MASTER

FINANCE

MASTER´S FINAL WORK

DISSERTATION

THE IMPACT OF FED ANNOUNCEMENTS ON BITCOIN PRICE AND ON THE BITCOIN FUTURES-SPOT SPREAD

XIA QIANG

JUNE - 2023

MASTER
FINANCE

MASTER´S FINAL WORK
DISSERTATION

THE IMPACT OF FED ANNOUNCEMENTS ON BITCOIN PRICE AND ON THE BITCOIN FUTURES-SPOT SPREAD

XIA QIANG

SUPERVISION:
PROFESSOR GIL NOGUEIRA

JUNE - 2023

ABSTRACT

This dissertation analyzes the impact of the FOMC announcements on the Bitcoin price and the spread between Bitcoin futures and spot prices. The analysis covers the period from January 2022 to April 2023. An event-driven analysis model is used to determine the association between these events and Bitcoin. Results indicate that the FOMC announcements, specifically during a contractionary monetary policy cycle, do not exhibit a statistically significant influence on the prices of Bitcoin. Moreover, these announcements do not appear to affect the spread between the futures and spot prices of Bitcoin. However, further study suggests the indirect impact of Fed monetary policy decisions on Bitcoin returns. Results suggest that events that lead the market to form expectations of the Fed increasing interest rates negatively affect Bitcoin returns, while events that lead investors to anticipate the Fed pausing the rate hike cycle have a positive impact on Bitcoin returns. In contrast, statistical analysis shows that Bitcoin Spread is only affected by events that cause the market to anticipate a Fed interest rate hike decision. Furthermore, evidence suggests that the price of Bitcoin demonstrates a positive reaction to events characterized by turmoil within the banking system. Conversely, it exhibits a negative response to the collapse of cryptocurrency companies.

RESUMO

Esta dissertação analisa o impacto dos anúncios do FOMC sobre o preço da Bitcoin e o spread entre os futuros da Bitcoin e os preços à vista. A análise abrange o período de janeiro de 2022 a abril de 2023. É utilizado um modelo de análise orientado por eventos para determinar a associação entre estes eventos e a Bitcoin. Os resultados indicam que os anúncios do FOMC, especificamente durante um ciclo de política monetária contracionista, não apresentam uma influência estatisticamente significativa sobre os preços da Bitcoin. Além disso, estes anúncios não parecem afetar o spread entre os preços de futuros e à vista da Bitcoin. No entanto, um estudo mais aprofundado sugere o impacto indireto das decisões de política monetária do Fed nos retornos da Bitcoin. Os resultados sugerem que os eventos que levam o mercado a formar expectativas de que a Fed aumente as taxas de juro afetam negativamente os retornos da Bitcoin, ao passo que os eventos que levam os investidores a antecipar que a Fed faça uma pausa no ciclo de subida das taxas têm um impacto positivo nos retornos da Bitcoin. Em contrapartida, a análise estatística mostra que o Bitcoin Spread só é afetado por eventos que levam o mercado a antecipar uma decisão de subida das taxas de juro da Fed. Além disso, as provas sugerem que o preço da Bitcoin demonstra uma reação positiva a eventos caracterizados por turbulência no sistema bancário. Por outro lado, apresenta uma reação negativa ao colapso das empresas de criptomoeda.

PALAVRAS-CHAVE: Bitcoin; Anúncios do FOMC; Análise Orientada para Eventos; Bitcoin Spread; Eficiência de Mercado

Códigos JEL: E44; E52; G14.

ACKNOWLEDGMENTS

I am immensely grateful to my supervisor, Professor Gil Nogueira, for his availability, guidance, expertise, and invaluable support, as well as his indispensable suggestions that greatly contributed to the development of this study.

I am also deeply thankful to all my Master professors, whose teachings and knowledge have broadened my understanding of Finance. I have received a solid academic foundation thanks to their unwavering dedication to teaching and unwavering commitment to excellence.

I am also grateful to my colleagues from CGD, Alexandre Chanal, Armando Oliveira, Filipa Lobo and Patrícia Tavares, for generously sharing their professional and life experiences with me. I would like to express my sincere appreciation for their unwavering support throughout the final year of my master's program.

A sincere expression of appreciation is extended to Xin Chen for her encouragement, and support, which have been a constant source of motivation.

I would like to express my sincere gratitude to all those who have made direct or indirect contributions to the successful completion of this dissertation.

Finally, I could not have completed this dissertation without the full support of my parents and my sisters, whose unconditional love, encouragement, and support have fueled my determination to reach this milestone. Thank you for being there during both the challenging and rewarding moments.

GLOSSARY

BTC – Bitcoin

BMI – Bitcoin Misery Index

CBOE - Chicago Board Options Exchange

CME – Chicago Mercantile Exchange

CPI – Consumer Price Index

EPU – Economic Policy Uncertainty

EUR – Euro

Fed – Federal Reserve

FOMC – Federal Open Market Committee

GDP – Gross Domestic Product

PPI - Producer Price Index

USA – United States of America

USD – US dollar

TABLE OF CONTENTS

List of Figures

List of Tables

1. INTRODUCTION

"*[Virtual currencies] may hold long-term promise, particularly if the innovations promote a faster, more secure and more efficient payment system.*"

- Ben Bernanke,

Former Federal Reserve Chair and Nobel Prize winner

(November 18, 2013)

"*Crypto assets are highly volatile (...) They're more of an asset for speculation, so they're not particularly in use as a means of payment. It's more of a speculative asset. It's essentially a substitute for gold rather than for the dollar.*"

- Jerome Powell,

Federal Reserve Chair

(March 23, 2021)

The cryptocurrency market has witnessed remarkable growth since the conceptualization of Bitcoin by Nakamoto (2008) resulting in the emergence of several new cryptocurrencies. Despite the market's expansion, Bitcoin has retained its position as the market leader. On January 1, 2023, Bitcoin continues to dominate the cryptocurrency market, accounting for 40% of the total cryptocurrency market capitalization. This value is more than double the market share of the second-largest cryptocurrency, Ethereum, which represents only 18.41% of the total market[1].

The primary motivation behind Bitcoin's creation was to establish a decentralized, peer-to-peer electronic payment system that could facilitate secure and fast transactions without the need for a central authority, such as a bank or government.

On the other side, while central banks play a crucial role in managing monetary policy and promoting economic stability, there are also discussions and criticisms regarding their potential negative impacts in terms of transmitting inappropriate monetary policies. An illustrative example is the 2008 Great Financial Crisis, where numerous academic papers and articles have attributed the recession to the Federal Reserve's decision to maintain low interest rates as a means to stimulate economic growth (Taylor, 2007; Baily et al., 2009; White, 2009). Consequently, this policy resulted in an inflow of capital into the housing market, subsequently triggering a rapid escalation in home prices. It is also argued that the Fed, by maintaining persistently low short-term interest rates over an extended period, incentivized fund managers to engage in the acquisition of mortgage and other asset-backed securities. Despite being aware of the associated risks, these securities offered higher yields and were given high ratings by credit agencies, enabling fund managers to provide positive returns to investors while covering their expenses in a low-rate environment (Baily et al., 2009).

---

[1]Based on data from the coinmarketcap.com, retrieved from: `https://coinmarketcap.com/charts/`

Figure 1: Bitcoin Historical Price vs. Federal Funds Rate (Upper Bound): Jan 2009 – Mar 2023:
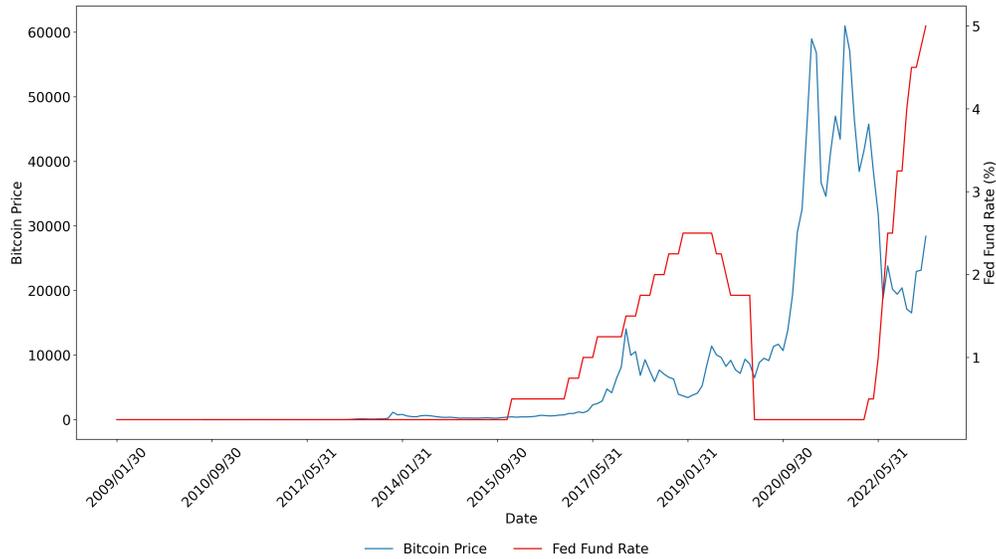
Source: Bloomberg

The idea that a central bank could be held responsible for generating and triggering economic crises was a catalyst for the creation of Bitcoin aiming to address the inherent deficiencies of the prevailing monetary and financial systems[2]. To comprehensively assess whether Bitcoin is truly isolated from the influence of central banks' monetary policy and to evaluate whether it effectively fulfills the intended role attributed to it upon its creation, an event study analysis was conducted in this paper.

