CAN BITCOIN REPLACE THE US DOLLAR AS A WORLD RESERVE CURRENCY? A VOLATILITY RESEARCH ON BITCOIN PRICES

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A Thesis Submitted to
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ABSTRACT

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Kanar, Görkem

Master's Program in Financial Economics

Advisor: Assoc. Prof. Dr. Gül Ertan Özgüzer

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The aim of this research is to determine whether Bitcoin (BTC) could be used as a medium of exchange rather than a speculative asset as considered in the literature and in public and could replace the US dollar as the world reserve currency. Global distrust for traditional financial instruments after the financial crisis of 2008, currency debasement of the US Dollar with an expansion of the M2 money supply, and rising inflation rates led to the emergence of blockchain technology as an alternative to the current centralized financial system. In this thesis, I conduct three empirical investigations. My findings indicate that BTC is not yet ready to be a world currency due to its high volatility. However, my findings also show that BTC price volatility tends to decrease over time, increasing the price stability and potential currency usage of the network.

Keywords: Bitcoin, Blockchain, Currencies, Cryptocurrencies, Trust, Volatility.

ÖZET

BİTCOİN ABD DOLARININ YERİNİ REZERV PARA BİRİMİ OLARAK ALABİLİR Mİ? BİTCOİN FİYATLARI ÜZERİNE VOLATİLİTE ARAŞTIRMASI

Kanar, Görkem

Finans Ekonomisi Yüksek Lisans Programı

Tez Danışmanı: Doç. Dr. Gül Ertan Özgüzer

Kasım, 2022

Bu araştırmanın amacı, Bitcoin'in (BTC) literatürde ve kamuoyunda değerlendirildiği üzere spekülatif bir varlık olmaktan çok bir takas aracı olarak kullanılıp kullanılamayacağını belirlemektir. 2008 mali krizinden sonra geleneksel mali araçlara yönelik güvensizlik, M2 para arzının artması ile birlikte ABD Dolarının para biriminin değer kaybetmesi, mevcut merkezi finans sistemine bir alternatif olarak blokzinciri teknolojisinin ortaya çıkmasına neden oldu. Bu tezde, üç ampirik araştırma yapılacaktır. Bulgularım, BTC'nin yüksek volatilitesi ile henüz bir dünya rezerv para birimi olmaya hazır olmadığını gösteriyor. Bununla birlikte, bulgularım aynı zamanda BTC fiyat volatilitesinin zamanla azalma eğiliminde olduğunu ve bunun da ağın fiyat istikrarını ve potansiyel para birimi olarak kullanılabilirliğini artırdığını gösteriyor.

Anahtar Kelimeler: Bitcoin, Blokzinciri, Güven, Kripto para birimleri, Para birimleri, Volatilite.

TEŞEKKÜR

Tez çalışmalarımda bana yol gösteren ve yardımcı olan değerli hocalarım Doç. Dr. Gül Ertan Özgüzer'e, Prof. Dr. Oğuz Esen'e, Prof. Dr. Erdem Özgür'e ve Dr. Öğr. Üyesi İdil Göksel'e. Tez sürecine gelene kadar derslerinde bana yardımı dokunan ve akademik olarak moral desteği veren kıymetli hocam sayın Prof. Dr. Hakan Yetkiner'e;

Bana maddi ve manevi katkılarıyla tez yazmam için uygun ortamı sağlayan ve beni sabırla dinleyebilen sevgili aileme;

Hayat görüşümü değiştiren, geliştiren ve bana bireysel özgürlüğün önemini gösteren dünyaca ünlü ekonomistlerden sayın Milton Friedman, Murray Rothbard, Thomas Sowell, Frederick Hayek ve Ludwig Von Mises'e bilimsel yönden çalışmalarıyla ışık olup yol gösterdikleri için;

Teşekkürlerimi sunarım.

-Veritas Vos Liberabit-

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LIST OF ABBREVIATIONS

BTC: Bitcoin

CBDC: Central Bank Digital Currencies

CEFI: Centralized Finance

COVID-19: Coronavirus Disease 2019

CDO: Collateralized Debt Obligation

CPU: Central Processing Unit

CVA: Credit Valuation Adjustment

DEFI: Decentralized Finance

DLT: Distributed Ledger Technology

DVA: Debit Valuation Adjustment

FED: Federal Reserve

FVA: Funding Valuation Adjustment

GPU: Graphics Processing Unit

IoT: Internet of Things

LIBOR: London Interbank Offered Rate

MMORPG: Massively Multiplayer Online Role-Playing Game

OTC: Over The Counter

USD: United States Dollar

The U.S: United States

XMR: Monero

CHAPTER 1: INTRODUCTION

The rising global distrust for traditional financial instruments after the financial crisis of 2008 gave birth to the first decentralized currency. Bitcoin (BTC), the first and the most popular decentralized currency, was created by Satoshi Nakamoto (Nakamoto, 2008). A new decentralized system without a need for central authority has gained mass attention. Rising inflation rates may have also contributed to the popularity of BTC since BTC has a limited supply, which would induce a low inflation rate. Since its inception in 2010, the prices of BTC have been very volatile. Therefore, both in the literature and in public BTC has been identified as a volatile and speculative asset. However, BTC is the first use case of blockchain technology, which emerged as an alternative to the current centralized financial system with the claim to replace financial intermediaries within a more secure and faster environment.

Adapting to changes in technology often faces resistance from corporate management. Nonetheless, resisting changes and failing to adapt often result in financial decline and losing market share to competitors. Kodak refused to change its printed hard copy photography policy to digital photography and Nokia and Blackberry, which were late to adopt Apple's revolutionary touch screen and software developments in the cellphone industry are two main examples. Blockchain technology provides an alternative to traditional systems by being more secure and faster than the currently used technologies. Therefore, central banks also seek to take advantage of blockchain technology and use their own digital currencies.

In modern times, central banks can create currencies out of thin air without any physical (Gold, Silver) backing and they must be trusted to keep the monetary system going on. However, economic policies with greater good intentions, restrictions on the free flow of money, unnecessary regulations and high taxes, and arbitrary price controls disrupt free-market dynamics and create price impurities. Therefore, the trust between the state and the people is damaged, further causing a downward spiral into the chronic inflationary periods seen numerous times in history and modern times. BTC as the first decentralized currency could address these trust concerns and create a trust-minimized environment, providing maximum and predictable purchasing

power with minimal inflation due to the limited supply nature of the network. Satoshi Nakamoto said;

‘‘ *The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve. We have to trust them with our privacy, trust them not to let identity thieves drain our accounts.’’*

Thus, BTC may have the potential to be used as a currency rather than a speculative asset. In this thesis, I will explore whether BTC may replace the US dollar (USD) as a reserve currency. To this end, I will explore its pros and cons and compare its features to traditional currencies such as gold and fiat money. Price volatility decrease may improve the BTC currency aspect to enable its function as of medium of exchange.

In this thesis, I conduct three empirical analyses to scrutinize BTC price volatility, which are the Monte Carlo simulation, Time-Series analysis, and Maximum Drawdown model. Using the historical price volatility and past maximum drawdown values, we show that BTC price volatility has a declining trend. Monte Carlo simulation is performed to predict future prices and thereby to predict future price volatility of BTC. This analysis takes into account forty-four days of short-term price actions. Time series analysis, on the other hand, is made for a one-year period to enable a long-term price prediction, using past volatility. The third analysis, the maximum drawdown model, is used to show the risk that investors will face by illustrating the daily maximum percentage drawdown of prices. Furthermore, I calculate the 1000 days of Garman-Klass BTC volatility and 1000 Days of Yang Zhang BTC volatility. The findings of this analysis confirm those of the time-series analysis and the maximum drawdown model, indicating decreasing price volatility. The early stage of the network price action the period of 2012-2016- shows a higher degree of volatility and maximum drawdown values compared to the recent one -2017-2021 period.

CHAPTER 2: LITERATURE REVIEW

The economic literature and research on cryptocurrencies are relatively thin due to the technology being relatively new. To the best of my knowledge, this is the first study to analyze the decreasing volatility aspect of BTC which may suggest that the currency aspect of BTC could improve with future price stability. However, numerous papers analyze BTC price volatility including Bouoiyour and Selmi (2016), Elie Bouri, (2017), Katsiampa (2017), and David Ardia, (2019) conclude that BTC price volatility is too high for BTC to be used as currency. In their seasonality-adjusted research, Decourt, Chohan, and Perugini, (2019) showed that returns were higher on Wednesdays and on Tuesdays, in accordance with the findings of this research.

There is a strand of empirical literature that focuses on the volatility of BTC prices and stock market prices using GARCH models. Among many papers that use the GARCH model in the literature, Dritsaki, (2017) examined the Stockholm stock market volatility using daily stock return data. Katsiampa (2017), Baur and Dimpfl, (2021) Dhyrberg, (2016) compared the volatility of BTC, gold, and the dollar using the GARCH model.

Compared to other financial tools like the time-series model, the GARCH model looks at the likelihood of the volatility of the asset remaining high during high volatility periods or remaining low during low volatility periods. Takaishi, (2019) uses the hybrid Monte Carlo simulation to calculate the BTC volatility. Likitratcharoen, Kronprasert, Wiwattanalamphong, and Pinmanee, (2021) analyse the Covid-19 effects on BTC price volatility using Monte-Carlo simulation and VaR methods and found that Covid-19 increased the volatility of crypto market prices.

A few economic models were developed to study this new payment technology. Lo and Wang, (2014), Velde, (2013), Chiu and Wong, (2015) apply the mechanism design approach to review BTC. Folkinshteyn, Lennon, and Reilly (2015) compare the BTC technology to the world wide web development. Lustig, (2014) analyzes the algorithmic authority of human factors in the BTC community who would prefer to integrate BTC with existing companies.

Baur and Dimpfl, (2021) explores the idea of volatility against foreign currencies. They concluded that the volatility of BTC was higher than EUR, USD, and YEN.

Three most popular and used currencies in the world. Luther and White (2014) discuss the idea of entrepreneurial attempts which may cause BTC to be widely adopted. Also, they state the fact that BTC prices were unstable to be used as a medium of exchange. Glaser, Zimmermann, Haferkorn, and Siering (2014) examine whether BTC is an asset or a currency and conclude that BTC is used as a speculation tool and considered as an asset rather than a currency. Therefore, previous literature shows that BTC is a volatile asset rather than a currency. The difference between our research and the literature is that we explore the behavior of volatility in the future whereas the previous work has focused on historical volatility. The goal here is to show the trend of volatility in the future. Doing so, this research will scrutinize whether BTC may be used as a medium of exchange and replace USD as the reserve currency.

Also, Hayek's view of sound currency is very similar to BTC currency with a slight difference: it is not issued by the private enterprise but issued by the technology itself. Friedrich Hayek, (1988) quotes;

'' [*I] am more convinced than ever that if we ever again are going to have a decent money, it will not come from government: it will be issued by private enterprise, because providing the public with good money which it can trust and use can not only be an extremely profitable business; it imposes on the issuer a discipline to which the government has never been and cannot be subject. It is a business which competing enterprise can maintain only if it gives the public as good a money as anybody else.''*

Chapter 3 focuses on the traditional financial system, the inflation US Dollar, and the global reserve status of previous currencies. Chapter 4 examines the positive and negative aspects of blockchain technology. Chapter 5 shows the history and technological system behind the BTC network. Chapter 6 focuses on empirical analyses conducted in this thesis Chapter 7 concludes and gives policy implications.

CHAPTER 3: TRADITIONAL FINANCIAL INSTRUMENTS, US DOLLAR, AND INFLATION

Our modern monetary system still relies on the centralization of the currency issued by central banks. In this chapter, we will look at the traditional financial system, the US dollar, which is the current global reserve currency, and inflation.

