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ANALYTICAL MODEL FOR PREDICTING BITCOIN PRICE

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ABSTRACT

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The purpose of this research is to examine the relationships between Bitcoin and several financial metrics, such as indices and commodities, in efforts to reveal any influential significance between a specific variable and the price value of Bitcoin. The interested parties pertaining to this research include investors of crypto, university students specializing in business, or current shareholders of Bitcoin. The indices being analyzed for this research consist of the following: Nasdaq 100, S&P 500, Dow Jones Industrial Index, Russell 2000, Nikkei 225, S&P 500 Volatility Index (VIX), and the Shanghai SE Composite Index. The commodities being analyzed for this research consist of the following: Gold and Oil. The final variable included within this thesis will be the Euro Exchange Rate, as studies have shown previously the Euro Exchange Rate may have an influence on the price of Bitcoin. A series of statistical models will test the relationships among this data in order to produce a conclusion to influential factors of Bitcoin value.

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OBJECTIVES

The goal of this research is to develop an analytical model that could be utilized to predict the price of Bitcoin. In order for this to occur, a collection of data variables will be the initial step. The variable information collected is based on monthly and weekly data within the time frame of July 18th 2010 – December 12th 2021. The following data will be collected for the variables: Indices including Nasdaq 100, S&P 500, Dow Jones Industrial Index, Russell 2000 Index, Nikkei 225 Index, S&P 500 Volatility Index (VIX) and Shanghai SE Composite Index (monthly). Commodities including gold and oil. The EUR to USD Exchange Rate will also be collected for our purposes. The analytical model will be based on a linear approach known as multiple regression. Additionally, several other analytical methods will be utilized to interpret the data, such as descriptive statistics and several correlation matrixes that examine the behavior of the relationships amongst the variables. Descriptive statistics and correlation matrixes will also be utilized to measure cyber activity that has been hypothesized in previous studies to potentially have an influence on the price of Bitcoin, such as measuring monthly and weekly page views for Wikipedia pages including the word *Bitcoin*, in addition to search terms measured by Google that include the search term *Bitcoin.*

HISTORICAL BACKGROUND OF BITCOIN

Bitcoin officially launched in 2009, however it is hypothesized to be invented in 2008, in response to the financial crisis.[1] On October 31st, 2008, an individual named Satoshi Nakomoto posted the white paper for Bitcoin on a mailing list. The identity of Satoshi Nakomoto is actually unknown to this day. Satoshi Nakomoto can either be an individual or even a group of people.[2] Bitcoin (BTC) is a decentralized digital currency that is the first digital currency to utilize a peer-to-peer system. A peer-to-peer system means the digital currency is not backed by any financial intermediaries or governments. Bitcoin maintains a decentralized authority, and that means that there are several technologies and entities in charge of the credibility of the Bitcoin platform. These several entities are called "miners." Miners are the decentralized authority of Bitcoin and their responsibility is to solve complex mathematical equations that mine Bitcoins. Once enough mathematical equations are solved, eventually a Bitcoin is created or "mined", and then that Bitcoin is distributed via the Blockchain. It is important to mention that the process of mining a Bitcoin requires a lot of computer power to complete.[3] The Blockchain is a decentralized digital ledger, and the blockchain's responsibility involves recording, storing, and verifying transaction costs on the Blockchain. A blockchain is made out of blocks, and each block is a collection of Bitcoin transactions. Every time a miner mines a couple hundred thousand bitcoins, miners receive bitcoins as a reward. To

[1] Investopedia. 2021. *Bitcoin's Price History*. [online] Available at: <https://www.investopedia.com/articles/forex/121815/bitcoins-price-history.asp> [Accessed 24 December 2021].
[2] U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].
[3] Investopedia. 2021. *Bitcoin Definition: How Does Bitcoin Work?*. [online] Available at: <https://www.investopedia.com/terms/b/bitcoin.asp> [Accessed 24 December 2021].

fully understand the components that is Bitcoin, an overview of Bitcoin's history is imperative.

As previously mentioned, Bitcoin was launched in 2009 and was officially created in late 2008. On January 3rd, 2009, the first Bitcoin, named "Block 0" or "the genesis block", was mined. The first code encrypted to Block 0 states "The Times 03/Jan/2009 Chancellor on brink of second bailout for banks." *(Bitcoin Definition: How Does Bitcoin Work?, 2021)*

The relevance of typing that message was most likely intended to keep a record of the first Bitcoin mined. On January 9th of 2009, the second Bitcoin was mined, titled "Block 1."[4] Bitcoin, from its first ICO to around July of 2010, Bitcoin was worth fractions of a penny. It wasn't until August it went over a penny.[5] For the remainder of 2010, Bitcoin's prices stayed at this level. The first time an individual decided to sell their Bitcoin was in exchange for two pizzas, and this occurred on May 22nd, 2010.[6] This specific individual spent $10,000 bitcoins for two pizzas, at that time the pizza's market value was $25. Today, $10,000 bitcoins are worth over half a million dollars. (The Bitcoin price at the time of writing is $56,608). Up until that point, Bitcoins were only mined, not yet traded. Additionally, Bitcoins at that point in time did not have any currency value behind them, either.[7] In February 2011, the price of Bitcoin went over $1 for the first time. 2011 is also

[4] Investopedia. 2021. *Bitcoin Definition: How Does Bitcoin Work?*. [online] Available at: <https://www.investopedia.com/terms/b/bitcoin.asp> [Accessed 24 December 2021].
[5] Investopedia. 2021. *Bitcoin's Price History*. [online] Available at: <https://www.investopedia.com/articles/forex/121815/bitcoins-price-history.asp> [Accessed 24 December 2021].
[6] U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].
[7] Marr, B., 2021. *A Short History Of Bitcoin And Crypto Currency Everyone Should Read*. [online] Forbes. Available at: <https://www.forbes.com/sites/bernardmarr/2017/12/06/a-short-history-of-bitcoin-and-crypto-currency-everyone-should-read/?sh=392c09583f27> [Accessed 24 December 2021].

the year that Bitcoin finally has some competitors, Litecoin and Namecoin being among the first.[8] The rivalries tried to compete by stating their cryptocurrency products had lower rates and more software speed, however, Bitcoin was and still remains the top cryptocurrency in the market. The cryptocurrency market today is currently circulating hundreds of different types of digital coins.

In April of 2013, Bitcoin's value went up to $1,000 for the first time.[9] Unfortunately, this would not last very long, as Bitcoin had a crash and its price dropped down to $300. Many investors lost returns, and unfortunately this would not be the only time Bitcoins went missing. In January of 2014, 850 million bitcoins in circulation disappeared. The former cryptocurrency exchange where the bitcoins disappeared was called Mt. Gox. In summary, its server shut down and the bitcoins were gone shortly after. More information on this incident will be further explained later. At that time, the value of those bitcoins was $450,000. Today, those bitcoins are worth $4.4 billion dollars. In 2015, we saw the price of Bitcoin return to $1,000. In 2016, the rise of a competitive rival started to dominate the cryptocurrency market, and this cryptocurrency is called Euthereum.[10]

Euthereum (ETH) is another decentralized digital currency whose origin stems from Blockchain.[11] Euthereum is the database term for its currency, called "*ether*."

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[8]U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].

[9] U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].
[10] Marr, B., 2021. *A Short History Of Bitcoin And Crypto Currency Everyone Should Read*. [online] Forbes. Available at: <https://www.forbes.com/sites/bernardmarr/2017/12/06/a-short-history-of-bitcoin-and-crypto-currency-everyone-should-read/?sh=392c09583f27> [Accessed 24 December 2021].
[11] ethereum.org. 2021. *Home | ethereum.org*. [online] Available at: <https://ethereum.org/en/> [Accessed 24 December 2021].

Euthereum and Bitcoin share many similarities, however they share differences as well. Similar to Bitcoin, they are both decentralized so their digital ledger (Blockchain) is what verifies their transactions. Furthermore, they both use peer-to-peer technology to trade cryptocurrencies, such as investing in new companies or purchasing digital coins as a future medium-of-exchange. However, Euthereum possesses a specific blockchain technology that allows end users to utilize Euthereum for more than just a digital form of cash. Euthereum can also be used to create additional digital programs/platforms, and this feature is most commonly used by companies.[12] Moreover, Euthereum's technology also allows end users to trade several types of Euthereum digital coins. Currently on Euthereum's platform, there are 9,500 different types of digital coins in circulation. Today, Euthereum is still commonly considered Bitcoin's major competitor, as Bitcoin currently holds a majority of the cryptocurrency market share, around 46% (at the time of writing).[13]

Moving onward with the history of Bitcoin, in 2016, the cryptocurrency market started to become more popular. 2017 was the year that Bitcoin reached an all-time high (at the time) of $10,000. More individuals were learning about the digital currency and even banks, such as Citigroup and Barclays, started to strategize how they could benefit by including Bitcoin exchanges into their business model.[14] In December 2017, Bitcoin

[12] BlockApps. 2021. *What is the Difference Between Ethereum and Bitcoin?*. [online] Available at: <https://blockapps.net/blockchain-101-difference-ethereum-bitcoin/> [Accessed 24 December 2021].
[13] Bloomberg.com. 2021. *What's the Difference Between Bitcoin and Ethereum?*. [online] Available at: <https://www.bloomberg.com/news/articles/2021-05-09/bitcoin-and-ethereum-how-are-they-different-quicktake> [Accessed 24 December 2021].
[14] Marr, B., 2021. *A Short History Of Bitcoin And Crypto Currency Everyone Should Read*. [online] Forbes. Available at: <https://www.forbes.com/sites/bernardmarr/2017/12/06/a-short-history-of-bitcoin-and-crypto-currency-everyone-should-read/?sh=392c09583f27> [Accessed 24 December 2021].

reached another all-time-high price of $19,650.[15] Two months later in February of 2018, Bitcoin crashed, and its price fell just under $6,000. That loss is estimated to be around $13,800, nearly a 70% decrease from December. Some people believe that this decrease in price may be connected to short sellers in the derivative market. The analysts from the San Francisco Fed have brought this information to light. The reason why those analysts have reason to believe this was connected to short sellers is because not only did Bitcoin's price peak on December 17th, 2017, but also the Chicago Mercantile Exchange began exchanging derivatives on the same day, December 17th 2017. Because Bitcoin's price started to decline ever since December 17th, 2017, in conjunction with the 70% drop-off, led the analysts to believe that short sellers in the derivative market made an influence on Bitcoin's price at that time. More specifically, what the short sellers did that actually caused the drop-off was that they were betting the price of Bitcoin to decrease. Once this information got out, investors started to sell their bitcoins and the price dropped significantly.[16]

At this point in 2017-2018, cryptocurrencies were extremely popular. In fact, 2018 was the year where a lot of people were utilizing Bitcoin to seek investments for their startups, and investors were looking for ICO's to invest in, hoping it would lead them to large returns. ICO stands for Initial Coin Offering, and it works similarly to an IPO (Initial Public Offering). However, a majority of the ICO's published on the Blockchain from 2017 fell through due to investors acquiring that venture capital for

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[15] U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].

[16] Yahoo.com. 2021. *Derivative caused Bitcoin to crash, San Francisco Fed says*. [online] Available at: <https://www.yahoo.com/news/st-louis-fed-suggests-short-sellers-crushed-bitcoin-131420239.html> [Accessed 24 December 2021].

themselves.[17] Ever since then, from 2017 to now (2021), Bitcoin's price has increased over time, with frequent drops occurring every now and then. Recently, Bitcoin's price has reached its all-time high, recording a value of $68,521 on November 5th, 2021.[18] In fact, many individuals familiar with cryptocurrencies are nervous that the crash in 2017 looks familiar to the statistics of Bitcoin today, and some are suggesting a crucial drop-off of price again.

Some individuals familiar with the Bitcoin crash of 2017 believe a similar crash can happen again, especially after analyzing Bitcoin's prices at the end of this year. Realistically it can crash again, but other individuals familiar with cryptocurrency believe we are not in a similar situation as we were in 2017. The reason for this is because back in 2017, Bitcoin was still a controversial idea and not that many people invested at first, making the market not only small but invaluable also. Expert investors also decided not to participate, as they thought Bitcoin was a type of financial deceit. This is important to keep in mind because Bitcoin has been known to be used for illicit virtual activities, which is a probable reason as to why more people than not didn't trust the digital currency for so many years. Additionally, Bitcoin back then was primarily used for trading purposes. For example, holders of Bitcoin back then were more so focused on making returns in the short-term, hence selling whenever the price was expected to decline. However, in today's market, more people are holding onto their bitcoins instead of trading them. Because bitcoins are being held onto, there is now a value associated

[17] U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].
[18] Investing.com. 2021. *Bitcoin Historical Data - Investing.com*. [online] Available at: <https://www.investing.com/crypto/bitcoin/historical-data> [Accessed 24 December 2021].

with those bitcoins. In fact, over 62% of bitcoins have not circulated in over a year, suggesting its owners are holding onto their shares. Pertaining to bitcoins that are continuously in circulation, they make up about just under 15% of the total bitcoins in circulation. The total bitcoin in circulation right now is around over 80 billion, which is estimated to cost over $4.5 billion dollars of bitcoins in circulation. This suggests that we may not be in the same situation as we were in 2017, thanks to the accumulated value over the last four years.[19] Once again, the main reason why investors are holding onto their bitcoins is because most people see bitcoin as a risk asset that has great potential to grow in the future. There are many individuals who believe that the price of Bitcoin is going to reach $100,000 before the end of the year, based on supposedly accurate prediction models. Although that may be true or not true, one can never know for sure, especially since the price would have to increase by over $40,000 within the next month, which makes it more than likely not the case. In summary, Bitcoin has fascinated the world with its new technology and financial hope for the future, especially keeping in mind the state of the economy, which is currently going through extremely low interest rates, which is a good indicator for inflation. Pertaining to today's inflation rate increasing, some individuals are actually purchasing bitcoins in order to hedge inflation.

Bitcoin is a considerable option when considering hedging against inflation because Bitcoin is programmed to be scarce, meaning, only a certain amount of bitcoins will ever be produced, once again consisting around 21 million total and the last Bitcoin

[19] Bitcoin Magazine: Bitcoin News, Articles, Charts, and Guides. 2021. *Bitcoin 2017 Vs. 2021: How This Bull Run Is Different*. [online] Available at: <https://bitcoinmagazine.com/markets/bitcoin-2017-vs-2021-how-this-bull-run-is-different> [Accessed 24 December 2021].

planned to be mined will occur sometime in 2140.[20] Because inflation typically decreases demand in risk assets,[21] that can explain the recent drop in price for Bitcoin, from $68,000 to $56,800, all occurring in November of 2021. So far in this thesis, the history of Bitcoin has been discussed and analyzed, now this information will be utilized for our purposes, to interpret previous studies that coincide with our research purposes.