In addition, it should be noted that since the inception of Bitcoin, studies on this type of asset have predominantly occurred in a period characterized by a low-interest-rate environment and the implementation of quantitative easing monetary policies. According to Figure 1, it is evident that prior to 2022, the maximum Federal Funds Rate reached 2.5%. This situation persisted until the previous year, triggered by various factors such as the COVID-19 pandemic, the war between Russia and Ukraine, trade wars between China and the United States, and the trend towards deglobalization. These events have significantly impacted global supply chains and consequently led to widespread inflation worldwide, including in the United States. In fact, inflation reached a peak of 9.1% in the US (the highest level in over four decades), prompting the Fed to take measures to control the escalating inflationary pressures.

During the period under analysis in this research, the Fed has implemented the most aggressive increase in interest rates observed since the creation of Bitcoin. The Fed's actions resulted in

---

[2]Nakamoto's strong disapproval of the prevailing financial institutions and government intervention during the crisis is evident in the Bitcoin blockchain's first block of transactions. This block includes the well-known message "The Times 03/Jan/2009 Chancellor on brink of second bailout for banks." (Karau, 2021). This message refers to a headline from *The Times*. The message was intended to provide a timestamp and serve as a commentary on the financial crisis at that time, highlighting the motivation behind Bitcoin's creation.

a cumulative increase of 475 basis points, marking the highest level since Bitcoin's introduction into trading (as illustrated in Figure 1). This development raises questions regarding the potential impact of such a rapid adjustment by the Fed on the most prominent digital asset, which was originally designed to be shielded from the influence of central banks.

Many believe that the rapid growth of the crypto market could signal the beginning of a new era of financialization centered around virtual financial assets. However, this development has also introduced new sources of potential risk for investors. Consequently, there is a pressing need for the market to offer more avenues for managing these risks (Huynh et al., 2020). As a response, two major US derivatives exchanges, the Chicago Mercantile Exchange (CME) and the Chicago Board Options Exchange (CBOE) have commenced trading a wide range of financial instruments tied to cryptocurrencies, such as Bitcoin futures contracts[3] (Corbet et al., 2018).

There are ongoing discussions regarding the role of futures contracts in the Bitcoin market (Köchling et al., 2019). Some evidence suggests that futures contracts contribute to the informational efficiency of the Bitcoin market (Köchling et al., 2019), while others have concluded that there are arbitrage opportunities in the Bitcoin spot-futures market (Lee et al., 2020). Nevertheless, this study aims to provide evidence regarding the impact of the decisions made by the central bank, more specifically the Fed, on the pricing behavior of Bitcoin futures-spot spread.

In summary, this study primarily aims to achieve two key objectives. Firstly, I utilize the event study analysis methodology proposed by Hillenbrand (2021) to investigate the impact of Federal Open Market Committee (FOMC) announcements on the price of Bitcoin, along with several relevant events that occurred during the study period. My objective is to enhance the understanding of how Bitcoin's price is affected by such announcements, as well as its response to different events. Secondly, a similar study was carried out to investigate the influence of Fed interest rate decisions on the futures-spot spread movements of Bitcoin. The objective was to assess whether the analysis outcomes align with theoretical expectations and to assess the efficiency of the Bitcoin market.

---

[3]The CBOE (Chicago Board Options Exchange) Futures Exchange initiated the inaugural launch of Bitcoin Futures on December 10, 2017. Subsequently, one week later, CME (Chicago Mercantile Exchange) also introduced its Bitcoin futures contract on December 18, 2017.

2. LITERATURE REVIEW

Bitcoin, the pioneering decentralized digital currency, has attracted significant attention and interest from researchers, economists, and investors in recent years. The unique features of Bitcoin, such as its limited supply, decentralized nature, and potential for anonymous transactions, have sparked debates and controversies surrounding its viability, utility, and impact on traditional financial systems. Academic research on Bitcoin has experienced significant growth, reflecting the increasing interest in understanding its economic and financial attributes as well as its potential implications for individuals, businesses, and society at large.

Multiple studies have been conducted since the emergence of Bitcoin in the financial market with the aim of enhancing understanding of this new asset class known as cryptocurrency. Various aspects have been investigated in a comprehensive manner, such as momentum in the cryptocurrency market (Liu et al., 2020; Liu and Tsyvinski, 2021; Li et al., 2021), herding behaviors of cryptocurrency investors (Bouri et al., 2019; Kallinterakis and Wang, 2019; King and Koutmos, 2021; Kumar, 2021; Rubbaniy et al., 2021; Raimundo Júnior et al., 2022; Shrotryia and Kalra, 2022; Almeida and Gonçalves, 2023), crypto market bubbles (Garcia et al., 2014; Cheah and Fry, 2015; Cheung et al., 2015; Hafner, 2020; Xiong et al., 2020), cryptocurrency as portfolio diversifier (Lee et al., 2017; Feng et al., 2018; Rehman and Vo, 2020; Trimborn et al., 2020), crypto market liquidity (Zhang and Li, 2023; Brauneis et al., 2021; Aleti and Mizrach, 2021). These research efforts have sought to shed light on the fundamental drivers, risks, and opportunities associated with cryptocurrency, aiming to provide valuable insights for policymakers, investors, and market participants.

In the following subsection, a more detailed review of the existing literature relevant to the present study is provided, aiming to enhance understanding of the definitions, research methodologies, and findings presented by scholars in this particular field.

2.1 Related Literature

2.1.1 Bitcoin: Asset or Currency?

There are significant ongoing debates surrounding the role of Bitcoin within the financial system, despite its classification as a digital currency. Some authors argue that Bitcoin should be considered a currency, while others contend that it should be exclusively perceived as a speculative asset (European Central Bank, 2012).

According to Glaser et al. (2014), individuals who purchase Bitcoin for the first time on exchanges tend to retain these acquired Bitcoins in their exchange wallets for speculative purposes

rather than intending to utilize them as a medium of exchange for goods and services (i.e., as a currency). Additionally, the authors argue that the notion of Bitcoin being treated as an asset is reinforced by the observed reactions of Bitcoin returns to news events specifically related to this digital currency, which exhibit characteristics typically associated with speculative asset classes. Baur et al. (2018) subsequently arrived at a similar conclusion through an examination of transaction data from Bitcoin accounts, revealing that Bitcoin does not function as an alternative currency but rather as a speculative asset. Based on the evidence provided by these authors, I propose Hypothesis H1 for Research Question 1 of this paper, with Bitcoin being considered a speculative asset.

Research Question 1: Do FOMC announcements have a direct impact on Bitcoin price returns?

H1: FOMC announcements have a statistically significant effect on the price returns of Bitcoin.

2.1.2 Bitcoin: Impact of Monetary Policy and Macroeconomic Announcements

This study contributes to the existing literature examining the influence of monetary policy on asset prices in general (Kuttner, 2001; Gürkaynak et al., 2004; Bernanke and Kuttner, 2005; Gilchrist et al., 2019; Gürkaynak et al., 2021; Kroencke et al., 2021; Hillenbrand, 2021) and to the literature on Bitcoin in specific by providing empirical evidence regarding the impact of monetary policy on the price of Bitcoin.

According to Pyo and Lee (2020), the announcements made by the FOMC[1] have been discovered to have a negligible influence on the prices of Bitcoin. Likewise, macroeconomic announcements such as the Employment rate, Producer Price Index (PPI), and Consumer Price Index (CPI) seem to exhibit insignificant impacts on the prices of Bitcoin. However, a structural analysis conducted by Karau (2021) using a Proxy VAR model revealed the significant influence of monetary policy innovations implemented by both the Federal Reserve and the European Central Bank on Bitcoin prices. It is observed that shocks arising from contractionary monetary policies in the euro area result in price increases for Bitcoin. This response aligns with the conceptualization of Bitcoin as a digital form of gold, functioning as a digital hedge. Conversely, Bitcoin experiences a decline in value subsequent to disinflationary monetary tightening shocks initiated by the Federal Reserve. This result was supported by Ma et al. (2022), in a study utilizing univariate regression models, they observed that Bitcoin's price exhibits a negative response to the unexpected tightening of monetary policy, with a stronger cumulative effect in the days following FOMC meetings. Additionally, evidence shows the impact of monetary policy becomes more pronounced during periods of market booms, as indicated by the

---

[1]The Federal Open Market Committee comprises twelve members. The FOMC convenes eight regular meetings annually, supplemented by additional meetings as deemed necessary. During these meetings, the Committee evaluates economic and financial conditions, establishes a suitable course of monetary policy, and evaluates the risks to its long-term objectives of maintaining price stability and fostering sustainable economic growth.

findings derived from the analysis employing quantile regression. Furthermore, the researchers discovered a sustained impact of monetary policy shocks on Bitcoin prices, as evidenced by the outcomes of impulse response analysis.

