Unravelling the Mysteries of Bitcoin: Exploring the Determinants of Returns and Volatility

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***Abstract*—As a digital currency, Bitcoin has increasingly gained significance in the global economy and financial market. This paper investigates the factors that impact the returns and volatility of Bitcoin. Specifically, this study documents that the return of Bitcoin is positively related to Bitcoin trading volume, Ethereum returns and stock market returns, and is negatively associated with Ethereum trading volume and economic uncertainty. Additionally, this study finds that the volatility of bitcoin returns is positively correlated with bitcoin returns and negatively correlated with factors such as the standard deviation of Ethereum and the S&P500. These findings provide valuable insights for investors interested in expanding their investment options and learning more about Bitcoin.**

***Keywords*—Bitcoin, investment, return, volatility**

I. Introduction

In today's rapidly evolving digital landscape, the emergence of cryptocurrencies has revolutionized the financial sector (Financial Times, 2023)[1]. Among these virtual assets, Bitcoin stands out as the most prominent and widely recognized digital currency. Its significant market capitalization and influence on other cryptocurrencies make understanding Bitcoin's returns and volatility crucial for investors and financial analysts (Reuters, 2023)[2]. By studying these aspects, individuals can make more informed decisions regarding their investment strategies and better anticipate market trends. As public interest in Bitcoin and its integration into everyday life grows, the importance of examining its returns and volatility cannot be overstated. This essay aims to shed light on these critical factors, providing valuable insights for those navigating the complex world of cryptocurrencies.

Fig. 1 demonstrates the mining activities across the world. Hashrate data shows that Bitcoin mining activity is occurring in most countries of the world, with the United States and China being the most active countries for Bitcoin mining. Bitcoin mining is validating and adding new transactions to the public ledger, known as the blockchain, and ensuring the security and integrity of the Bitcoin network. Miners compete to solve complex mathematical problems using specialized computer hardware (Investopedia, 2023)[3]. The first miner to solve the problem gets the opportunity to add the latest block of transactions to the blockchain and is rewarded with newly minted bitcoins and transaction fees. The vibrancy of bitcoin mining activity suggests that bitcoin production has become a significant economic activity.

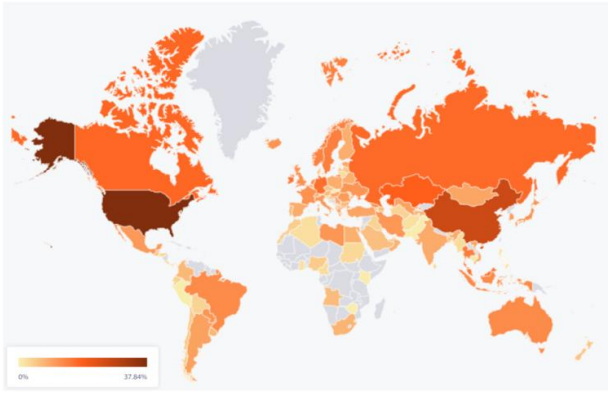

Fig. 1. The geographic distribution of Bitcoin's total Hashrate (Mining Map)
Data source: Cambridge Centre for alternative finance

Corresponding to, or more importantly, the supply side of Bitcoin is the trading of Bitcoin, which includes returns and volatility. Fig. 2 shows the price of Bitcoin and Bitcoin's Google search trends. The interest in Bitcoin is significantly correlated with fluctuations in Bitcoin returns. In addition to the statistics, some examples show the impact of Bitcoin currently. The owner of Musk's famous electric car brand Tesla spent 1.5 bn in 2021 to purchase Bitcoin, creating a big stir. The act of selling Bitcoin in August 2023 was the most likely cause of Bitcoin's price flash crash on 18 August. From $ 28,500 on August 17, once fell to $ 25,200 on August 18, a 24-hour drop of more than 11.5% as of 10:20 on August 20, the price of Bitcoin, the latest price of $ 26,100, a 24-hour increase of 0.44%, the last 7 days down 10.88%, the previous 30 days down 12.97%.

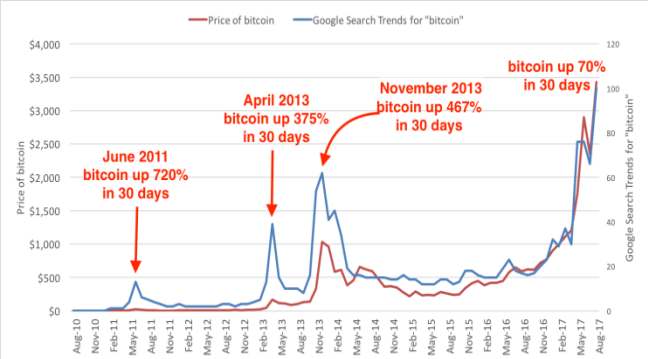

Fig. 2. The price of Bitcoin and Google search trends.
Data source: Yahoo Finance and Google

[1] https://www.ft.com/content/d0447dcd-9aa5-4f71-9919-5061e77772d5
[2] https://www.reuters.com/article/uk-hedgefunds-bitcoin-idUSKCN1FZ189/
[3] https://www.investopedia.com/tech/how-does-bitcoin-mining-work/

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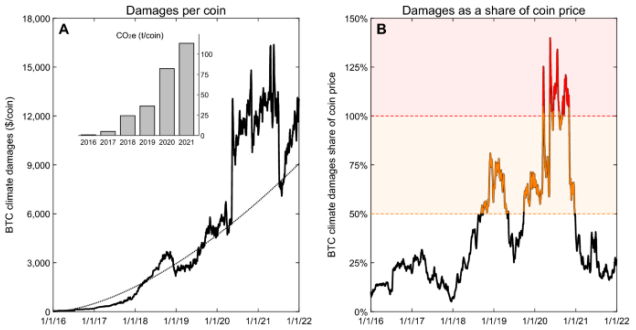

Fig. 3. Climate damages associated with Bitcoin mining.
Data source: Jones, Goodkind, and Barrens (2022)

Bitcoin-related activities have very important economic, social, and environmental implications. First of all, there is no limit to the volatility of Bitcoin's price, and a large number of investors lose huge amounts of money as a result. For instance, in January 2022, Bitcoin suffered a significant fall from its all-time high set in November, losing more than $30,000. A $1,000 investment made at the peak would be worth just $556 today. Second, Fig. 3 illustrates the adverse impact of Bitcoin mining activities on the climate. The production of Bitcoins consumes a large amount of electricity, thus generating additional greenhouse gases (Jone *et al.*, 2022).

