rewards based on how many people like their post (Steem foundation, 2017).

### **5.6.2 Basic attention token**

Basic attention token, or BAT, is a cryptocurrency that works in tandem Brave, a web browser. This cryptocurrency revolves around user attention. User attention is the amount of time a user spends looking at advertising. Adverts publishers get rewarded in BATS based on the amount of attention their ads get (Brave software, 2017).

### **5.6.3 Maidsafecoin**

Maidsafe is a decentralized data network. All the introduced data is fragmented and shared between the nodes of the system. The nodes of the system get Maidsafecoins as a reward, the number of the coins received is proportional to the amount of space in the computer they lend to the system (Nick Lambert, Qi Ma, David Irvine, 2015).

### **5.6.4 Golem**

The golem network is a decentralized way of sharing computing power. Nodes in the system can rent you their computing power in exchange for Golem tokens. As well nodes can rent the computer power to develop their own applications (Golem Network, 2016).

### **5.6.5 Augur**

Augur is a decentralized platform that rewards people that make accurate financial forecast. This reward is given out in Augur (Jack Peterson & Joseph Krug).

## **5.7 Other**

The cryptocurrencies under this category provide a different kind of services that we were not able to group. The coins that fall under this category are:

### **5.7.1 Ark**

This currency was created the twenty-second of March of thousand seventeen. Ark wishes to connect together different blockchains, through a type of smart contract called smart bridge. The smart bridge will allow the user of a blockchain, to take advantages of the uses of another blockchain, without having to buy any additional cryptocurrency. An example: Usually to run smart contracts on the Ethereum blockchain you will need to own a specific amount of Ethereum, Ark allows you to use the same contracts by only holding Bitcoin (The Ark Crew).

### **5.7.2 Gas**

Gas is the secondary currency of Neo. All transactions that occur in the Neo blockchain have a cost in gas, therefore users that develop Dapps in Neo will need to hold gas to ensure that their smart contract work.

### **5.7.3 Decred**

Is an open, progressive, and self-funding cryptocurrency with a system of community-based governance integrated into its blockchain with a hybridized consensus algorithm. The idea behind Decred is to create a cryptocurrency in where miners and users share the power (Lefteris Karapetsas).



#### **5.7.4 Firstcoin**

The information of this coin is very vague, it seems that people that buy the currency will get a passive income of around 5% monthly. If you refer any person, you will get part of their profits as well. It seems like a Ponzi scheme.

#### **5.7.5 Walton**

Walton combines radio frequency identification with blockchain, it aims at disrupting current logistics and supply chain management systems. In order to maintain this system, clients need to use Walton tokens.

## 6 RESEARCH METHODOLOGY

We conducted a qualitative, and quantitative analysis of all the aforementioned cryptocurrencies. The qualitative study includes the functionality of each coin, its technical aspects, and a brief history. Additionally, we have compared each coin to its competitors using SW analysis. All of this data was extracted from the white papers of each of the currencies; a white paper is technical explanation of the functionalities of a cryptocurrency.

We analyzed the historical data of the tokens to calculate their lifespan, their historical volatility, their historical profit, the risk-adjusted return, and all their respective correlations and covariance. We extracted the financial data of each of the cryptocurrencies for the last 365 days: Opening and close, daily volume, market cap. All the calculus was done on a daily basis and later on annualized. The data was extracted from Coinmarketcap.com, the most reliable databases for cryptocurrencies.

### 6.1 Volatility

As is common in financial theory, volatility is used as an approximation of the risk of an investment. We used the standard deviation of a sample of both the positive and negative returns to calculate the volatility of each cryptocurrency. We calculated the standard deviation of a sample, since the lifespan of each cryptocurrency varied, as well we used it as it is the standard on the financial industry, and it allows us to calculate the Sharpe ratio. We chose to calculate the conventional standard deviation over the downside deviation since cryptocurrencies are prone to form bubbles, and downside deviation will not take this factor into account. We used the following formula:

$$\delta = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

## 6.2 Covariance

Covariance measures the degree to which assets move in tandem. Under modern portfolio theory, investing into assets with low covariance will allow investors to diversify away unsystematic risk. Diversified portfolios have the potential of having a better risk-adjusted return, than any individual asset. We calculated the covariance of every single coin to calculate its correlation ratio.