[20] Investopedia. 2021. *Bitcoin Definition: How Does Bitcoin Work?*. [online] Available at: <https://www.investopedia.com/terms/b/bitcoin.asp> [Accessed 24 December 2021].
[21] Bloomberg.com. 2021. *Using Bitcoin as an Inflationary Hedge*. [online] Available at: <https://www.bloomberg.com/news/videos/2021-11-23/bitcoin-as-an-inflationary-hedge-video> [Accessed 25 December 2021].

PREVIOUS RESEARCH

There are four previous studies that were introduced to the researchers of this thesis. The first previous study analyzed was called *The Economics of BitCoin Price Formulation* by Pavel Ciaian, Miroslava Rajcaniova, an d'Artis Kancs. This study was sponsored by the European Commission, Economics and Econmetrics Research Institute (EERI), Catholic University of Leuvin (LICOS), and the Slovak University of Agriculture of Nitra (SUA).[22] This study analyzes data from 2009-2014, and the objective of this research was to interpret the relationships between the price of Bitcoin and specific economic factors, such as the supply-demand network associated with Bitcoin, investor interest in Bitcoin, as well as global financial predictive measures. The article summarized three imperative factors that influence the price of Bitcoin, described as the following: supply-demand fundamentals, Bitcoin's appeal to investors, and global developments in an economic and financial perspective.

Pertaining to the supply-demand fundamentals, it was stated that the demand for Bitcoin is piloted by investors trust in Bitcoin's value as a future legal tender. The supply for Bitcoin is pre-calculated via blockchain technology. This is because Bitcoin has pre-determined dates to where they get mined and eventually sold. There will always be a specific amount of Bitcoin in circulation and the total amount of Bitcoin that can ever be in circulation is 21 million Bitcoin, in which the last Bitcoin will not be mined until sometime in February 2140. How the article narrowed down the supply-and demand

[22] Arxiv.org. 2021. [online] Available at: <https://arxiv.org/ftp/arxiv/papers/1405/1405.4498.pdf> [Accessed 24 December 2021].

network for Bitcoin was established in the form of mathematical equations. The mathematical equation for the total Bitcoin money supply (M^S) is expressed as the following:

$$M^S = P^B B$$

where P^B =the exchange rate of Bitcoin, and B= the total stock of Bitcoins in circulation. The mathematical equation representing the demand in Bitcoin (M^D) is expressed as the following: $M^D = \frac{PY}{V}$

where P= the general price level of goods and services, Y= the size of the Bitcoin economy, and V= the velocity of Bitcoin circulation. How one would measure the velocity of Bitcoin circulation would be to quantify the frequency for every Bitcoin used to purchase goods and services. Once the researchers established the supply and demand equations independently, they were able to come up with an equation that is an estimate of a prediction model in order to predict the price of Bitcoin using its supply and demand network, and that equation is expressed as the following:

$$P^B = \frac{PY}{VB}$$

Therefore, this equation states that the price of Bitcoin is determined by taking the multiplication of the general price level of goods and services and the size of the Bitcoin economy, then dividing that by the product of the velocity of Bitcoins in circulation and the total stock of Bitcoins in circulation. However, it is important to mention that this is only a measure of Bitcoin price in a perfect market setting. Knowing financial markets never have and never will be perfect, additional detailing of the equation could increase the accurate predictability of Bitcoin price. Therefore, it is essentially an estimate of a predictive model.

The second valuable factor that the authors of this study believe to influence the price of Bitcoin is its appeal to investors. Because Bitcoin is not intrinsically valuable, there are investors that do not participate in the cryptocurrency market. Additional reasons include the volatility of Bitcoin price, and because the market is still considered a small market, that volatility in price is going to be either really negative or really positive. Security breaches are another fear amongst potential investors of cryptocurrency and that is because of the size and volatility of the Bitcoin market can drastically affect the price. However, many investors spend much time and money when pursuing investment opportunities, such as transaction costs. Because investment opportunities in the media spotlight diminish transaction costs for investors, this inevitably turns into a new method of trading. According to authors of this study, the fluctuation of investment behavior per popular investment opportunities can alter the price of Bitcoin, depending on the nature of the news within the media, as that is a hypothesized overall cryptocurrency indicator. Finally, researchers of this study tested the theory concerning global financial progress and if it can have an influence on the price of Bitcoin, such as oil prices, exchange rates, as well as stock market indices. These factors overall represent the current status of the economy and financial markets, hence explaining its incredible influence on Bitcoin.

In order to interpret the data correctly, the research team utilized a VAR (Vector Autoregression) estimation approach, a type of statistical model in order to identify trends, patterns or relationships among the price of Bitcoin and their associated variables. Their results suggest that the two strongest variables to have an impact on the price of Bitcoin are the size of the Bitcoin economy and the velocity of Bitcoin circulation. However, other variables seem to stabilize the prices of Bitcoin, and this study suggests

that the demand-side of the supply and demand network has a stronger influence on the price of Bitcoin, so this will consist of variables such as, once again, the size of the Bitcoin economy and the velocity of Bitcoin circulation. As a reminder, the velocity of Bitcoin circulation is calculated by measuring each independent Bitcoin spent on goods and services. Furthermore, the researchers also found that Bitcoin's appeal to investors was another significant factor pertaining to its influence on the price of Bitcoin. Investor appeal was quantified via Wikipedia views on the searched term "Bitcoin," in efforts to capture investor interest as accurately as possible. Finally, this research stated that they did not find statistical significance between the variables of Bitcoin price, economic and financial metrics. These would include indices, exchange rates and oil prices. This result was in contraction with the studies made by van Wijk (2013),[23] a source referenced within the study, so that information is inconclusive. This research paper brought a lot of information to light, and it is time to move forward with the second previous study in connection with this thesis.

The second previous study pertaining to the price of Bitcoin is called *Analyzing Bitcoin Price Volatility* by author Julio Cesar Soldevilla Estrada, from the University of California, Berkeley.[24] The purpose of this paper was to examine variables that may be related to each other in terms of Bitcoin's price and volatility. The variables included within this data set include Bitcoin price, S&P 500, VIX and Bitcoin realized volatility.

[23] Arxiv.org. 2021. [online] Available at: <https://arxiv.org/ftp/arxiv/papers/1405/1405.4498.pdf> [Accessed 24 December 2021].
[24] Smallake.kr. 2021. *Analyzing Bitcoin Price Volatility*. [online] Available at: <http://www.smallake.kr/wp-content/uploads/2017/12/Thesis_Julio_Soldevilla.pdf> [Accessed 25 December 2021].

More specifically, the author wanted to run statistical models to test the relationships amongst these variables, specifically:

Bitcoin Price ● S&P 500

Bitcoin Price ● VIX

Bitcoin Realized Volatility ● S&P 500

Bitcoin Realized Volatility ● VIX

*Bonus: Bitcoin Weekly Price ● Blockchain Google Trend Time Series

As mentioned in the previous study, *The Economics of Price Formation,* the authors wanted to quantify investor's appeal of Bitcoin. In order to do this, the authors measured Wikipedia page views on Bitcoin. Similar to that study, this study decided to measure the popularity of Bitcoin throughout the years via google searches. The author of this study quantified the term "Blockchain" via a google database called Google Trends. One can utilize this platform to quantify any google term searched within a personalized time period. However, the model for Google Trends is more so a suggestive model per the actual results, rather than exact data entries. This is because the searched google terms are measured on a scale of 1-100, 1 representing there is not enough information to make a claim on this information, while 100 represents a major surge in google searches. Although the data for this information may be mostly accurate, it is at its foundation an informative suggestion of a model. The author wanted to complete two main objectives with this data. 1) The author wanted to run a test called the Granger-causality relationship test. This test determines the significance of a specific relationship. It is also used for

prediction models as well, as it analyzes a time series, a form of data that happens over a longer period of time, to see if it is capable of predicting another time series.[25] Additionally, the author ran the variables through a specific model called the vector autoregression model (VAR), in efforts to pull information regarding the relationships with the variables. The data range utilized for this study ranges from mid September 2010 - mid April 2017.

The results from this previous study are actually very similar to the results from *The Economics of Price Formation* study. However, pertaining to this study, the author did not find a significant relationship between Bitcoin price and S&P 500, which is another study so far that suggests financial metrics have no influence on the price of Bitcoin. In regard to the relationship between Bitcoin price and the VIX (S&P 500 Volatility Index), there was also no defined relationship between these two variables within the results of the statistical model. However, the author was able to find a significant relationship between Bitcoin price realized volatility and S&P 500, at the 5% level. The results further explain that Bitcoin price realized volatility may have information that could predict future S&P 500 prices. In other words, Bitcoin price "Granger-causes" S&P 500 prices. However, the S&P 500 does not have information that can influence future Bitcoin prices. The relationship between Bitcoin price realized volatility and S&P 500 is very interesting because information from both variables influences the others' price. Therefore, the variables Granger-cause each other. Finally, we move onto the last relationship to be analyzed, Bitcoin price and Blockchain Google

[25] Medium. 2021. *A Quick Introduction On Granger Causality Testing For Time Series Analysis*. [online] Available at: <https://towardsdatascience.com/a-quick-introduction-on-granger-causality-testing-for-time-series-analysis-7113dc9420d2> [Accessed 24 December 2021].

Trends. This relationship is more difficult to analyze because the term used to measure Bitcoin popularity was "Blockchain." Blockchain is the technology that records the transactions of not only Bitcoin, but other cryptocurrencies as well. Therefore, that could have affected the results from this study. Overall, the author stated the number of searches for Blockchain could have represented investors' curiosity in Blockchain, not just Bitcoin. Ethereum, Dogecoin, and Binance coins are examples of other cryptocurrencies that are also on the blockchain technology.

The third previous study relevant for the purposes of this thesis is called *What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis.* This study was published April 15th, 2015. The author of this article is named Dr. Ladislav Kristoufek, who has been a researcher and a professor for several institutions over the course of his career. Universities and institutions affiliated with this study include the Warwick Business School of the University of Warwick, the Institute of Information Theory and Automation at the Academy of Sciences of the Czech Republic, as well as the Institute of Economic Studies from Charles University, and the source of this study comes from journals.plos.org.[26]

This study primarily focuses its analysis on factors that may drive the price of Bitcoin, which are generally categorized financially, economically and socially. More specifically, this study identifies six variables that may contribute to the price of Bitcoin, which include economic indicators, technical aspects, transaction instances, influence of Chinese markets, investor interest, and the overall collective concern of Bitcoin being

[26] Krištoufek, L., 2021. *What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis*. [online] Econpapers.repec.org. Available at: <https://econpapers.repec.org/RePEc:plo:pone00:0123923> [Accessed 24 December 2021].

considered a safe haven. In order to confirm or deny those factors as legitimate Bitcoin price drivers, information related to the study's data collection and statistical methods is crucial to the credibility of the study's findings.

This study utilized a statistical method known as a wavelet. A wavelet is a form of a mathematical and statistical analysis that identifies the location of specific frequencies, strongly correlated or negatively correlated, amongst the relationships of selected variables.[27] Researchers of this study also utilized six different series data in order to compute their analysis, which are summarized as the following: Bitcoin Price Index, Blockchain, exchanges, search engines, Financial Stress Index, and the price of gold. After this series data was analyzed, researchers of this study explained whether or not the six variables mentioned earlier prove to have a significant relationship and/or influence on the price of Bitcoin, utilizing the indices, exchanges, commodities, and interests just mentioned. Further inspection of these variables is necessary to understand the intent of the research behind this study.

The Bitcoin Price Index is an index that represents the relationship of the exchange rate between Bitcoin (BTC) and the US dollar (USD). Within this index, there are four imperative cryptocurrency exchanges utilized within this study for analytical purposes, and those cryptocurrency exchanges include Bitfinex, Bitstamp, and two former cryptocurrency exchanges known as BTC-e and Mt. Gox. As previously mentioned, Mt. Gox reached insolvency in 2014. It is important to note that Bitcoin was officially created in 2009 with trading beginning in 2010, and Mt. Gox was the leading

[27] ScienceDirect. 2021. *Wavelet Analysis*. [online] Available at: <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/wavelet-analysis> [Accessed 25 December 2021].

cryptocurrency exchange from Bitcoin's inception until the insolvency of the cryptocurrency exchange, which explains its relevance to the analysis.

Mt. Gox was created in 2010 whose geographical inception was derived from Japan. The official name for the former cryptocurrency exchange was titled *"Magic: The Gathering Online Exchange."* The indigenous owner of Mt. Gox is IT developer Jed McCalbe, and the original purpose of the platform Mt. Gox was actually intended for a game involving trading "magic" cards, however it later transformed to the cryptocurrency exchange that is recognized today. In early 2011, McCalbe sold the exchange to another IT developer, Mark Karpelés. The reason why Mt. Gox is extremely relevant to Bitcoin history is because during its active years, 2010-2014, this cryptocurrency exchange accounted for 70% of all Bitcoin transactions. To put this information into perspective, the exchanges relative to this study, being once again Bitfinex, Bitstamp and BTC-e, accounted for 90% of all Bitcoin transactions in 2015. Although those are interesting statistics, it is imperative to keep into consideration that Mt. Gox was one of the first platforms that exchanged bitcoins, which is reasonable enough to hypothesize that is why Mt. Gox accumulated a majority of Bitcoin transactions. Bitcoin was also still considered an extremely small market during Mt. Gox's active years, which also made it easier to obtain a majority of the Bitcoin market. Regardless, Mt. Gox plays a significant role in the determinants of Bitcoin price, if not today then at least as a reference point for Bitcoin's initial years.[28]

[28] CoinDesk. 2021. *Mt. Gox*. [online] Available at: <https://www.coindesk.com/company/mt-gox/> [Accessed 24 December 2021].