The price of Bitcoin is so volatile and on an upward trend that the idea of doing a study on the subject was suddenly sparked to find out the reasons for the price volatility of Bitcoin and its impact on Bitcoin earnings.

This essay mainly studies the returns and volatility of Bitcoin and some of the possible factors that may have contributed to them, probably by using some knowledge of normal distributions and regression analysis to chart and comb through the data to see how Bitcoin's returns have fluctuated. On top of that, this essay found out that Bitcoin's returns may be related to its standard deviation and trading volume, and even the trading volume and prices of other virtual currencies may impact Bitcoin's returns. Bitcoin's volatility also depends on several factors, and as this research discussed and compared, not only does Bitcoin's average returns affect its volatility, but the average returns and standard deviations of other virtual currencies may also affect Bitcoin's volatility. Political uncertainty is also an element to consider. Also in the essay, specific periods are analyzed to determine exactly what factors affect Bitcoin's returns and volatility. At the same time, this study has two main contributions.

First, as Bitcoin is a currency with no real value, this research plays a role in how its price is determined and can help people have a deeper understanding of the value of Bitcoin and what factors are associated with it. For example, some of the questions are whether Bitcoin is a safe-haven asset or not, and this research can help people see that it is positively correlated with uncertainty, thus showing that it is not a safe-haven asset. This is to enable people to properly assess the returns and risks of Bitcoin and choose what they are comfortable with to invest in.

Second, this research can help academics get a clearer picture of the importance of Bitcoin as it is a digital currency that has no real value, and some people may not know as much about it.

The remainder of the essay is organized as follows: Section II reviews the related studies on Bitcoin; Section III presents the data analysis of this study; Section IV discusses the empirical findings; Section V discusses a practical case of the study; Section VI concludes this essay.

II. Definitions and Influences of Bitcoin

Baur *et al.* (2018) examines the definition of Bitcoin and analyze the question of whether Bitcoin is a medium of exchange or an asset. They analyze the statistical properties of Bitcoin to find that it is uncorrelated with traditional assets at all times. Also, they investigate Bitcoin account transaction data and find that Bitcoin is primarily used as a speculative investment and is neither a substitute currency nor a medium of exchange. Yermack has similar insights about Bitcoin and they both agree that Bitcoin is primarily used as a speculative investment. Yermack (2015) investigates the volume of consumer transactions in Bitcoin. He finds that Bitcoin only achieves a very small amount of consumer transaction volume. In addition, the volatility of Bitcoin is much higher than that of widely used currencies, posing a greater short-term risk to users. However, Bitcoin is useless for risk management. Bitcoin faces a lot of risks every day. He sees Bitcoin as more of a speculative investment than a currency alone. However, Bitcoin may not only have the qualities of a speculative asset but also the characteristics of a standard financial asset. Kristoufek (2015) examines the potential drivers of Bitcoin's price, ranging from fundamentals to speculative and technical factors. He further investigates the potential impact of the Chinese market, using a continuous wavelet framework to comment on the development of interconnections over time. He finds that Bitcoin becomes a unique asset, with attributes of both a standard financial asset and a speculative asset. Furthermore, Bitcoin can be explored from many different angles than just this one. Kayal and Rohilla (2021) demonstrate that Bitcoin is studied from different economic and financial perspectives, illustrating the fundamentals of this digital currency and the current state of the development of Bitcoin in its infancy. It is not enough to have some exploration of the fundamentals and current state of development of Bitcoin. Since Bitcoin has the characteristics of a standard financial asset, it certainly has its pros and cons. Yang and Zhang (2014) investigated how Bitcoin works from a technical point of view and performed some economic analyses. At the same time, they explore the advantages and disadvantages of Bitcoin as a currency and analyze them empirically using mathematics. As Bitcoin is being run and used, certain implications arise from its use. Tschorsch and Scheuermann (2016) study the impact of Bitcoin. They believe that Bitcoin has revolutionized the digital currency space and has influenced many neighboring sectors. They begin by describing the protocol and building blocks of Bitcoin. Using this as a basis, they discuss existing contributions and results to continue exploring the design space. They extrapolate the basic structure and insights at the heart of the Bitcoin protocol and its applications.

III. The Influences of Blockchain

John *et al.* (2022) illustrates that Bitcoin is not only a technological innovation but also a solution to an economic problem. It can effectively solve a common problem that

exists with any payment system-the problem of double spending. The structural problems of Bitcoin as a new mechanism for obtaining consensus in a decentralized environment are also explored by them. At the same time, they examine a range of issues regarding the development of the blockchain model and crypto users. There are some similarities between PwC and what he is studying, which involves technological innovations in cryptocurrencies such as Bitcoin and some of the blockchain issues related to these currencies. PwC (2015) investigates technology on cryptocurrencies, exploring the potential positive uses of the technology and how it can be kept secret. It also explores the positive and negative effects of blockchain on the public. The blockchain associated with Bitcoin could not only have some impact on the public but also cause some problems. Vranken (2017) explores Bitcoin as an electronic currency with transactions in its system stored in a publicly traded ledger. The security of the area chain relies on the computationally intensive algorithms of Bitcoin mining. However, this "proof-of-work" algorithm consumes a lot of energy, but how much has become a controversial topic. He gives a specific range and suggests alternatives. After studying other applications of area chains, he concludes that energy consumption is not a major issue.