3.1 Fiat Money and Inflation

Fiat money is a currency that a government has declared to be legal tender. Legal tender means that the value of the currency is supported by the faith and the credit of the government that creates it. All physical paper money in the world today is fiat money. Because fiat money cannot be redeemed for gold or silver from central banks directly, it is essentially no different than monopoly money with better paper quality and counterfeit security measures. The intrinsic value of fiat money is close to zero or only worth the paper, it is printed on. Value is only guaranteed by the trust of the people to be used as a medium of exchange.

'*Value of money depends on the willingless of economic agents to accept it, no matter what material is made of.'* (Skaggs, 1998)

The quality of a society is directly related to the quality of its currency. Diluting the money supply or increasing the money supply is one of the main reasons for inflation. In general terms, inflation is seen as a general rise in prices, which is directly related to the growth of the money supply. Throughout history, there are countless pieces of evidence of rising inflation with the expanding money supply and the ease of credit. Ludwig Von Mises (1951) describes inflation as;

''*Inflation is an increase in the quantity of money without a corresponding increase in the demand for money.''*

A stable currency leads to stable prices of goods and services, which leads to a stable civilization. A stable civilization also leads to economic growth and prosperity.

Prices are a way of distributing goods to those who value them the most. If prices are held too low, consumers are more incentivized to buy more than they normally would because of the opportunity of the low costs. In inflationary environments consumers are incentivized to stock up any goods they find in the stock due to the expansion of the money supply making currency worth less as time passes. Artificially created price controls or hyperinflation may cause black markets to emerge due to artificially suppressed price mechanisms and consumers might not be able to find goods in stock.

3.2 Fractional Reserve Banking

The purpose of the banking system is to have a safe way to store money. General public opinion about the bank is person Person A deposits the money in the bank, and the bank gives person B the requested credit from person A. The existing system of fractional reserve banking is that banks are legally allowed to create digital money out of thin air by lending money that they do not have while collecting interest payments.

Before 26.03.2020, banks in the U.S had to keep the 10% of the deposits in reserve before lending money to their customers. However, 10% of the deposit requirement was removed with an announcement from the central bank of the United States. This policy change also further strengthens the danger of bank rushes. Since lending money they do not have, any bank rush or a rumor of insolvency could create a severe problem within the banking industry.

3.3 Global Reserve Currencies

Throughout history world's reserve currency status changed with time. If BTC gets more attention; we may see a shift in the change of the world reserve currency.

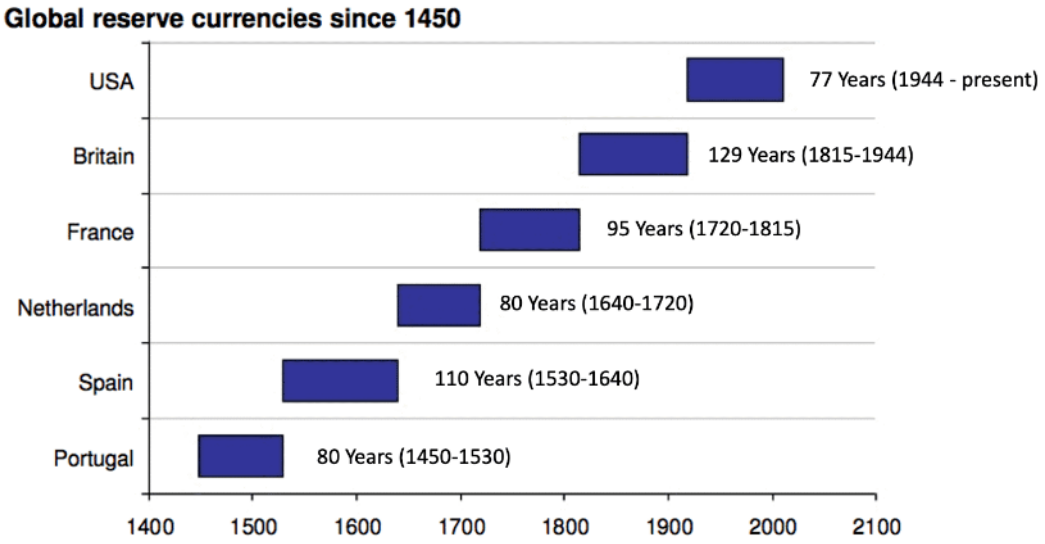


Figure 1. World reserve currencies. (Source: Russell, 2022)

Currently, US Dollar is the global reserve currency. As seen in Figure 1. The average world reserve currency status lasts for 95.1 years. With the adoption of BTC, we may see US Dollar lose its world reserve currency status as had been experienced by currencies of countries or empires. In the following sub-chapters, I will examine the current world reserve currency US dollar, inflation, money supply dilution, and the 2008 mortgage crisis.

3.4 The Debasement of The U.S Dollar

Between 1944-1971 U.S dollar was pegged to 35$ an ounce and all the other national currencies were pegged to the U.S dollar as the dollar was the world reserve currency Hammes and Wills, (2005). Late 1940's dollar was undervalued, meaning that 35$ an ounce of official price-fixing to gold and USD was scarce. The real value of the dollar was lower than 35$ an ounce. This meant that the U.S had a big trade surplus while the rest of the countries in the world had difficulty meeting their balance of payments.

Beginning in the late 1940's Fed tried to solve this problem by reducing the scarcity of the dollar by printing more money.1948 Marshall plan also helped to create

international competitors to U.S manufacturing such as Japan, contributing to the trade deficit created by easing the monetary policy.[1] (Brian Reinbold, 2019).

The dollar was now above the 35$ an ounce level convertibility rate that was created by the federal reserve. Realizing the situation, gold started to outflow out of the U.S and central banks around the world, mainly France President Charles De Gaul and Switzerland demanded their gold out of the U.S vaults. Charles De Gaul famously sent the navy of France to collect their gold showing the seriousness of the situation

(Lin and Neely, 2020)

The coinage act of 1965 also removed all silver content from dimes and quarters and reduced the silver material to half a dollar.[2] In 1970 half dollar silver content was completely eliminated. Vietnam war in the 1960s plus heavy deficit spending and borrowing further reduced the real dollar value in the market. 35$ ounce gold for a dollar peg was unsustainable and President Richard Nixon's Executive Order 11615, on August 15, 1971, suspended the exchangeability of the US dollar into gold and practically ended the Bretton Woods system. System change was designed to be a temporary measure, but the floating fiat system is still used in the current world.

''*Nothing is so permanent as a temporary government program''.* (Friedman and Friedman, Tyranny of the Status Quo, 1984)

3.5 2008 Financial Crisis of Credit Default Swaps and Mortgage Crisis

Credit default swaps are like insurance against a company defaulting on its debt obligations. Essentially, when people buy a credit default swap, they are swapping risks with someone else. Colletarized Debt Obligations in 2008 included bad mortgage loans given to everyone even without income verifications and adjustable rates. In return, housing demand increased and costs became higher and higher leading to the real estate bubble, which crashed the markets in the 2008 economic crisis affecting the whole world economy. CDOs fundamentally are debt instruments where institutions

[1] Marshall plan was an aid program designed to help to the World War 2 destroyed Europe by U.S.
[2] Coinage act of 1965 reduced silver content from half dollar from 90 percent to 40 percent.

pool together the investor's money and use the underlying asset (bond, mortgage, or loan) as collateral for protection in case the borrower defaults. These CDOs essentially are made in tranches. The highest levels are triple AAA which is paid first and considered less risky and rated by the credit agencies such as Moody's. B-level tranches are considered riskier. B-level tranches may fail more than triple AAA, but in return, they can be more profitable. Traditional CDOs generate their income from cash assets like mortgages and credit loans while synthetic CDOs generate their income from non-cash derivatives like credit default swaps, options, and other contracts. Synthetic CDOs are highly criticized since they played a significant role in the 2008 crisis. Rating agencies like Moody's and Standard and Poor's played a vital role in rating the CDOs. Deliberately rating CDOs's a higher rate due to pressure from the banks led to devastating economic effects which happened in the 2008 mortgage crisis.

United States government using taxpayer's money issued 700 billion USD worth of bailout program Rose, (2009). This bailout program was used to financially save the banks, insurance companies, and mortgage service providers from bankruptcy and received a lot of criticism from the public. While average citizens of the US were allowed to go bankrupt; the same competitive free market rules did not apply to greedy bankers who exploited the corrupt system of rating agencies, mortgages, and Credit Default Swaps. They instead received a reward for disrupting the world economy and causing the people who bought their underlying assets, which were tied to the mortgages, to lose their life savings.

Credit rating agencies that give a perfect rating to the defaulting loans did not get punished. The safety net created by the governments allowed banks to take more significant risks that ordinary people did not have. Too big to fail approach is an objectively wrong approach from the free-market perspective and level playing field which should be the goal of every government. Special rights given to the companies reduce the overall effectiveness of the free market and create distrust between the governments and their citizens. Occupy wall street riots in 2012 were mainly against the injustices and the unfairness of the system which protects wealthy people or organizations from bankruptcy. Too big to fail approach is a branch of the part of the same tree which creates the need for the greater good. Not letting failed companies go

bankrupt was also heavily criticized by academics as these companies were often called zombie companies by scholars.[3] Therefore, both the 2008 financial crisis and the policies undertaken after the financial crisis led people to look for alternative currencies or investment options.

3.6 39-years High USA Inflation Rates (2021)

USA inflation statistics show us that inflation rates are at 39 years high.[4] Inflation is a lagging indicator of the increase in money supply and it is directly correlated with the demand for money. The reason often given by the media is that inflation is transitory and the reason for inflation is supply chain shocks and will correct itself after the pandemic of 2020 is over. Since inflation is the taxation of savings, increasing the money supply puts a financial burden on people's savings and retirement. Ultimately the primary culprit behind the 39-year high inflation is misguided bad monetary policy from the federal reserve printing money to save the day and unpreparedness of the government's ability to predict and take precautions before disasters happen. The money supply (M2) has increased by 40% since the pandemic of March 2020.

Unprecedented quantitative easing, zero interest rates, and monthly purchases of 120 billion USD a month of mortgage-backed securities and treasuries with freshly printed money are other main reasons for 39 years of record-high inflation of 6.8% rates in the United States. The radicalness of this quantitative easing program becomes more apparent when we look at the bigger picture. The exponential acceleration of the monetary base is at unseen levels in United States history.

'*Hayek was highly critical of "monetary nationalism", meaning the management of currency by a monopolistic central bank which imposes an inflation tax by overshooting monetary targets.'* (Ravier, 2020)

[3] Zombie companies are those who need bailouts to function in the market.

[4] https://www.statista.com/chart/18344/year-over-year-change-of-the-consumer-price-index-for-all-urban-consumers/

The economy, especially the stock market, is propped up by leverage. Wages of the working class never increased to justify the stock market and real estate prices, and prices can only go higher based on more credit being created into the economy. The central bank is pressured to keep near-zero percent negative interest rates and federal funds rates near zero percent in order to stimulate the economy. Monthly bond purchases are propping up assets in the stock market, insurance funds, and real estate and are used to finance billions in imports, to keep the financial system stable. FED is forced to print money. It has already shown up in the M2 money supply and we are beginning to see its effects of it, as money velocity rises. The FED has decided to increase the dollar supply in order to keep the system solvent and to keep asset prices and the stock market higher.

FED with its Quantitative easing policy now faces a dilemma of rising interest rates slow or fast. Rising interest rates fast would crash the market and disrupt the economy further, causing unemployment to rise, however not rising the interest rates or acting slowly would also mean facing the inflation problem. The next subchapter will show us that the M2 money supply increased dramatically starting in 2020.

3.7 BTC prices, M2 Supply, and Federal Funds Rate

The data series used were M2 Money supply, billions of dollars, and Coinbase BTC U.S. Dollars. Data series about US Dollar, S&P 500 index, and M2 money supply information were taken from the federal reserve official site named *fred*.