The reason why Mt. Gox is no longer considered an active exchange today is because of several incidents throughout Mt. Gox's life. In mid-2011, it is believed that the exchange was hacked by an individual or a group of individuals that utilized an active account not belonging to the hacker, which gave the hacker the ability to sell an extremely large amount of bitcoins. As a result, the price of bitcoins decreased dramatically. The hacker also gained access to thousands of accounts, which resulted in the theft of a multitude of confidential data which affected around 60,000 account holders. Three incidents in 2013 alone caused internal damage to Mt. Gox's operations, one involving the symmetrical division of the bitcoin platform, resulting in differential transactional operations. Therefore, Mt. Gox had to pause incoming bitcoin deposits. The second incident occurred two months later in May of 2013. This incident involved a $75 million breach of contract lawsuit from one of Mt. Gox's professional associates, CoinLab. The breach of contract in question was concerning the acquisition of Mt. Gox's U.S.A. consumers that was previously agreed upon, however CoinLab claims there was no delivery concerning this previous agreement. Not that much longer, Mt. Gox was unable to operate monies incoming and forthgoing, and this course of action was implemented by the U.S. Department of Homeland Security. The following year in 2014, Mt. Gox suffered a cyber security attack resulting in the loss of nearly 850,000 bitcoins, as mentioned earlier. However, around 200,000 bitcoins were able to be recovered soon after. Shortly before this occurred, Mt. Gox underwent technical difficulties which brought about the suspension of bitcoin withdrawals. Because of the technical difficulties and the massive loss of Bitcoins, Karpelés stepped down as CEO of Mt.Gox, and bankruptcy was filed in the amount of $63.6 million as well as the filing of liquidation, in

which a trusted bankruptcy moderator liquidated the assets associated with Mt. Gox. After a brief history of Mt. Gox, its potential significance is now understood in regards to today's fluctuations in Bitcoin price.[29]

Moving onward regarding the exchanges incorporated into the Bitcoin Price Index for this particular study, the remaining exchanges collected for this study include Bitfinex, Bitstamp and BTC-e. Bitfinex was formed in 2012. Their current leadership team includes but is not limited to Chief Executive Officer (CEO) JL van der Velde, Chief Financial Officer (CFO) Giancarlo Devasini, Chief Operating Officer (COO) Claudia Lagorio, Chief Technology Officer (CTO) Paolo Ardoino, Chief Compliance Officer (CCO) Peter Warrack, and General Counsel Stuart Hoegner. Bitstamp was created in 2011, and their current leadership team includes but is not limited to Julian Sawyer as CEO, Stephen David Bearpark as CFO, Sameer Dubey as COO, David Osojnik as CTO, Mel Tsiaprazis as Chief Commerical Officer (CCO), Koenraad Dom as Chief Risk Officer (CRO) and Barbara Daliri Freyduni as Chief Growth Officer (CGO).[30]

BTC-e was an active cryptocurrency exchange at the time this study was conducted and published, however in 2017, the U.S government shut down the cryptocurrency platform due to an FBI investigation confirming illicit cyber activities conducted utilizing BTC-e technology. So much so that it is hypothesized that leadership originating from BTC-e was involved in the theft of 530,000 bitcoins from Mt. Gox, and these bitcoins were in addition to the 850,000 bitcoins that were already lost from the

[29] CoinDesk. 2021. *Mt. Gox*. [online] Available at: <https://www.coindesk.com/company/mt-gox/> [Accessed 24 December 2021].
[30] Bitfinex.com. 2021. [online] Available at: <https://www.bitfinex.com/about> [Accessed 24 December 2021].

cryptocurrency exchange years prior. The specific leadership in question of this theft surrounds Mr. Alexander Vinnik. The exchange launched in July of 2011, and it traded legal tenders and cryptocurrencies such as the U.S. Dollar and Euthereum. Much like Bitcoin and Euthereum, BTC-e was a decentralized cryptocurrency exchange.[31] Bitfinex is technically considered a centralized cryptocurrency exchange, however it does have the technology to operate with a decentralized authority, and Bitstamp utilizes a centralized authority to verify cryptocurrency transactions.

There are five more data series included within this study, in which the second series to be briefly analyzed is Blockchain. Once again, Blockchain is the digital ledger that verifies transactions for cryptocurrencies, as well as being an informational source pertaining to updated Bitcoin market information. This study utilized Blockchain to analyze six variables that may or may not be indicators for Bitcoin price, and those components include the total amount of bitcoins in circulation at that time, the total amount of transactions with the exception of exchange transactions, approximate output volume, trade volume, transaction volume ratio, hash rate and difficulty. The following quote from a Multidisciplinary Digital Publishing Institute (MDPI) article explains the logistics of Blockchain technology: "*Blockchain consists of three important concepts: blocks, nodes, and miners. There are three elements to define a block; data in the block, a 32-bit whole number called a nonce and a 256-bit number called a hash. When a block is created, a nonce is randomly generated; subsequently, the nonce generates the block header i.e., cryptographic hash. Nodes are electronic devices that maintain the*

[31] Crypto Asset Recovery. 2021. *What Happened To BTC-e.com (and Wex.nz)?*. [online] Available at: <https://cryptoassetrecovery.com/2021/04/22/what-happened-to-btc-e/> [Accessed 25 December 2021].

blockchain and keep the network functioning. They are kind of access points to a distributed ledger and hence no one person or entity controls it, which gives the decentralized nature to blockchain technology. Every node has its copy of the blockchain, and the network must algorithmically approve any newly mined block for the chain to be updated, trusted, and verified. Each participant is given a unique alphanumeric identification number that shows their address. Bitcoin shows that due to a system of checks and balances, the blockchain maintains integrity and creates trust among users and hence public information can be safely stored in it. New blocks are created by miners by a process called mining. Since every block in a blockchain not only has its unique nonce and hash but also refers to the previous block, mining can become complex for large blockchains. Miners solve a complex math problem to find an acceptable hash to nonce. A 32-bit nonce and 256-bit hash have approximately 4 bn nonce hash combinations, making finding the right one extremely difficult. When a miner finds that, their block is added to the blockchain."[32]

Hash rate is defined as the rate of productivity in which miners produce bitcoins.[33] The more bitcoins miners produce, the more *difficult* it becomes to mine more bitcoins. Mining bitcoins requires a certain amount of *computational power* to mine each bitcoin. This is a relevant reason as to why Bitcoins are supplied at a decreasing rate. Mining bitcoins is essential to Blockchain not only concerning the supply chain, but the

[32] Mdpi.com. 2021. *Risks - A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets*. [online] Available at: <https://www.mdpi.com/journal/risks> [Accessed 25 December 2021].
[33] Finance.yahoo.com. 2021. *Yahoo is part of the Yahoo family of brands*. [online] Available at: <https://finance.yahoo.com/news/hash-rate-cryptocurrency-calculated-172307967.html> [Accessed 24 December 2021].

hash rate is also a reliable indicator regarding the security of Bitcoin technology.[34] The higher the hash rate, the stronger the Bitcoin security. The third data series this study utilized was the exchanges that were discussed earlier, but more specifically this study focused on the exchange's volumes. Furthermore, the study wanted to analyze the relationship between the U.S. Dollar and Chinese Renminibi (CNY) Bitcoin markets. Researchers of this study believed that China may have had an influence on the value of Bitcoin, so this study utilized prices and volumes as variables and analyzed their cryptocurrency market relationship, if any. This is relevant to the study as a majority of U.S. dollar transactions occur within Bitcoin markets, obtaining a market share of around 90%, which was hypothesized to be involved in the makeup of Bitcoin value.

The fourth variable being considered within this previous study are search engines, such as Google and Wikipedia. As mentioned earlier, investor interest somewhat played a significant role involving the movement of Bitcoin price, so those metrics are necessary to measure against other financial metrics in an attempt to identify any patterns or trends. The fifth data series being considered is the Financial Stress Index (FSI). The Financial Stress Index is constructed by the Federal Reserve Bank of Cleveland that measures financial tension overall within relevant markets. Finally, the last variable being considered as a data series is the price of gold. Because gold and Bitcoin share some similarities, such as limited supply, an analysis of their relationship may hold significance to the study.

[34] Nicehash.com. 2021. *NiceHash - Leading Cryptocurrency Platform for Mining and Trading*. [online] Available at: <https://www.nicehash.com/blog/post/blockchain-basics-what-is-hashrate> [Accessed 24 December 2021].

All of the data series and methods have been analyzed, which now leads to the results of the study. Pertaining to economic drivers, researchers have found that in 2014 Bitcoin was attractive to investors on the basis that specific strategies could bring about profit increases of around 12,000% percent in a little over 2 years, 30 months to be exact if the investor maintained what is known as the *buy-and-hold strategy,* according to researchers. The buy-and-hold strategy entails purchasing a stock and holding that stock in hopes that investment increases in value over time. This strategy is different from others such as active stock trading, which is commonly known as short-term buying low-priced stocks and selling high-priced stocks. Additionally, researchers of this study identified a specific pattern of Bitcoin's price from October 2011 to January of 2014, captured below in **Figure 1.**

Figure 1: Bitcoin Price Index October 2011 – January 2014

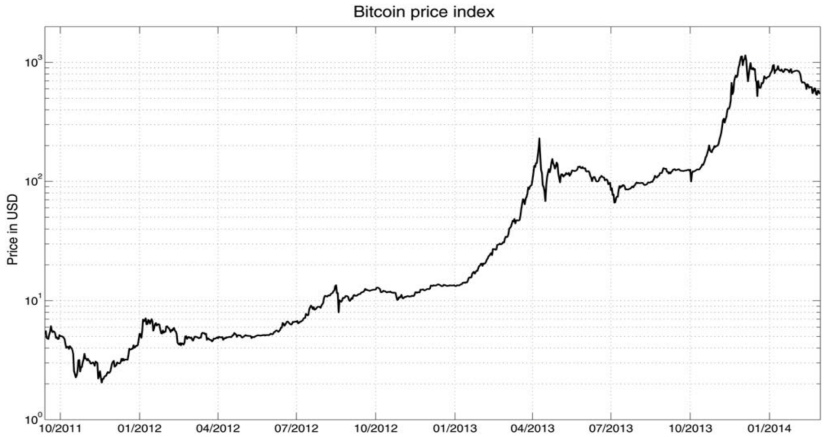


Fig 1. Bitcoin price index. Values of the index are shown in the USD (for the USD markets) and in the logarithmic scale.

Source: PLOS ONE What Are the Main Drivers of the Bitcoin Price?[35]

[35] Krištoufek, L., 2021. *What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis*. [online] Econpapers.repec.org. Available at: <https://econpapers.repec.org/RePEc:plo:pone00:0123923> [Accessed 24 December 2021].

Figure 2: Bitcoin Price Index November 2014 – November 2021

Source: CoinDesk[36]

The researchers within this study noticed in *Figure 1* that the price of Bitcoin would fluctuate by brief, sudden increases in price, followed by short-term drops in value. However, the price has never returned to its initial value after the price rose again. This chart shows that the price of Bitcoin has overall increased over time. For example, after the spike in Bitcoin price in late 2011/early 2012, it was followed by a period of decreased price fluctuations, the study identifies this time period of price reductions as *corrections.* Just over a year later, the chart exemplifies the same pattern. The spike in Bitcoin price in April of 2013 was followed by a period of corrections. This particular price correction lasted until October of 2013, when the price spiked even higher, as well as also maintaining a correction period after the fact. Another chart, labeled **Figure 2,** represents Bitcoin's price from November 2014 to November 2021, for comparative and analytical purposes.

[36] CoinDesk 20. 2021. *Bitcoin Price | BTC Price Index and Live Chart*. [online] Available at: <https://www.coindesk.com/price/bitcoin/> [Accessed 24 December 2021].

Figure 2 briefly sets the framework for how much Bitcoin has grown in value over the years. *Figure 1* and *Figure 2* almost do not look like they are exemplifying the same variables, which shows the gravity of Bitcoin's value. In Figure 2, Bitcoin maintained somewhat of an equilibrium during 2015-2017. Towards the end of 2017 and the beginning of 2018, another price spike is identified. During the end of 2018, price corrections occurred until late 2021, keeping into consideration the slight price increase in 2009. It is also important to consider the economic status from 2020 until today. In late 2019, the world was hit with a pandemic known as the COVID-19 pandemic. The COVID-19 pandemic was responsible for a majority of an economic shutdown within the United States, as well as other parts of the world. The disease was also responsible for the death of over 700,000 people (and still counting). Additionally, many businesses were forced to shut down due to the pandemic, and to say that COVID-19 had no role in the price fluctuations for Bitcoin from 2020 to the present day would be a serious claim, however further analysis would be required to confirm that as factual. Overall, this analysis has concluded that there has been somewhat of a pattern identified in Bitcoin's price value over time, however the definite origin(s) of that pattern still remains uncertain.

In terms of economic drivers, the researchers from this study conclude that Bitcoin price is relative to the economic theory called the *quantity theory of money.* The quantity theory of money behaves according to the quantity of the asset in circulation. Therefore, Bitcoin price is related to its current amount in circulation.[37] This is a probable

[37] Richmondfed.org. 2021. [online] Available at: <https://www.richmondfed.org/-/media/richmondfedorg/publications/research/economic_review/1974/pdf/er600301.pdf> [Accessed 24 December 2021].

claim, considering all studies thus far have proven supply and demand fundamentals are key drivers of Bitcoin value. This information will be further determined after the results are revealed from the data analysis conducted per this thesis. For example, the demand for Bitcoin increases when the supply increases, as a means to purchase bitcoins for as little as possible. When the price starts to decrease, typically an investor would either trade or hold onto their investment. It is a coincidence to consider that Bitcoin may react to standard economic theories of supply and demand, however its frequent high volatility would suggest otherwise.

The research study then considers investor interest and mining as a factor in Bitcoin price predictions. Researchers found within a 30-100 day time period occurring during the months of January of April of 2013, there was somewhat of a relationship between internet interest in Bitcoin and its price. The research study does indicate that Bitcoin's price did increase by $87 within this same time period, so this price increase may or may not have been due to investor interest, however it does present a plausible case and the research study suggests there is an assumed connection. The following quote from the study further explains this connection, *"The interest in Bitcoin appears to have an asymmetric effect during the bubble formation and its bursting - during the bubble formation, interest boosts the prices further, and during the bursting, it pushes them lower; Increased interest has a more rapid effect during the price contraction than during the bubble build-up."*[38]

[38] Krištoufek, L., 2021. *What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis*. [online] Econpapers.repec.org. Available at: <https://econpapers.repec.org/RePEc:plo:pone00:0123923> [Accessed 24 December 2021].