IV. The Price Bubble of Bitcoin

Deng (2017) realizes that Bitcoin as a worldwide digital currency with common intrinsic value combines normal distribution test sup ADF test and other methods to test the Bitcoin price bubble from the perspectives of price deviation and explosiveness. Bitcoin price bubbles are examined from the perspective of price divergence and explosiveness and it is proved that there is a bubble economy in Bitcoin price. It investigates some speculative factors that lead to Bitcoin price bubbles and even Bitcoin price bubbles continue to inflate due to the lack of regulation. In addition, he finds that one of the reasons for the persistence of the Bitcoin price bubble is that its benefits have been overstated and thus overvalued. This would be possible due to some market manipulation. He therefore makes several recommendations to the government to improve the situation so that online finance can grow healthily and stably. One other individual has also done some research that confirms the idea that there is a price bubble in Bitcoin. Cheah and Fry (2015) investigate the price of Bitcoin and model this price. As a result, they show the existence of a price bubble for Bitcoin and investigate that there is some empirical evidence that the fundamental price of Bitcoin is zero.

V. Factors Influencing the Price of Bitcoin

Liu and Tsyvinski (2020) investigate whether the argument that the price evolution of cryptocurrencies is related to the factors of production of cryptocurrencies is justified as well as the risk and reward momentum of cryptocurrencies with relatively low-risk exposure compared to other traditional financial assets. They do their research from the perspective of whether the price of cryptocurrencies such as Bitcoin changes concerning its factors of production. This next study is fundamentally different from the perspective it examined. Schilling and Uhlig (2019) analyze the evolution of cryptocurrency prices and the implications for monetary policy through a model. They derive the basic pricing equation in this model. At the same time, they give a "speculative price constraint," when Bitcoin is traded at a suppressed level in the hope that the price of Bitcoin appreciates and further provide a general methodology for constructing equilibrium to prove their existence. They discuss the price change of Bitcoin in two further scenarios. Bitcoin price changes are not only about these factors, but may also involve traditional determinants. Ciaian *et al.* (2015) examines the price formation of Bitcoin, taking into account the traditional determinants of currency prices and deriving testable hypotheses based on the Barro model. Using data, they find that market forces and the attractiveness of Bitcoin to investors and users have a significant impact on the price of Bitcoin. As the study progresses, they estimate that there is no support for the idea that macro-financial developments drive the price of Bitcoin in the long run. The next study looked at influencing factors that are less similar to the previous ones and this report manages to find some relationships that held between them. Georgoula *et al.* (2015) investigates the relationship between Bitcoin price and fundamental economic variables, technical factors, and measures of collective sentiment. To study this, they mainly use time series analysis. The series of short-term regressions they present shows that Twitter sentiment ratios are positively correlated with the price of Bitcoin. The short-term analysis also explains that the level of public interest in Bitcoin and the hash rate have a positive effect on the price of Bitcoin. In contrast, the value of Bitcoin is negatively affected by the exchange rate of the US dollar against the euro. They also use a vector error correction model to explore the long-run relationship variables that exist between the covariates. In this long-term analysis, it is shown that the price of Bitcoin is positively correlated with the number of Bitcoins in circulation and negatively correlated with the Standard and Poor's 500 stock market index. Technical and economic factors about Bitcoin are also very important. Li and Wang (2017) investigate the determination of the Bitcoin exchange rate, for which a theory-driven empirical study is conducted. At the same time, they consider technical and economic factors. To address the problem of cointegration in smooth and non-smooth time series disorder, they use auto-regressive distributed lag models with boundary test methods in their estimation. Also, to detect potential structural changes, they estimate their empirical model over two periods of Mt. Gox closure. In the short run, the Bitcoin exchange rate adjusts to changes in economic fundamentals and market conditions. They also identify the significant impact of mining technology and the declining importance of mining difficulty in Bitcoin exchange price determination. The following study goes in the same general direction as the previous one but identifies a few different factors. Hayes (2017) explores the possible determinants of value formation in cryptocurrencies, including Bitcoin. As Bitcoin grows, the ability to value Bitcoin and related cryptocurrencies is critical to its establishment as a legitimate financial asset. Using cross-sectional empirical data examining 66 of the most widely used cryptocurrencies, he estimates a regression model that identifies three main drivers of cryptocurrency value: the level of competition in the producer network, the

rate of production per unit, and the difficulty of the algorithms used to "mine" the cryptocurrency. This equates to a marginal relative difference in the cost of production of one digital currency versus another and he identifies a difference in relative production costs-electricity input, cryptocurrency output. He uses this as the basis for a no-arbitrage scenario for cryptocurrencies similar to Bitcoin and then formalizes the production cost model used to determine the fair value of Bitcoin. Exchanges are also inextricably linked to Bitcoin's price movement. Gandal *et al.* (2018) investigates tradable activity on Mt. Gox by exploiting user-described hungry transaction data. During their research, they found that the exchanges are highly correlated with an increase in the price of Bitcoin. They argue that if bot activity is indeed the cause, that long has demonstrated that manipulation can have a significant real-world impact. For exchanges, it's most important to make sure there are no fraudulent transactions. While total market capitalization has increased, the potential for manipulation has also increased. At the same time, the volume of trading can drive up the exchange rate and regulators could reassess policies that leave the ecosystem unregulated and actively monitor it.