Intervals were selected quarterly from (2015-01-01) to (2022-05-01). Figure 2 illustrates the relationship between the M2 Money supply and BTC prices. A sharp increase in M2 money supply is observed in (2020-03-01) that may have positively affected the rise of the BTC prices.

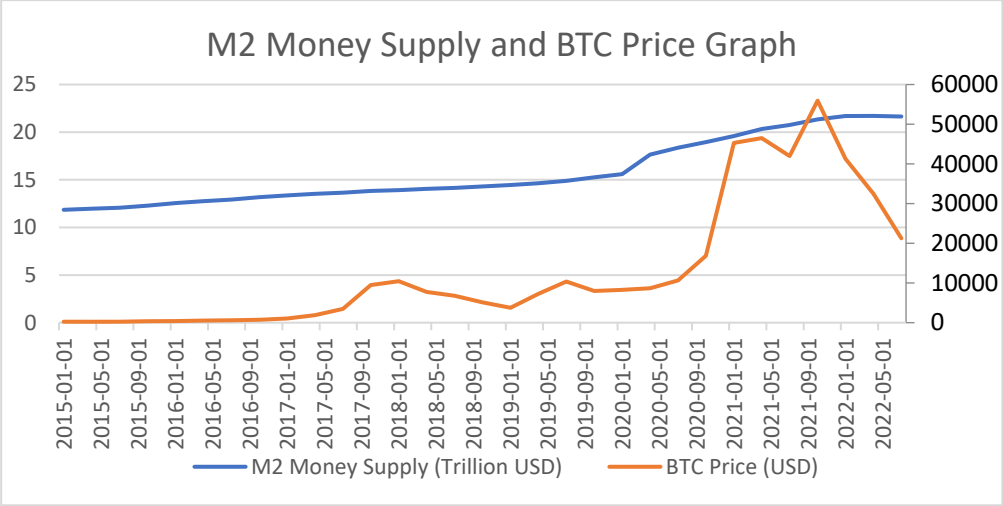


Figure 2. M2 Money supply and BTC price.

The strong correlation between S&P 500 index and BTC price can be seen clearly in Figure 2, especially between (2021-09-01) and (2022-02-01). Both the prices and index are showing bearish signs which may have been the result of federal reserves funding rate increases and the end of the quantitative easing policy.

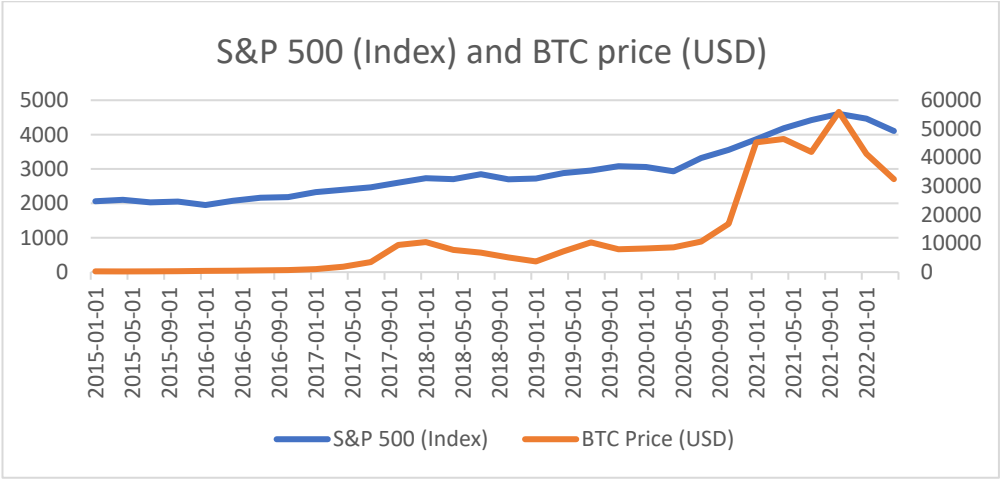


Figure 3. S&P 500 (Index) and BTC price (USD).

Figure 3 depicts together the federal funds rate and BTC prices. Near zero values of the federal funds rate are seen between 2020-03-01 and 2021-09-01. Easy access to

credits created by the federal reserve may have resulted in the BTC bull run of 2021. As soon as the federal funds rate is raised we see a clear decline in BTC prices.

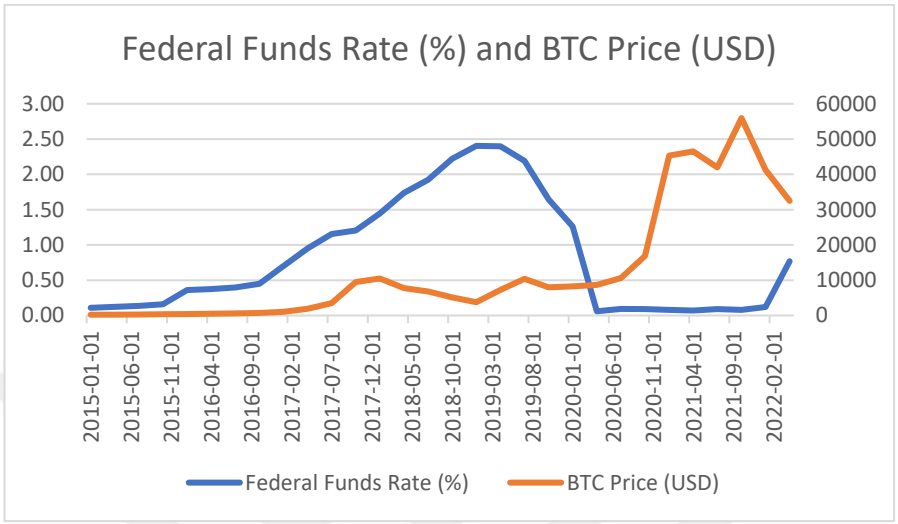


Figure 4. Federal funds Rate (%) and BTC Price (USD).

CHAPTER 4: POSITIVE AND NEGATIVE FEATURES OF BLOCKCHAIN

Although blockchain technology has promising features compared to the currencies used before. It is not without disadvantages. In this chapter, we will compare the positive and negative aspects of blockchain technology over the BTC, Gold, and US Dollar and concerns over some of the problems this new technology faces. These concerns may be the biggest limitation of the adoption of the BTC.

BTC gained mass attention thanks to its fast and secure decentralized technology. However, to achieve this secure proof of work, the BTC network uses electricity. The power usage of BTC gets higher as the network gets used more which may be the biggest limitation of BTC to being used as a currency rather than a volatile asset.

With the rise of BTC's popularity, central banks all over the world have shown interest in blockchain technology for the creation of digital currencies, The usage of central bank digital currencies (CBDC) could enable faster transfer and lower financial transaction costs., However, this comes with the cost of lower privacy.

4.1 Features of Money

There are mainly three functions of money. Store of value, medium of exchange, and unit of account. Since BTC aims to be a currency to be used rather than a speculative asset for traders. We will compare the features of BTC, Gold, and, Fiat money to show their advantages and disadvantages. Gold and fiat money was as used as a currency for longer than the lifespan of BTC.

Table 1. Comparison of BTC, Gold, and Fiat (US Dollar) currency. (Source: Held, 2019).

Traits	**Bitcoin**	**Gold**	**Fiat (Dollar)**
Verifiable	High	Moderate	Moderate
Fungible	High	High	High
Portable	High	Low	High
Durable	Moderate	Low	High
Divisible	High	Low	Moderate
Scarce	High	Moderate	Low
Established History	Low	High	Low
Censorship Resistant	High	Moderate	Low
Unforgable Costliness	High	High	Low
Decentralized	High	Low	Low
Openly Programmable	High	Low	Low

When we examine the contents of Table 1. The most critical disadvantage of BTC is; its unestablished history against the established history of gold. However, BTC has positive features like being decentralized and openly programmable. Scarcity is another favorable feature of BTC since there will be a limited number of BTC in circulation compared to the mining of gold and money printing measures of the central banks. Scarcity with the increased popularity of BTC plays an important role in increased volatility and valuation. Demand increases from the public with limited supply may cause upwards price pressure as BTC gets more popular in the eye of the public. Central banks may also create their own digital currencies to compete with BTC.

4.2 *Central Bank Digital Currencies and Ethical aspect of CBDC (Privacy)*

Central Banks throughout the world are exploring the idea of creating the CBDC which uses permissionless or permissioned distributed ledger technology (DLT) or conventional methods, although DLT is not fundamentally required to create digital currencies. A sound digital currency created by central banks could replace the traditional payment system or could be used in addition to the systems or to back up the traditional systems. Benefits of the CBDC include ease of use, cross-border payments, fast and low-cost transactions, and general ease of accessibility for the general public using devices such as smartphones or personal computers.

CBDC policy goals are continued access to central bank money, financial inclusion, payment system efficiency, payment system safety, and efficiency, mitigation of currency substitution risk, improvement of payments and banking competitiveness, monetary policy implementation, and household fiscal transfers. Critical requirements for every CBDC are strong cybersecurity, technical stability and resilience, sound technical governance, and safe and reliable custody. Safeguarding privacy while allowing law enforcement to have control is also an important decision that should be decided by the central banks.

Full privacy-allowed currencies that allow anonymity also exist in blockchain space. Central banks stated that full privacy of the users will not be allowed on the new currencies since it will enable tax evasion, money laundering, and, illegal purchases invisible. Privacy is also another concern for all parties. Physical cash is highly private while digital cash or CBDC would be monitored by central banks or governments. This also raises an ethical question of how much privacy would people give up to achieve a fast and efficient currency. Privacy concerns of the users may also defer them to the BTC which is highly private compared to the central bank digital currencies. BTC has high privacy features by design but it is also not, by all means, untrackable since user wallet transactions are visible and public on-chain. Privacy-focused untrackable currencies such as Monero XMR also exist.

Monero is secure, low-fee, and fungible, meaning users can send XMR around the globe despite broken financial systems. Innovative privacy features such as Ring Signatures, Stealth Addresses, and Ring CT ensure that Monero's blockchain is

obfuscated. In other words, the financial history of all Monero users is encrypted from the prying eyes of adversaries on a public blockchain, with transactions being visible only by a user willingly providing a view key.

Monero has also improved upon the scaling downsides of current popular cryptocurrencies. To avoid high fees, dynamic block size ensures that the size of the blocks will increase as the amount of transactions increases. Further, the mining network algorithm RandomX establishes that anybody with a CPU can participate in mining, preventing the ASIC miner domination that creates a high barrier to entry. Lastly, the mining network will be preserved by Tail Emission instead of the block reward falling to zero like with BTC, the block reward gradually approached 0.6 XMR in June 2022, where it will forever stay. This constant linear inflation means the inflation rate will asymptotically go to zero while continuing to provide an incentive to miners to maintain the network.

Table. 2 Consumer needs and CBDC design choices. (Source: World Economic Forum, 2021)

Consumer Needs	**CBDC Design Choices**
Cross Border Payments	Wholesale or retail interlinkages
Accessible to all	Account or token-based access technology
Ensure privacy in lawful exchange	Distributed Ledger Technology
Resilient and Robust Operations	Importance of Architecture
Convenient real-time payments	The operational role of the Central Bank
Cash-like with peer-to-peer functionality	Conventional Central bank Infrastructure

CBDC figure compares the needs of the consumers (left side) and the design choices of central banks (right side).

4.3 Environmental Concerns over the BTC Network

BTC network which runs on a proof of work (POW) network needs miners to confirm and solve the blocks in order to transfer the currency from one person to another. To achieve this secure network, BTC transaction block problems have to be solved by GPU or CPU units. GPU and CPU units spend real electrical energy. What we can is that the BTC network turns electrical power to secure the network.

Central bank currencies created by the laws of government may solve this issue by using proof of stake network technology which consumes no energy and produces no carbon footprints. Proof of stake uses a consensus mechanism to confirm the transaction on the blockchain and reduces the amount of computational work needed to verify blocks and transactions. Both system mechanisms secure the network by blockchains synchronizing data, validating information, and processing transactions.