Mining is a technical factor taken into consideration as well. Previously, it was mentioned that the hash rate is a representation of the productivity in miners, and miners require additional computational power the more bitcoins that are produced. Researchers of this study believe this may also be a factor because in some cases, mining can be considered an investment style of choice. Instead of purchasing bitcoin, individuals will pursue the opportunity to retrieve bitcoins by mining. However, because of the increasing difficulty of computational power required to mine more bitcoins, many miners must eventually abandon this investment style. This result hypothesizes that bitcoin price will increase because more miners will choose this avenue of obtaining bitcoins, hence the increase in difficulty as well as the hash rate. Furthermore, the decrease in mining because of increased difficulty shifts the investment style from supply to demand, hence also producing an increase in Bitcoin value. Therefore, this study establishes the connection between Bitcoin supply and Bitcoin price, especially keeping into consideration the motivation to mine bitcoin is to retrieve more bitcoins. To put this example into perspective, this is like an investor pursuing investment opportunities through the media versus the traditional avenue of investing costs. Media attention to a specific investment is free and public knowledge, otherwise investors would have to pay investing costs to obtain information on investment opportunities.

Furthermore, mining can even be considered a conflict of interest if its role is manipulated. For example, depending on the minors' intentions, miners can manipulate blockchain technology to adjust exchange rates to their advantage, whether that results in increasing or decreasing bitcoin value. Conflict of interest is a common issue that unfortunately occurs frequently in the professional world, especially in finance.

Therefore, the probability of mining bitcoins is potentially a conflict of interest is a probable claim. The next variable of concern is whether or not Bitcoin is considered to be a safe haven. According to the research, the Financial Stress Index and the price of gold have very little significance on the price of Bitcoin. This is a credible claim considering the size of the Bitcoin economy and its history of volatile prices - this proves instability and can drive Bitcoin price either up or down. Therefore, this led researchers to conclude that there is no evidence within their analysis to support that Bitcoin is a safe haven.

Finally, China's potential influence can be examined. The initial reason to believe China may have an influence on Bitcoin value can be attributed to cryptocurrency events that occur in China coincidently show major price increases or decreases in Bitcoin. For example, A digital retailer in China announced it was going to accept bitcoins as a form of payment in October of 2013. Soon after, Bitcoin's value quickly increased. Note that China banned cryptocurrency trading of all kinds with regulations beginning in December of 2013 and regulations have been updated as of September 2021. Bitcoin data was analyzed within USD and CNY markets in order to determine a significant relationship, if any. Below captures the result of that analysis via the wavelet statistical method, represented as **Figure 3.**

Figure 3 represents the bitcoin exchange volumes and the bitcoin prices between the CNY and USD markets. Researchers from this study suggest there is no long-term significance within their relationships, however there are presently short-term instances of an influential relationship. However, researchers make it evident the known presence of high-correlation between these two markets may be an indicator for these results, however wavelet partial coherence was installed as a means to control this reaction.

Figure 3: *PLOS ONE* Bitcoin Prices in USD and CNY

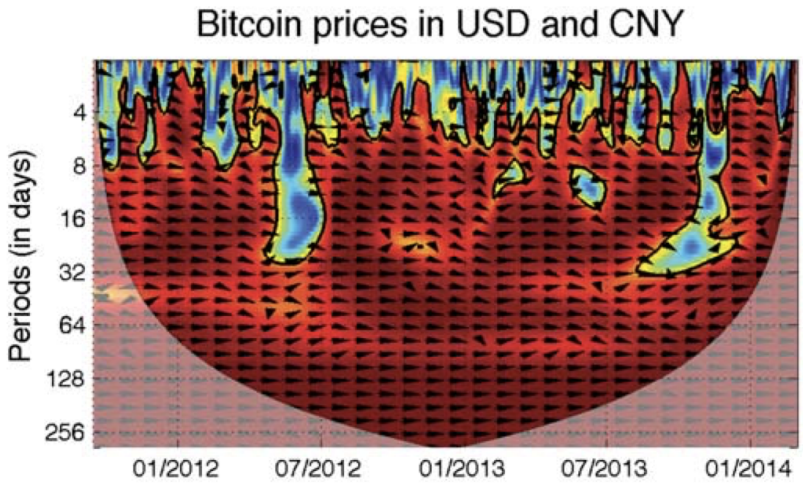


Figure 3.1: *PLOS ONE* Bitcoin Exchange Volumes in USD and CNY

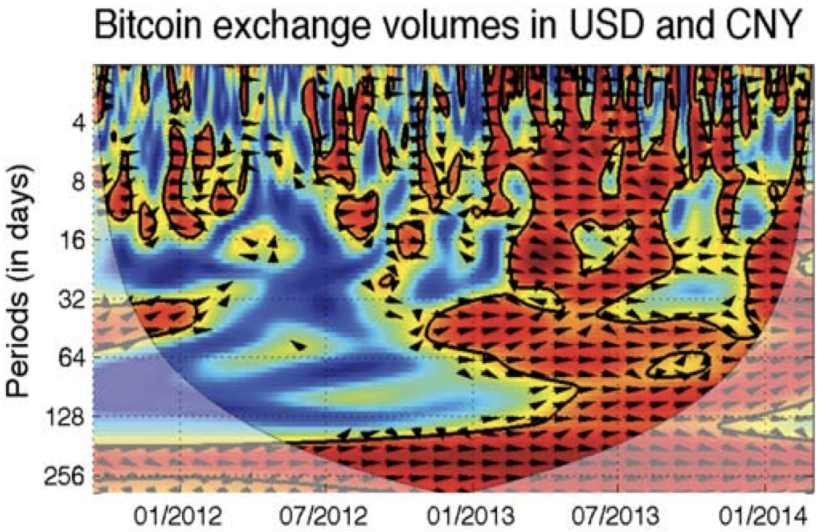


Figure 3.2: *PLOS ONE* Bitcoin and Exchange Volume in CNY

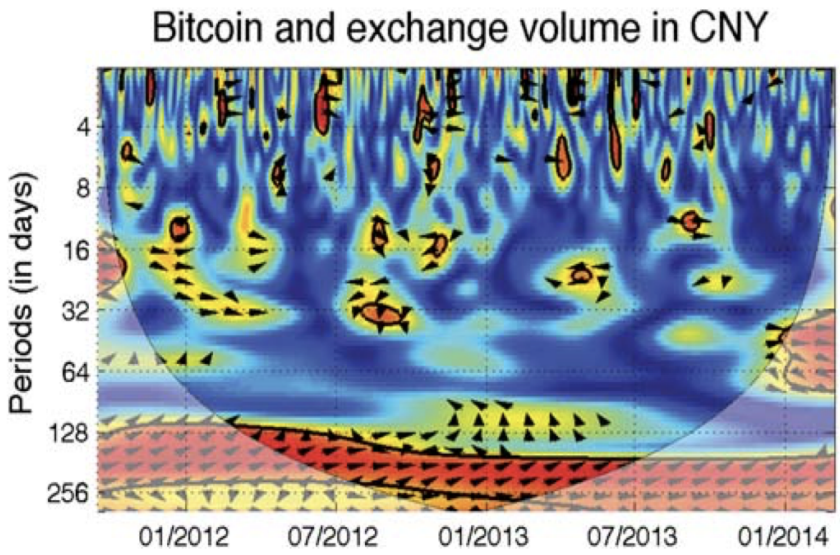
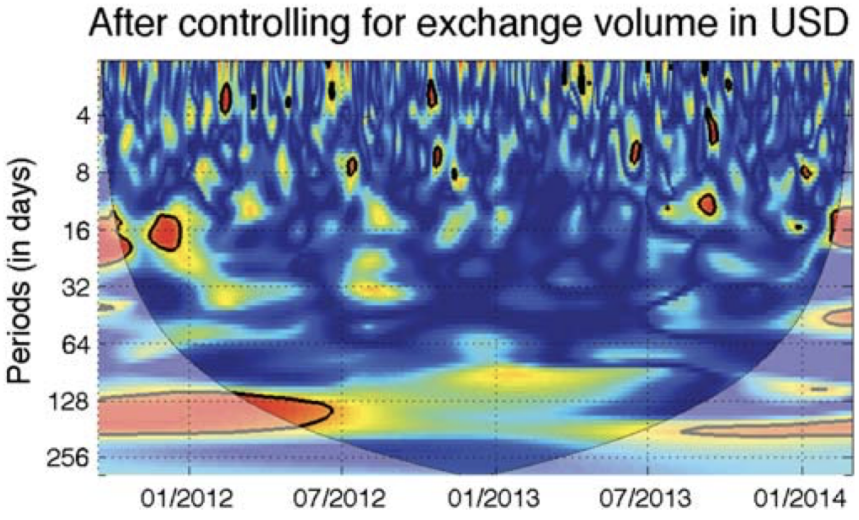


Figure 3.3*: PLOS ONE* After Controlling for Exchange Volume in USD



Source: PLOS ONE What Are the Main Drivers of the Bitcoin Price?[39]

[39] Krištoufek, L., 2021. *What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis*. [online] Econpapers.repec.org. Available at: <https://econpapers.repec.org/RePEc:plo:pone00:0123923> [Accessed 24 December 2021].

To conclude the findings from this study, the authors conclude five crucial aspects regarding what indicators are the main drivers for Bitcoin price. The first conclusion pertains to bitcoin's price relationship to standard economic theories, such as the quantity theory of money, with respect to traditional supply and demand fundamentals, and this can be credited to bitcoin's limited supply as a vital aspect. The second conclusion that authors describe concerns bitcoin's price to be motivated by the incentive to mine bitcoins. This presents a cause-and-effect relationship with mining bitcoins when the computational power becomes too difficult for an individual to mine, hence transitioning into a direct consumer relationship. The third conclusion indicates investor interest as another main driver of bitcoin price. Thus far, this is the third study to conclude investor interest as a crucial indicator for bitcoin price. Researchers conclude Bitcoin is not technically established as a safe haven as a means of trade and investment, this can be crediddted to confuirmed illicit cyber transactions and activities. Finally, researchers conclude that the USD and CNY markets have no definite relationship due to no clear evidence, however thay indicate there may be instances of connections amongst the markets. Once again, that can be attributed to the markets' high correlation and/or short-term volatility within those markets. This thesis will introduce one last previous study as a means to demonstrate bitcoin's progression within financial markets.

The last previous study to be analyzed is titled *A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets* which was posted by the Multidisciplinary Digital Publishing Institute (MDPI). MDPI is an online publisher known for its credible scientific journals. This article was published November 12, 2021

from authors Yianni Doumenis, Javad Izadi, Pradeep Dhamdhere, Epameinondas Katsikas, and Dimitrios Koufopoulos. This study utilized bitcoin prices ranging from September 2014 - September 2021 and analyzed those prices against the S&P 500 Index, gold, and Treasury bonds.[40] The findings within this study are especially imperative for our purposes because it analyzes bitcoin data before and during the COVID-19 pandemic, which helps to objectively analyze bitcoin behavior. Statistical models utilized include correlation analysis amongst the cryptocurrency and the financial assets, in addition to a measurement of the mean absolute percentage error in regards to bitcoin volatility before and throughout the pandemic, as well as an augmented Dickey-Fuller (ADF) test.

Within the literature review of this study, the researchers try to explain the logistics of Bitcoin today. Thus far, bitcoin's history has been analyzed and an evidenced analysis of bitcoin's establishment in today's financial and cryptocurrency markets will be essential for the analysis later throughout this thesis. The authors describe Bitcoin as somewhere in the middle of a fiat currency and a commodity, in other words, somewhere in the middle between gold and cash, in digital form. Bitcoin and gold are similar in the sense they both share a limited supply, however they are still considered different financial entities. This is because gold, known as a commodity, has an intrinsic value behind its worth. In other words, its value is physical. Bitcoin has no intrinsic value as its form is digital and its value is driven by the hope of its investors that it will be worth true value later on, which represents the medium-of exchange aspect behind Bitcoin. Keep in

[40] Mdpi.com. 2021. *Risks - A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets*. [online] Available at: <https://www.mdpi.com/journal/risks> [Accessed 25 December 2021].

mind, Bitcoin's supply cap will always be 21 million bitcoins, but gold's true supply will never be known, which further separates the two assets.

In efforts to better understand what predicts Bitcoin price, author *Vieira (2017)* from the MDPI study collected data such as daily bitcoin price, daily price of gold in USD (per ounce), daily amount of bitcoin transactions and the total amount of distinctive bitcoin addresses, transaction fees paid to miners, the total value of coin base block rewards, daily treasury yield rates of "Treasury Inflation-Protected Securities", and accumulated Wikipedia views related to the term "Bitcoin."[41] For additional reference, the value of coin base block rewards is a representation of the rewards miners receive whenever a block is created, in which the current reward for every block is 50 bitcoins. In summary of this analysis, Vieira concludes that volatility amongst the cryptocurrency relationship with the identified financial assets represents significance in recognition of bitcoin price. For example, decreases in Bitcoin price have a more dramatic effect on its volatility and the markets involved versus increases in Bitcoin price. Vieira also makes a claim that bitcoin price has an inverse relationship with daily gold prices and the total amount of verified bitcoin transactions. The authors within this study make it evident that emerging cryptocurrencies do not have a limited supply like their competitor Bitcoin, and this may affect the overall value of Bitcoin and related cryptocurrencies in the future when Bitcoin reaches its supply cap. In terms of our purposes, this may not be a factor presently, however this will be very imperative for future studies as we learn more about Bitcoin and its associated behaviors. After previous study analysis and independent

[41] Mdpi.com. 2021. *Risks - A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets*. [online] Available at: <https://www.mdpi.com/journal/risks> [Accessed 25 December 2021].

research, authors of this study concluded three hypotheses concerning bitcoin price and its volatility:

"**Hypothesis 1:** *The volatility of Bitcoin as a cryptocurrency is higher than that of other financial assets.* **Hypothesis 2:** *The mean absolute percentage error for the volatility of Bitcoin before the COVID-19 outbreak is more than during the COVID-19 outbreak comparing it with other financial assets.* **Hypothesis 3:** *There is a positive correlation between Bitcoin, S&P 500, gold and treasury bonds."*[42]

After much analysis, the authors from this research conclude that Bitcoin has incredible volatility compared to the tested financial assets, once again those being S&P 500, gold and treasury bonds. Therefore, Bitcoin cannot be associated with established economic monetary systems. This finding also concludes the first hypothesis. Currently, Bitcoin is within the 20% percentile concerning volatility which is why as of recently investors treat the cryptocurrency as a variable of exchange and/or investment. In addition, due to its decentralized peer-to-peer nature, it lacks the debt required to back up the speculative asset as a fiat currency, which contributes to much risk associated with bitcoin especially in combination with its volatile tendencies. The ADF test was utilized to test the second hypothesis in conjunction with evaluators such as the mean absolute error (MAE), mean absolute percentage error (MAPE), root-mean-square error (RMSE), and standard deviation of the error (SDE). Researchers conclude that the price of gold increased whenever Bitcoin price experienced high volatility. The MAPE for the volatility of Bitcoin before the COVID-19 outbreak was 433.22% and the MAPE for the volatility of Bitcoin during the COVID-19 outbreak was 78.39%, a difference of

[42] Mdpi.com. 2021. *Risks - A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets*. [online] Available at: <https://www.mdpi.com/journal/risks> [Accessed 25 December 2021].