VI. The Efficiency of the Bitcoin Market and Bitcoin Returns

Nadarajah and Chu (2016) investigate the efficiency of the market of Bitcoin through five different tests of returns of Bitcoin and show that the returns of Bitcoin do not satisfy the efficient market hypothesis. Furthermore, they illustrate through eight different tests that a simple power transformation of Bitcoin returns does assume and does not cause any missing information. The purpose of the study of Urquhart is similar to his and the difference is that Urquhart (2016) discusses it in terms of situations. Urquhart (2016) examines the market efficiency of Bitcoin through some strong tests. These tests show that the returns of Bitcoin are inefficient, but when splitting the sample into two sub-samples by period. He finds that some of the tests prove that Bitcoin is efficient in the latter period. From this, his research surmises that Bitcoin is in an inefficient market but is potentially heading towards an efficient one. Instead of limiting himself to the issue of Bitcoin's market efficiency, several fundamental macroeconomic indicators are relevant to Bitcoin. Corbet *et al.* (2020) further examines the impact of macroeconomic reports on Bitcoin returns based on four macroeconomic indicators and conclude that of the four only a few have a significant impact.

VII. The Forecasting of the Price of Bitcoin

Poongodi *et al.* (2020) explores that Bitcoin is not only an alternative to fiat currency, but also a preferred investment. However, it still has some drawbacks, such as limiting government intrusion due to taxation. They use a lot of price-prediction models for this cryptocurrency. From explorations of them, they find that the most important features of the blockchain network's impact on the price of Bitcoin are the following: the first one is the total amount of Bitcoin transactions, the second one is the frequency of the transactions, the third one is the current price of Bitcoin and the last one is the presence of market capital in the form of Bitcoin. Following this, they use a time-series ARIMA model to analyze the price, and similar results are obtained. They talk about some price prediction models, and in the same way, Chaim and Laurini (2018) look at some of the issues related to prediction. Chaim and Laurini (2018) probe through the standard normal stochastic volatility model about the formulas and how they can be used to predict the volatility of Bitcoin. Unlike previous research, Demira *et al.* (2018) looks at a new dimension. Demir *et al.* (2018) adopts an empirical investigation to explore the extent to which economic policy uncertainty predicts Bitcoin returns. Bitcoin can be accurately predicted. McNally *et al.* (2018) investigates what makes it possible for the direction of the price of Bitcoin in USD to be accurately predicted, where the price data is derived from the price index of Bitcoin. The task is implemented with a Bayesian-optimized RNN with varying degrees of success at the end. The ARIMA model is implemented to compare with the deep learning model and as they expected the nonlinear deep learning approach performs better while the ARIMA predictions perform poorly. Finally, the learning models are benchmarked on GPUs and CPUs. After their research, they found that the training time of GPU is going to be due to CPU. The other one's research also used knowledge about Bayesianism. Jang and Lee (2017) analyze the time series of the Bitcoin process and explain the role of the Bayesian neural network. They also selected the most relevant features from the blockchain information that deeply involve the supply and demand of Bitcoin and used them to train the model to improve the prediction performance of the latest Bitcoin pricing process. In addition, they conducted an empirical study illustrating that BNN performs well in predicting Bitcoin price time series and explaining the high volatility of recent Bitcoin prices.

VIII. Data and Methodology

A. Sample Construction and Main Variables

To construct the sample for the study, this thesis collects financial data from Yahoo Finance, including the price of Bitcoin, the price of Ethereum, the price of the S&P500, and the yield of the T-bill. In addition, to study the impact of economic uncertainty on the price and volatility of Bitcoin, this thesis uses the Economic Uncertainty Index constructed by Baker, Bloom, and Davis (2016).

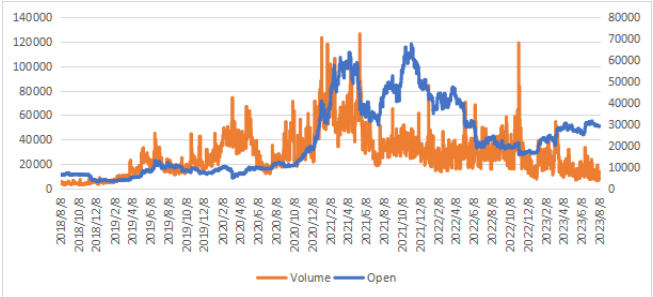

Fig. 4. The open price and trading volume of Bitcoin (2018–2023).
Data source: Yahoo finance

The main variables used in the study include the returns on several financial assets, which this study measures using the simple rate of return. The yield is the daily rate of return calculated as:

$$R = \frac{Price_t}{Price_{t-1}} - 1$$

This study also uses standard deviations of monthly return as the proxy of volatility, which is calculated as:

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

where R is the monthly return of specific financial assets. N is the number of trading days in a month.

B. Sample Statistics

There is a relationship between the trading volume of Bitcoin and its public price, as Fig. 4 presents the fact that the trading volume of Bitcoin is climbing from 2018 to 2020, but the price is not changing much. From the end of 2020 to February 2021, trading volume begins to soar while the price of Bitcoin rises. From June 2021 to December 2021, the price rose to its peak, but the volume of transactions dropped sharply. The trading volume of Bitcoin rises as its price begins to taper off in 2022. Starting in February 2023, the price of Bitcoin begins to recover, and the volume of transactions begins to decline.

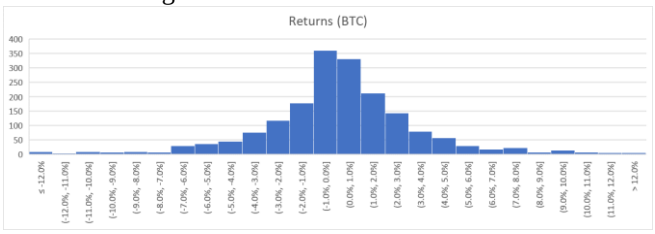

Fig. 5. The distribution of Bitcoin returns (2018–2023).
Data source: Yahoo finance

After presenting the relationship between Bitcoin's trading volume and its public price, this essay uses a histogram of the distribution of Bitcoin's returns to reflect some of the relationships between frequencies. Fig. 5 is a histogram depicting the returns that represent the distribution of the data. This study chose to use a logarithmic yield calculation. In Fig. 5, it can show that the frequency is highest in blocks of plus or minus 1%. The next two blocks are plus 1 to plus 2% and minus 1 to minus 2% is the second most common. As the data deviates more and more from zero, the frequency decreases.