Table 3. Power usage of the BTC.

Dates	Yearly Electrical Consumption (Terawatt-hour)	Cumulative Electrical Consumption (Terawatt-hour)
2015	3.54	9.55
2016	5.46	15.01
2017	14.44	29.45
2018	45.44	74.89
2019	57.04	131.98
2020	68.02	200.50
2021	104.89	305.39

As illustrated in Table 3. The cumulative electrical consumption of bitcoin rises as more people use the network. Power usage increase may be the biggest disadvantage of the BTC as of being the world reserve currency.

4.4 Oracle Problem

Essentially the purpose of blockchain technology is decentralization and a movement towards a 'trustless' world. What is meant by this, is that blockchains are inherently under the control of no one entity, such as a government, corporation, etc. They are open to everyone and entirely transparent. Immutable, and uncensorable. Blockchains make massive sacrifices like energy costs or cutting-edge technology in order to maintain this safe decentralization, this is what makes blockchains valuable.

For blockchains to achieve something more than just sending tokens around, blockchains need to interact with the real world and be able to have meaningful agreements and contracts on the chain, something more than just sending tokens from address A to address B. These are done in something called a 'smart contract'. A smart contract is a piece of code that lives on-chain, this code automatically executes the instant the necessary parameters for its execution are met. All of Decentralized Finance today is run by smart contracts.

To get any information about the real world on the chain, users need an 'Oracle'. A reliable source of definitive truth. The obvious solution is to connect smart contracts to some database like AWS, and just use that as your Oracle. This will work fine but may create failure points. The point of blockchain is to have a system that is more secure than traditional systems. If you have all decentralized networks running your smart contract, the point of failure could be the execution of the smart contract being entirely reliant on a centralized source of data. A chain is only as strong as its weakest link, it does not matter if the system has the most decentralized computing network in the world running your smart contracts if the source of data, which governs how the contract executes is entirely centralized.

This problem, of finding a way to get information on the chain, in a way that matches the level of security and decentralization of blockchains, is known as 'The Oracle Problem', and this is the main problem Chainlink and numerous crypto projects try to solve. Oracles are the most obvious, and most vulnerable attack vector for most smart contracts. Chainlink solves this problem by decentralizing oracles. Aggregating the results of multiple 'nodes', to come up with one answer. There are multiple levels of security ensuring these nodes provide honest, accurate data to the network. The point

is that they are economically incentivized, to be honest, and penalized if they're dishonest. There is a reputation system and several safeguards work to keep the oracles reliable and secure.

The Chainlink token is used to pay for any of the services on the network, and eventually will be 'staked' by Chainlink nodes in the sense that it is locked in the network and will be taken from these nodes if they misbehave. Chainlink is inherently modular and customizable to allow customers to pick and choose their nodes according to their needs.

Chainlink is currently the leading major player in the oracle space. They have a significant first-mover advantage, and the network currently secures billions of dollars locked in Decentralized Finance (DEFI). They have yet to see any serious competition, with other competitors like api3 having nothing more than a whitepaper and no customers. Almost every major protocol uses chainlink oracles to secure it, with the notable exception of MakerDAO and Compound. Notably, both of these networks have suffered from attacks on their oracles, leading to the losses of their users' millions of dollars. Compound recently announced that it was planning on moving to Chainlink oracles.

In the long term, unless another solution is found for the oracle problem, Chainlink or any other oracle company will stand to have a monopoly on secure oracles. The market for secure oracles is massive and the derivatives market is worth quadrillions.

4.5 Derivatives and Blockchain Use Cases Other than Being a Currency

Derivatives are fundamentally a contract between two or more parties whose contract values are based on underlying assets such as commodities, stocks, bonds, currencies, interest rates, and market indexes. Standardized contracts allow traders to trade the contracts on exchanges like the London metal exchange, which eliminates exposure to risks. If one side of the contract doesn't meet its contractual obligations. Exchanges also will take fees for their services, and it should be worth paying for the fees. Since trust is the most expensive thing money can not purchase.

Options and futures can mainly be divided into two features. Usage of options and futures can be purely speculative, which traders can bet on the outcome of the prices

for only profit-seeking reasons. These are called speculators, and they don't need the utility provided by the contracts, like the famous incident of the oil trade speculator who forgot to close their position. If the trader does not want to give oil barrels a free world tour, they should close their oil positions in the market. Forgetting to close the position will lead to traders receiving tonnes of oil barrels depending on the position size. Also, companies and producers can use these financial instruments to lock in the prices of commodities. This way, they can be protected from price volatility in the market. In developing countries hedging should be especially important since the economic and political climate in developing countries are sensitive to changes which in turn makes the markets more volatile, like currency shocks or unexpected interest rate changes with systemic risks. Blockchain technology can be used to secure derivatives contracts and monitor supply chains to minimize the risks of human errors (Marconi, 2017). Derivative contracts can be automated by smart contract technology which has orders of magnitude safer than traditional paper guarantee methods.

In futures contracts, traders either go long by buying the contract expecting prices to rise or go short if they think the underlying asset's price will decline. Options include call options and put options, which if traders want to buy, they need to pay premiums, whereas futures contracts don't have premiums. Buying a call option is buying the right to sell. Selling call options is selling rights to buy underlying securities. Buying a put option is buying a right to sell the underlying securities. Selling a put option is selling a right to sell the underlying securities.

Removing trust between parties is possible in smart contracts, which automatically punish the breach of the contract by using a predetermined collateral mechanism. Trust minimization by mathematical proof is a key real-life use case of the blockchain. Using off-chain data for on-chain platforms enables contracts to become intelligent and self-aware of their situation and surroundings. Derivative contracts being automated by the price data feeds is a revolutionary cutting-edge technology being developed by numerous crypto projects. Use cases are not limited to derivatives as any contract that can be used in a meaningful way such as insurance, crop and weather data, or IoT devices can be programmed to be automated. Ice cream trucks that have IoT sensors can report the temperature inside the air-conditioned truck and if the temperature is safe for delivery or not. Any abnormal parameter increase will be reported to the

contract owners. Any breach of safe temperature that will cause damage to the goods will cancel the contract and result in an automatic punishment of the truck owner for violating the contract. Banks that receive data from the smart contract then will deliver the collateral for the breach of the agreement to the receiver of the goods. The same concept can be applied to derivatives without IoT data but with market data or liquidation events.

Hedgers or speculators do hedging to reduce exposure to upside or downside risks in the market. Risks can never be eliminated in investments but can be mitigated by hedging. Futures hedging includes short hedges, which are used when the underlying assets in futures contracts are expected to fall in value. Long hedges are used when the underlying assets in futures contracts are expected to rise in value. Hedge positions in the futures market can be short positions or long positions. One of the hedging strategies is cross-hedging. Cross-hedging is used in markets where there is no viable futures market for the owned commodity. This investment strategy involves taking a position on a commodity followed by an equal but opposite futures position on a different commodity with similar price movements.

In options, traders pay premiums for the contracts and can use a wide variety of strategies suited to their expectations. The short position in options is called put options. The long position in options is call options. Some of the option trading strategies include covered calls, protective puts, long straddle, long strangle, short straddle, short strangle, bull spreads, bear spreads, and box spreads. The straddle strategy is betting on the volatility of an underlying asset. If traders expect higher volatility in the market long straddle strategy can be used to profit from the volatility. This strategy is especially good in emerging markets where volatility will be higher than the developed countries. On the contrary, a short straddle is used when the volatility is expected to be low. Both buying call options and selling call options are speculative investment strategies where the investors only make a profit if they correctly guess the direction of the stock's price.

Forwards and futures contracts have some differences. Forwards uses a custom-made contract, traded on OTC, and settled upon maturity. Futures uses a standardized contract, are traded on exchanges, and can be settled on a daily basis. There are 5 underlying asset types used in derivatives. Equity Derivatives, Interest Rate

Derivatives, Commodity Derivatives, Foreign Exchange Derivatives, and Credit Derivatives. Derivative Markets both OTC and exchanges are in a growth trend.

Traditionally before the 2008 crisis, LIBOR and swap rates were the risk-free rates used in collateralized transactions. However, during the 2008 crisis, people switched to using Overnight Index Swap Rates. After the crisis, regulations have been put in place for CVA and DVA calculations, and the market moved away from valuing collateralized derivatives at LIBOR rates to funding higher than the LIBOR rates. The reason for that regulation was to incorporate the counter-party credit risk into transactions.

Table 4. Positive use cases of blockchain technology.

Positive Use Cases
Currency
Insurance
Internet of Things (IoT) for Supply Chain Logistics and Temperature Tracking for the Perishables
Trust Minimization
Central Bank Digital Currencies
Automated Smart Contracts and Derivatives
Weather Data
Swift Banking Messaging Systems for Payments
Peer-to-peer payments
Non Fungible Tokens (NFT) for the proof of ownership
Decentralized Finance (DEFI) for lending and borrowing services
Digital ID confirmation (KYC)
True Inflation Measurements
Government & Voting and For Safely Securing Documents

Table 5. Negative use cases of blockchain technology.

Negative Use Cases
Money Laundering
Drug Trafficking
Human trafficking
Dark marketplace trading
Cybercrime
Fraud

Table 6. Popular illegal items bought with BTC in Silk Road. (Source: Moore and Christin, 2013).

Category	**Number of Items**	**Percentage**
Weed	3,338	13.7%
Drugs	2,193	9.0%
Prescription	1,784	7.3%
Bezodiazepines	1,193	4.9%
Books	955	3.9%
Cannabis	877	3.6%
Hash	820	3.4%
Cocaine	630	2.6%
Pills	473	1.9%

One of the biggest criticism against BTC is its use in criminal activities. However, any currency including the US dollar is also susceptible to criminal use cases. Since users are responsible for their transaction activities, there are safety responsibility

issues. There is a potential risk of getting hacked. Once the transaction is sent to the network it is impossible to reverse the process. BTC also presents user error risks and should be approached with care and attention.

CHAPTER 5: BLOCKCHAIN TECHNOLOGY AND BITCOIN AS A CURRENCY

In this chapter, I will explain the technology behind BTC currency, the history of cryptocurrencies, and the determinants of the price of BTC. Any demand increase and decrease for BTC may cause price shocks and volatility. To understand this I will look at the unique supply mechanism of BTC, which is limited by the network mathematically.

5.1 Blockchain Technology

In order to understand cryptocurrencies, we need to understand the underlying technology. Blockchain is a technology that enables the transfer of digital tokens or assets from one individual to another individual.

The main problem that blockchain tries to solve is a money transfer for an exchange of goods and services. Today if person A wants to move or transfer money to person B. In order to send money from Turkey to the United States of America, this is typically done using a 3rd trusted party. A trusted 3rd party identifies the person and the balance account and moves the money after taking some fee to the right person. This transaction typically lasts three banking days. However, in blockchain technology, people can use their computer power (CPU or GPU) to confirm the transaction by running software designed to mine BTC. This process is called mining and the people who confirm transactions of BTC and store them in the blockchain are called miners. This way we can have much faster transactions with lower fees and no trusted third party. The benefit of this technology is no one owns the BTC currency since there is no company or government behind it. It is an open-source technology in which everyone with an internet connection can participate.

Developments on decentralized finance applications (dApps) and staking, lending, and borrowing services provided by DEFI (Decentralized Finance) products. Individual users can use their capital to gain interest rates from stable coins or their preferred choice of cryptocurrency without any institution. Being your own bank,

borrowing money with collateral without any entity brings the cost of security responsibility. Individuals who use these applications and digital wallets are responsible for the safety of their own funds. Researching and using known trusted protocols and exchanges are key to being safe from the dangers of losing funds. Sending funds to the wrong digital addresses by typo mistake is a common occurrence among new users. Transactions on the blockchain are irreversible, once the sender confirms, the transaction outcome will be final. Figure 1 shows transaction between the Alice Bob and Charlie and their interaction with blockchain technology exchanging three BTCs with each other in the peer-to-peer network of the BTC. Miners confirm the transaction and take fees designed for verifying the exchange while not knowing the names or locations of the persons engaging with each other.