354.83% in a matter of 2-3 years, hence accepting the second hypothesis. Finally, researchers conclude that there is a strong correlation amongst bitcoin price and the associated financial assets, a claim that has been denied by previous studies. Not only do these findings differentiate from previous studies, but these findings are especially objective as our findings are conducted within the same time period. In result, researchers accept their third hypothesis.

Overall, all four studies provided extensive information vital for our purposes. Our study, however, will include several indices for examination, instead of just the S&P 500 Index or Dow Jones Industrial Index. Additionally, instead of measuring Bitcoin probability via "Blockchain" google searches, this study will incorporate language such as *"Bitcoin", "Bitcoin.com", "Economics of Bitcoin,* etc. Moreover, the inclusion of international indices diversifies our research and hopefully this will produce a pool of more accurate and promising results. Finally, before we officially begin the statistical testing of the presented data, an overall analysis on the background of Bitcoin can be helpful for the overall research process.

DATA SET

Once again, the main objective for this thesis is to determine through statistical modeling if there are any significant relationships amongst the variables, especially if these relationships are influential on Bitcoin's stock price. The variables included in this study are: Nasdaq 100, S&P 500, Dow Jones Industrial Index, Russell 2000 Index, Nikkei 225, Gold, Oil, S&P 500 Volatility Index (VIX), the euro exchange rate, and the Shanghai SE Composite Index. Of these variables, seven are indices, two are commodities, and one is an exchange rate. The data set ranges from July 18th, 2010 – December 12th, 2021. There are two sets of data, a monthly representation of the variables and a weekly representation of the variables. It is important to mention that the data for Bitcoin price, for both monthly and weekly data sets, have zero value from the inception of Bitcoin to July 18th, 2010, and the reason for this is because Bitcoin was worth fractions of a penny which makes those values statistically insignificant. The monthly and weekly data sets for Bitcoin and the rest of the variables were pulled from *Investing.com.*[43] How one can obtain this data specifically is to go to their website and type in the stock you wish to analyze in their search engine. Once one finds the stock they are looking for, there should be a button that says, "Historical Data." Once one clicks on historical data, one will be presented with daily prices for their stock. *Investing.com* has filters on their historical data tab so that users can manipulate the data to their needs. For example, I was able to change my data from daily to monthly or daily to weekly, I also put in the data range I wanted and once I was done, I was able to download those two

[43] Investing.com. 2021. *Bitcoin Historical Data - Investing.com*. [online] Available at: <https://www.investing.com/crypto/bitcoin/historical-data> [Accessed 24 December 2021].

files into excel. The main difference between this study and previous studies before this one is that this study is incorporating multiple indexes and commodities in order to better diversify the results, whereas other studies only included one or two of those variables. This study will also utilize Google Trends Database in order to quantify Bitcoin popularity, as a means to represent the demand for the digital currency. It is evident that Bitcoin is motivated by not only supply-and-demand, but also important news from the media also has the power to influence the price of Bitcoin, and this is because the market for Bitcoin is still considered a small and volatile market, so either positive and/or negative news can influence investors to manipulate their bitcoin holdings. For example, the context of Elon Musk's tweets have a connection to changes in Bitcoin price. Therefore, a measure of Bitcoin popularity is an essential aspect of this research.[44]

[44] Shevlin, R., 2021. *How Elon Musk Moves The Price Of Bitcoin With His Twitter Activity*. [online] Forbes. Available at: <https://www.forbes.com/sites/ronshevlin/2021/02/21/how-elon-musk-moves-the-price-of-bitcoin-with-his-twitter-activity/> [Accessed 24 December 2021].

METHODOLOGY

The research is a time series with a range of data pertaining to specific variables within the study. There are various observations conducted within this study for margin of error purposes. All monthly data pertaining to price, change %, and Wikipedia page views was observed from September 2010 – December 2021. All weekly data pertaining to price, change %, and Wikipedia page views was observed from July 18th, 2010 - December 12th, 2021. Shanghai Price Index is included within monthly price and change % datasets but is separated from weekly price and change %. This is because Shanghai's raw dataset excluded dates corresponding with the other variables, those being all indices and commodities. Therefore, weekly Shanghai Price Index price and change % is measured independently with Bitcoin price and change % in efforts to reduce a margin of error as a means to best accurately represent the findings. Monthly prices and change % for all indices and commodities, in addition to Bitcoin, contain 136 observations each, totaling a data input of 1,496 entries. Weekly prices and change % for all indices and commodities, in addition to Bitcoin contain 596 observations each, totaling a data input of 5,960 entries. Shanghai Price Index weekly price and change % contains 587 observations (excluding Bitcoin observations), totaling a data input of 1,174 entries. Monthly Wikipedia page views contain 136 observations, totaling a data input of 544 entries. Weekly Wikipedia page views contain 596 observations, totaling a data input of 2,384 entries. Total observations across all variables add up to 2,051 observations and a total data input of 11,558 entries. The techniques utilized within this research include descriptive statistics, outliers, correlation, and regression. The statistical programs

utilized for this research include Excel and SPSS. Google Trend Data will be analyzed August 2010 – December 2021.

RESULTS

Table 1 shows the *monthly* descriptive statistics for *prices* involving variables including Bitcoin, indices or commodities.

Table 1: Monthly Prices Descriptive Statistics Indices/Commodities

Bitcoin Price	
Mean	7043.328676
Standard Error	1164.28608
Median	631.5
Mode	4.9
Standard Deviation	13577.79225
Sample Variance	184356442.4
Kurtosis	6.362455258
Skewness	2.647909017
Range	61309.5
Minimum	0.1
Maximum	61309.6
Sum	957892.7
Count	136

Nasdaq Price	
Mean	5919.157941
Standard Error	310.6248961
Median	4621.05
Mode	#N/A
Standard Deviation	3622.477653
Sample Variance	13122344.35
Kurtosis	0.856336792
Skewness	1.263205318
Range	14137.88
Minimum	1998.04
Maximum	16135.92
Sum	805005.48
Count	136

S&P 500 Price	
Mean	2333.629265
Standard Error	74.68912537
Median	2104.17
Mode	#N/A
Standard Deviation	871.0173942
Sample Variance	758671.301
Kurtosis	0.196175088
Skewness	0.830088101
Range	3537.73
Minimum	1131.42
Maximum	4669.15
Sum	317373.58
Count	136

Dow Jones Price	
Mean	20327.0926
Standard Error	574.765507
Median	17970.335
Mode	#N/A
Standard Deviation	6702.86005
Sample Variance	44928332.8
Kurtosis	-0.6022348
Skewness	0.57251922
Range	25031.54
Minimum	10788.05
Maximum	35819.59
Sum	2764484.59
Count	136

Russell 2000 Price	
Mean	1297.9114
Standard Error	35.2553128
Median	1226.75
Mode	#N/A
Standard Deviation	411.144066
Sample Variance	169039.443
Kurtosis	0.15077131
Skewness	0.71321444
Range	1666.39
Minimum	644.16
Maximum	2310.55
Sum	176515.95
Count	136

Nikkei 225 Price	
Mean	17916.29632
Standard Error	501.9842769
Median	18913.135
Mode	#N/A
Standard Deviation	5854.092341
Sample Variance	34270397.14
Kurtosis	-0.801484405
Skewness	0.00206848
Range	21018.05
Minimum	8434.61
Maximum	29452.66
Sum	2436616.3
Count	136

Gold Price	
Mean	1470.17243
Standard Error	18.6464602
Median	1390.2
Mode	1347.1
Standard Deviation	217.453225
Sample Variance	47285.9052
Kurtosis	-0.6737496
Skewness	0.62361015
Range	905.9
Minimum	1121
Maximum	2026.9
Sum	199943.45
Count	136

Oil Price	
Mean	68.9722794
Standard Error	1.96484477
Median	64.32
Mode	48.24
Standard Deviation	22.9138306
Sample Variance	525.043634
Kurtosis	-1.1853335
Skewness	0.16801666
Range	95.09
Minimum	18.84
Maximum	113.93
Sum	9380.23
Count	136

VIX Price	
Mean	18.1383824
Standard Error	0.58767776
Median	16.305
Mode	12.12
Standard Deviation	6.85344144
Sample Variance	46.9696596
Kurtosis	6.25161492
Skewness	2.10686169
Range	44.03
Minimum	9.51
Maximum	53.54
Sum	2466.82
Count	136

Euro Xchange Rate Price	
Mean	1.21372279
Standard Error	0.00935112
Median	1.18475
Mode	1.0987
Standard Deviation	0.10905187
Sample Variance	0.01189231
Kurtosis	-0.9316112
Skewness	0.51694204
Range	0.4286
Minimum	1.0513
Maximum	1.4799
Sum	165.0663
Count	136

ShangHai Price	
Mean	2879.50846
Standard Error	46.0733718
Median	2922.365
Mode	#N/A
Standard Deviation	537.303229
Sample Variance	288694.76
Kurtosis	0.06851016
Skewness	0.2489547
Range	2632.53
Minimum	1979.21
Maximum	4611.74
Sum	391613.15
Count	136

The size for this sample is 1,496 observations (136*11). Bitcoin has a mean of 7043.32 and a median of 631.5, exemplifying data that is skewed to the right. Nasdaq 100 has a mean of 5919.15 and a median of 4261.05, exemplifying data that is skewed to the right. S&P 500 has a mean of 2333.62 and a median of 2104.17, exemplifying data that is skewed to the right. Dow Jones has a mean of 20327.09 and a median of 17970.33, exemplifying data that is skewed to the right. Russell 2000 has a mean of 1297.91 and a median of 1226.75, exemplifying data that is slightly skewed to the right, this distribution is nearly symmetrical. Nikkei 225 has a mean of 17916.29 and a median of 18913.13, exemplifying data that is skewed to the left. Gold has a mean of 1470.17 and a median of 1390.1, exemplifying data that is slightly skewed to the right. Oil has a mean of 68.97 and a median of 64.32, exemplifying data that is skewed to the right, this distribution is nearly symmetrical. VIX has a mean of 18.13 and a median of 16.30, exemplifying data that is slightly skewed to the right, this distribution is nearly symmetrical. The Euro Exchange Rate has a mean of 1.21 and a median of 1.18, exemplifying data that is slightly skewed to the right, this distribution is nearly symmetrical. Finally, Shanghai Price Index has a mean of 2879.50 and a median of 2922.36, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. Nikkei 225 and Shanghai Price Index data skews to the left, while the remaining variables skew to the right.

All variables sustain a standard deviation within three standard deviations of the mean. However, several outliers were detected amongst the monthly price data set. Bitcoin price had outliers, in order of most recent and all occurring in 2021, of

$56,882.90 (November 2021), $61,309.60 (October 2021), $57,720.30 (April 2021) and $58,763 (March 2021). Reasons pertaining to the recent outliers can be hypothesized to be attributed to recent volatility within the economic environment. VIX prices had three outliers throughout the last 11 years all above three standard deviations of the mean, and Shanghai Price Index had one outlier above three standard deviations of the mean.

Table 2 shows the *weekly* descriptive statistics for *prices* involving variables including Bitcoin, indices or commodities.

Table 2: Weekly Prices Descriptive Statistics Indices/Commodities

Bitcoin Price	
Mean	6804.219463
Standard Error	549.397139
Median	615.55
Mode	0.1
Standard Deviation	13412.49347
Sample Variance	179894981
Kurtosis	6.891765182
Skewness	2.74678876
Range	64398.5
Minimum	0.1
Maximum	64398.6
Sum	4055314.8
Count	596

Nasdaq Price	
Mean	5813.690151
Standard Error	145.9444729
Median	4534.43
Mode	#N/A
Standard Deviation	3562.95865
Sample Variance	12694674.34
Kurtosis	0.850682452
Skewness	1.257260164
Range	14781.7
Minimum	1791.64
Maximum	16573.34
Sum	3464959.33
Count	596

S&P 500 Price	
Mean	2308.189648
Standard Error	35.5487388
Median	2101.775
Mode	1271.5
Standard Deviation	867.8553144
Sample Variance	753172.8467
Kurtosis	0.137426086
Skewness	0.807201648
Range	3647.43
Minimum	1064.59
Maximum	4712.02
Sum	1375681.03
Count	596

Dow Jones Price	
Mean	20157.6396
Standard Error	276.234789
Median	18007.215
Mode	#N/A
Standard Deviation	6743.75062
Sample Variance	45478172.5
Kurtosis	-0.6089005
Skewness	0.57096418
Range	26178.42
Minimum	10150.65
Maximum	36329.07
Sum	12013953.2
Count	596

Russell 2000 Price	
Mean	1286.38329
Standard Error	17.1118201
Median	1218.655
Mode	#N/A
Standard Deviation	417.752767
Sample Variance	174517.374
Kurtosis	0.16383637
Skewness	0.71180129
Range	1827.59
Minimum	609.49
Maximum	2437.08
Sum	766684.44
Count	596

Nikkei 225 Price	
Mean	17741.3771
Standard Error	242.825918
Median	18403.65
Mode	9430.96
Standard Deviation	5928.13614
Sample Variance	35142798.1
Kurtosis	-0.8039677
Skewness	0.06062224
Range	22340.04
Minimum	8160.01
Maximum	30500.05
Sum	10573860.8
Count	596

Gold Price	
Mean	1466.63767
Standard Error	8.8839264
Median	1384.45
Mode	1287.3
Standard Deviation	216.884283
Sample Variance	47038.7923
Kurtosis	-0.6794461
Skewness	0.66701547
Range	958.5
Minimum	1114.5
Maximum	2073
Sum	874116.05
Count	596

Oil Price	
Mean	68.9437919
Standard Error	0.9302617
Median	63.735
Mode	53.99
Standard Deviation	22.7105823
Sample Variance	515.770546
Kurtosis	-1.1903661
Skewness	0.15654897
Range	96.99
Minimum	16.94
Maximum	113.93
Sum	41090.5
Count	596

VIX Price	
Mean	17.6180872
Standard Error	0.28602383
Median	15.86
Mode	11.98
Standard Deviation	6.9827316
Sample Variance	48.7585405
Kurtosis	10.3645125
Skewness	2.52093891
Range	56.9
Minimum	9.14
Maximum	66.04
Sum	10500.38
Count	596

Euro Xchange Rate Price	
Mean	1.21482701
Standard Error	0.00439522
Median	1.1849
Mode	1.1018
Standard Deviation	0.10730111
Sample Variance	0.01151353
Kurtosis	-1.0366997
Skewness	0.4495562
Range	0.4351
Minimum	1.0451
Maximum	1.4802
Sum	724.0369
Count	596

The size for this sample is 5,960 observations (596*10). Bitcoin has a mean of 6804.21 and a median of 615.5, exemplifying data that is skewed to the right. Nasdaq 100 has a mean of 5813.69 and a median of 4534.43, exemplifying data that is skewed to the right. S&P 500 has a mean of 2308.18 and a median of 2101.77, exemplifying data that is skewed to the right. Dow Jones has a mean of 20157.63 and a median of 18007.21, exemplifying data that is skewed to the right. Russell 2000 has a mean of 1286.38 and a median of 1218.65, exemplifying data that is skewed to the right. Nikkei 225 has a mean of 17741.37 and a median of 18403.65, exemplifying data that is skewed to the left. Gold has a mean of 1466.63 and a median of 1384.45, exemplifying data that is skewed to the right. Oil has a mean of 68.94 and a median of 63.73, exemplifying data that is skewed to the right. VIX has a mean of 17.61 and a median of 15.86, exemplifying data that is skewed to the right. Finally, the Euro Exchange Rate has a mean of 1.21 and a median of 1.18, exemplifying data that is skewed to the right. Apart from the Shanghai Price being

excluded from this particular set of data, the monthly and weekly findings thus far are consistent in skewness.