Table 1. Bitcoin returns by year

Year	Average of Return	StdDev of Return	Min of Return	Max of Return
2018	−0.3598%	3.4463%	−14.3561%	10.8224%
2019	0.1790%	3.5330%	−15.1820%	16.0042%
2020	0.3809%	4.0073%	−46.4730%	16.7104%
2021	0.1282%	4.2043%	−14.8107%	17.1821%
2022	−0.2819%	3.3613%	−17.4053%	13.5764%
2023	0.2575%	2.3511%	−6.4425%	9.0431%

After collecting data on Bitcoin transactions for the last six years, this essay wanted to analyze the annual returns of Bitcoin and then use that to analyze Bitcoin. As shown in Table 1, for the average return, the average return is negative in 2018 and 2022, and in 2023 the average return is the highest reaching 0.2575%. For the standard deviation of returns, there are two years where the standard deviation exceeds 4%, in 2020 and 2021. By 2023 the standard deviation is still relatively low. For the minimum return, the minimum return in 2020 is almost negative fifty percent, which is a serious loss. By reviewing the information, it is known that an extreme value of Bitcoin occurred on 12 March 2020, when the price of Bitcoin suddenly fell below the $4,000 mark, hitting its lowest point in almost a year. For the maximum gain this series of data is nothing special, from 2018 to 2022, the maximum gain of Bitcoin has been 10 percent or more, in 2023 so far, the maximum gain is lower, below 10 percent.

As shown in Table 2, this mean value is less than one percent. The value of the median is not very different from the mean, nor is it more than one percent. The standard deviation reaches more than three percent. The minimum value is close to a negative forty-seven percent, while the maximum value is close to a positive seventeen percent.

Table 2. Statistics of Bitcoin returns

Statistic	Value
Mean	0.0839%
Median	0.0755%
Standard Deviation	3.6258%
Sample Variance	0.0013
Kurtosis	17.3977
Skewness	−1.1879
Minimum	−46.4730%
Maximum	17.1821%
Number of Observations	1826

Skewness and kurtosis are also two important metrics in statistics. In the field of finance. Skewness and kurtosis are usually used to assess the price of an asset and the risk and return characteristics of a portfolio, here this research will use these two data to analyze the price and reporting characteristics of Bitcoin.

As indicated in Table 2, skewness is a statistic that expresses the skewness of the data distribution, it is an indicator that describes the asymmetry of the data distribution. A positively sliced distribution indicates that the tails of the distribution are on the right side, a negatively skewed distribution indicates that the tails of the distribution are on the left side, and an unskewed distribution indicates that the distribution is symmetrical. In Table 2, the skewness is a negative number, close to a negative one, which means it belongs to a negatively skewed distribution.

Kurtosis is a statistic that describes how spiky the distribution is. A high kurtosis distribution means that the distribution has sharper peaks than a normal distribution, a low kurtosis distribution means that the distribution has flatter peaks than a normal distribution, and a normal distribution means that the distribution is similar to a normal distribution. In Table 2, the degree of kurtosis is a positive number, about seventeen point four. This means that this is a peaked distribution. Based on these two indicators, it is possible to determine whether the distribution of the data series satisfies normality, and thus evaluate the value of using the mean indicator.

IX. Empirical Results

A. The Determinants of Bitcoin Returns

To demonstrate the determinants of the Bitcoin price, a regression analysis was performed on Bitcoin data collected over the past six years. Based on Table 3, this can be seen

clearly that the coefficient of the volume of Bitcoin is positive, which is 0.024. The coefficient is statistically significant at a 1% level (*p*-value = 0). This indicates that Bitcoin's daily volume has a positive correlation with Bitcoin's day return.

Table 3. Regression: The determinants of Bitcoin returns (Y is R (Bitcoin))

	Coefficients	Standard Error	t Stat	*p*-value	Lower 95%	Upper 95%
Intercept	−0.025	0.042	−0.605	0.545	−0.107	0.056
Vol(Bitcoin)	0.024	0.003	7.270	0.000	0.017	0.030
Vol(Ethereum)	−0.022	0.003	−7.744	0.000	−0.027	−0.016
Vol(S&P500)	−0.001	0.002	−0.710	0.478	−0.005	0.002
Uncertainty	0.000	0.000	−2.239	0.025	0.000	0.000
R(Ethereum)	0.610	0.013	48.318	0.000	0.586	0.635
R(S&P500)	0.166	0.057	2.901	0.004	0.054	0.278
R(T-Bills)	−0.005	0.004	−1.256	0.209	−0.013	0.003

The same research methodology is useful for Ethereum and the coefficient of the volume of Ethereum is negative, which is −0.022. And then this is statistically significant at a 1% level (*p*-value = 0) and this shows that Bitcoin's day's yield has a negative correlation with the trading volume of Ether, one of its competing currencies. In the correlation level, the higher the volume of Ether, the lower Bitcoin's return will be.

The relationship between S&P500 trading volume and Bitcoin returns is similar to the relationship between Ethereum trading volume and Bitcoin returns, both of which are negative. Only the exact values are different, with the former having a value of −0.001 However, the coefficient is not statistically significant (*p*-value = 0.478). This suggests that there is a negative correlation between Bitcoin's return for the day and the volume of the U.S. stock market. Bitcoin and the U.S. stock market may be a substitute for each other. If the volume is high on one side, trading on the other side will be inactive.