$$Cov(x, y) = \frac{\sum((x_i - x_m) * (y_i - y_m))}{n - 1}$$

## 6.3 Correlation

Correlation ratio, just as a covariance measures how does the price of investment move together. But covariance only tells us if the assets in question move together or oppositely, but the correlation coefficient tells us accurately how much the price of one asset will move in tandem with the other. Correlation ratio goes from -1 to 1. Two assets with a correlation of -1 will fluctuate the same amount, in opposite directions. Assets with a correlation of 1 will move perfectly in tandem. Correlation serves to create a diversified portfolio

$$Corr = \frac{Cov(x, y)}{\sigma_x \sigma_y}$$

## 6.4 Risk-adjusted return

We chose Sharpe ratio over Treynor ratio when calculating the risk-adjusted return of each currency. The Treynor ratio heavily relies on beta and diversification, and an index of cryptocurrencies offers little diversification. The systematic risk of an altcoin and Bitcoin differs substantially, but the systematic risk of all the altcoins tends to be very similar. Therefore the Sharpe ratio presents itself as a better tool to compare a portfolio of cryptocurrencies to a more mainstream portfolio, more importantly, the Sharpe ratio has become the industry standard, and is very well known and recognized.

$$\text{Sharpe ratio} = \frac{\text{Return portfolio} - \text{Risk free rate}}{\sigma \text{ of portfolio}}$$

## 7 INDEX CONSTRUCTION METHODOLOGY

The first financial indexes were created to reflect the price changes of securities on the financial markets; they were designed to be market indicators. But today indexes have evolved, any basket of securities weighted and selected based on a set of published rules can be virtually be considered an index. This rules used to fairly simple, but as exchange-traded funds have gained popularity, they have become increasingly complex. Nevertheless, indexes used by the exchange-traded fund must follow certain requirements, one of this requirement being that the rules they follow to construct and maintain the index must be accessible by the general public, either through the index provider's webpage, or the webpage of the correspondent financial regulators. Also, the rules should be presented comprehensively, ensuring that any reader will obtain a reliable knowledge of the characteristics of the index.

While indexes should be transparent with their information, in practice this does not always happen, as index construction methods grow in complexity, the less information the index providers will disclose. Custom indexes that aim at outperforming a specific benchmark will tend to reveal as little information as possible, so competitors will not be able of mimicking their methods. Market indexes that only aim at being a market indicator will provide full disclosure of their rules. This provides a trade-off between expected returns and knowledge, and consequently trust.

As indexes try to achieve better risk-adjusted returns, they will provide less information forcing investors to trust them with their money. Investors might trust the skill of the manager, like the general idea that the index is based on, or might simply be blinded by the promise of beating the market. Investors who do not aim at beating the market, do not need to place any trust on the skill of the index provider since a market index strictly follows the rules, any investor will know how it will behave at any given point.

There are several methods for constructing and maintaining indexes; such practices have a significant impact on investors. Two indexes that track the same market but follow different rules will differ in returns, risk, and fees. Any savvy investor that wishes to invest in an exchange-traded fund should be aware of the characteristics of the index. The rules that are used to build and maintain an index can be categorized in what is known as Index Strategy Boxes (Figure 7). Index Strategy Boxes provide investors with a comprehensive

view of an index. They divide the characteristics of an index into two different dimensions, Security selection, and Security weighting. Security selection englobes the rules an index uses to choose which securities form a part of its pool of assets; it is divided into three subcategories: Quantitative, Screened, and Passive. Security weighting englobes the criteria used to set the respective weight percentage of each of the securities inside the index; it assigns importance.