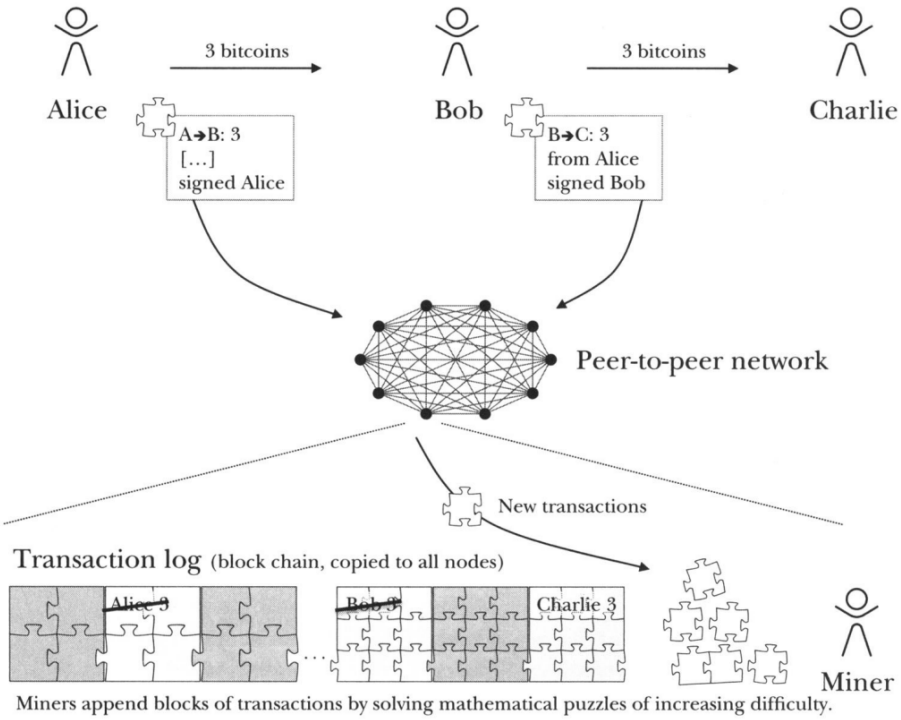


Figure 5. Bitcoin blockchain transaction demonstration. (Source: Böhme, Christin, Edelman, and Moore, 2015)

The actual cryptographic algorithms used in BTC are US Government standards that had been developed nearly a decade earlier. BTC relies on the Elliptic Curve Digital

Signature Algorithm (ECDSA) as the transaction signing mechanism (Johnson, Menezes, and Vanstone, 2001), the SHA-256 as the hash function (Federal Information Processing Standards Publication, 2004), and the Hash-cash technique as the POW mechanism.

5.2 Proof of Work Mechanism

Proof of work is a breakthrough in computer science that solves the Byzantine general problem[5], and proof of work requires the burning of energy to remain trust minimized; anything less reduces its security, which is unacceptable for an application that has the aim of being a sound and transparent currency. The aim of this technology is that there is no single central point of failure. Suppose miners get shut down by any entity with authoritarian power. The network will adjust the difficulty of the system to enable an easier mining process that can be distributed to low-electricity-cost places in the world. Satoshi Nakamoto explains why he chose the proof of work mechanism for payments including the double spending problem:

''*A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. To compensate for increasing hardware speed and varying interest in running nodes over time, the proof-of-work difficulty is determined by a moving average targeting an average number of blocks per hour. If they're generated too fast, the difficulty increases.''* (Nakamoto, 2008)

[5] The Byzantine Generals Problem is a game theory problem, which describes the difficulty decentralized parties have in arriving at a consensus without relying on a trusted central party.

5.3 Chronological History of BTC

BTC started just with an anonymous name/developer called Satoshi Nakamoto earlier in 2008's. A site called bitcoin.org was registered in August 2008. Satoshi Nakamoto published a white paper on his work in October 2008. The first BTC was mined by the creator for 50 BTC in January 2009. One week later, version 0.1 BTC core was released. In May 2010, the first real-world transaction took place in Florida by the programmer and early user Laszlo Hanyecz. Pizza cost him about 10.000 BTC worth around 25 dollars at that time. The current value of the transaction that Laszlo Hanyecz made is worth about 210 million dollars as of June 2022. In July 2010, Mt.Gox was established as a BTC exchange.

February 2011, is an especially important milestone, because one BTC reached parity with one U.S dollar, and the popularity of the currency grew on the dark side of the internet where people used BTC to buy illegal drugs or guns on the internet black market named 'silk road.' One of the biggest exchange sites called Coinbase is founded in June 2012. In November 2013, BTC reached a valuation of 1.000 dollars. It seemed impossible to reach these levels of success, but belief in the technology by the early backers made the vision possible. In the early stages founder of this technology said this in the internet forums '*'If you don't believe it or don't get it, I don't have the time to try to convince you, sorry.''*, however, in February 2014. The biggest BTC exchange site M.t Gox got hacked and lost 800.000 BTC. Class action lawsuit is still going on to this date. This event led to the biggest crash in BTC history as prices went down from 1000 dollars to 250-300 dollars, losing more than half of its market price. This led to two years of a bear market and BTC was declared dead by numerous news articles. In January 2018, BTC reached an all-time high of 20.000 USD from 1.000 USD making their investors a 2000% return; however, later in that year price dropped 84% to 3.000 USD.

5.4 Historical E-Currencies

Before BTC was ever created, there were other digitally created currencies that failed to get where BTC is now mainly due to several flaws in their core system, being centralized, and the lack of adoption by the public. DigiCash was an electronic currency corporation created by David Chaum in 1990. DigiCash was unique in that they were anonymous due to some cryptographic algorithms developed by its founder. In 1998 DigiCash declared bankruptcy and liquidated its assets to Ecash, another digital currency company, which was purchased by InfoSpace in February 2002. The idea of creating a digital currency is not new but having companies behind the currencies creates a systematic risk of being bankrupt by the price volatilities and human error. OS-Gold, Standard Reserve, and INTGold claimed to be Digital gold currencies that were created and failed between 1999 and 2004. OS-Gold, Standard Reserve, and INT Gold were an attempt to create digital currencies. All these companies failed because they couldn't achieve and go beyond being an institution with assets and balance sheets. The underlying technology of mathematical proof is what established trust between the blockchain and its users. Virtual economies are observed in Massively Multi-Player Online role-playing games (MMORPGs). The largest virtual gaming economies are currently found in MMORPGs. Such as Runescape, World of Warcraft, Guild Wars, Warhammer Online, Lord of the Rings Online and Final Fantasy X, and many more video games that have their own in-game economy and currency.

5.5 Supply Side of Bitcoin

The total supply of BTC units is 21 million BTC. This number will never change as supply is fixed in the BTC core programming code. Current circulation numbers are 19,082,318 BTC as of June 2022. Please note that circulating numbers are always changing due to miners getting their fees for transaction verification. The estimated year to reach almost the total supply is 2140. The estimated year to reach 99% supply is 2033.

BTC will never reach 100% circulated supply due to miners confirming transactions and taking some BTC fees to themselves. BTC algorithm will increase the mining difficulties to deal with this problem. Even if BTC reaches a million-dollar price, it will distribute the fees like 0.00000085 Satoshis. One BTC is equal to 100 million units called satoshis. As BTC gets expensive and harder to obtain for ordinary people, transaction fees also get higher when the prices increase. This greatly affects the adoption rate of BTC. Transaction confirmation can take five minutes up to six to 24 hours depending on the congestion of the network, which is still mostly faster and cheaper than current banking transfers.

5.6 Supply and Demand Curve of Bitcoin

BTC supply, as being shown in figure 6, presents a relatively rigid supply side which, in return, any increase of demand from retail or institutions such as Tesla or hedge funds who are looking to enter the crypto space as investment drives the price higher. Scarcity combined with the popularity and safety of the technology, compared to paper guarantees of the central banks, attracts new users looking for a relatively safe place from inflation and money printing of the governments if the owners of the BTC can endure price volatility.

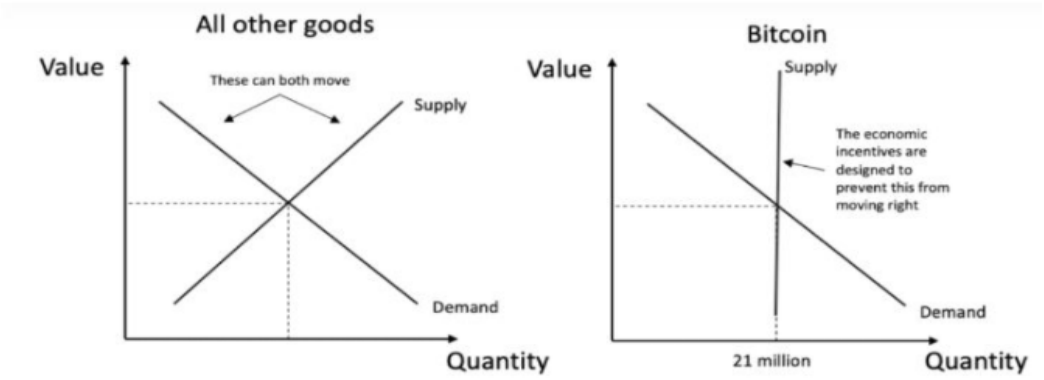


Figure 6. Unique supply and demand dynamics of BTC, compared to other goods. (Source: Unchained Capital, 2020)

CHAPTER 6: EMPIRICAL ANALYSIS

In this chapter, I will explore whether BTC can be used as a payment method as it was intended when it was created. To reach this goal, I make three empirical investigations. The first one is a Monte Carlo simulation to show short-term volatility. The second is a time series analysis to show long-term volatility and the third one is a maximum drawdown model to show the maximum risk investors or users will face.
The data for the BTC prices and historical volatilities were taken from leading platforms of exchanges of BTC such as *yahoofinance*, *coinbase.com*, *binance.com*, and *bitmex.com*. Data that were taken from various sources were evaluated in Monte-Carlo simulation using excel, Time series analysis, and the Maximum-Drawdown model using Python programming language and Google Colab. Additional information about written codes can be found in the appendices section for the readers.

6.1 Predicting Short-term Future Bitcoin Prices Using Bitcoin Annual Volatility Index in Monte-Carlo Simulation

In this sub-chapter, I use BTC annual and daily volatility percentages and BTC prices and performed the Monte-Carlo simulation 1000 times to predict prices forty-four days later. However, the outside factors and systematic risks are not calculated in the simulation, which may change the price drastically. Systematic risks of countries banning, regulating, or restricting money transfers for crypto-related assets are not taken into account. This simulation is done purely to examine the volatility effect on prices and should not be seen as a speculative price prediction for investment purposes. Monte Carlo simulation does not take outside events or shocks into account. Future researchers can deepen the research by examining the outside event effect on future volatility.

The various approaches to BTC price valuation include binomial tree models, Monte Carlo simulation, and finite difference methods. These three different methods aim to focus on the objective goal of calculation speed and accuracy. Monte Carlo simulation is simple and flexible. It can be easily modified to adapt to different processes. Monte Carlo simulation can be used to calculate the process of generating future BTC and

stock valuations. This process is created on a computer and aims to generate a series of BTC or stock price trajectories.

Monte Carlo simulation is a preferred method for VaR[6] calculations and is also frequently used in the quantitative finance field. The Monte Carlo method is one the most simple, powerful, and comprehensive method when it is used correctly in terms of measuring market risk. It is a computer-intensive VaR calculation method.