The most obvious thing in Table 3 is the coefficient of uncertainty, as it is zero. It is statistically significant at a 1% level (*p*-value = 0.025). This indicates that Bitcoin's return on the day has a significant negative correlation with the uncertainty index. The Uncertainty Index is a measure of uncertainty in the world's economies. The level of uncertainty is measured by the attributes of newspaper articles. When uncertainty is high, Bitcoin has a lower return. This shows that Bitcoin is not a safe-haven asset, it has no safe-haven asset properties. This is because when uncertainty is high, the yield of a safe-haven asset is significantly higher.

Similar to the correlation between the return of Ethereum and the return of Bitcoin. To be specific, the coefficient of the return of Ethereum is positive, which is 0.610. This is statistically significant at a 1% level (*p*-value = 0). This suggests that Bitcoin's return is positively correlated with Ether's return.

The S&P500 stock market's return is also positively correlated with Bitcoin returns, because the coefficient of the return of SP500 is positive, which is 0.166. It is statistically significant at a 1% level (*p*-value = 0.004).

The coefficient of the return which is −0.005 of the risk-free assets is negative, which is −0.005. Unfortunately, the coefficient is not statistically significant (*p*-value =0.209). This indicates that Bitcoin's return is negatively correlated with the risk-free asset, i.e., U.S. Treasuries.

B. The Determinants of Bitcoin Volatility

The determinants of Bitcoin volatility are as important as the price influences. Regarding the determinants of Bitcoin price volatility, this study also chooses to use regression analysis for this research. As presented in Table 4, it is positive that the coefficient of the average of the return of Bitcoin is 0.543. This is statistically significant at a 1% level (*p*-value = 0.012) and indicates that Bitcoin's average return has a positive correlation with Bitcoin volatility.

Table 4. Regression: The determinants of Bitcoin 1-month VOLATILITY (Y is monthly STD (Bitcoin))

	Coefficients	Standard Error	t Stat	*p*-value	Lower 95%	Upper 95%
Intercept	−0.002	0.0077	−0.324	0.746	−0.017	0.012
R(Bitcoin)	0.543	0.2117	2.565	0.012	0.119	0.967
STD(Ethereum)	0.551	0.0659	8.351	0	0.418	0.683
R(Ethereum)	−0.366	0.1569	−2.336	0.023	−0.680	−0.052
STD(S&P500)	−0.209	0.3359	−0.622	0.536	−0.882	0.464
R(S&P500)	−0.364	0.6440	−0.566	0.573	−1.655	0.925
STD(T-Bills)	0.020	0.0124	1.663	0.101	−0.004	0.045
R(T-Bills)	−0.030	0.0382	−0.791	0.432	−0.106	0.046
Uncertainty	0	0	1.583	0.118	0	0

There is a negative correlation between the standard deviation of Ethereum and Bitcoin volatility, because the coefficient of the standard deviation of the return of the Ethereum is positive, which is 0.551. As well as Ethereum and Bitcoin are substitutes. It is statistically significant at a 1% level (*p*-value = 0). In the correlation level, the higher the standard deviation of Ether, the lower Bitcoin volatility will be.

The correlation is similar to the previous factor and is also negative, because the coefficient of the average return of Ethereum is negative, which is −0.367, but it is not statistically significant (*p*-value = 0.023). This suggests that there is a negative correlation between Bitcoin volatility for the day and the average return of Ethereum. Bitcoin and Ethereum may be a substitute for each other. It means that if the average return of Ethereum is high on one side, trading on the other side will be inactive.

Since the standard deviation of the S&P500 is a measure of Bitcoin volatility in the world economy, this essay included it as one of the factors in the study. And as Table 4 shows, the value of the S&P500 on this chart also has some significance. The coefficient of the standard deviation of the standard deviation of S&P500 is negative. It is statistically significant at a 1% level (*p*-value = 0.536). This indicates that Bitcoin volatility on the day has a significant negative correlation with the standard deviation of the S&P500.

That still for the S&P500, its average return is also somewhat related to Bitcoin. The coefficient of the average return of the S&P500 is negative, which is −0.36. It is statistically significant at a 1% level (*p*-value = 0.573). This suggests that Bitcoin volatility is negatively correlated with the S&P500's average return.

Treasury bills are also one of the main factors affecting Bitcoin's volatility. The positive coefficient of the standard deviation of the T-bills is 0.020. It is statistically significant at a 1% level (*p*-value = 0.101) and it proves the positive correlation between them again.

Treasury bill returns are negatively correlated with Bitcoin's volatility, their coefficient is negative is −0.030, but

this coefficient is not statistically significant (*p*-value = 0.432). This once again emphasizes the correlation between Bitcoin volatility and the average return of T-bills is negative.

The values of the uncertainty index are prominent in Table 4. It is staggering that the coefficient of the uncertainty is zero and it is statistically significant at a 1% level (*p*-value = 0.119). This indicates that Bitcoin volatility on the day has a significant negative correlation with the uncertainty index. The Uncertainty Index is a measure of uncertainty in the world's economies. The level of uncertainty is measured by the attributes of newspaper articles. When uncertainty is high, Bitcoin has a lower volatility. This shows that Bitcoin is not a safe-haven asset, it has no safe-haven asset properties. This is because when uncertainty is high, the yield of a safe-haven asset is significantly higher.

X. The Discussion of Baseline Results

In recent years, cryptocurrencies have attracted considerable attention from investors and researchers alike, with Bitcoin being the most prominent example. Analyzing the factors that influence Bitcoin's returns can provide valuable insights for investors looking to make informed decisions about their cryptocurrency investments.