Similarly to the monthly findings, all variables within the weekly findings sustain a standard deviation within three standard deviations of the mean. Once more, there are outliers detected within the findings. Variables Bitcoin, Nasdaq 100 and VIX contained outliers within their data. Bitcoin had 28 outliers within the last 4 years, Nasdaq 100 had one outlier in the amount of $16, 573.34 (August 2021) which is slightly above three standard deviations of the mean, the upper limit being $16,502.56. VIX had 10 outliers within its data, 7 of which were consecutive and above three standard deviations from the mean, ranging from 40.11-66.04. The remaining 3 outliers occurred within August 2011 – September 2011, in order from most recent, those entries were 42.96, 41.25, and 43.05. Table 3 shows the *monthly* descriptive statistics for *change %* involving variables including Bitcoin, indices and commodities.

Table 3: Monthly Change % Descriptive Statistics Indices/Commodities

Bitcoin Change %	
Mean	0.183495588
Standard Error	0.051926542
Median	0.06845
Mode	0
Standard Deviation	0.605562331
Sample Variance	0.366705737
Kurtosis	29.19165673
Skewness	4.738880418
Range	5.0981
Minimum	-0.3887
Maximum	4.7094
Sum	24.9554
Count	136

Nasdaq Change %	
Mean	0.017363235
Standard Error	0.003866347
Median	0.0193
Mode	0.0278
Standard Deviation	0.045088972
Sample Variance	0.002033015
Kurtosis	0.280603125
Skewness	0.021573879
Range	0.241
Minimum	-0.0891
Maximum	0.1519
Sum	2.3614
Count	136

S&P 500 Change %	
Mean	0.011780882
Standard Error	0.003323265
Median	0.0179
Mode	0.0179
Standard Deviation	0.0387556
Sample Variance	0.001501997
Kurtosis	1.512946157
Skewness	-0.347282464
Range	0.2519
Minimum	-0.1251
Maximum	0.1268
Sum	1.6022
Count	136

Dow Jones Change %	
Mean	0.010132353
Standard Error	0.00333054
Median	0.01135
Mode	0.0216
Standard Deviation	0.038840435
Sample Variance	0.001508579
Kurtosis	1.713237663
Skewness	-0.442578109
Range	0.2558
Minimum	-0.1374
Maximum	0.1184
Sum	1.378
Count	136

Russell 2000 Change %	
Mean	0.010936029
Standard Error	0.004578
Median	0.01605
Mode	-0.0084
Standard Deviation	0.053388191
Sample Variance	0.002850299
Kurtosis	2.831546047
Skewness	-0.438668808
Range	0.4019
Minimum	-0.219
Maximum	0.1829
Sum	1.4873
Count	136

Nikkei 225 Change %	
Mean	0.009872794
Standard Error	0.004231295
Median	0.0133
Mode	-0.0259
Standard Deviation	0.04934495
Sample Variance	0.002434924
Kurtosis	0.248953032
Skewness	-0.294178028
Range	0.2557
Minimum	-0.1053
Maximum	0.1504
Sum	1.3427
Count	136

Gold Change %	
Mean	0.003700735
Standard Error	0.003974436
Median	0.0014
Mode	0.0035
Standard Deviation	0.046349488
Sample Variance	0.002148275
Kurtosis	0.335186534
Skewness	0.148961616
Range	0.2575
Minimum	-0.1212
Maximum	0.1363
Sum	0.5033
Count	136

Oil Change %	
Mean	0.00750735
Standard Error	0.01083627
Median	0.01315
Mode	-0.038
Standard Deviation	0.12637151
Sample Variance	0.01596976
Kurtosis	18.5054675
Skewness	1.82680422
Range	1.4262
Minimum	-0.5424
Maximum	0.8838
Sum	1.021
Count	136

VIX Change %	
Mean	0.02853897
Standard Error	0.02316929
Median	-0.0227
Mode	-0.2023
Standard Deviation	0.27019798
Sample Variance	0.07300695
Kurtosis	5.09753804
Skewness	1.64972316
Range	1.8047
Minimum	-0.459
Maximum	1.3457
Sum	3.8813
Count	136

Euro Xchange Rate Change %	
Mean	-0.0005787
Standard Error	0.00206257
Median	-0.00095
Mode	-0.0191
Standard Deviation	0.02405353
Sample Variance	0.00057857
Kurtosis	0.90250707
Skewness	-0.2577874
Range	0.1441
Minimum	-0.0695
Maximum	0.0746
Sum	-0.0787
Count	136

ShangHai Change %	
Mean	0.00415368
Standard Error	0.00504871
Median	0.0036
Mode	0.0068
Standard Deviation	0.05887762
Sample Variance	0.00346657
Kurtosis	2.73229883
Skewness	0.12808342
Range	0.4322
Minimum	-0.2265
Maximum	0.2057
Sum	0.5649
Count	136

The size for this sample is 1,496 observations (136*11). Bitcoin has a mean of 0.18 and a median of 0.06, exemplifying the data is skewed to the right. Nasdaq 100 has a mean of 0.017 and a median of 0.019, exemplifying data that is skewed slightly to the left, this distribution is nearly symmetrical. S&P 500 has a mean of 0.011 and a median of 0.017, exemplifying data that is skewed slightly to the left, this distribution is nearly symmetrical. Dow Jones has a mean of 0.010 and a median 0.011, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. Russell 200 has a mean of 0.010 and a median of 0.016, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. Nikkei 225 has a mean of 0.009 and a median of 0.013, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. Gold has a mean of 0.003 and a median of 0.0014, exemplifying data that is slightly skewed to the right. Oil has a mean of 0.007 and a median of 0.013, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. VIX has a

mean of 0.02 and a median of -0.02, exemplifying data that is slightly skewed to the right. The Euro Exchange Rate has a mean of -0.00057 and a median of -0.00095, exemplifying data that is skewed slightly to the left. Finally, Shanghai has a mean of 0.004 and a median of 0.0036, exemplifying data that is skewed slightly to the right, this distribution is nearly symmetrical.

All variables sustain a standard deviation within three standard deviations of the mean. Outliers within this dataset occur across multiple variables. S&P 500, Dow Jones, Russell 2000, and Oil have outliers that occurred in the same month, March 2020. March 2020 was the beginning of the spread of COVID-19 nationally and internationally, this is also the month the U.S. had an economic shutdown due to the pandemic. This can be hypothesized that the pandemic had somewhat of an influence on these outliers. Overall, Bitcoin has a total of 3 outliers occurring in its early years – in order of most recent, these outliers were 470.94%, 346.09%, and 201.99%. Prices in Bitcoin's early years were very small, which provides explanation regarding the large outliers. The month where Bitcoin had its most recent outlier of 470.94% was the same month Bitcoin's price increased over $1,000 dollars for the first time ever, which occurred in November 2013. S&P 500 and Dow Jones each had that one outlier that occurred in March 2020. Russell 2000 has one more additional outlier of 18.29%, slightly above three standard deviations from the mean. Oil has an outlier of -54.24% that occurred in March 2020 and another outlier 2 months later, that outlier being 88.38%. VIX has two outliers, the most recent one occurring in February of 2020 (112.90%) and another outlier years prior in August of 2015 (134.57%) with both outliers being above three standard deviations from the mean. Euro Exchange Rate has an outlier in September 2010 (7.46%) which is three standard

deviations above the mean. Finally, Shanghai Price Index had a total of three outliers within this data set occurring between the dates December 2014 – January 2016.

Table 4 shows the *weekly* descriptive statistics for *change %* involving variables including Bitcoin, indices and commodities.

Table 4: Weekly Change % Descriptive Statistics Indices/Commodities

Bitcoin Change %	
Mean	0.034643792
Standard Error	0.007301831
Median	0.00995
Mode	0
Standard Deviation	0.17826042
COSample Variance	0.031776777
Kurtosis	14.08028526
Skewness	2.604717125
Range	1.7918
Minimum	-0.5159
Maximum	1.2759
Sum	20.6477
Count	596

S&P 500 Change %	
Mean	0.002723993
Standard Error	0.000896478
Median	0.00365
Mode	0.0061
Standard Deviation	0.021885812
Sample Variance	0.000478989
Kurtosis	7.884405621
Skewness	-0.732085465
Range	0.2708
Minimum	-0.1498
Maximum	0.121
Sum	1.6235
Count	596

Nasdaq Change %	
Mean	0.003981544
Standard Error	0.001010485
Median	0.00525
Mode	0.0072
Standard Deviation	0.024669079
Sample Variance	0.000608563
Kurtosis	2.74592833
Skewness	-0.39935576
Range	0.2196
Minimum	-0.1252
Maximum	0.0944
Sum	2.373
Count	596

Dow Jones Change %	
Mean	0.002376174
Standard Error	0.000922946
Median	0.00325
Mode	0.0096
Standard Deviation	0.022531981
Sample Variance	0.00050769
Kurtosis	11.30722035
Skewness	-0.832338617
Range	0.3014
Minimum	-0.173
Maximum	0.1284
Sum	1.4162
Count	596

Russell 2000 Change %	
Mean	0.002580537
Standard Error	0.00121661
Median	0.004
Mode	0.0004
Standard Deviation	0.029701224
Sample Variance	0.000882163
Kurtosis	6.450785054
Skewness	-0.244716159
Range	0.3504
Minimum	-0.1654
Maximum	0.185
Sum	1.538
Count	596

Gold Change %	
Mean	0.000926678
Standard Error	0.000901544
Median	0.0015
Mode	-0.0057
Standard Deviation	0.022009497
Sample Variance	0.000484418
Kurtosis	3.475016741
Skewness	0.030706315
Range	0.2155
Minimum	-0.0964
Maximum	0.1191
Sum	0.5523
Count	596

Nikkei 225 Change %	
Mean	0.00226124
Standard Error	0.00115599
Median	0.0025
Mode	0.0137
Standard Deviation	0.02822124
Sample Variance	0.00079644
Kurtosis	4.55483549
Skewness	-0.2450176
Range	0.3313
Minimum	-0.1599
Maximum	0.1714
Sum	1.3477
Count	596

Oil Change %	
Mean	0.00118154
Standard Error	0.0020836
Median	0.0026
Mode	0.0023
Standard Deviation	0.05086715
Sample Variance	0.00258747
Kurtosis	6.43654511
Skewness	-0.0346424
Range	0.6106
Minimum	-0.2931
Maximum	0.3175
Sum	0.7042
Count	596

VIX Change %	
Mean	0.01275503
Standard Error	0.00714693
Median	-0.01245
Mode	-0.0017
Standard Deviation	0.17447877
Sample Variance	0.03044284
Kurtosis	10.1035877
Skewness	2.00689849
Range	1.775
Minimum	-0.4266
Maximum	1.3484
Sum	7.602
Count	596

Euro Xchange Rate Change %	
Mean	-0.0001567
Standard Error	0.00049017
Median	-0.00015
Mode	-0.0001
Standard Deviation	0.01196653
Sample Variance	0.0001432
Kurtosis	0.93933215
Skewness	-0.1463935
Range	0.0819
Minimum	-0.0401
Maximum	0.0418
Sum	-0.0934
Count	596

The size for this sample is 5,960 observations (596*10). Bitcoin has a mean of 0.034 and a median of 0.009, exemplifying data that is skewed to the right. Nasdaq 100 has a mean of 0.0039 and a median of 0.005, exemplifying data that is skewed to the left. S&P 500 has a mean of 0.002 and a median of 0.003, exemplifying data that is skewed to the left, this distribution is nearly symmetrical. Dow Jones has a mean of 0.002 and a median of 0.003, exemplifying data that is skewed to the left, this distribution is nearly symmetrical. Russell 2000 has a mean of 0.002 and a median of 0.004, exemplifying data that is skewed to the left, this distribution is nearly symmetrical. Nikkei 225 has a mean of 0.0022 and a median of 0.0025, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. Gold has a mean of 0.0009 and a median of 0.0015, exemplifying data that is slightly skewed to the left, this distribution is nearly symmetrical. Oil has a mean of 0.0011 and a median of 0.0026, exemplifying data that is skewed to the left. VIX has a mean of 0.012 and a median of -0.012, exemplifying data that is skewed to the right. Finally, the Euro Exchange Rate has a mean of -0.00015 and a median of -0.00015, exemplifying a symmetrical distribution.

All variables sustain a standard deviation within three standard deviations of the mean. The analysis identified correlated outliers across various variables. From February 23rd 2020 – May 10 2020, there were 37 total outliers across all variables except for Bitcoin. Probable cause for these outliers may be credited to the global economic shutdown caused by the COVID-19 pandemic. Outside of these identified outliers, Bitcoin had 11 outliers from the earlier portion of the data, Nasdaq 100 had 6 additional outliers, S&P 500 had 5 additional outliers, Dow Jones had 2 additional outliers, Russell 2000 had 4 additional outliers, Nikkei 225 had 3 additional outliers, Gold had 6

additional outliers, VIX had 8 additional outliers, and the Euro Exchange Rate had 4 additional outliers. The total sum of outliers for this dataset results is 86.