Three different scenarios were evaluated in our simulation. Bull Market, Neutral, and Bear Market scenarios. All these scenarios analyze the forty-four days of short-term price action. Results even with the neutral scenario show us that BTC is highly susceptible to outside world events and volatility affects the price of the asset by more than 30% in most cases.

Table 7. Simulation Details.

Starting Price	$ 42.640		02.03.2022
Volatility (daily)	4,66%		
Annual Volatility	89,87%		

Data used in Monte-Carlo Simulation.

Starting date of simulation: 12.01.2022

Annual volatilities of BTC = 89,87%

Daily volatilities of BTC = 4,66%

BTC price in simulation = 42.640 $

The formula used to calculate volatilities;

$$\sigma = \left(\int_{-\infty}^{+\infty} (r_c - \mu)^2 p(r_c) \mathrm{d}r_c\right)^{1/2},$$

Where r c is a return of BTC investment;

σ is a daily volatility

p is a predicted price

[6] Value at risk.

Using daily volatility we calculate the BTC price after 44 days.

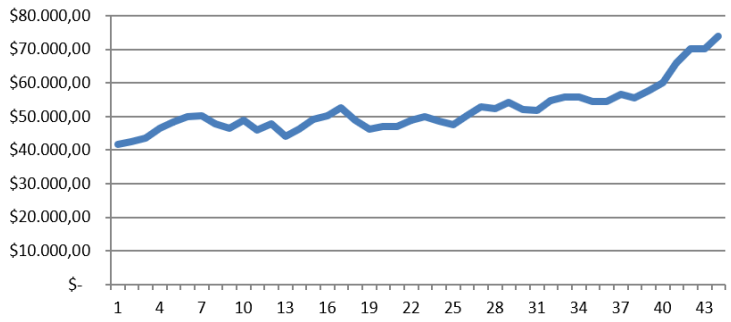
Data used;

- Annual percentage of BTC volatility
- Daily percentage of BTC Volatility
- BTC prices of the most recent date
- 24-hour volatility data points taken from[7]

6.1.1 Bull-run Scenario

Table 8 in this scenario shows a clear uptrend in price action which can indicate more new money and demand coming to the BTC market and possibly can indicate payment adoption from well-established companies like 'Amazon' or 'eBay' or countries like China and the US having a positive look on BTC can also change the price in a positive way.

Table 8. Bull-run scenario.



Mean	$ 43.278,32
Median	$ 40.838,59
St Dev	$ 13.675,57
5%	$ 25.326,14
95%	$ 69.390,47
10%	$ 28.354,09
90%	$ 62.464,70

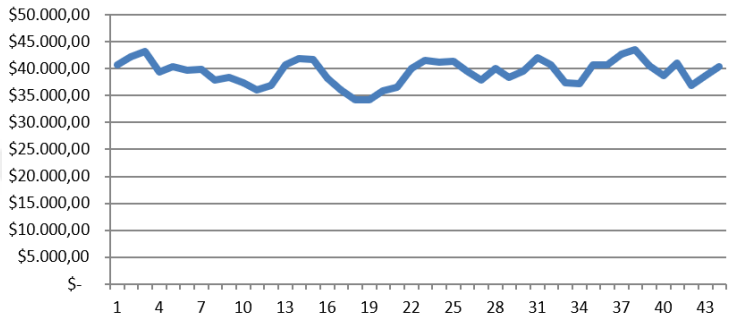
After 44 days expected price of BTC is over 70.000 $.

[7] bitmex.com/app/index/.BVOL24H.

6.1.2 Neutral Scenario

Table 9 shows a clear sideways price action which can indicate markets will stagnate this month and there will be no drastic news or price changes in the market.

Table 9. Neutral scenario.



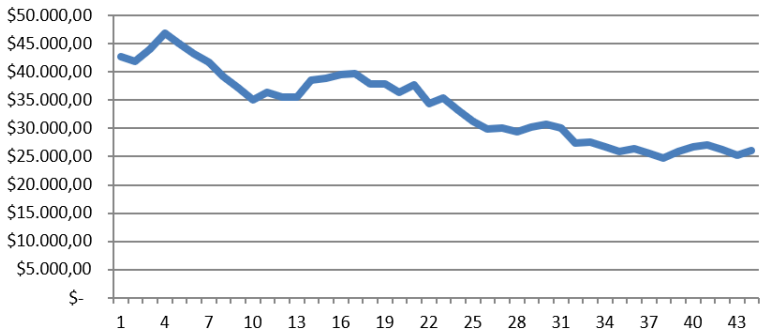
Mean	$ 41.650,65
Median	$ 39.658,15
St Dev	$ 12.733,56
5%	$ 23.562,33
95%	$ 65.315,51
10%	$ 26.732,49
90%	$ 58.323,60

After 44 days expected price of BTC is between 35.000 $-45.000 $.

6.1.3 Bear-Market Scenario

This scenario in Table 10 shows a clear downtrend of price action. Which will indicate news on upcoming big government taxation, strict regulation in crypto-space, or investor sentiment change which will impact the price negatively.

Table 10. Bear-market scenario.



Mean	$ 43.282,24
Median	$ 41.404,05
St Dev	$ 13.834,02
5%	$ 24.454,57
95%	$ 68.051,23
10%	$ 27.891,94
90%	$ 61.553,40

After 44 days expected price of BTC is between 23000-47000.

6.1.4 Results

Results were evaluated with three different scenarios. A bull-run scenario was where the BTC price climbed more than 30%. The neutral scenario was where the price ranged by 15% and stagnated, which is not necessarily a bad thing for people who wants to use it as a currency The bear-market scenario is where volatility hits the BTC price, making it drop by more than 30%.

The common point concluded after the simulation was that BTC is too volatile to be used as a currency. Almost no seller or buyer wants to sell or purchase common everyday items with such an extremely volatile currency. It is simply not desirable since volatility will have a tremendous effect on a company's profitability and predictability.

Moreover, results indicate that people use BTC as a store of value and a speculative asset rather than its main function of being a medium of exchange. One of the reasons that support this view is world's largest video game platform 'Steam' owned by Valve Corporation, accepted BTC as a form of payment back in 2014, but in November 2017, they stopped using it as payment due to the volatility of BTC prices. Statement Of Valve corporation about using Bitcoin as a Payment method. Valve Corporation, (2017)

'' As of today, Steam will no longer support Bitcoin as a payment method on our platform due to high fees and volatility in the value of Bitcoin.

In the past few months we've seen an increase in the volatility in the value of Bitcoin and a significant increase in the fees to process transactions on the Bitcoin network. For example, transaction fees that are charged to the customer by the Bitcoin network have skyrocketed this year, topping out at close to $20 a transaction last week (compared to roughly $0.20 when we initially enabled Bitcoin). Unfortunately, Valve has no control over the amount of the fee. These fees result in unreasonably high costs for purchasing games when paying with Bitcoin. The high transaction fees cause even greater problems when the value of Bitcoin itself drops dramatically.''

Steam not accepting BTC is correlated with the findings in this paper. Stability and predictability is the choice of the businesses, volatility makes it hard to calculate the prices, business costs, and profit margins.

6.2 Long-term Time Series Analysis and Maximum Drawdown Model

In this section, we will use the yahoofinance data and Twelve Data Api to pull BTC price data into the fbprophet model to forecast BTC prices for one year and determine the maximum drawdown buyers can expect from BTC. Fbprophet and Python provide the necessary tools to create a model in google colab. The model will look into the prices starting from 2014-09-17 to 2022-06-06 and create a prediction based on the daily closing adjusted price to 2023-06-06. Python data analysis programming language is used as panel data. Dataframe is implemented from yahoofinance. Matplotlib is used to show data visualization and graphical plotting. Seasonality will also be reviewed to give the readers a better idea of the model. The prediction is explained in simple steps.

One year later BTC price prediction found in the model is $61.798, which is comparable to the recent prices of $19.000, which is an increase of more than 300%. The overall trendline remains bullish despite temporary price drops. Supply being limited by the cryptography of the BTC ensures that there is no excess supply increase. Therefore a demand rise due to an increased interest in the general public or an institution may increase the price and cause an increase in its volatility.

6.3 Time Series Model Setup and One-Year Price Forecast (06-06-2023)

Initial implementation for the time series model. Fbprophet, pandas as a Python data analysis tool, Matplotlib as an open-source API, and data visualization will be used for the model.

$Y(t) = g(t)+h(t)+s(t)+e(t)$ The following components of Fbprophet for fitting of dates are as follows,

$y(t)$ = Additive Regressive Model

$g(t)$ = Trend Factor

(t) = Holiday Components

(t) = Seasonality Component

e(t) = Error Term

Table 11. Date and adjusted close data.

	Date	Adj Close
0	2014-09-17	457.33
1	2014-09-18	424.44
2	2014-09-19	394.79
3	2014-09-20	408.90
4	2014-09-21	398.82
..		
2815	2022-06-02	30467.48
2816	2022-06-03	29704.39
2817	2022-06-04	29832.91
2818	2022-06-05	29906.66
2819	2022-06-06	31576.69

Dataframe of 2820 data points. This dataframe will be included in the model and will be analyzed. Starting date is (2014-09-17).

Table 12. Table of ‘ds’ and ‘y’.

	ds	y
0	2014-09-17	457.33
1	2014-09-18	424.44
2	2014-09-19	394.79
3	2014-09-20	408.90
4	2014-09-21	398.82
..		
2815	2022-06-02	30467.48
2816	2022-06-03	29704.39
2817	2022-06-04	29832.91
2818	2022-06-05	29906.66
2819	2022-06-06	31576.69

Columns are redefined as ‘ds’ and ‘y’ to be able to be recognized by the model language. Dataframe taken from Yahoo Finance will be inserted into the model. Date as a ‘ds’ and the adjusted close price is denoted as a ‘y’.

Table 13. Present tail end of the data frame.

	Ds	y
2815	2022-06-02	30467
2816	2022-06-03	29704
2817	2022-06-04	29832
2818	2022-06-05	29906
2819	2022-06-06	31576

Price in (2022-06-06) is at 31.576 $.

Table 14. Future dates tail end of the data frame.

	Ds
3180	2023-06-02
3181	2023-06-03
3182	2023-06-04
3183	2023-06-05
3184	2023-06-06

Table 15. One-year time series forecast and lower and upper trends (2023).

	ds	trend	yhat_lower	yhatup	trendlow	trendup	yhat
3180	2023-06-02	63545	50908	71763	54424	69929	61079
3181	2023-06-03	63581	51840	72195	57419	69998	61244
3182	2023-06-04	63617	51611	71427	57433	70074	61395
3183	2023-06-05	63653	51597	71781	57446	70140	61586
3184	2023-06-06	63688	51498	71975	57460	70196	61793

Future_dates are defined as 365 days. 365 days are implemented in the model. Yhat,3184 is the final predicted price data of the BTC on (06-06-2023). Seasonality and a time period of 365 days are implemented. (2023-06-06) is the ending date of the prediction. The latest BTC price taken to date is (2022-06-06). The price in 2022-06-06 is calculated as 31.576 $.

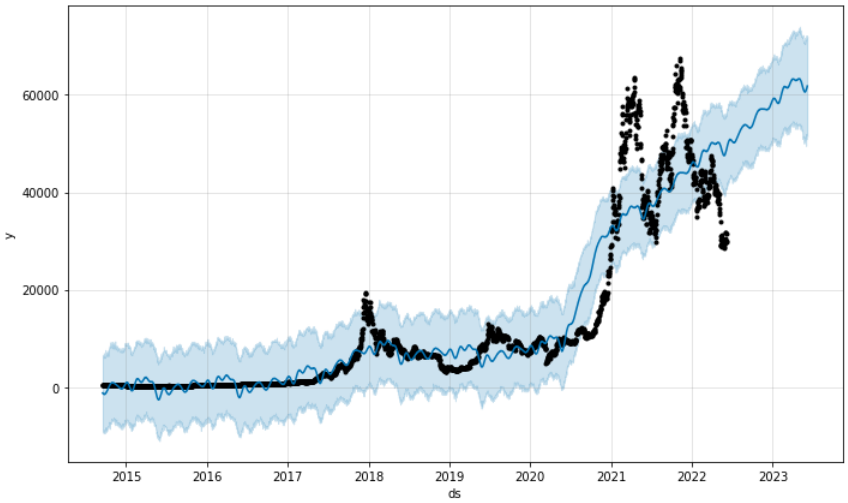


Figure 7. Time series analysis dot plot graph.