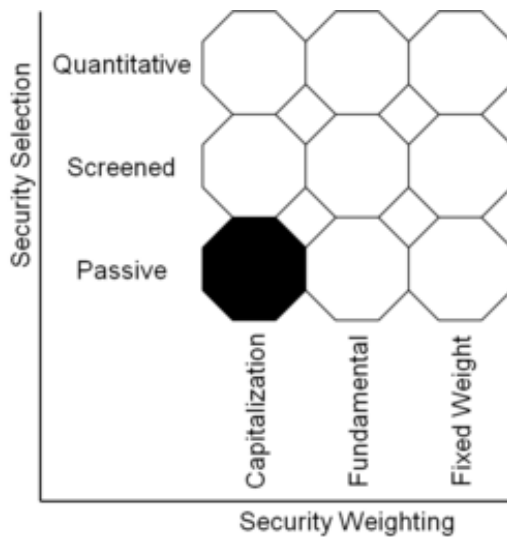


Figure 7 Index Strategy Boxes. (Richard.A.Ferri).

## 7.1 Security selection

Indexes should publish rules for security selection so that investors can obtain a working knowledge of the inner workings of the index. Investors that desire to invest in an exchange-traded fund must understand the impact of the different security selection rules. The rules than an index follow will affect its rate of return, the fees, and it will determine if investing in the index is considered an active management decision or a passive one. Active management is the attempt of beating the market, through the use of a human element. Security selection rules can be classified into three broad categories: Quantitative, screened, and passive security selection.

### 7.1.1 Quantitative

Quantitative indexes use complex mathematical black box methods to analyze and rank different securities (Richard A Ferri, 2004). A black box (figure 8), is any device or software that provides a specific output based on certain inputs, without any knowledge of the fundamental characteristics of what is calculating. This method produces mathematical models of the market, trying to predict which securities have the highest probability of beating the market. Investors should notice that black box methods use past performance as an almost perfect indicator of future performance. Historically, such assumptions have led to dangerous investing decisions.

Quantitative index providers do not claim that their custom index will produce a higher rate of return, but a higher risk-adjusted rate of return. To create a better investment vehicle, there is no need to beat the performance of the market nominally; the only thing needed is a better risk-adjusted rate of return. The most common measure of risk-adjusted rate of return is the Sharpe ratio.

Basing security selection rules on complex mathematical models has two natural consequences for exchange-traded funds: lack of transparency and high turnover. Index providers that produce quantitative indexes will try to disclose as little information as possible; otherwise, any competitor will be able of mimicking their index. This represents a problem for investors, as the only thing they can do is trust the genius of the index provider.

Restructuring rules based on complex mathematical models are not only hard to make, but as the index tries to beat the market, to fulfill its goal continually, it will have to be frequently restructured. Index and exchange-traded fund providers need to be paid for their time, the more time they spend building mathematical models and restructuring, the more fees they will charge to the investors. As well, frequent restructuring leads to a high turnover, many assets will be sold and bought, which will incur in transaction and brokerage fees. Traditional exchange-traded funds that track quantitative indexes, can be up to five times more expensive than its peers.

Summing up, quantitative indexes provide investors with the chance of beating the market, at the cost of higher risk and higher fees. They can be a perfect choice for aggressive investors that are willing to take risks.

Cryptocurrencies and quantitative security selection are a hard match. Cryptocurrencies are different to stock; they do not depend on a company. There are no financial ratios for bitcoin, and the only economic measures are price, return, and volatility. Savvy index managers could try to measure the number of uses of a token for other reasons than speculation, or the number of its users. But that is sometimes virtually impossible since the manager will have to rely on self-proclaimed data. An index that quantitatively tracks cryptocurrencies will be applying modern theory to it and trying to find which combination of cryptocurrencies will have the lowest Sharpe ratio.

### **7.1.2 Screened**

Screening is the process of setting filters that eliminate securities that have undesirable characteristics (Richard A Ferri, 2004). Screens can exclude securities that have certain fundamental qualities or those securities that lack those same qualities; screening is only limited to the imagination of the index provider. Since screening is arbitrarily by definition, the exchange-traded funds that choose to follow a screened index are committing an active investment strategy.

Exchange traded fund that tracks screened indexes are created for one specific purpose and aimed at a specific public. This purpose can be anything, from beating a benchmark, receiving dividends or appealing to the ethics of the investors. An example of the latter will be an index that tracks environmentally friendly companies. The transparency of this indexes will vary by index provider and complexity of the screen. As is natural they tend to disclose less information than passive indexes, but more than quantitative indexes. Screened indexes tend to use active marketing strategy.