Table 5 shows the *weekly* descriptive statistics for *price* and *change %* involving variables Bitcoin Price, Bitcoin Change %, Shanghai Price and Shanghai Change %.

Table 5: Weekly Price/Change % Descriptive Statistics Bitcoin & Shanghai Index

Bitcoin Price	
Mean	6881.710733
Standard Error	557.0899042
Median	623
Mode	0.1
Standard Deviation	13497.22037
Sample Variance	182174957.7
Kurtosis	6.731268425
Skewness	2.720892411
Range	64398.5
Minimum	0.1
Maximum	64398.6
Sum	4039564.2
Count	587

Bitcoin Change %	
Mean	0.035174957
Standard Error	0.007411729
Median	0.0109
Mode	0
Standard Deviation	0.179571994
Sample Variance	0.032246101
Kurtosis	13.81283268
Skewness	2.578533299
Range	1.7918
Minimum	-0.5159
Maximum	1.2759
Sum	20.6477
Count	587

ShangHai Price	
Mean	2885.86559
Standard Error	22.2247587
Median	2930.55
Mode	2976.53
Standard Deviation	538.463295
Sample Variance	289942.72
Kurtosis	0.4224212
Skewness	0.34401332
Range	3187.14
Minimum	1979.21
Maximum	5166.35
Sum	1694003.1
Count	587

Shanghai Change %	
Mean	0.00098979
Standard Error	0.00113906
Median	0.0020215
Mode	0
Standard Deviation	0.02759728
Sample Variance	0.00076161
Kurtosis	2.89298742
Skewness	-0.4990333
Range	0.22814931
Minimum	-0.1331675
Maximum	0.09498179
Sum	0.58100537
Count	587

As a reminder, weekly Bitcoin price data is skewed to the right and weekly Bitcoin change % is also slightly skewed to the right, with near symmetry. Shanghai Price has a mean of 2885.86 and a median of 2930.55, exemplifying data that is skewed to the left. Shanghai Change % has a mean of 0.00098 and a median of 0.002, exemplifying data that is also slightly skewed to the left.

All variables maintain a standard deviation that is within three standard deviations from the mean. All variables also experienced outliers, especially Bitcoin Price, as mentioned earlier. As a reminder, Bitcoin price had 28 outliers in the last 4 years and Bitcoin Change % had 11 outliers. Shanghai price had 4 outliers above three standard deviations from the mean, and Shanghai Change % experienced 11 outliers, with a majority of those being below three standard deviations from the mean.

Table 6 shows the *monthly* descriptive statistics involving variables including Bitcoin price and Wikipedia page views titled *Bitcoin, Bitcoin Network, Economics of Bitcoin,* and *History of Bitcoin.*

Table 6: Monthly Descriptive Statistics Wikipedia Pages

Bitcoin Price	
Mean	7043.328676
Standard Error	1164.28608
Median	631.5
Mode	4.9
Standard Deviation	13577.79225
Sample Variance	184356442.4
Kurtosis	6.362455258
Skewness	2.647909017
Range	61309.5
Minimum	0.1
Maximum	61309.6
Sum	957892.7
Count	136

Wiki Views BN	
Mean	6002.889706
Standard Error	868.2121688
Median	3682
Mode	0
Standard Deviation	10125.00678
Sample Variance	102515762.3
Kurtosis	18.64567603
Skewness	3.805942973
Range	74278
Minimum	0
Maximum	74278
Sum	816393
Count	136

Wiki Views Bitcoin	
Mean	268287.5809
Standard Error	28248.61606
Median	172372.5
Mode	#N/A
Standard Deviation	329432.6427
Sample Variance	1.08526E+11
Kurtosis	14.59814221
Skewness	3.474848567
Range	2300940
Minimum	917
Maximum	2301857
Sum	36487111
Count	136

Wiki Views EB	
Mean	1140.46324
Standard Error	207.940076
Median	0
Mode	0
Standard Deviation	2424.97716
Sample Variance	5880514.25
Kurtosis	25.4548219
Skewness	4.42797898
Range	18356
Minimum	0
Maximum	18356
Sum	155103
Count	136

Wiki Views HB	
Mean	39448.2794
Standard Error	6885.14679
Median	14190.5
Mode	0
Standard Deviation	80293.9194
Sample Variance	6447113494
Kurtosis	36.739249
Skewness	5.27596168
Range	704415
Minimum	0
Maximum	704415
Sum	5364966
Count	136

The size for this sample is 680 observations (136*5). As a reminder, monthly Bitcoin price data is skewed to the right. Wiki Views Bitcoin has a mean of 268287.58 and a median of 172372.5, exemplifying data that is slightly skewed to the right. Wiki Views Bitcoin Network has a mean of 6002.88 and a median of 3682, exemplifying data that is skewed to the right. Wiki Views Economics of Bitcoin has a mean of 1140.46 and a median of 0, exemplifying data that is skewed to the right. Finally, Wiki Views History of Bitcoin has a mean of 39448.27 and a median of 0, exemplifying data that is skewed to the right.

All variables sustain a standard deviation within three standard deviations of the mean. We are aware of Bitcoin's monthly outliers totaling up to 4, all occurring within 2021. All related bitcoin Wikipedia pages had a common time period with correlated outliers, occurring around December 2017 – January 2018. This was around the time Bitcoin became more popular amongst financial markets, which may be a probable reason for the occurrence of these outliers. Wiki Views Bitcoin in December of 2017 had

a total of 1,719,723 views, Wiki Views Bitcoin Network had a total of 38,200 views and 48,618 views in January of 2018. Wiki Views Economics of Bitcoin has 18,356 views in December of 2017 and 14,864 views in January of 2018. Finally, Wiki Views History of Bitcoin has 290,822 views in December of 2017. All of these outliers were above three standard deviations from their means. Aside from this correlation, Wiki Views Bitcoin had 4 outliers years prior, Wiki Views Bitcoin Network had 3 outliers as of more recent years, and Wiki Views History of Bitcoin has 2 outliers in May and June of this year, 2021.

Table 7 shows the *weekly* descriptive statistics involving variables including Bitcoin price and Wikipedia page views titled *Bitcoin, Bitcoin Network, Economics of Bitcoin,* and *History of Bitcoin.*

Table 7: Weekly Descriptive Statistics Wikipedia Pages

Bitcoin Price		***Wiki Views Bitcoin***	
Mean	6804.219463	Mean	61227.14597
Standard Error	549.397139	Standard Error	3784.904121
Median	615.55	Median	37863
Mode	0.1	Mode	40042
Standard Deviation	13412.49347	Standard Deviation	92401.28531
Sample Variance	179894981	Sample Variance	8537997528
Kurtosis	6.891765182	Kurtosis	69.42476697
Skewness	2.74678876	Skewness	6.695687411
Range	64398.5	Range	1330325
Minimum	s0.1	Minimum	105
Maximum	64398.6	Maximum	1330430
Sum	4055314.8	Sum	36491379
Count	596	Count	596

Wiki Views BN	
Mean	1369.786913
Standard Error	122.7051553
Median	776
Mode	0
Standard Deviation	2995.614606
Sample Variance	8973706.867
Kurtosis	48.09783691
Skewness	6.328489192
Range	29670
Minimum	0
Maximum	29670
Sum	816393
Count	596

Wiki Views EB	
Mean	260.239933
Standard Error	25.4179882
Median	0
Mode	0
Standard Deviation	620.532174
Sample Variance	385060.179
Kurtosis	46.8880178
Skewness	5.81745032
Range	7078
Minimum	0
Maximum	7078
Sum	155103
Count	596

Wiki Views HB	
Mean	9001.62081
Standard Error	811.23756
Median	3386
Mode	0
Standard Deviation	19804.8328
Sample Variance	392231402
Kurtosis	57.0160633
Skewness	6.27882821
Range	261616
Minimum	0
Maximum	261616
Sum	5364966
Count	596

The size for this observation is 2,980 observations (596*5). As a reminder, Bitcoin weekly price data is skewed to the right. Wiki Views Bitcoin has a mean of 61227.14 and

a median of 37863, exemplifying data that is skewed to the right. Wiki Views Bitcoin Network has a mean of 1369.78 and a median of 776, exemplifying data that is skewed to the right. Wiki Views Economics of Bitcoin has a mean of 260.23 and a median of 0, exemplifying data that is skewed to the right. Finally, Wiki Views History of Bitcoin has a mean of 9001.62 and a median of 3386, exemplifying data that is skewed to the right. All monthly and weekly data pertaining to Wikipedia Page Views and Bitcoin Price all exemplify data that is skewed to the right.

All variables sustain a standard deviation within three standard deviations from the mean. As a reminder, weekly Bitcoin price had 28 outliers within its sample. All Wikipedia page views had correlated outliers within the time frame of November 26th 2017 – January 28th 2018. Within this time frame, Wiki Views Bitcoin had 4 outliers, Wiki Views Bitcoin Network had 3 outliers, Wiki Views Economics of Bitcoin had 8 outliers, and Wiki Views History of Bitcoin had 3 outliers. Apart from these outliers, Wiki Views Bitcoin had 8 additional outliers, Wiki Views Bitcoin Network had 6 additional outliers, Wiki Views Economics of Bitcoin had 1 additional outlier, and Wiki Views History of Bitcoin had 10 outliers occurring almost consecutively within the time frame of April 25th 2021 – June 20th 2021.

Table 8 shows the *monthly correlation* involving variables including Bitcoin price, all indices and commodities.

Table 8: Monthly Prices Correlation Matrix

	Bitcoin Price
Bitcoin Price	1
Nasdaq Price	**0.885516635**
S&P 500 Price	**0.845070597**
Dow Jones Price	**0.80189546**
Russell 2000 Price	**0.832664285**
Nikkei 225 Price	**0.721738458**
Gold Price	**0.542107271**
Oil Price	-0.159412152
VIX Price	0.175976956
Euro Xchange Rate Price	-0.209551315
ShangHai Price	**0.453723615**

Results highlighted in green show significant correlation amongst the variables. The strongest correlation is amongst the relationship between Bitcoin price and Nasdaq 100 price, maintaining a correlation of 88%. Following this relationship, Bitcoin price and S&P 500 also maintain a high correlation of 84%. Some honorable mentions such as Russell 200 price, Dow Jones price and Nikkei 225 price also have a significant relationship with Bitcoin price, all maintaining a correlation above 72%. The commodity that shows significant correlation with Bitcoin price is the price of Gold, maintaining a correlation of 54%. Finally, Shanghai monthly price shows some correlation with Bitcoin price, maintaining a correlation of 45%.

Table 9 shows the *weekly correlation* involving variables including Bitcoin price, all indices and commodities.

Table 9: Weekly Prices Correlation Matrix

	Bitcoin Price
Bitcoin Price	1
Nasdaq Price	**0.873711535**
S&P 500 Price	**0.831042265**
Dow Jones Price	**0.790557268**
Russell 2000 Price	**0.824310524**
Nikkei 225 Price	**0.720660664**
Gold Price	**0.540206775**
Oil Price	-0.150797891
VIX Price	0.10637435
Euro Xchange Rate Price	-0.201310607

Results highlighted in green show significant correlation amongst the variables. The strongest correlation is amongst the relationship between Bitcoin price and Nasdaq 100 price, maintaining a correlation of 87%. Following this relationship, Bitcoin price and S&P 500 also maintain a high correlation of 83%. Honorable mentions in order of significance include Russel 2000 price, Dow Jones price, and Nikkei 225 price, once again all maintaining a correlation above 72%. Once again, Gold price is the only commodity showing a significant relationship with Bitcoin price, maintaining a correlation of 54%. This is consistent thus far with monthly data.

Table 10 shows the *weekly correlation* involving variables including Bitcoin price, Bitcoin change %, Shanghai price and Shanghai change %

Table 10: Weekly Prices Bitcoin/Shanghai Correlation Matrix

	Bitcoin Price
Bitcoin Price	1
Bitcoin Change %	-0.039853526
ShangHai Price	**0.438468317**
Shanghai Change %	0.005576965

Results highlighted in green show significant correlation amongst the variables. The only relationship showing some significance are amongst the variables of Bitcoin price and Shanghai price, exemplifying a correlation of 43%. Because this data is separated from the weekly indices and commodities, it is difficult to determine the interpretation of this relationship, for the purposes of diminishing potential marginal error.

Table 11 shows the *monthly correlation* involving variables including Bitcoin price and Wikipedia Page Views, those pages being titled *Bitcoin, Bitcoin Network*, *Economics of Bitcoin* and *History of Bitcoin*.

Table 11: Monthly Wikipedia Pages Correlation Matrix

	Bitcoin Price
Bitcoin Price	1
Wiki Views Bitcoin	0.004163822
Wiki Views BN	0.368076979
Wiki Views EB	**0.479530244**
Wiki Views HB	**0.601140181**

Results highlighted in green show significant correlation amongst the variables. According to this correlation analysis, Wikipedia page views for the History of Bitcoin shows the strongest correlation amongst all other variables, exemplifying a correlation with Bitcoin price of 60%. Following this relationship, Wikipedia page views for the Economics of Bitcoin has a significant correlation of 47% with Bitcoin price.

Table 12 shows the *weekly correlation* involving variables including Bitcoin price and Wikipedia Page Views, those pages being titled *Bitcoin, Bitcoin Network*, *Economics of Bitcoin* and *History of Bitcoin*.

Table 12: Weekly Wikipedia Pages Correlation Matrix

	Bitcoin Price
Bitcoin Price	1
Wiki Views Bitcoin	0.022316407
Wiki Views BN	0.301676829
Wiki Views EB	**0.457437189**
Wiki Views HB	**0.583288329**

Results highlighted in green show significant correlation amongst the variables. According to this correlation analysis, Wikipedia page views for History of Bitcoin has a significant correlation with Bitcoin price, maintaining a correlation of 58%. Following this relationship, Wikipedia page views for Economics of Bitcoin also exemplifies somewhat significance within its relationship with Bitcoin price, exemplifying a correlation of 45%.

Figure 4 shows the regression results for the *monthly* data by using the Statistical Package for The Social Sciences (SPSS).