The dotted black lines represent the BTC prices. The lighter blue price band shows the overall trendline. The blue line is the predicted prices by the model. Bull runs of 2018-2021-2022 can be seen in the figure 7, which may indicate a demand increase with supply being fixed. Famous fund manager Micheal Saylor, Banks, and Tesla owner Elon Musk's purchases in 2021 may also have contributed to the increase in prices. Federal funds rates were also lower meaning that credits were cheaper than in 2022. Ease of credit coupled with institutional interest could be the main reasons of the price increase. However, with the funds rate increase, the overall global bearish trends with inflation and recession fears and the Russian-Ukrainian war may also cause the prices to decrease to below $20.000 which is an almost 75% decrease in prices. The top price of the bull run in 2021 was around $69.000.

Figure 8. The detailed version of the dot plot graph.

To show weekly, monthly, and yearly predictions, the model is imported into Plotly. Results show us that BTC is currently (06-06-2022) undervalued according to the model. High volatility is clearly seen in Figure 8. Table 15 suggests that the BTC price will be at 61.793$.

6.3.1. Seasonality

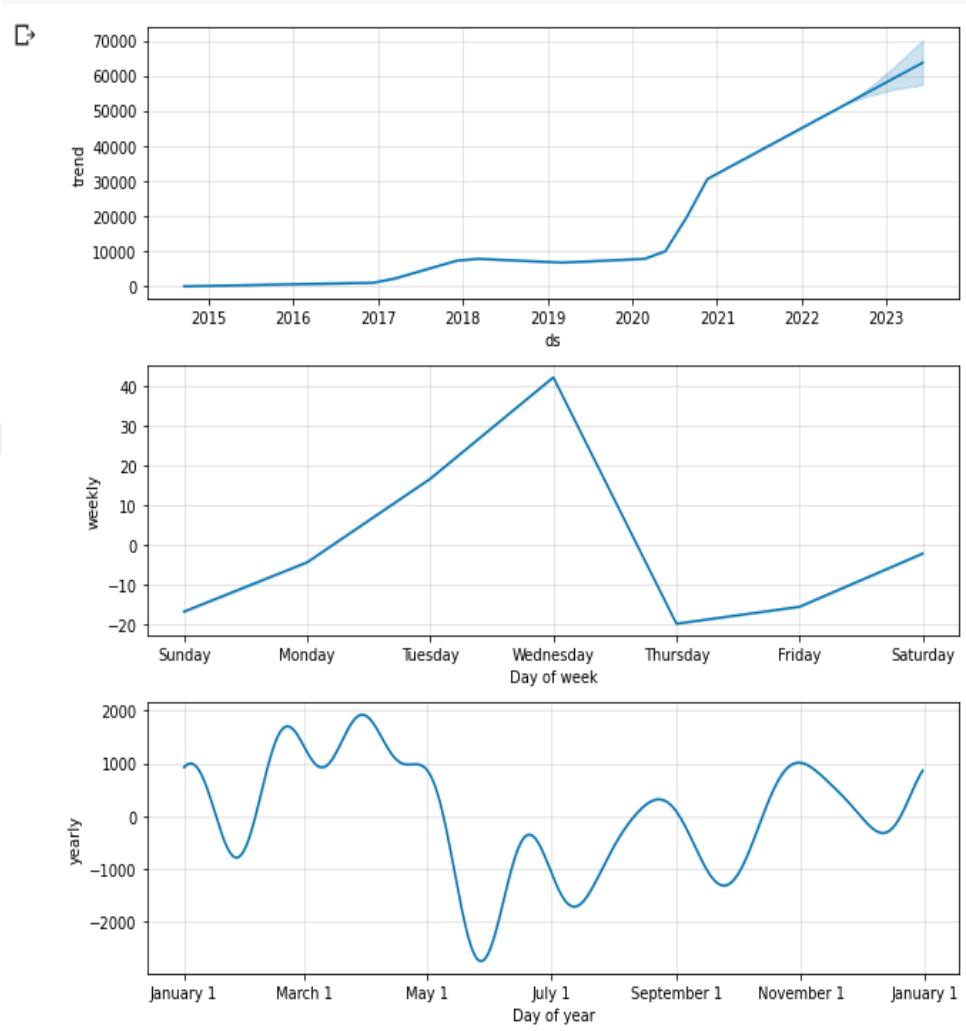


Figure 9. Seasonality

In Figure 9, I implemented seasonality and time period. Timeframe of 365 days as a function is added with seasonality to the model. Seasonality indicates that Wednesday was the best day of the week for the price of the BTC. Monthly seasonality shows us that May is the worst price-performing month for the BTC. Decourt, Chohan, and Perugini, (2019) analyzed the weekday effects on the return of BTC and they found that Tuesdays and Wednesdays were the best days of return for the BTC, in accordance with our findings.

6.4 BTC Maximum Drawdown (MDD) Python Model

This model aims to show us the worst-case scenario analysis for the buyers of BTC. The maximum risk that buyers will face. It is an important risk parameter to consider showing the potential downside of the BTC price action. The model will be built using Twelve Data API and Google Colab. MDD in this model will start on 06.06.2021 through 06.06.2022. Intervals are calculated daily. The model represents the maximum loss investors will face on a given day.

The formula used to calculate the Maximum Drawdown

$$MDD(t) = \frac{TV(t) - PV(t)}{PV(t)}$$

Where;

MDD as a Maximum drawdown

TV as a Trough Value

PV as a Peak Value

T as a Timeframe

```
[47] import matplotlib.pyplot as plt
     dd.plot()
     max_draw.plot()
     plt.show()
```

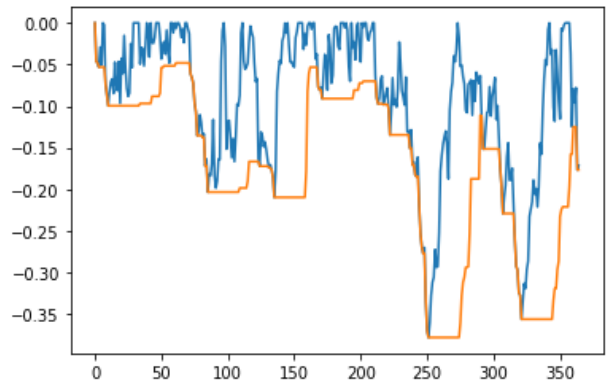


Figure 10. BTC maximum drawdown model graph

Table 16. Statistical results of the BTC maximum drawdown model.

	Drawdowns
Count	365.00000
Mean	-0.175256
Median	-0.166702
Std	0.100668
Min	-0.378170
25%	-0.209709
50%	-0.166702
75%	-0.090971
Max	0.000000

6.4.1 Results

Table 16 and Figure 10 9 summarize the results of calculations showing us that investors may face a maximum 37% drawdown with their capital. The maximum daily drawdown amount of 37% remains too high for risk-aversive investors. Although the BTC price uptrend remains on track for higher prices, these advantages come back as disadvantages through increased volatility. From the business point of view, if BTC is used as a medium of exchange, prices of goods and services businesses provide may fluctuate a maximum of 37%, this volatility would make pricing of the goods harder than fiat money pricing. Predictability is also lower than the dollar, meaning businesses will have a hard time calculating their profit and cost margins due to volatility in BTC prices.

6.5 BTC Price Volatility Decreases as Its Network Matures

One of the key aspects of a currency is stability. Since the inception of the BTC network volatility continued to be an issue for the day-to-day usage of the network. What we can establish and see from the prices is that, from the first day of the creation of the network to the current date, volatility seems to be decreasing as time goes on. In this model, we will look at the past maximum drawdowns of BTC from 2012-2016 to 2017-2021 and use 1000 days of Garman-Klass BTC volatility and 1000 Days of Yang Zhang BTC volatility.

Table 17. Comparing maximum drawdowns between (2012-2016), (2017-2021).

	Maximum_drawdown
2012	85,74%
2013	70,28%
2014	72,16%
2015	84,53%
2016	68,35%

	Maximum_drawdown
2017	52,44%
2018	83,34%
2019	82,37%
2020	75,35%
2021	53,10%

Table 18. The mean median of BTC volatility.

	Mean	Median
2012-2016	76,21%	72,16%
2017-2021	69,32%	75,35%

6.6 1000 Days of Garman-Klass BTC Volatility

Garman Klass is a volatility estimator that incorporates open, low, high, and close prices of an asset. T is 1000 days.

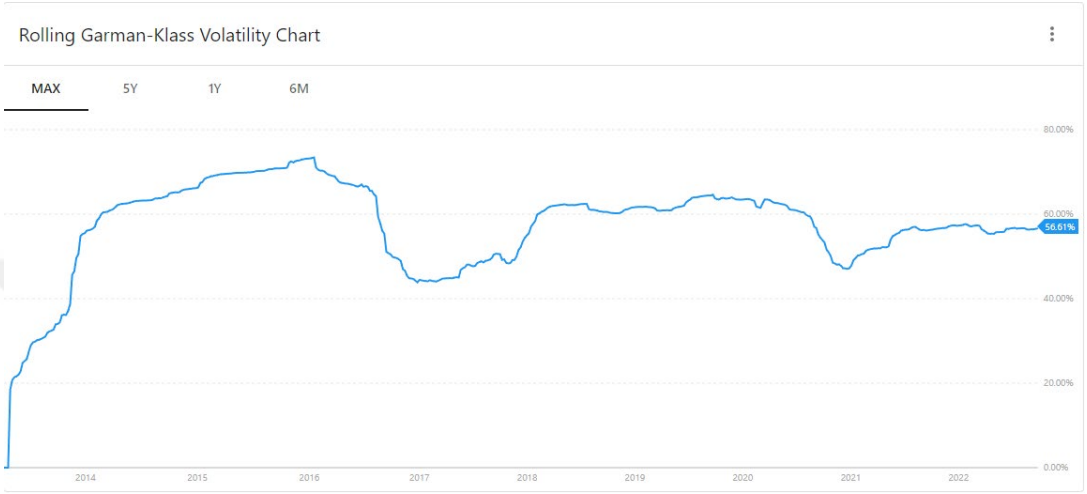


Figure 11. Garman-Klass volatility chart. (Source: Portfolioslab, 2022)

The formula used to calculate volatilities;

$$\sigma_{GK} = \sqrt{\frac{1}{2T}\sum_{t=1}^{T} \ln\left(\frac{h_t}{l_t}\right)^2 - \frac{2\ln 2 - 1}{T}\ln\left(\frac{c_t}{o_t}\right)^2}$$

Where: t, is the number of days in the sample period.

Ot, is the open price on day-t.

Ht, is the high price on day-t.

Lt, low price on day t.

Ct, close price on day t.

6.7 1000 Days of Yang Zhang BTC Volatility

Yang Zhang is a historical volatility estimator that handles both opening jumps and the drift and has a minimum estimation error. T is 1000 days.

$$k = \frac{\alpha - 1}{\alpha + \frac{T+1}{T-1}}$$

$$\sigma_o^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(\ln\left(\frac{o_t}{c_{t-1}}\right) - Avg\ln\left(\frac{o_t}{c_{t-1}}\right)\right)^2_{\text{volatility}} \quad \text{Overnight}$$

$$\sigma_c^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(\ln\left(\frac{c_t}{o_t}\right) - Avg\ln\left(\frac{c_t}{o_t}\right)\right)^2 \quad \text{Close volatility}$$

Where: t, is the number of days in the sample period.