Empirical evidence has demonstrated that Bitcoin reacts to macroeconomic announcements such as durable goods and unemployment reports. However, additional evidence suggests that there is a negligible relationship between Bitcoin returns and indicators like GDP and the Consumer Price Index (CPI) (Corbet et al., 2020b). Research also indicates that Bitcoin exhibits a negative reaction to positive news following unemployment and durable goods announcements. In other words, when positive data regarding these indicators is released, Bitcoin's value tends to decrease. Conversely, when negative data regarding these indicators is released, Bitcoin's value tends to increase (Corbet et al., 2020b). In a more recent study conducted by Benigno and Rosa (2023), it was revealed that Bitcoin does not exhibit any significant reaction to either monetary or macroeconomic news. This finding aligns partially with my own research, which suggests that a narrow window surrounding the FOMC announcements has no substantial direct influence on the price of Bitcoin. However, the expectations of the market regarding the Federal Reserve's interest rate decisions have a significant effect on the Bitcoin price, as elaborated later in detail in this study.

2.1.3 Bitcoin: Hedge or Safe-Haven?

Regarding the hedging properties of Bitcoin, there is evidence that supports its role as an effective hedging tool. Empirical evidence supports the effectiveness of Bitcoin as a hedge against fiat currencies (Majdoub et al., 2021), this conclusion received additional confirmation through the discovery of hedging properties exhibited by Bitcoin concerning fiat currencies in Asia, particularly when considering medium and long-term timeframes. This hedging effectiveness is more pronounced in Asian fiat currencies when compared to gold or oil (Kinkyo, 2022). Regarding the hedging properties of Bitcoin across various geographical regions, the available evidence suggests its effectiveness in mitigating risks within developed stock markets (Jeribi and Ghorbel, 2021), as well as the equity markets of the Asia Pacific region and Japan (Bouri et al., 2020a).

Furthermore, research has revealed that Bitcoin can potentially serve as a hedge for various types of investors, offering protection against a wide range of financial assets and investment strategies, which include the equity markets of Finland, the Netherlands, and the USA, as well as crude oil (Urom et al., 2020); industry sector portfolios and bonds (Akhtaruzzaman et al., 2020); sustainable, Islamic, and traditional investments (Disli et al., 2021); commodities (Naeem et al., 2021; Fakhfekh et al., 2021).

However, some authors have reached conclusions contrary to the aforementioned studies by revealing the limited effectiveness of hedging with Bitcoin (Charfeddine et al., 2020). This conclusion is additionally supported by the research conducted by Wang et al. (2021), who suggest that Bitcoin's high volatility renders it unsuitable as a proper hedging tool for stocks.

Evidence has also revealed the safe-haven property of Bitcoin across all US equity indices, as demonstrated by Bouri et al. (2020b). Additionally, Corbet et al. (2020a) suggest that Bitcoin exhibits weak safe-haven characteristics when considering the S&P500 index, as similar results were obtained for the FTSE250 and STOXX600 indexes (Będowska-Sójka and Kliber, 2021). When analyzing the commodities market, evidence suggests that Bitcoin can effectively serve as a safe-haven asset for crude oil (Corbet et al., 2020a). Furthermore, there is additional evidence supporting Bitcoin's role as a safe-haven during periods of extreme Economic Policy Uncertainty (EPU) shocks (Jareño et al., 2020; Wang et al., 2019). However, evidence demonstrates that during periods of severe financial and economic disruption, such as the bear market triggered by the COVID-19 pandemic, Bitcoin neither acted as a safe-haven nor served as a hedging instrument (Conlon and McGee, 2020).

In order to determine whether the results of my analysis presented in section 4 indicate that Bitcoin exhibits hedging or safe-haven asset properties, I begin by distinguishing these two properties. Baur and Lucey (2010) proposed a testable distinction between a hedge and a safe-haven by defining them as follows: a hedge is an asset that, on average, exhibits either no correlation or a negative correlation with another asset or portfolio. Furthermore, a strict hedge is an asset that, on average, demonstrates a strictly negative correlation with another asset or portfolio. On the other hand, a safe-haven is described as an asset that, during periods of market stress or turmoil, displays either no correlation or a negative correlation with another asset or portfolio. In addition, Baur and McDermott (2010) extended prior definitions by presenting them in a more precise way, distinguishing between weak and strong forms. A strong (weak) hedge is characterized as an asset that exhibits a negative correlation (no correlation) with another asset or portfolio on average. A strong (weak) safe-haven asset is characterized by a negative correlation (no correlation) with another asset or portfolio during specific periods characterized by market instability or disruption.

I contribute to the existing body of literature by providing insights into the potential role of Bitcoin as a safe-haven asset. Based on the definitions proposed by Baur and Lucey (2010) and Baur and McDermott (2010), Bitcoin can be considered a strong safe-haven asset that safeguards investors during periods of banking sector turmoil. This proposition is supported by the results of the regression analysis, which reveal a negative correlation between the price of Bitcoin and such events, which are characterized by a widespread decline in banking stocks.

2.1.4   Bitcoin: Impact of Market Sentiment

As for market sentiment's impact on Bitcoin returns, evidence indicates that different types of sentiment do have an impact on the Bitcoin price. Naeem et al. (2020) discovered that the influx of highly positive news results in an increase in Bitcoin returns, while the influence of highly negative news on Bitcoin returns is found to be limited. This situation is due to the heightened involvement of optimistic crypto-investors during periods of cryptocurrency price escalation, indicating that the cryptocurrency market predominantly mirrors the information provided by optimistic crypto-investors.

Rognone et al. (2020) discovered evidence indicating that Bitcoin exhibits a positive response following both positive and negative news events. This finding suggests that the enthusiasm surrounding Bitcoin remains unaffected by the sentiment conveyed in the news. Moreover, this effect is amplified during periods characterized by market bubbles. However, when news about cyber-attacks and fraudulent activities in the crypto domain emerges, Bitcoin experiences a decrease in both returns and volatility.

In addition, Gaies et al. (2021) investigated the influence of market sentiment on the price of Bitcoin. The researchers have confirmed that Bitcoin is influenced by market sentiment through the verification of the impact of a sentiment indicator called the Bitcoin Misery Index (BMI) on Bitcoin prices. Furthermore, they have discovered that an optimistic shock to the Bitcoin market leads to an increase in Bitcoin values, whereas a pessimistic shock results in a decrease. Additionally, the short-term impact of positive shocks is found to be more pronounced than that of negative shocks, whereas, in the long run, Bitcoin returns exhibit greater sensitivity to pessimistic shocks.

According to my analysis, Bitcoin value is affected by investor's sentiment regarding crypto sector companies. Particularly when a company with substantial influence in the cryptocurrency market declares bankruptcy, the price of Bitcoin tends to exhibit a negative response.

2.1.5   Bitcoin: Market Efficiency

Evidence from many studies suggests the inefficiency of the cryptocurrency market (Gregoriou, 2019; Rehman and Apergis, 2019; Ante and Meyer, 2021; Fousekis and Grigoriadis, 2021). These inefficiencies can give rise to potential arbitrage opportunities that investors can capitalize on (Andrade et al., 2021; Tadi and Kortchemski, 2021).

Through a study conducted by Sensoy (2019), the weak-form efficiency[2] of Bitcoin prices in US dollars (BTCUSD) and euros (BTCEUR) was examined. The findings reveal that both markets have exhibited an increase in informal efficiency at the intraday level since the beginning of 2016. Empirical results indicate that the BTCUSD market displays slightly higher efficiency compared to BTCEUR. Furthermore, there is evidence suggesting an inverse relationship between frequency and pricing efficiency, regardless of the chosen currency. Moreover, the study reveals that market liquidity has a positive impact on the informational efficiency of Bitcoin prices, whereas volatility negatively impacts the efficiency of the Bitcoin market.

In addition, Kankanam Pathiranage et al. (2021) propose that Bitcoin's efficiency will enhance progressively over time, considering its status as an emerging industry that necessitates growth. This finding aligns with the conclusion reached by Sensoy (2019). Taking into account the geographical distribution of the Bitcoin market, it becomes apparent that developing countries encounter

---

[2]According to Fama (1970), weak-form efficiency implies that the current market prices of financial assets incorporate all available past information and historical price data, resulting in the current prices being uninfluenced by past information.

greater inefficiency. This inefficiency is compounded by prevailing policy challenges and issues such as corruption and unemployment, as noted by Kankanam Pathiranage et al. (2021).

2.1.6 Bitcoin: Impact of Bitcoin Futures

Multiple studies have demonstrated the potential of Bitcoin futures to serve as a hedging mechanism, safeguarding investors against unforeseen fluctuations in the cryptocurrency market (Sebastião and Godinho, 2020; Almeida and Gonçalves, 2022).

Additionally, Köchling et al. (2019) found that the introduction of Bitcoin futures enhances the informal efficiency of Bitcoin. However, further empirical evidence presents conflicting conclusions by demonstrating market inefficiencies in both the Bitcoin spot and futures markets, as it identifies systematic and persistent deviations from no-arbitrage prices (Lee et al., 2020). Additionally, substantial evidence has been found suggesting that the futures basis provides information about futures fluctuations in the spot price as well as the risk premium. However, it has been observed that these predictors are not entirely unbiased. Furthermore, the study reveals that deviations from arbitrage bounds have widened in response to an escalating number of Bitcoin hacking and fraud incidents, as well as the emergence of alternative cryptocurrencies (Lee et al., 2020). Nevertheless, due to the cointegration between Bitcoin spot and futures markets, engaging in Bitcoin futures-spot arbitrage strategies could pose substantial risks for investors (Lee et al., 2020).