In conclusion, screened indexes offer investors with a wide range of different exchange-traded portfolios. Investors that want to increase exposure to a certain type of securities, such as dividends stocks or environmentally friendly companies, will find what they are looking for in screened indexes. Nevertheless, investors should be aware that screened

indexes do not necessarily aim at outperforming a benchmark or maximizing the Sharpe ratio, they try to fulfill a custom purpose. This can lead to higher risk and high fees, but investors will be wise of judging screened indexes on a case by case basis.

A screened selection methodology would work for cryptocurrencies. Many would say that most of the cryptocurrencies will not survive the test of time, and adding screens to an index might prevent adding cryptocurrencies to the index that one day will disappear. A possible screen for a cryptocurrency index could be that the currency it's already being used in practice.

### **7.1.3 Passive**

Passive security selection for many years was the only form of security selection used in exchange-traded fund management. Still, today is the most used methodology, as is known for its simplicity and its reliability. Passive indexes aim at representing a market, without any bias or any arbitrage by the index providers (Richard A Ferri, 2004). The target market can be anything: emerging markets, cryptocurrencies, Asian bonds, blue-chip stocks. To represent the market passive indexes do not need to own all of the stocks in the selected market, only enough securities to faithfully represent price movements in the target market.

As most indexes are created to be tracked by an exchange-traded fund, index providers will exclude securities that will encumber the tracking. Some examples of this securities are low liquidity stocks, mutual funds, and other exchange-traded funds. As most of this securities have little impact on the market, excluding them will not hurt the ability of the index to track the market.

Passive indexes have the advantage of being extremely transparent and having the lowest turnover. Tracking a market might be challenging in practice, but mathematically is extremely simple; passive indexes will provide full disclosure of their security selection rules. The only thing a passive index will not publish is its unique divisor. This divisor is used to account for stock splits, spin-offs, and other structural changes, index providers tend not to share such divisor. A famous example of this divisor is the Dow divisor, which gets smaller every time a stock undergoes a structural change. The divisor started as



simply the number of stocks inside the index, but as stocks adjusted over time, the divisor has become smaller and smaller.

Currently, the numerical value of the divisor is below zero. As the passive selection rules are rather simple, passive indexes do not need to be often restructured. This leads to a lower turnover and consequently lower fees.

Passive indexes will provide the return of the market, minus fees and any tracking error the exchange-traded fund might have. By eliminating the human factor, passive indexes present themselves as the less risky choice. By strictly following fully published rules, they remove uncertainty for investors. Not attempting to outperform the market, allows passive indexes to be fairly cheap to maintain, and consequently are the most economical option for investors. All of these qualities make passive indexes perfect for investors looking to enter new markets, and for those who want a cheap and safe investment.

Cryptocurrencies are hard to understand. Any investment product based on cryptocurrencies should be readily understood, so it does not add any extra difficulty for investors. Passive indexes are distinguished by any investor in any market; they are direct and straightforward. As well passive indexes serve as useful benchmarks, and there is still not a popular benchmark for cryptocurrencies.

## **7.2 Security weighting**

The first step to create an index is to choose which securities it will track. The second step is to select a weighting scheme for those securities. Different weighting methodologies have a profound impact on the end product. Securities are weighted through three different methods: capitalization weight, fundamental weight, and fixed weight. Most of the weighting methodology used by index providers will fall into one of these methods, but some indexes could fit into two asset security weighting categories.

### 7.2.1 Capitalization

The idea behind capitalization weighting is to let the markets decide the importance of each individual security (Richard A Ferri, 2004). Market capitalization is the measure of this importance, market capitalization is calculated by multiplying the number of shares outstanding by their market price. It is the total value of the stocks of a company. The value of a company on any given day can be thought as a consensus price of all global investors for the specific company. If there were no global consensus, the company's market value would change, if investors globally believe that a company is overpriced, they will sell and short the company's stock, this will lead to a drop in market value and a new global consensus. Letting the market decide the importance of securities, is letting investors decide the weight of each the securities, index providers do not influence the weighting process. This is why capitalization weighting, is known as passive weighting.