Figure 4: Monthly Regression Analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.949[a]	.901	.897	4361.343354000

a. Predictors: (Constant), Oil Price , Russell 2000 Price , Nasdaq Price, Nikkei 225 Price, Dow Jones Price

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22415348660.000	5	4483069732.000	235.687	.000[b]
	Residual	2472771060.000	130	19021315.850		
	Total	24888119720.000	135			

a. Dependent Variable: Bitcoin Price

b. Predictors: (Constant), Oil Price , Russell 2000 Price , Nasdaq Price, Nikkei 225 Price, Dow Jones Price

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-12092.922	3503.052		-3.452	.001
	Nasdaq Price	4.863	.391	1.298	12.430	.000
	Dow Jones Price	-2.167	.337	-1.070	-6.426	.000
	Russell 2000 Price	39.096	6.317	1.184	6.189	.000
	Nikkei 225 Price	-1.155	.376	-.498	-3.072	.003
	Oil Price	62.972	29.060	.106	2.167	.032

a. Dependent Variable: Bitcoin Price

The Coefficients table explains the following information pertaining to the relationship between bitcoin price and its associated variables: For every unit increase in Nasdaq price ($1), Bitcoin price will increase by 4.863. For every unit increase in Dow Jones Price, Bitcoin price will decrease by 2.167. For every unit increase in Russell 2000 price, Bitcoin price will increase by 39.096. For every unit increase in Nikkei 225 price,

Bitcoin price will decrease by 1.155. For every unit increase in Oil price, Bitcoin price will increase by 62.972.

Figure 5 shows the regression results for the *weekly* data by using the Statistical Package for The Social Sciences (SPSS).

Figure 5: Weekly Regression Analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.941[a]	.885	.884	4568.519561000

a. Predictors: (Constant), VIX Price, Dow Jones Price, Oil Price , Nikkei 225 Price, Nasdaq Price, Russell 2000 Price

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	94744276170.000	6	15790712700.000	756.573	.000[b]
	Residual	12293237500.000	589	20871370.980		
	Total	107037513700.000	595			

a. Dependent Variable: Bitcoin Price

b. Predictors: (Constant), VIX Price, Dow Jones Price, Oil Price , Nikkei 225 Price, Nasdaq Price, Russell 2000 Price

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-19159.474	2315.947		-8.273	.000
	Nasdaq Price	4.422	.256	1.175	17.288	.000
	Dow Jones Price	-2.213	.166	-1.113	-13.327	.000
	Russell 2000 Price	40.464	3.293	1.260	12.287	.000
	Nikkei 225 Price	-.903	.178	-.399	-5.078	.000
	Oil Price	85.699	13.943	.145	6.147	.000
	VIX Price	166.182	38.655	.087	4.299	.000

a. Dependent Variable: Bitcoin Price

The Coefficients table explains the following information pertaining to the relationship between bitcoin price and its associated variables: For every unit increase in Nasdaq price ($1), Bitcoin price will increase by 4.422. For every unit increase in Dow Jones price, Bitcoin price will decrease by 2.213. For every unit increase in Russell 2000 price, Bitcoin price will increase by 40.464. For every unit increase in Nikkei 225 price, Bitcoin price will decrease by 0.903. For every unit increase in Oil price, Bitcoin price will increase by 85.699. For every unit increase in VIX price, Bitcoin price will increase by 166.182.

These results suggest that the monthly prices for indices and commodities represent that the following variables are significant at the 5% level: Nasdaq Price, Oil Price, Dow jones Price, Russell 2000 Price, Nikkei 225 Price. The following variables within this model are not significant at the 5% level: S&P 500, Gold, VIX, Shanghai and Euro Exchange Rate. These results also suggest that the weekly prices for indices and commodities represent that the following variables are significant at the 5% level: Nasdaq Price, Oil Price, Dow Jones price, Russell 2000 Price, Nikkei 225 Price, and VIX price. The following variables are not significant at the 5% level: S&P 500, Gold, and Euro Exchange Rate.

Figure 6 shows the popularity results for the search term and currency *Bitcoin* via Google Trends

**popularity is measured on a hypothetical scale from 0-120*

**0 = very low popularity; *120 = very high popularity*

Figure 6: Google Trends *Bitcoin Currency* Popularity 2010 – 2021

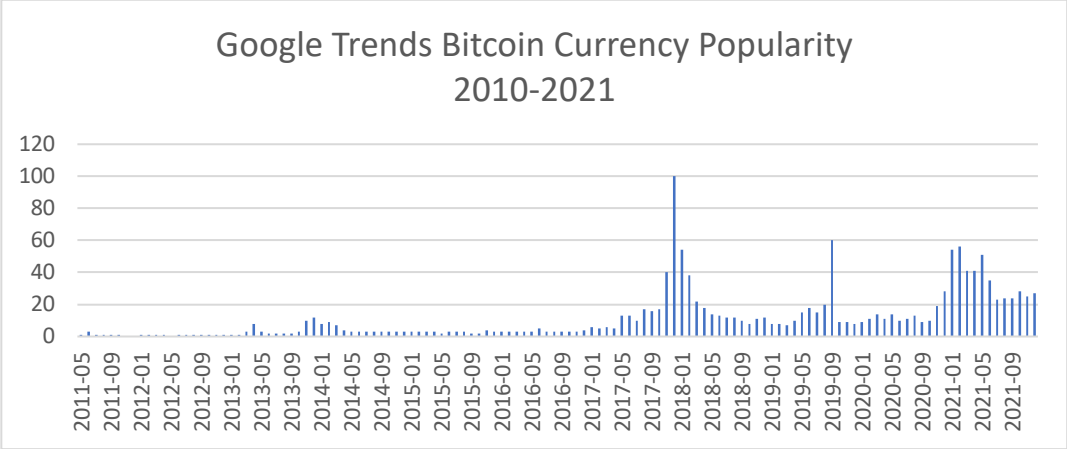


Figure 7 shows the popularity results for the search term *bitcoin price* via Google Trends

Figure 7: Google Trends *Bitcoin Price* Popularity 2010 - 2021

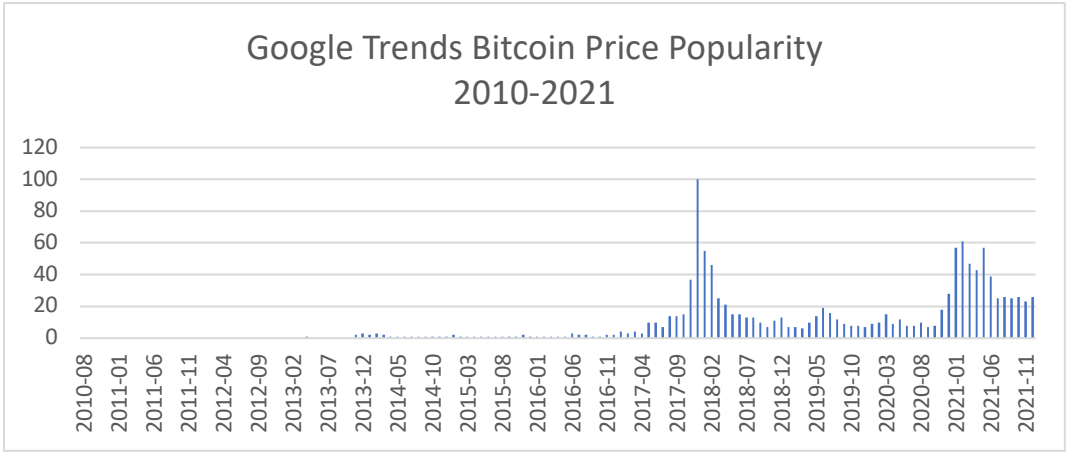


Figure 8 shows the popularity results for the search term *Bitcoin.com* via Google Trends

Figure 8: Google Trends *Bitcoin.com* Popularity 2010 - 2021

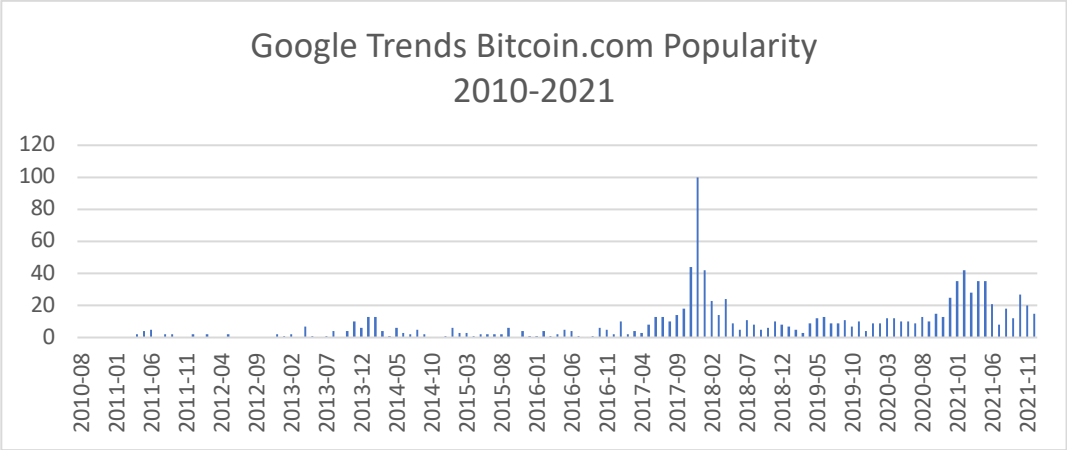


Figure 9 shows the popularity results for the search term *Economics of Bitcoin* via Google Trends

Figure 9: Google Trends *Economics of Bitcoin* Popularity 2010 - 2021

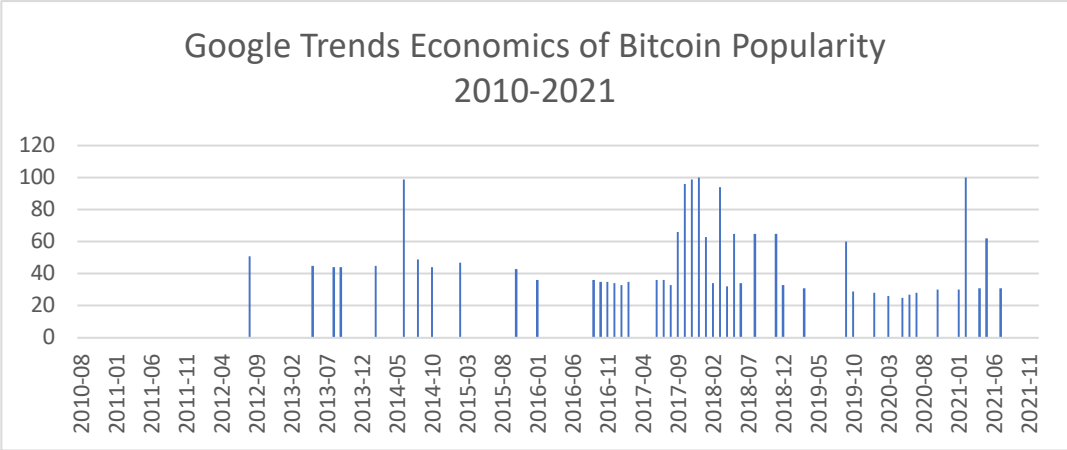
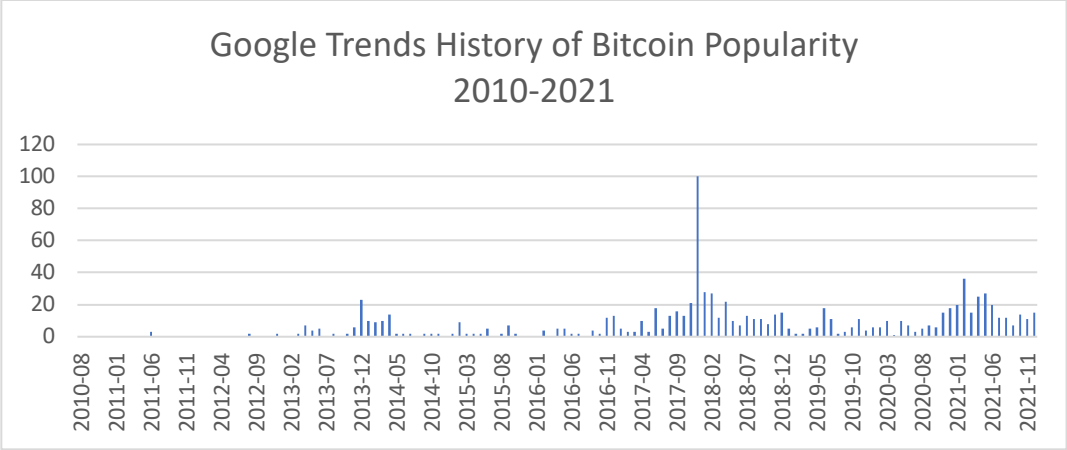


Figure 10 shows the popularity results for the search term *History of Bitcoin* via Google Trends

Figure 10: Google Trends *History of Bitcoin* Popularity 2010 – 2021



The Google Trends Data brings about interesting findings. Previously mentioned within the correlation section, the *Economics of Bitcoin* and the *History of Bitcoin* showed significant correlation with Bitcoin price. According to google search terms, *Economics of Bitcoin* and History of Bitcoin were overall more popular search terms compared to *Bitcoin.com, Bitcoin Price*, and *Bitcoin* (the currency). *Figure 6* seemed to rise in popularity in three strong peaks thus far: in 2013-2014, 2018, and 2020-2021. *Figure 7* and *Figure 8* follow a similar pattern to *Figure 6* except at a lower frequency, only experiencing peaks in 2018 and 2020-2021. *Figure 9* experiences an extensive amounts of popularity peaks, as early as 2012 which is not seen in any of the remaining google trends data. In fact, Figure 9 had the same level of popularity in 2014 as it did in January of 2021, a popularity score of 100. This is an interesting finding considering how much the cryptocurrency market has grown within the last 7 years. *Figure 10* produced average results compared to *Figures 6-8*.

CONCLUSION

This thesis made an attempt to analyze variables categorized as financial indices, commodities, Wikipedia data as well as Google Trends data in efforts to better understand the behavior of Bitcoin price. We have examined their relationship and interpreted their measures based on a model structured by two divisions; monthly and weekly data sets, in efforts to identify significance amongst their individual as well as collective relationships. In conclusion, we have determined that there is some significance between Bitcoin price and financial indices, especially Nasdaq 100 and Russell 200 price, however Bitcoin behaves as a speculative asset and in result our model is not a good model to accurately predict Bitcoin price on a consistent basis. Paying attention to the overall economic stance of financial markets in addition to attentive effort towards digital markets and medias is a method to predict Bitcoin price most accurately. Another study that can be utilized to further the research could include factors such as future economic events, positive or negative, that affect financial markets and interpreting that data, as well as considering indices as commodities to analyze a different method of behavior for cryptocurrency markets and its associated prices.

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