In this paper, I utilize event study analysis to investigate the relationship between the price spread of Bitcoin futures and spot prices, with a particular focus on examining their reaction to the FOMC interest rate decisions as well as their response to other event announcements.

3. DATA and METHODOLOGY

3.1   Sample Construction

The primary time series of interest is the spot price of Bitcoin in US dollars. This data was obtained in daily frequency from Bloomberg, using the mid-quotes at 8 p.m. London time. A study sample was constructed using this information, covering the period from January 25, 2022, to April 11, 2023. Similarly, the synchronized daily series of CME Bitcoin futures[1] prices in US dollars was also acquired from Bloomberg using mid-quotes at 8 p.m. London time. A sample of 305 observations was obtained for this study based on the collected data. Additionally, the FOMC announcement schedule for the period under analysis was obtained from the official website of the Federal Reserve[2].

$$R_{log}^{BTC} = ln\left(\frac{BTC_t}{BTC_{t-1}}\right) = ln(BTC_t) - ln(BTC_{t-1}) \tag{3.1}$$

$$ln(\text{BTC } Spread_t) = ln(\text{BTC } Futures_t - \text{BTC } Spot_t) \tag{3.2}$$

Based on the data sample, I compute the daily logarithmic returns for the Bitcoin spot price, as well as the logarithmic price difference between the Bitcoin futures and the Bitcoin spot, referred to as logarithmic Bitcoin Spread. These calculations are expressed by Equations 3.1 and 3.2, respectively.

The study period encompasses significant events, such as the failure of several relevant companies in the crypto industry[3], geopolitical conflict[4], the implementation of restrictive monetary policies in response to a high inflationary environment, and the collapse within the traditional banking system[5]. All these events are organized and described in Table 2. These notable occurrences make it an excellent data sample for conducting an event study analysis, given their relevance and potential impact.

---

[1] Note that I focus on CME Bitcoin Futures because the alternative, CBOE Bitcoin futures contracts, ceased listing new contracts in March 2019 due to insufficient trading volume.

[2] Federal Reserve meeting calendars can be found on: `https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm`.

[3] The bankruptcy of FTX and crypto-lender Celsius' failure.

[4] Russia-Ukraine war.

[5] The Silicon Valley Bank and Signature Bank failures in the US and the Credit Suisse crisis in Europe.

3.2 Descriptive Statistics

Table 1: Data Sample Descriptive Statistics

	BTC Spot	BTC Futures	Log Return BTC Spot	Log BTC Spread
Observ.	305	305	305	305
Min	15,632	15,615	-0.2288277	-0.1140781
1st Quartile	19,814	19,695	-0.0160013	-0.0051654
Median	23,081	23,065	-0.0020012	-0.0002661
Mean	26,465	26,462	-0.0006292	-0.0004221
3rd Quartile	30,959	30,930	0.0164545	0.0051588
Max	47,968	48,190	0.1869561	0.08194
Std.Dev	8,976.29	8,991.91	0.04047	0.01916281
Skewness	0.8514	0.8472	-0.546095	-0.8366142
Kurtosis	-0.656	-0.641	5.7992426	8.8184571

The table presents descriptive statistics, including maximum, minimum, mean, quartiles, median, standard deviation, skewness, and kurtosis, for the variables. The data utilized in this analysis consists of daily observations spanning from January 2022 to April 2023.

Table 1 presents the descriptive statistics for all variables discussed earlier, which will be incorporated into the event study empirical model. The average Bitcoin spot and futures price is 26,465 and 26,462 in US dollars, which are very close, as expected[6]. Regarding the log returns of Bitcoin spot, the average return for the study period is -0.06%, it seems that the announcements made by the Federal Reserve during the study period did not have a noticeable impact on the price of Bitcoin. Regarding the log spread between spot and futures values of Bitcoin, the mean value is approximately -0.0004221. In terms of market volatility of Bitcoin, the standard deviation for both Bitcoin spot and futures is close to 9,000. Additionally, concerning Bitcoin's daily returns, its volatility stands at approximately 4.05%, while the log Bitcoin Spread's variability around the mean is approximately 0.01916. A negative skewness in the Bitcoin returns indicates a longer left tail. A large positive kurtosis value for both the log returns of BTC spot and log BTC Spread indicates the presence of heavy tails, where their distributions exhibit more extreme values compared to a normal distribution.

3.3 Sample Description: Event Decomposition

Based on the time series of the Bitcoin spot price of the study sample, I identified all dates where the logarithmic returns exceeded $+5\%$ or fell below -5%. This filtering process aimed to isolate

---

[6]The proximity between spot and futures Bitcoin prices in the analyzed sample can be visually confirmed by Figure 5, which is presented in the appendices.

Table 2: Key Event Description

Type of Events	Event Description	No. of Occurrence
Fed Rate Hike	When the Federal Open Market Committee decides to increase the federal funds target rate in response to high inflation during the study period.	9
Positive Fed Expectation	When the market forms an expectation that the Federal Reserve will decide to end its restrictive monetary policy, due to easing inflationary pressures, soft macroeconomic data, and dovish speeches by FOMC members.	10
Negative Fed Expectation	When the market anticipates that the Federal Reserve will keep its restrictive monetary policy due to increasing inflationary pressures, strong macroeconomic data, and hawkish speeches by FOMC members.	11
Crypto Failure	Potential crypto-related failures, such as the bankruptcy of companies like FTX or the failure of Celsius, that could have significant repercussions on the industry.	9
Bank Failure	An event related to the traditional banking sector's turmoil. For example, the bankruptcy of SVB.	2

the most significant occurrences that had either a positive or negative impact on Bitcoin's price. The objective was to investigate the influence of different events on the price of Bitcoin. The output of this process is displayed in Table 3 and Table 4. Furthermore, the main drivers of movement on each date were identified, taking into account the news headlines on that specific day. After eliminating some dates with no clear explanation for price movements, the remaining dates were classified into four types of events, as presented in Table 2. Each type of event was accompanied by a description and the number of occurrences during the research period.

The dates in Table 3 were organized in descending order based on the daily returns of Bitcoin, specifically focusing on returns above +5%. This arrangement helps in understanding which types of events contribute more strongly to Bitcoin's price increase. On the other hand, Table 4 was organized in ascending order based on the daily returns of Bitcoin, specifically focusing on returns below −5%. This arrangement allows for a better comprehension of the events that caused the biggest negative changes in the Bitcoin price. Based on the findings from Table 3, it was observed that bank failures associated with Silicon Valley Bank (SVB) and Signature Bank, despite the latter also being considered crypto-friendly, had the most significant positive impact on Bitcoin's price during the analyzed time span. Additionally, two events indicating an anticipated shift towards a more dovish monetary policy stance by the Federal Reserve also had a notable influence on Bitcoin's price. Regarding Table 4, the most substantial depreciation of Bitcoin during the analyzed period was attributed to a series of events related to crypto failures, along with market expectations of a more hawkish stance from the Fed.

Despite the small sample size of bank failure-related events, I decided to include them in my analysis due to their significant impact and extensive implications on the global banking sector during

the study period. This series of bank collapses, which occurred in March 2023, commenced with the bankruptcy of Silicon Valley Bank[7], marking it as the second-largest bank failure in the history of the United States[8]. Subsequently, numerous regional banks in the US experienced a similar fate, further fueling concerns regarding the stability of Credit Suisse, one of the most substantial banks on a global scale. These occurrences were accompanied by an extensive sell-off of banking stocks and triggered a large-scale bank run, intensifying the existing concerns.

Table 3: Event Decomposition: Events with BTC Log Returns Above +5%

Dates with BTC returns above +5%	Type of Events	Event News	News Source
13/03/2023	Bank Failure	Bitcoin surges 18% amid SVB, Signature Bank failures.	Morningstar
10/11/2022	Positive Fed Expectation	October's inflation cooled to its slowest pace of the year.	Barron's
31/05/2022	Positive Fed Expectation	Jerome Powell's speech clarified the Fed's plan for a soft economic landing.	Coindesk
04/02/2022	Other Positive Macro News	Surprising positive job and unemployment data.	Forbes
09/09/2022	Other	Bitcoin breaches $20,000 amidst dollar drop in "bearish rally".	CNBC
09/03/2022	Crypto Regulation	Cryptocurrencies rose following President Biden's supportive executive order on digital assets.	CNBC
15/02/2023	Positive Fed Expectation	Bitcoin rebounds above $22.5K following CPI report.	Coindesk
27/07/2022	Fed Rate Hike	BTC briefly rallies above $23K post 75 bps dovish Fed rate hike.	Bloomberg
07/02/2022	Other Positive Macro News	Bitcoin surged above $44,000 on Monday on positive U.S. jobs data.	Barron's
19/07/2022	Positive Fed Expectation	BTC holds $20K support, ignores 1% rate hike possibility.	Coindesk

---

[7]Although the failure of Silvergate Bank took place one day before SVB Bank's, I consider the latter to be the trigger that initiated this banking crisis. This is primarily due to SVB Bank's larger size and the fact that Silvergate Bank also has exposure to cryptocurrency. Hence, SVB Bank's impact on the crisis is more significant.

[8]In March 2023, Silicon Valley Bank was the second-largest bank failure in US history. That was until First Republic Bank knocked it off that spot on May 1, 2023, according to Bloomberg. News can be found on: `https://www.bloomberg.com/news/articles/2023-05-01/first-republic-ranks-as-second-largest-ever-us-bank-failure#xj4y7vzkg`.