Just like passive security selection, capitalization weighting aims at mimicking the behavior of the market. Capitalization weighting and passive security selection share the same qualities, they charge low fees, they have a high degree of transparency, and investors do not need to trust the ability of the managers.

There are four different basic types of capitalization-weighted indexes. Full cap, free float, constrained/capped, and liquidity. Full cap indexes include the total market capitalization of a security and used to be the most common method in market indexes. Free float is an adjustment to full cap; it excludes from the calculation the value of the shares that cannot be publicly traded. Companies tend to have a certain amount of stock held by individuals or entities that cannot legally sell the stock.

By calculating the market capitalization of only the stocks that are available to trade in the public markets, free float indexes are more accurate when tracking the target market. As well, free float indexes are easier to replicate by exchange-traded funds and serve as fair tool to set a benchmark when judging the performance of active management.

Free float indexes have overtaken full cap indexes as the industry standard. Liquidity-adjusted capitalization-weighted indexes, as the name indicates, adjust the market capitalization to the amount of liquidity securities have. It's a similar procedure to how free float indexes adjust the market capitalization to the number of shares that can be publicly

traded. Investment products based on indexes require a certain liquidity to be properly maintained and not represent a risk for investors. Applying free float weighting to companies with large free float market capitalization, but low liquidity will impede exchange-traded fund providers from accurately tracking the securities. This methodology is widely used to track emerging markets that are not very actively traded. Capped weight indexes limit the weight of any given security, to avoid overexposure to large market cap securities. Traditionally this indexes, cap the weight of securities at five or ten percent of the total pool of assets in the index.

Investors that desire to get exposure to a market, but do not aspire to outperform it, should consider investing in capitalization-weighted indexes. This weighting methodology, compared to its peers, offers the investors a cheap, safe, and reliable investment.

Bitcoin's market capitalization is more than fifty percent of the whole cryptocurrency market, and traditional indexes do not usually have security that is more than half the index. A cryptocurrency capitalization-weighted index, for many investors, will be overexposed to bitcoin. But that is better than being overexposed to smaller altcoins. Altcoins are a risky game, and new altcoins come and go very quickly. Capitalization-weighted will be the safest way of creating a cryptocurrency fund.

### **7.2.2 Fundamental**

Fundamental weighting selects the weight of securities in an index, based on a factor other than market capitalization (Richard A Ferri, 2004). Fundamental index providers create weighting factors, the complexity of this factor ranges from one single variable to intricate multifactor models. Traditionally these factors are financial factors, extracted from corporate financial statements, but some index uses qualitative data to weight their securities. Fundamental indexes can be weighted based on the amount of dividends they pay, their asset turnover, and debt to equity ratio, environmental impact, etc. There is no limit to what can be chosen as a weighting factor, and investors will be wise to judge fundamental indexes on a case by case basis.

Investing in a fundamental index can be tricky, it can be hard to pinpoint when does a fundamental fund, stop being a passive management product and it becomes active management. Both investors that follow passive management, and investors that are looking

for a product that will outperform the market, should be careful when dealing with fundamental indexes.

Fundamental indexes can be extremely complex to construct, maintain, and comprehend. The more complex the weighting factor, less information will be disclosed, it will grow harder to comprehend, and it will have to be restructured more frequently. Most fundamental indexes will have to be restructured each quarter, as dividends get paid out, and new financial statements are published. As a result, fundamental indexes will incur in higher cost for the investor than its peers.

Fundamentally weighted indexes are a good investment vehicle for those investors that are trying to get exposure to a very specific factor. For example: investors that believe that certain financial factors will determine the success of a company. As the weighting rules can be extremely specific, investors should do their due diligence, and only invest if they completely trust the rules.

Just like quantitative security selection, fundamental weighting is a hard methodology to apply to cryptocurrencies. Most cryptocurrencies are completely decentralized, and their performance has nothing to do with their developers. There are not many factors that index providers can use to apply fundamental weighting, aside from the aforementioned ones, risk and return.