The positive correlation between Bitcoin's daily returns and its daily trading volume highlights the role of market sentiment and investor behavior in driving price movements. This irrational behavior, where traders tend to buy when prices are high and sell when prices are low, can result in market bubbles and subsequent crashes. Understanding this dynamic can help investors make more informed decisions and potentially take advantage of market inefficiencies.

Furthermore, the competitive nature of the cryptocurrency market is illustrated by the negative correlation between Bitcoin's daily returns and the trading volume of similar cryptocurrencies, such as Ethereum. As investors shift their focus and capital between different cryptocurrencies, price movements can be influenced by changes in demand for these assets. Recognizing this relationship can help investors diversify their portfolios and manage risk more effectively.

Another interesting aspect is the negative correlation between Bitcoin's daily returns and the trading volume of the U.S. stock market. This suggests that investors may view these assets as substitutes, with increased activity in one market potentially leading to decreased activity in the other. This relationship could be particularly relevant during periods of market stress when investors may reallocate their investments between different asset classes in search of safety or higher returns

Additionally, Bitcoin does not possess safe-haven asset properties, as evidenced by the significant negative correlation between its returns and the uncertainty index. During times of heightened uncertainty, investors typically flock to assets that are perceived as safe, such as gold or government bonds. However, the data suggests that Bitcoin is more likely used as a speculative tool for potential gains rather than as a store of value during uncertain times.

The positive correlation between Bitcoin's returns and Ethereum's returns implies that these cryptocurrencies may share similar market dynamics and investor sentiment. As a result, they might be used interchangeably to some extent. Investors could consider this relationship when constructing their portfolios, potentially using these assets to hedge against each other or to gain exposure to the broader cryptocurrency market.

Moreover, the positive correlation between Bitcoin's returns and the S&P500 stock market's returns suggests that these assets may be influenced by similar macroeconomic factors or investor sentiment. This relationship could be useful for investors seeking to understand how broader market trends might impact their cryptocurrency investments.

The negative correlation between Bitcoin's returns and risk-free assets, such as U.S. Treasuries, highlights the risk-averse behavior of investors. When yields on risk-free assets rise, investors may prefer these safer options over riskier investments like Bitcoin. This relationship underscores the importance of considering the broader investment landscape when making decisions about cryptocurrency investments.

Another noteworthy finding is the positive correlation between Bitcoin's average return and its volatility. This suggests that higher returns are often accompanied by increased price fluctuations, which could be driven by profit-seeking behavior among investors. Understanding this dynamic can help investors manage their risk exposure and make more informed decisions about their cryptocurrency investments.

The interconnected nature of the cryptocurrency market is evident in the negative correlation between Bitcoin's returns and the standard deviation of Ethereum's returns. This relationship highlights the potential for spillover effects between different assets, with fluctuations in competing cryptocurrencies impacting Bitcoin's volatility. Investors should be aware of these dynamics when constructing their portfolios and managing risk.

The negative correlation between Bitcoin's daily returns and Ethereum's average returns suggests that these cryptocurrencies may function as substitutes for each other. This relationship could have implications for portfolio diversification and risk management, as investors may choose to allocate their capital between these assets depending on their respective returns and risk profiles.

Finally, the significant negative correlation between Bitcoin's volatility and the uncertainty index reinforces the conclusion that Bitcoin is not a safe-haven asset. This relationship suggests that during times of heightened uncertainty, investors may not view Bitcoin as a reliable store of value or a means of preserving wealth. Understanding this dynamic can help investors make more informed decisions about their exposure to cryptocurrencies during periods of market stress.

XI. Subsample Analysis: Evidence from COVID-19 Pandemic

When it comes to periods of epidemics, benchmark regressions may suffer a little bit. This is because epidemics are characterized by several things, such as people not working, people being pessimistic, or people being uncertain about the future–that's the kind of environment that makes it even more difficult to get access to finance, and in this particular case, the results will be slightly different relative to the benchmark regression.

Table 5. Regressions: The determinants of Bitcoin return (Y is daily R (Bitcoin))

Panel A. before COVID-19

	Coefficients	Standard Error	t Stat	*p*-value	Lower 95%	Upper 95%
Intercept	0.006	0.068	0.102	0.918	−0.127	0.141
R(Ethereum)	0.586	0.016	36.352	0	0.554	0.617
R(S&P500)	0.272	0.067	4.019	0	0.139	0.405
R(T-Bills)	−0.005	0.004	−1.328	0.184	−0.013	0.002
Vol(Bitcoin)	0.020	0.004	4.993	0	0.012	0.028
Vol(Ethereum)	−0.019	0.003	−5.501	0	−0.026	−0.012
Vol(S&P500)	−0.002	0.002	−0.873	0.382	−0.006	0.002
Uncertainty	0	0	−1.507	0.132	−0	0

Panel B. COVID-19

	Coefficients	Standard Error	t Stat	*p*-value	Lower 95%	Upper 95%
Intercept	−0.025	0.041	−0.604	0.545	−0.106	0.056
R(Ethereum)	0.610	0.012	48.317	0	0.585	0.635
R(S&P500)	0.165	0.057	2.901	0.003	0.053	0.277
R(T-Bills)	−0.004	0.003	−1.255	0.209	−0.012	0.002
Vol(Bitcoin)	0.023	0.003	7.269	0	0.017	0.029
Vol(Ethereum)	−0.021	0.002	−7.744	0	−0.027	−0.016
Vol(S&P500)	−0.001	0.001	−0.710	0.477	−0.004	0.002
Uncertainty	0	0	−2.238	0.025	0	0

As Table 5 shows one of the first and most obvious differences between them is that this variable is the Economic and Political Uncertainty Index. During the epidemic, its effect on Bitcoin disappeared. And even if it didn't disappear it at least became insignificant. Especially before the outbreak, it was more significant throughout, but it was insignificant during the outbreak, and that suggests that during the outbreak, economic volatility had a weaker impact on Bitcoin's returns.