17/03/2023	Bank Failure	SVB Financial files for Chapter 11, BTC and other crypto offers safe alternative amid banking crisis.	Bloomberg
28/03/2022	Other	Bitcoin rallies as holders accumulate; Luna Foundation Guard buys $1B BTC.	Coindesk
17/01/2023	Positive Fed Expectation	Cooler CPI boosted Bitcoin by 8% as investors anticipated a Fed policy shift on rate hikes.	Investopedia
12/01/2023	Positive Fed Expectation	Slower inflation allows Fed to reduce rate hikes to 25 basis points per meeting from 50 in December.	Coindesk
28/02/2022	Geopolitical Risk	Amidst the Russian invasion, Bitcoin transactions in Russian ruble and Ukrainian hryvnia on centralized exchanges hit a months-long peak.	CNBC
20/01/2023	Positive Fed Expectation	Traders expect a 97% chance of a 25 bps rate hike by the FOMC, down from the anticipated 50 bps increase, due to a significant decline in the PPI.	Coindesk
06/06/2022	Other	Experts remain bullish on cryptocurrencies despite recent dips.	Finbold
07/07/2022	Positive Fed Expectation	Recent economic data eased inflation concerns.	Bloomberg
28/07/2022	Positive Fed Expectation	Less aggressive Fed raises hopes for crypto winter thaw.	Bloomberg
01/03/2022	Other	Bitcoin surges again as crypto demand rises as a haven.	Bloomberg
04/05/2022	Positive Fed Expectation	Fed Chair Powell said no 75 basis points rate hike at upcoming meetings.	Bloomberg
05/07/2022	Other	Bitcoin's recent price movement seems to have driven out speculative investors who may have contributed to establishing a support level for the cryptocurrency.	Decrypt
13/01/2023	Other	Despite the turmoil in the crypto world, Bitcoin enthusiasts remain unfazed.	Bloomberg

12/09/2022	Other	Bitcoin rallied further as global markets improved and traders awaited US CPI data while monitoring a significant Ether blockchain upgrade.	Bloomberg
14/07/2022	Other	Bitcoin surpasses $20,000, Celsius removes uncertainty.	Bloomberg

The dates in this table are arranged in descending order based on returns above +5% among the 305 observations. The date with the highest return is displayed first, while the date with the lowest return is displayed last.

Table 4: Event Decomposition: Events with BTC Log Returns Below -5%

Dates with BTC returns below -5%	Type of Events	Event News	News Source
13/06/2022	Crypto Failure	Crypto lending platform, Celsius pauses withdrawals.	CNBC
09/11/2022	Crypto Failure	Binance abandoned plans to acquire FTX.	CNBC
09/05/2022	Negative Fed Expectation	Worries over Fed's tight monetary policy.	Reuters
13/09/2022	Negative Fed Expectation	Bitcoin prices dropped on higher-than-expected U.S. inflation.	Barron's
08/11/2022	Crypto Failure	Bitcoin price drop amid FTX-Binance tussle.	WSJ
19/08/2022	Negative Fed Expectation	Bitcoin's sharpest monthly decline as hopes fade for a dovish Fed.	Business Insider
05/05/2022	Negative Fed Expectation	Traders digesting Fed rate hike announcement contribute to overall market weakness.	Investing.com
11/05/2022	Negative Fed Expectation	April's consumer price index surged by 8.3%, exceeding the estimated 8.1% and approaching a 40-year high.	CNBC
09/03/2023	Crypto Failure	Bitcoin drops as Silvergate Bank's (a crypto-friendly lender) collapse highlights a major threat to US crypto industry.	Bloomberg
17/02/2022	Negative Fed Expectation	Potential overly aggressive Fed tightening may jeopardize all risky assets.	Coindesk
30/06/2022	Crypto Failure	Crypto lender Celsius explores options to safeguard assets.	Coindesk
11/04/2022	Negative Fed Expectation	Bitcoin price dropped on Monday due to concerns over rising rates and potential Fed tightening.	CNBC
01/06/2022	Other	Bitcoin bulls likely liquidated positions, causing the drop.	Bitcoin.com

11/07/2022	Negative Fed Expectation	May's CPI rose by 8.6%, the highest in 40 years. June's rates may surge further as the Fed plans to raise rates by 75 basis points.	Forbes
04/03/2022	Geopolitical Risk	Bitcoin slumps amid escalating Russia-Ukraine conflict.	Bloomberg
10/03/2022	Negative Fed Expectation	Bitcoin rally fades ahead of US inflation data as investors brace for the end of quantitative easing.	Bloomberg
21/11/2022	Crypto Failure	Bitcoin drops below $16K amid FTX shockwaves in the crypto market.	Bloomberg
11/11/2022	Crypto Failure	FTX file for bankruptcy in the US.	CNBC
14/06/2022	Crypto Failure	Bitcoin declines as Celsius weighs on sentiment.	Bloomberg
26/07/2022	Crypto Regulation	Crypto slumps as US regulators intensify scrutiny.	Bloomberg
22/02/2022	Geopolitical Risk	Bitcoin prices drop amid Russia-Ukraine tensions.	CNBC
26/04/2022	Negative Fed Expectation	Investors' risk aversion rose due to concerns about central bank tightening.	Coindesk
03/03/2023	Crypto Failure	Bitcoin fell over 5% as customers fled Silvergate, a crypto bank whose stock plummeted 58% in U.S. trading.	Coindesk
06/09/2022	Negative Fed Expectation	Rising U.S. inflation to boost interest rates this year.	Yahoo Finance

The dates in this table are arranged in ascending order based on returns below -5% among the 305 observations. The date with the lowest return is displayed first, while the date with the highest return is displayed last.

3.4 Methodology

In terms of methodology to test H1, this paper is most closely aligned with the literature of Hillenbrand (2021), which employed an event-driven analysis to identify the impact of the Fed monetary policy. In particular, I aim to study the response of Bitcoin returns during a short-term window around monetary policy announcements made by the Fed using the proposed event study analysis.

In this study, Equation 3.3 has been derived by adapting Equation 4 proposed by Hillenbrand (2021) to evaluate the statistical significance of an event through a simple regression analysis.

Specifically, I have conducted a regression analysis where the daily logarithmic returns of Bitcoin price in dollars on day t, denoted as R_{log}^{BTC} is regressed on a dummy variable that is set to 1 when day t falls within a 3-day window of the event and 0 otherwise.

$$R_{log}^{BTC} = ln\left(\frac{BTC_t}{BTC_{t-1}}\right) = \beta_0 + \beta_1 \text{Dummy (3-day Event window)}_t + \epsilon_t \tag{3.3}$$

The present regression analysis aims to assess the statistical significance of the impact of days falling within a 3-day event window, as opposed to those falling outside of it.

$$ln(\text{BTC } Spread_t) = \beta_0 + \beta_1 \text{Dummy (3-day Event window)}_t + \epsilon_t \tag{3.4}$$

To investigate the impact of a specific type of event on the price difference between Bitcoin futures and Bitcoin spot, adjustments were also made to the equation presented by Hillenbrand (2021). So Equation 3.4 was created to conduct a regression analysis, wherein the daily logarithmic Bitcoin Spread, denoted as $ln(\text{BTC } Spread_t)$, was regressed on a binary dummy variable. The dummy variable was set to 1 when day t fell within a 3-day event window and 0 otherwise.

4. RESULTS

Figure 2: 3-day Window around FOMC Meetings
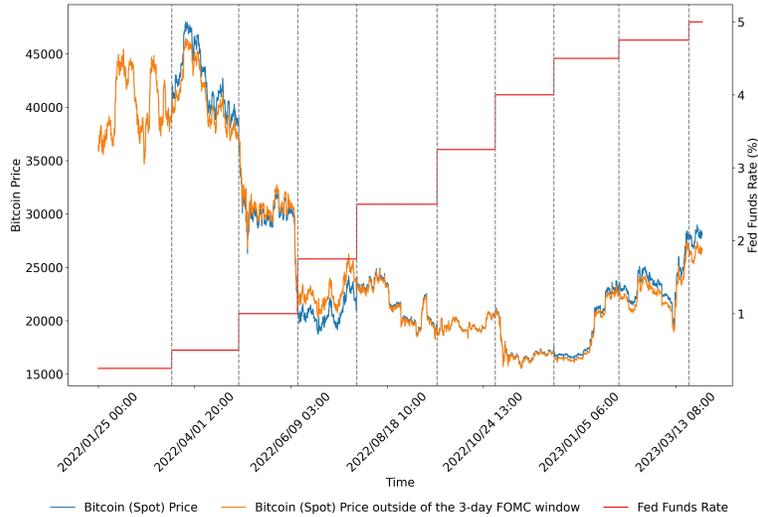
(a) Bitcoin Spot
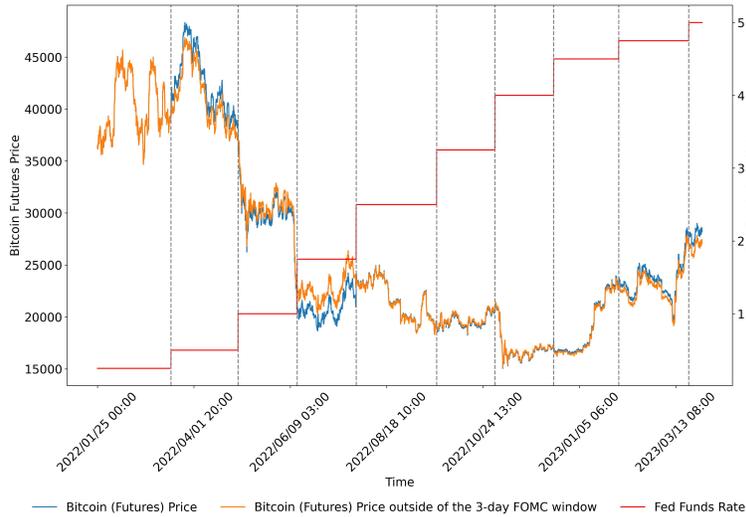
(b) Bitcoin Futures

Both panels (a) and (b) of Figure 2 compare the actual Bitcoin price with the Bitcoin price movement on all days outside a narrow time window around monetary policy meetings of the Federal Reserve for spot and futures, respectively. These panels exhibit a high degree of similarity. Upon examining these two figures, where the FOMC announcement dates are represented by the dashed lines, it can be observed that after removing the 3-day window around FOMC announcements, the new price (represented by the orange line) remained relatively close to the original price (depicted by the blue line) that falls within the 3-day FOMC window. This observation holds true for both Bitcoin

spot and Bitcoin futures prices.