### **7.2.3 Fixed weight**

Fixed weighting, as the name indicates fixes the weight of the securities to a certain value. There are different fixed weighting schemes: equal weighting, modified equal weighting, leveraged weighting, and inverse weighting (Richard A Ferri, 2004). Equal weighting lives up to its name by giving the same weighting to all the selected securities. Modified equal weighting, ranks the securities into different levels of equal weights. Each level will have a different weight, while securities at the same level will be equally weighted. Securities in the first level will weight five percent, in the second level of four percent. The rank a security is given will depend on a factor arbitrarily chosen by the index providers.

Leveraged weighting is used to mirror an index, but using borrowed capitals to increase the exposure to the market. In practice, this multiplies the profit and losses by the percentage of the borrowed capital. A two times leveraged exchange-traded fund, will return twice the performance of the benchmark. Inverse weighting will track a benchmark inversely, the index and the benchmark will move in tandem, but in opposite directions. Inverse weighting can be leveraged as well.

Equal weighting and modified equal weighting have an inherent problem. They are impossible to put into practice. An exchange-traded fund can buy securities at an equal weight, but as the price of this securities fluctuates, the weight of each security will change with it. Managers will have to be constantly selling to keep the weights equal, and that is virtually impossible.

Fixed-weighted indexes are by nature transparent; the only information index providers might not disclose is the factor used to rank securities in equal and modified equal weighting. Leveraged and inverse weighting, need to have the same weight than the benchmark that they are tracking. Fixed-weighted indexes are considered a passive investment; investors do not need to trust the skill of the managers. The fees of equally weighted index are reasonably low, while leveraged and inverse has higher fees.

Fixed-weighted indexes are a versatile tool. They provide investors with a passive investment that adds extra exposure to securities with smaller market capitalization, while never overexposing the investor to any individual security. But as well, they can be a great passive investment to short a market, or to get leveraged exposure.

Cryptocurrencies with small market capitalization are extremely risky. Not only they are volatile, even by cryptocurrencies standards, but most cryptocurrencies are less than one year old. Getting overexposure to smaller cryptocurrencies can prove to be too risky. Leveraged weighting, will prove too risky as well, a cryptocurrency market fund will be more volatile than a normal leveraged fund. Such levels of volatility will most likely not be well accepted.

## 8 DISCUSSION AND CONCLUSION

Cryptocurrencies face many issues that regular securities do not: they are exposed to hacking, risk of being outlawed, and to invest in cryptocurrencies requires that investors acquire a completely new set of tools and skills. I believe this to be the key problems that must be solved before cryptocurrencies are truly implemented in the real world on a big scale. In the thesis, I have been presenting information, on how a company could provide a service that helps cryptocurrencies solve one of these key issues: Investors having to acquire a new set of tools and skills.

My approach to this problem has been to recognize the lack of investment vehicles that investors can access to achieve exposure to cryptocurrencies. I believe that the lack of financial professionals, that can advise and invest the money of individual investors into cryptocurrencies, is currently holding the cryptocurrency market from becoming what it could be. The demand for this service greatly outnumbers the supply. There is an ever-growing demand and an almost non-existent supply. Solving this gap will not only prove to be extremely profitable for private companies, but it will as well help take cryptocurrencies to the next level.

In any other market, financial companies will have rushed to the market and fill this gap, but financial companies have their hands tied up. The current legal state of cryptocurrencies is the only reason this gap has not been filled, and financial companies cannot do anything about it. That is unless they embrace a new way of thinking, a way of thinking that includes blockchain, in where code replaces trust. Until lawmakers change their views on cryptocurrencies, tokenized funds are the only solution to fill this gap.

Tokenized funds present themselves as a way to disrupt the financial market. Just like how exchange-traded funds disrupted the mutual fund industry in the early nineties, tokenized funds have the potential to revolutionize the investment industry. I believe cryptocurrencies are the medium to bring the structure of tokenized funds into the spotlight, and at the same time, tokenized funds are currently the only way to make cryptocurrencies approachable. Nevertheless, companies will have to surpass all the challenges that tokenized funds present. The key problem with tokenized funds is trust. Investors do not fancy change, and this is understandable since investors put their money at stake. Making

investors trust a new kind of investment vehicle that is not backed by big financial companies, or by a government, will be a hard sell. That is why I believe that the whole structure of the investment vehicle must aim to optimize trust. Blockchain and smart contracts are perfect for this since they are technologies that can ensure trust. But this is new concepts, and investors will not necessarily trust them. It makes no difference if blockchain ensures trust if investors do not understand and trust the technology. The average person cannot read and understand the code behind a smart contract, so they have no reason to trust it. Investors might not trust the technology, the managers, and the product. This is why, a fund that invests in cryptocurrencies must be as simple as possible and offer such an investment opportunity, that investors are seduced by it.