Ot, is the open price on day-t.

Ht, is the high price on day-t.

Lt, low price on day-t.

Ct, close price on day-t.

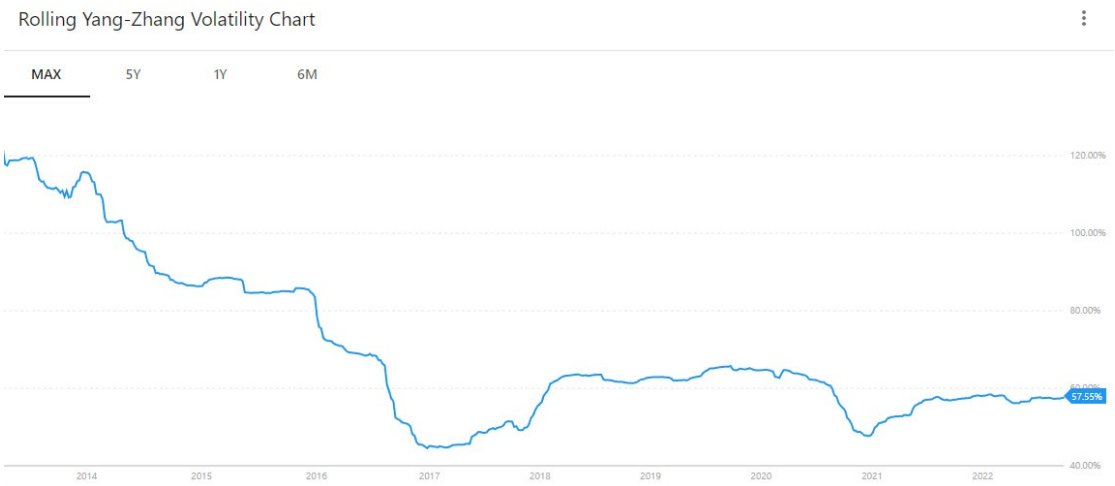


Figure 12. Yang-Zhang volatility chart. (Source: Portfolioslab, 2022)

6.7.1 Results

Results indicate that the 1000 Days of Yang-Zhang volatility and Garman-Klass BTC volatility calculations and my own findings of volatility results, support the theory of diminishing volatility over time. Which in return increases the currency aspect of the BTC, making it more likely to be adopted by businesses. BTC lostits volatility by 6,89% in my calculations compared to 2012-2016- to 2017-2021. If In the future BTC continues this volatility trend, it would improve its currency aspect of it.

Price volatility research conducted here assumes the BTC to be regulated fairly. If the BTC transactions are deemed illegal by big entities or governments. Volatility would be expected to be on the rise.

CHAPTER 7: CONCLUSION AND POLICY IMPLICATIONS

In this thesis, I explored whether BTC can be used as a medium of exchange and replace the US dollar as the world reserve currency. My findings indicate that BTC may not yet be ready to be a world reserve currency due to its high price volatility. However, due to the rising popularity and robust background of the technology, we may see a shift in currency use cases depending on different scenarios. Monte Carlo simulation showed us forty-four-day, which is a short-term price prediction. Prices are too volatile to be used by the public and businesses because they cannot calculate their profit and cost margins with such volatility. Maximum drawdown values showed us that investors could face a 37.8% drop in one day. To risk-averse investors, the price drop of 37.8% in a single day may not be approachable or attractive right now. However, speculators and high-risk-seeking investors who can bear the volatility may get higher rewards.

As the technology of blockchain matures we may see more entities and institutions adopting blockchain technology. DEFI products also open up a whole new era of the banking system to the people, removing the barriers of entry to the financial space by only requiring internet access and a digital wallet.

Monte-Carlo simulation and maximum drawdown model show us the historically high volatility aspect of the BTC. However, compared to 2012-2016 and 2017-2021 we see a price volatility decrease of 6.89%. The declining trend in BTC price volatility was first shown in this thesis to our knowledge. My data findings of the continued drop in price volatility would lead to an increase in the currency aspect of BTC. But limited supply and increased demand may still cause sudden price spikes and drops. Results also show us that BTC is not ready to be a world reserve currency due to price volatility.

In the future, researchers can explore the future of other crypto-currencies, if they take away the first-mover advantage of BTC. As inflation rises in every major developed and developing country, alternative currencies will remain the viable option to store wealth from the fiat currencies. Blockchain technology may evolve in upcoming years for the public and there may be better, faster, cheaper to use, and more advanced currencies that can replace the popularity of BTC or adoption can take place and we

can see higher prices of BTC in upcoming years due to the nature of the supply being almost constant. Nevertheless, blockchain technology is here to stay.

Furthermore, future researchers can be recommended to research Defi products and Dapps which are aiming to disrupt the traditional financial systems by replacing the lending and borrowing, and interest rate instrumentals of the central banking system with web 3.0 decentralized applications. Also, the logarithmic regression line of BTC shows the currency losing volatility as time goes on, future papers could explore the idea of BTC price volatility decreasing as the network matures. The medium of exchange aspect of the BTC would improve if the price volatility slowing down theory is further researched.

Moreover, Bakas, Magkonis, and Oh, (2022) find out 22 main drives for the demand for BTC and compared their effects on volatility. The main driving forces for volatility were BTC Google trends, total BTC circulation, US consumer confidence/trust, and the S&P 500 index in that paper. Future researchers can also examine the main demand-driving factors for more in-depth volatility research.

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APPENDICES

```
from fbprophet import Prophet
import pandas as pd
import matplotlib.pyplot as plt
import yfinance as yf
```

```
df = yf.download('BTC-USD')
```

```
[**********100%**********]  1 of 1 completed
```

```
df.reset_index(inplace = True )
df = df[['Date', 'Adj Close']]
```

```
future_dates = model.make_future_dataframe(periods= 365)
```

```
future_dates.tail()
```

```
[ ]  model.component_modes
```

```
    {'additive': ['yearly',
      'weekly',
      'additive_terms',
      'extra_regressors_additive',
      'holidays'],
     'multiplicative': ['multiplicative_terms', 'extra_regressors_multiplicative']}
```

Figure 13. Model components and codes.

```
df
```

	Date	Adj Close
0	2014-09-17	457.334015
1	2014-09-18	424.440002
2	2014-09-19	394.795990
3	2014-09-20	408.903992
4	2014-09-21	398.821014
...	...	...
2815	2022-06-02	30467.488281
2816	2022-06-03	29704.390625
2817	2022-06-04	29832.914062
2818	2022-06-05	29906.662109
2819	2022-06-06	31576.695312

2820 rows × 2 columns

Figure 14. Dataframe of dates and adjusted close

```
[ ] df.columns = ['ds', 'y']
```

```
df
```

	ds	y
0	2014-09-17	457.334015
1	2014-09-18	424.440002
2	2014-09-19	394.795990
3	2014-09-20	408.903992
4	2014-09-21	398.821014
...	...	...
2815	2022-06-02	30467.488281
2816	2022-06-03	29704.390625
2817	2022-06-04	29832.914062
2818	2022-06-05	29906.662109
2819	2022-06-06	31576.695312

2820 rows × 2 columns

```
[ ] model = Prophet()
```

```
[ ] model.fit(df)
```

Figure 15. Columns of ‘ds’ ‘y’ data.

```
[ ] model.component_modes
```

```
{'additive': ['yearly',
  'weekly',
  'additive_terms',
  'extra_regressors_additive',
  'holidays'],
 'multiplicative': ['multiplicative_terms', 'extra_regressors_multiplicative']}
```

```
df.tail()
```

	ds	y
2815	2022-06-02	30467.488281
2816	2022-06-03	29704.390625
2817	2022-06-04	29832.914062
2818	2022-06-05	29906.662109
2819	2022-06-06	31576.695312

```
[ ] future_dates = model.make_future_dataframe(periods= 365)
```

```
[ ] future_dates.tail()
```

	ds
3180	2023-06-02
3181	2023-06-03
3182	2023-06-04
3183	2023-06-05
3184	2023-06-06

Figure 16. Seasonality and future dates tail data

```
[ ] prediction = model.predict(future_dates)
```

```
prediction.tail()
```

	ds	trend	yhat_lower	yhat_upper	trend_lower	trend_upper	yhat
3180	2023-06-02	63545.838975	50908.515194	71763.143922	57424.301058	69929.982330	61079.074921
3181	2023-06-03	63581.609693	51840.727571	72195.686066	57419.297043	69998.149965	61244.453511
3182	2023-06-04	63617.380410	51611.867477	71427.659288	57433.120354	70074.947729	61395.987094
3183	2023-06-05	63653.151128	51597.824838	71781.721513	57446.943666	70140.533833	61586.074145
3184	2023-06-06	63688.921845	51498.009256	71975.886455	57460.766978	70196.269677	61793.532652

Figure 17. Prediction data with the lower and upper trend.

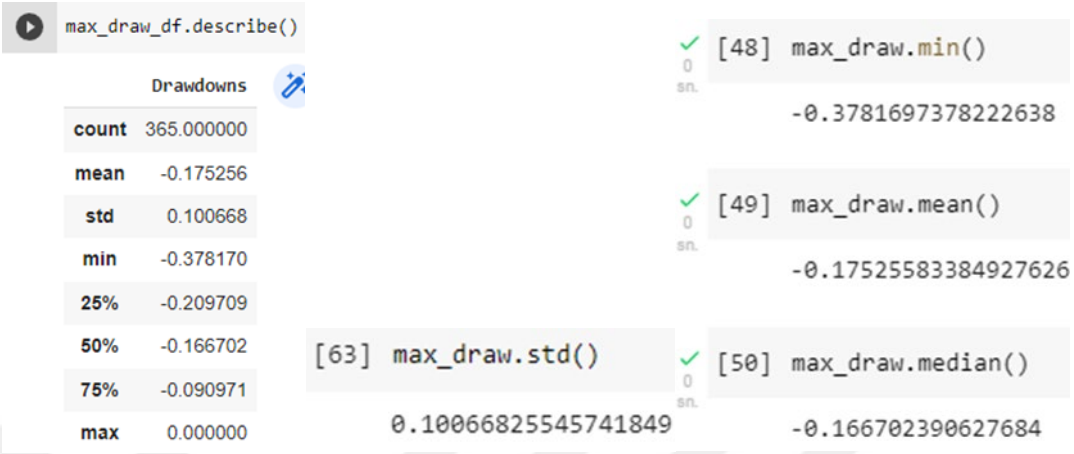

Figure 18. Detailed statistical data of the model.

```
[33] import pandas as pd, requests, numpy as np, datetime as dt
```

```
        interval = "1day",
        symbol = "BTC/USD",
        format = "JSON",
        exchange = "BINANCE",
        start_date = "2021-06-06 15:02:00",
        end_date = "2022-06-06 15:02:00",
        timezone = "exchange",
```

```
[26] end_date = dt.datetime(2022,6,6)
     start_date = dt.datetime(2021,6,6)
```

```
[23] api_url = f'https://api.twelvedata.com/time_series?
```

```
[30] data = requests.get(api_url).json()
```

```
[37] data_final = pd.DataFrame(data['values'])
```

```
[45] data_final['close'] = pd.to_numeric(data_final['close'], errors='coerce
```

```
[41] window = 1
```

```
[46] roll_max = data_final['close'].rolling(window, min_periods= 1).max()
     dd = data_final['close'] / roll_max -1
     max_draw= dd.rolling(window, min_periods=1).min()
```

```
max_draw_df= pd.DataFrame(columns=['Drawdowns'])
max_draw_df['Drawdowns'] = max_draw
max_draw_df
```

Figure 19. Detailed statistical data of the model.