Figure 3: Bitcoin Spread Within and Outside the 3-day FOMC Window
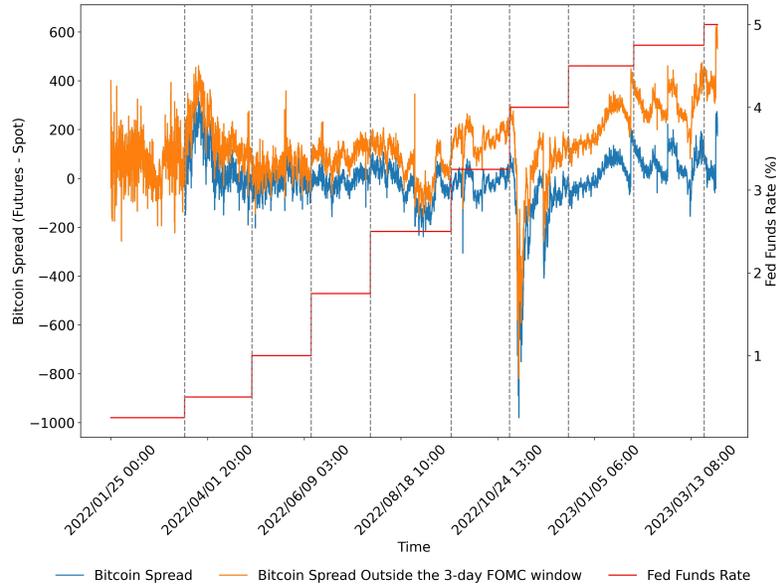
Concerning the spread between the Bitcoin futures and spot prices illustrated in Figure 3, it is observed that the spread outside the 3-day FOMC window (depicted by the orange line) is higher than the original Bitcoin Spread (represented by the blue line).

The impact of Federal Reserve announcements on Bitcoin appears to be more evident in Figure 3, specifically in relation to the Bitcoin Spread, in comparison to the Bitcoin spot and futures graphs. This disparity can be attributed to the differing scales of each graph, with the former exhibiting a noticeably smaller scale compared to the latter.

4.1   FOMC Announcements Analysis Regression Results

Table 5 reports the estimation results of Equation 3.3, which provides a detailed analysis of the potential influence of Federal Reserve announcements on Bitcoin returns during the analyzed period. The table also includes information regarding the interest rate hike decisions made by the FOMC on each announcement day. It was observed that regardless of the rate hike dimension, none of the FOMC announcements had a significant impact on Bitcoin returns. This is in line with the conclusions reached by Pyo and Lee (2020) and Benigno and Rosa (2023). However, the presented findings differ from the conclusions drawn by Karau (2021) and Ma et al. (2022).

Although statistically insignificant, the regression analysis coefficients suggest that an increase in the Fed's interest rate hike dimension relative to previous announcements may have a negative impact on Bitcoin returns. This observation might indicate that a more hawkish monetary policy adopted by the Fed tends to affect Bitcoin returns negatively.

20

Table 5: Regression: Log Bitcoin Returns Within vs. Outside the 3-day FOMC Window

Date	Fed Hike (in Basis Points)	FOMC 3-day Window	Constant	R^2
22/03/2023	25	0.0036256 (0.154)	-0.0006649 (-0.285)	0.00008
01/02/2023	25	0.0110242 (0.469)	-0.0007377 (-0.316)	0.000725
14/12/2022	50	0.004955 (0.211)	-0.000678 (-0.291)	0.000147
02/11/2022	75	-0.0021286 (-0.090)	-0.0006083 (-0.261)	0.000027
21/09/2022	75	-0.0041315 (-0.176)	-0.0005886 (-0.252)	0.000102
27/07/2022	75	0.0277835 (1.184)	-0.0009025 (-0.388)	0.004604
15/06/2022	75	-0.0382580 (-1.634)	-0.0002529 (-0.109)	0.008731
04/05/2022	50	-0.016085 (-0.684)	-0.000471 (-0.202)	0.001543
16/03/2022	25	0.0175821 (0.748)	-0.0008022 (-0.344)	0.001844
Observations	305			

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation occurs on a daily basis.

The estimation results of Equation 3.4 presented in Table 6 further indicate the statistical insignificance of the Federal Reserve's monetary policy shock on the spread of Bitcoin. This finding suggests that the spread between the futures and spot prices of Bitcoin does not exhibit a significant reaction to an interest rate hike decision by the Federal Reserve.

Table 6: Regression: Log Bitcoin Spread Within vs. Outside the 3-day FOMC Window

Date	Fed Hike (in Basis Points)	FOMC 3-day Window	Constant	R^2
22/03/2023	25	-0.002511 (-0.225)	-0.000397 (-0.360)	0.000168
01/02/2023	25	0.013556 (1.220)	-0.000555 (-0.504)	0.00489
14/12/2022	50	-0.000626 (-0.056)	-0.000416 (-0.377)	0.00001
02/11/2022	75	0.002689 (0.241)	-0.000449 (-0.406)	0.000192
21/09/2022	75	0.001772 (0.159)	-0.000440 (-0.398)	0.000084
27/07/2022	75	-0.004001 (-0.359)	-0.000383 (-0.347)	0.000426
15/06/2022	75	0.004441 (0.399)	-0.000466 (-0.422)	0.000525
04/05/2022	50	-0.001791 (-0.161)	-0.000405 (-0.366)	0.000085
16/03/2022	25	-0.015682 (-1.413)	-0.000268 (-0.243)	0.006544
Observations	305			

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis.

4.2 Event Analysis Regression Results

Table 7: Regression: Log Bitcoin Returns Within vs. Outside the 3-day Event Window

Key Events	Event 3-day Window	Constant	Obs.	R^2	No. of Occurrence
Fed Rate Hike	0.0005272 (0.065)	-0.0006759 (-0.278)	305	0.000014	9
Positive Fed Expectation	0.021744*** (2.783)	-0.002697 (-1.119)	305	0.02492	10
Negative Fed Expectation	-0.027516*** (-3.660)	0.002168 (0.904)	305	0.04234	11
Crypto Failure	-0.038773*** (-4.461)	0.002168 (0.928)	305	0.06162	9
Bank Failure	0.058133*** (3.549)	-0.001773 (-0.772)	305	0.0399	2

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis. Regression analyzes were performed for each relevant event date associated with Positive Fed Expectation, Negative Fed Expectation, Crypto Failure and Bank Failure. The results of these analyses are presented in Tables 13, 14, 15, and 12, respectively, which can be found in the appendices.

Based on the estimated results of Equation 3.3 for different event types displayed in Table 7, it can be inferred that the occurrence of events within a 3-day window around the FOMC announcements has no significant impact on the returns of Bitcoin, therefore H1 is not valid. However, the manifestation of Positive and Negative Fed Expectations in the market has a statistically significant impact on Bitcoin returns. In particular, the formation of positive expectations among market participants regarding the FOMC's decision to pause leads to an average increase in Bitcoin's price of 2.17%, whereas the manifestation of negative expectations results in an average decrease of 2.75%. Furthermore, events related to Crypto Failure within the 3-day event window have led to an average decline in the price of Bitcoin of 3.88%. Conversely, the occurrence of Bank Failure related events has caused an average increase in the price of Bitcoin of 5.81% within the 3-day event window.

Table 8: Regression: Log Bitcoin Spread Within vs. Outside the 3-day Event Window

Key Events	Event 3-day Window	Constant	Obs.	R^2	No. of Occurrence
Fed Rate Hike	-0.000260 (-0.067)	-0.000399 (-0.347)	305	0.000015	9
Positive Fed Expectation	0.001882 (0.502)	-0.000601 (-0.520)	305	0.000832	11
Negative Fed Expectation	0.006025* (1.664)	-0.001035 (-0.896)	305	0.009057	11
Crypto Failure	-0.005388 (-1.272)	-0.000033 (-0.029)	305	0.005308	9
Bank Failure	0.007156 (0.905)	-0.000563 (-0.508)	305	0.0027	2

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis. Regression analyzes were performed for each relevant event date associated with Positive Fed Expectation, Negative Fed Expectation, Crypto Failure and Bank Failure. The results of these analyses are presented in Tables 13, 14, 15, and 12, respectively, which can be found in the appendices.