There are several ways to achieve trust; the first way is to build a fund that requires no trust. Mutual funds require the investor to trust on the ability of the manager, and it's a perfect example of the principal-agent problem. If a mutual fund that actively invests in cryptocurrencies is launched today, potential customers will not have the information to trust the ability, and reliability of the managers. Therefore, I suggest an exchange-traded fund. Exchange traded funds follow publicly published written rules, and they are very well understood by the average investor.

An investor that invests in an ETF does not need to trust the manager, he simply has to trust the rules, and he can analyze how those rules would have historically fared. The simpler the rules, the better. This means that the index that the exchange-traded fund follows must be considered a passive investment. Any index construction methodology that aims at beating the market requires the investors to trust the managers. Any methodology that does not disclose the rules to their full extent requires investors to place trust in the fund. The tokenized fund must require as little trust as possible, so all those methodologies are excluded. The only methodologies left are: creating a market index, a market index with very simple screens, and creating a market index that has modified equal weighting.

Personally, I believe a market index is the best option. A modified equally weighted fund will overexpose investors to low market capitalization cryptocurrencies, and that is an added risk. Most investors only know of Bitcoin, and would only invest in Bitcoin. Other cryptocurrencies such as Ethereum and Ripple, have a very strong reputation as well. There are being supported by many companies internationally. But this is not the case for

most of the altcoins; most cryptocurrencies remain completely unknown to the public. Increased exposure to these cryptocurrencies, it's not only risky from a financial point of view, but it will require the trust of investors. A market index, with simple screens, if necessary, will be easy to trust. If a company can create an index that correctly tracks the movements of the cryptocurrency, it will have created a unique product. Market indexes are not just used by exchange-traded funds providers, but by economist and the media, to study and report the market.

Currently, there is not one single cryptocurrency index that serves the role of the SP500 in the United States of America. Any index that achieves to become one of the benchmarks for the market will obtain a level of authority and popularity, which no custom index will be able to match.

Creating a market index about cryptocurrencies is still hard task. Cryptocurrencies, in many ways, work similarly to emerging markets. And just like emerging markets liquidity is a problem, many cryptocurrencies have a relatively high market capitalization but are illiquid. Creating an exchange-traded fund that tracks such a market, without taking the liquidity into account is a risk, an unnecessary one. I believe that the index should follow liquidity-adjusted market capitalization rules.

You can imagine blockchain as an intrinsically safe, decentralized and immutable digital autonomous entity. A decentralized application on the blockchain can sustain itself, it has no need for owners or developers; picture an autonomous company conducting all of its operations on its own. This company could sign papers, invest in the stock market, do accounting and pay its own taxes. All of this without the need for a person, excluding any possibility of corruption or wrongdoing by any human agent. Such a company will never lie, or steal the money from its clients, it would be completely autonomous, and it could be completely trusted.

A fund that follows the same structure, could be fully trusted by any investor. Such a fund will need to follow very specific rules, which do not change over time. Moreover, these rules have to be recognized as successful ones, and be understood by the general public; otherwise, it will be considered a bad investment. For all of this reasons, the tokenized fund that I propose is an exchange-traded fund that tracks a liquidity-adjusted market index.



This fund would follow all of the mentioned criteria. An exchange-traded fund maintains its price level near to net asset value through a decentralized process known as creation and redemption. Passive market indexing rules are the safest and well-known rules to construct an index, they rule out the human factor. Liquidity adjustments are sought after in emerging markets, in where investors fear a massive sell-out. A tokenized index that follows the aforementioned rules, will provide a trustworthy service, that will enable any investor to achieve exposure to cryptocurrencies, in a way that transcends regulation and borders.

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