It's very likely that because it's in a situation of extreme uncertainty, in other words, there's external uncertainty, the economic uncertainty index for this thing, it's probably covered by the cover and the economic uncertainty index does not affect the returns of this Bitcoin.

Table 6. Regressions: The determinants of Bitcoin 1-month volatility (Y is monthly STD (Bitcoin))

Panel A. before COVID-19

	Coefficients	Standard Error	t Stat	*p*-value	Lower 95%	Upper 95%
Intercept	−0.040	0.034	−1.178	0.265	−0.117	0.036
R(Bitcoin)	0.364	0.540	0.673	0.515	−0.839	1.568
STD(Ethereum)	0.686	0.219	3.131	0.010	0.198	1.175
R(Ethereum)	−0.445	0.501	−0.889	0.394	−1.562	0.670
STD(S&P500)	−1.222	1.203	−1.016	0.333	−3.903	1.458
R(S&P500)	−1.267	2.296	−0.552	0.592	−6.384	3.848
STD(T-Bills)	−1.118	1.538	−0.727	0.483	−4.546	2.309
R(T-Bills)	−2.460	2.444	−1.006	0.337	−7.907	2.987
Uncertainty	0	0	1.644	0.131	0	0

Panel B. COVID-19

	Coefficients	Standard Error	t Stat	*p*-value	Lower 95%	Upper 95%
Intercept	0.009	0.006	1.423	0.162	−0.003	0.022
R(Bitcoin)	0.643	0.196	3.280	0.002	0.246	1.041
STD(Ethereum)	0.601	0.059	10.142	0	0.481	0.721
R(Ethereum)	−0.467	0.152	−3.072	0.003	−0.776	−0.159
STD(S&P500)	0.149	0.284	0.523	0.603	−0.427	0.726
R(S&P500)	0.186	0.604	0.308	0.759	−1.039	1.412
STD(T-Bills)	0.007	0.011	0.668	0.508	−0.014	0.029
R(T-Bills)	−0.038	0.032	−1.184	0.243	−0.105	0.027
Uncertainty	0	0	-0.419	0.677	0	0

Regarding other significance, it seems that what was significant in the full sample remained significant during the epidemic, and what was not significant in the full sample did not change significantly during the epidemic.

The sign of the coefficients also did not change, and those that were positive in the full sample remained so during the epidemic. The negative sign in the full sample remained the same during the epidemic. There is no shift between positive and negative correlations.

The magnitude of the coefficients changed during the epidemic. The coefficient on the Ethereum return fell by about 0.03, while the coefficient on the S&P500 rose by about 0.1, and there was essentially no change in the coefficient on the T-bills. The volume coefficients for Bitcoin, Ethereum, and the S&P500 all fell more significantly during the epidemic.

Similarly, when it comes to the epidemic period, a lot of the coefficients change along with the problems of the society during the epidemic. For the comparison of these two graphs, one of the most obvious is the coefficients of many of the factors, which have changed both positively and negatively.

Table 6 shows the first and most obvious difference between these figures is the economic and political uncertainty index. Its effect on Bitcoin volatility virtually disappeared during the epidemic. This also suggests that economic fluctuations had little impact on Bitcoin volatility during the epidemic.

During the epidemic, the magnitude of the coefficients changed, and regarding the specific changes, for example, the coefficient of Ether's return fell by about 0.02, while the coefficient of the standard deviation of the S&P500 rose by about 1.07. The coefficients of the Ether's return remained almost unchanged. The coefficient of the standard deviation of the Treasury Roll, the coefficient of return, and so on have all realized significant increases.

XII. Conclusion

This paper examines Bitcoin's returns and volatility, and some of the possible factors that could be contributing to them, mostly by plotting and combing through the data using some knowledge of normal distributions and regression analysis to understand how Bitcoin's returns fluctuate. This research found that Bitcoin's returns may be related to its standard deviation and trading volume, and even the trading volume and prices of other virtual currencies may have an impact on Bitcoin's returns. Bitcoin's volatility also depends on many factors, and as this study discusses and compares in this essay, not only does the average return of Bitcoin itself affect its volatility, but the average return and standard deviation of other virtual currencies may also affect the volatility of Bitcoin itself. Political uncertainty is also a factor to consider. Additionally, in the essay, specific periods are analyzed to determine what factors affect Bitcoin's returns and volatility.

This research helps investors better understand Bitcoin and, more importantly, what factors may cause Bitcoin's returns and volatility to change. With this information, they can more accurately judge timing and assess risk. Companies, as a specific example of an investor who might use Bitcoin as an investment product, can more fully judge how to maximize a company's returns by using several of the volatility factors examined in this study. For regulators, this data and analysis

can help them gain a more comprehensive understanding of Bitcoin, and having an understanding of the factors that affect Bitcoin returns and volatility can make it easier for them to regulate the market.

This essay examines the issue of influencing factors affecting Bitcoin's returns and earnings, and due to space reasons and main reasons, this study does not elaborate much on some minor concepts. This paper argues that many factors can affect the returns and volatility of Bitcoin. This helps people to understand Bitcoin more fully and make better risk assessments. It can also stimulate interest in the field and diversify the study of Bitcoin. Bitcoin's limitations, the government's attitude towards Bitcoin, Bitcoin's management model, whether Bitcoin will become a mainstream currency in the future, what lies behind Bitcoin's bubble economy, and what factors underpin Bitcoin's overvalued price can all be explored. Even more, in today's world situation, gold is seen as a safe-haven asset and is bought in large quantities, so is it possible for decentralized Bitcoin to become analogous to gold in the future? These questions are worth exploring and studying in the future.

Conflict of Interest

The author declares no conflict of interest.

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