Upon analyzing the estimated results of Equation 3.4 presented in Table 8 and taking into consideration the period of the study, it is evident that the majority of events analyzed do not yield a statistically significant impact on the Bitcoin Spread. However, it is worth noting that the event labeled "Negative Fed Expectation" stands out as an exception.

The regression analysis indicates that announcements related to Positive Federal Reserve Expectation (i.e., the announcement that led the market to anticipate the end of the contractionary monetary policy cycle), Crypto Failure, and Bank Failure exhibit a negligible impact on the price spread of Bitcoin futures and spot.

However, the release of information in the market that indicates an impending rise in interest rates by the Federal Reserve, or Negative Fed Expectation, can have significant effects on the Bitcoin Spread. Specifically, this phenomenon tends to increase the log spread between the Bitcoin futures price and the Bitcoin spot price by 0.006025.

In accordance with Hull (2015), the theory suggests that when the underlying asset, such as Bitcoin, does not generate any income, the relationship between the futures price and spot price of Bitcoin can be expressed as follows:

$$F_0 = S_0 e^{rT} \tag{4.1}$$

Concerning Bitcoin futures contracts, taking into consideration equation 4.1, F_0 is the price of the Bitcoin futures, S_0 is the spot price of the Bitcoin, r is the risk-free rate, and T is the time to maturity.

Regarding the only statistically significant event, Negative Fed Expectation, the coefficient's sign in the regression analysis displayed in Table 8 is consistent with the theoretical expectations when considering the futures and spot prices parity formula, as described by equation 4.1. When investors anticipate an increase in interest rates by the Federal Reserve, which leads to an increase in the risk-free rate. This, in turn, results in an increase in the value of the futures contract for Bitcoin and consequently an increase in the spread between Bitcoin's futures and spot prices.

The fact that the behavior of Bitcoin Spread during this type of event aligns with theoretical expectations, where new information is correctly reflected in the price movements of Bitcoin spot and futures, can provide support for the existence of market efficiency in the Bitcoin market during events that generate expectations of a Federal Reserve interest rate hike. Consequently, there is no evidence to suggest the existence of any arbitrage opportunities that investors can exploit. The empirical evidence demonstrating the absence of market inefficiency suggests that Bitcoin futures represent a viable strategy for risk mitigation within the Bitcoin market, particularly during such an event.

However, it should be noted that in the Fed Rate Hike and Positive Fed Expectation announcements, the signs of the respective coefficients are not aligned with the futures-spot parity formula presented in Equation 4.1, which might indicate some inefficiency in the Bitcoin market during these events as it diverges from the theoretical expectations. However, it is worth mentioning that these events do not demonstrate a statistically significant impact on Bitcoin Spread movements. Therefore, capturing arbitrage opportunities from such market inefficiencies would be challenging.

Figure 4: Bitcoin Price Spread vs. Federal Funds Rate (Upper Bound)
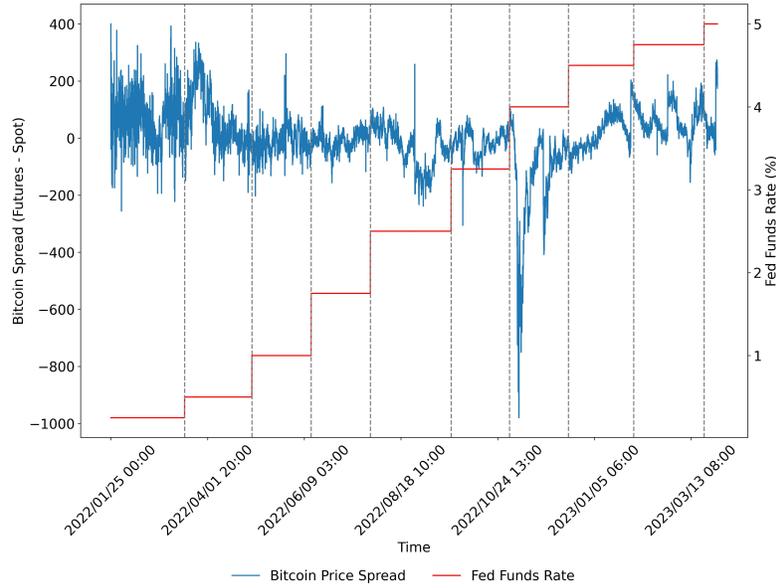
Furthermore, as depicted in Figure 4, the spread between the price of Bitcoin futures and the price of Bitcoin spot exhibits considerable volatility. This high level of market uncertainty makes it really difficult to exploit any arbitrage opportunities from the futures-spot Bitcoin strategy.

4.3 Robustness Tests

Table 9: Robustness Tests: Log Bitcoin Returns Within vs. Outside the 7-day Event Window

Key Events	Event 7-day Window	Constant	Obs.	R^2	No. of Occurrence
Fed Rate Hike	-0.010331* (-1.811)	0.001505 (0.580)	305	0.01071	9
Positive Fed Expectation	0.004042 (0.697)	-0.001438 (-0.554)	305	0.001601	10
Negative Fed Expectation	-0.012762** (-2.270)	0.002090 (0.806)	305	0.01673	11
Crypto Failure	-0.015994** (-2.397)	0.001573 (0.635)	305	0.04016	9
Bank Failure	0.021091* (1.702)	-0.001390 (-0.591)	305	0.009471	2

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis.

Table 10: Robustness Tests: Log Bitcoin Spread Within vs. Outside the 7-day Event Window

Key Events	Event 7-day Window	Constant	Obs.	R^2	No. of Occurrence
Fed Rate Hike	-0.000125 (-0.046)	-0.000396 (-0.321)	305	0.000007	9
Positive Fed Expectation	0.000186 (0.068)	-0.000459 (-0.374)	305	0.000015	10
Negative Fed Expectation	0.004002 (1.497)	-0.001275 (-1.033)	305	0.007337	11
Crypto Failure	-0.003109 (-0.976)	0.0000061 (0.005)	305	0.003136	9
Bank Failure	0.0027166 (0.461)	-0.000520 (-0.465)	305	0.000701	2

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis.

The sensitivity of the regression results to changes in the window size was assessed through robustness tests similar to those employed by Benigno and Rosa (2023). Different event windows were explored to evaluate the consistency and reliability of the findings.

The re-estimated results of Equations 3.3 and 3.4 for a 7-day event window are presented in Tables 9 and 10, respectively.

In Table 10, the results show that for a 7-day Event window, even the Negative Fed Expectation's effect on Bitcoin Spread is no longer statistically significant. This finding calls into question the conclusion drawn in the preceding subsection, thereby compromising its validity. Regarding the Bitcoin returns, Table 9 shows that the majority of the results of Subsection 4.2 continue to hold, with the exception of the Positive Fed Expectation event, which is no longer statistically significant for Bitcoin price movements. In contrast, there is now empirical evidence supporting the notion that Fed announcements have a negative statistically significant impact on Bitcoin returns at a level of 10% for a longer event window.

These findings raise doubts about the significance of Positive Fed Expectation on Bitcoin returns, as well as the impact of Negative Fed Expectation on Bitcoin Spread. They suggest the need for additional empirical evidence to establish a potential causal relationship between these types of events and Bitcoin.

A possible explanation for the Fed Announcements becoming statistically significant on Bitcoin returns for the 7-day event window might be the fact that, due to the comparatively limited

liquidity of the Bitcoin market, the assimilation of information into prices may require a longer dura-
tion. The immediate response fails to accurately depict the influence of monetary policy on Bitcoin
prices (Ma et al., 2022). Hence, further evidence is required to fully substantiate the disconnection of
Bitcoin from monetary policy shocks initiated by the Federal Reserve.

Table 11: Robustness Tests: 25-hour Event Window

Key Events	Event 25-hour Window	Constant	Obs.	R^2	No. of Occurrence
Panel A: Log Bitcoin Returns Within vs. Outside the 25-hour Event Window					
Fed Rate Hike	0.0008457 (1.608)	-0.0000516 (-0.550)	7060	0.0003663	9
Panel B: Log Bitcoin Spread Within vs. Outside the 25-hour Event Window					
Fed Rate Hike	0.001558*** (4.677)	-0.0003331*** (-5.600)	7060	0.00309	9

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics
are shown in parentheses. The observation is on an hourly basis. The source of the data is Bloomberg. The
data sample covers the period from January 25, 2022, to April 11, 2023.

Table 11 presents the re-estimated outcomes of Equation 3.3 in Panel A and Equation 3.4
in Panel B for a 25-hour Event window centered around the event's occurrence (12 hours before and
after the event). Note that I performed the regression analysis solely for the FOMC announcements,
as this is the only event for which the announcement hour is officially provided.

The findings regarding the Bitcoin returns were consistent with those observed within the
3-day event window, indicating that the influence of FOMC announcements on the price of Bitcoin
is insignificant. However, the response of the spread between Bitcoin futures and spot prices to the
Federal Reserve's interest rate hike has now achieved statistical significance at a level of 1%. According
to this sensitivity analysis, more evidence is required to evaluate whether there is a correlation between
FOMC Announcements and Bitcoin Spread.

5. CONCLUSIONS

This paper examines the influence of Federal Reserve announcements and various significant events on the price of Bitcoin. It also analyzes how these factors affect the divergence between Bitcoin futures and spot prices. A regression model is employed in this study, using data sourced from Bloomberg. This study contributes to the existing literature by analyzing Bitcoin pricing and Bitcoin futures-spot Spread behaviors during a period characterized by a sharply contractionary monetary policy.

This paper presents empirical evidence suggesting that monetary policy innovations implemented by the Federal Reserve have a negligible direct effect on the price of Bitcoin, in line with Pyo and Lee (2020) and Benigno and Rosa (2023). However, when the market incorporates negative expectations regarding the Fed's monetary policy, i.e., receives information that leads to the belief of further contractionary monetary measures, it does have a statistically significant effect on the Bitcoin price. This effect is manifested as a decrease in the value of Bitcoin. Conversely, events that have generated optimistic expectations regarding the Fed's monetary policy, specifically anticipating the end of disinflationary measures, contribute positively to the value of Bitcoin. These results might reveal that the market tends to anticipate and incorporate announcements that may potentially influence the Federal Reserve's future decisions regarding monetary policy, even before they are solidified. Hence, the findings presented above suggest that the Federal Reserve's decisions do have an indirect influence on the price return of Bitcoin.

Nevertheless, the observed results regarding the Fed Rate Hike and Positive Fed Expectation events require further investigation to gain a deeper understanding of the relationship between Bitcoin and these events due to inconsistencies observed across different time windows, which raise questions regarding the validity of the obtained results.

In this study, I have also discovered evidence indicating that during periods of turbulence in the established financial market, particularly when there is a loss of confidence in the banking sector, the value of Bitcoin tends to exhibit an increase. Given the negative correlation between the price of Bitcoin and events associated with banking sector turmoil, which are accompanied by a widespread decline in banking stocks, it can be argued, in accordance with the definitions presented by Baur and Lucey (2010) and Baur and McDermott (2010), that Bitcoin can be considered a strong safe-haven asset for banking sector investors.

Moreover, through empirical analysis, I found a significant decline in the value of Bitcoin during a specific period characterized by a prevailing negative sentiment associated with the collapse of crypto-related companies, supporting the findings of Gaies et al. (2021).

Furthermore, based on empirical analysis, it can be concluded that both the instability of the banking system and the collapse in the crypto sector do not significantly affect the spread of Bitcoin's futures and spot. Similar results were obtained regarding FOMC announcements and events that generate optimistic anticipation about the end of monetary policy tightening.

However, events that generate pessimistic expectations and imply an increased likelihood of interest rate hikes by the Fed do have a significant impact on the Bitcoin Spread, and the fact that the spread movement matches theoretical expectation suggests that, during this type of event, the futures-spot market of Bitcoin does not exhibit pricing inefficiencies. Therefore, this finding can further support the notion that Bitcoin's futures serve as an effective tool for hedging Bitcoin-related risks in such an environment. These results offer some support for the evidence presented by Sebastião and Godinho (2020) and Almeida and Gonçalves (2022). Nevertheless, the inconsistent findings from empirical analyzes conducted with varying event windows raise doubts about the robustness of conclusions regarding the widening of the Bitcoin Spread during a Negative Fed Expectation event as well as the unresponsiveness of the Bitcoin Spread to Fed Announcements.

As mentioned earlier, the main drivers of Bitcoin spot returns are announcements that contribute to anticipating future Fed actions, announcements regarding bank failures, and the crises surrounding the crypto sector. However, the results show that the strategy of investing in Bitcoin Spread does not appear to be responsive to the majority of the events analyzed. This observation suggests that the predictability of the Bitcoin Spread investment strategy tends to be lower during these events. Consequently, if investors believe that the Federal Reserve will halt interest rate hikes, investing in Bitcoin becomes more attractive. Conversely, if investors anticipate a continuation of rising interest rates, investing in Bitcoin may yield lower profitability. Furthermore, for investors seeking a hedge against potential risks in the banking sector, Bitcoin represents a favorable investment opportunity. Moreover, if investors believe that a collapse in the cryptocurrency market is imminent, short-selling Bitcoin may be considered a viable option. However, it is important to note that these periods are often accompanied by significant volatility, so investors must assume a significant level of risk.

The research findings presented here are very informative for Bitcoin investors, as they offer valuable insights into the price dynamics of Bitcoin under various market conditions. According to the discoveries presented in this paper, Bitcoin traders can enhance their comprehension of the impact of different events on Bitcoin's price movements, thereby enabling them to devise more effective trading strategies in response to varying market environments. The findings also bear significant relevance for risk management purposes, as they reveal the safe-haven characteristics of Bitcoin during banking turmoil.

The primary limitation of this study relates to the restricted sample size observed for certain events. In the future, as new events emerge in the market, a larger sample size will be accessible to

investors, enabling the achievement of more robust results. Another limitation arises from the use of regression analysis as the sole methodology employed in this study to assess the impact of various events on Bitcoin's value. A more systematic or structural analysis should be conducted in subsequent research to thoroughly investigate each significant event mentioned in this paper.

Future studies could enhance their analysis by incorporating additional occurrences and conducting a more comprehensive examination of Bitcoin's potential as a safe-haven amidst instability in the traditional banking system, given the limited sample size examined concerning the Banking Turmoil event. Further research could endeavor to conduct a more systematic analysis that investigates the market efficiency of the Bitcoin by examining the abnormal pricing deviation between Bitcoin futures and spot prices during periods of restrictive monetary policies.

REFERENCES

Akhtaruzzaman, M., Sensoy, A., and Corbet, S. (2020). The influence of bitcoin on portfolio diversi-
fication and design. *Finance Research Letters*, 37:101344.

Aleti, S. and Mizrach, B. (2021). Bitcoin spot and futures market microstructure. *Journal of Futures
Markets*, 41(2):194–225.

Almeida, J. and Gonçalves, T. C. (2022). Portfolio diversification, hedge and safe-haven properties
in cryptocurrency investments and financial economics: A systematic literature review. *Journal of
Risk and Financial Management*, 16(1):3.

Almeida, J. and Gonçalves, T. C. (2023). A systematic literature review of investor behavior in the
cryptocurrency markets. *Journal of Behavioral and Experimental Finance*, page 100785.

Andrade, D. M. d., Barros Jr, F., Motoki, F. Y., and Oliveira da Silva, M. (2021). Price dynamics
of cryptocurrencies in parallel markets: evidence from bitcoin exchanges in brazil. *Studies in
Economics and Finance*, 38(5):1040–1053.

Ante, L. and Meyer, A. (2021). Cross-listings of blockchain-based tokens issued through initial coin
offerings: Do liquidity and specific cryptocurrency exchanges matter? *Decisions in Economics and
Finance*, 44(2):957–980.

Baily, M. N., Litan, R. E., and Johnson, M. S. (2009). The origins of the financial crisis.

Baur, D. G., Hong, K., and Lee, A. D. (2018). Bitcoin: Medium of exchange or speculative assets?
Journal of International Financial Markets, Institutions and Money, 54:177–189.

Baur, D. G. and Lucey, B. M. (2010). Is gold a hedge or a safe haven? an analysis of stocks, bonds
and gold. *Financial review*, 45(2):217–229.

Baur, D. G. and McDermott, T. K. (2010). Is gold a safe haven? international evidence. *Journal of
Banking & Finance*, 34(8):1886–1898.

Będowska-Sójka, B. and Kliber, A. (2021). Is there one safe-haven for various turbulences? the
evidence from gold, bitcoin and ether. *The North American Journal of Economics and Finance*,
56:101390.

Benigno, G. and Rosa, C. (2023). The bitcoin–macro disconnect. *FRB of New York Staff Report*,
(1052).

Bernanke, B. S. and Kuttner, K. N. (2005). What explains the stock market's reaction to federal reserve policy? *The Journal of finance*, 60(3):1221–1257.

Bouri, E., Gupta, R., and Roubaud, D. (2019). Herding behaviour in cryptocurrencies. *Finance Research Letters*, 29:216–221.

Bouri, E., Lucey, B., and Roubaud, D. (2020a). Cryptocurrencies and the downside risk in equity investments. *Finance Research Letters*, 33:101211.

Bouri, E., Shahzad, S. J. H., and Roubaud, D. (2020b). Cryptocurrencies as hedges and safe-havens for us equity sectors. *The Quarterly Review of Economics and Finance*, 75:294–307.

Brauneis, A., Mestel, R., and Theissen, E. (2021). What drives the liquidity of cryptocurrencies? a long-term analysis. *Finance Research Letters*, 39:101537.

Charfeddine, L., Benlagha, N., and Maouchi, Y. (2020). Investigating the dynamic relationship between cryptocurrencies and conventional assets: Implications for financial investors. *Economic Modelling*, 85:198–217.

Cheah, E.-T. and Fry, J. (2015). Speculative bubbles in bitcoin markets? an empirical investigation into the fundamental value of bitcoin. *Economics letters*, 130:32–36.

Cheung, A., Roca, E., and Su, J.-J. (2015). Crypto-currency bubbles: an application of the phillips–shi–yu (2013) methodology on mt. gox bitcoin prices. *Applied Economics*, 47(23):2348–2358.

Conlon, T. and McGee, R. (2020). Safe haven or risky hazard? bitcoin during the covid-19 bear market. *Finance Research Letters*, 35:101607.

Corbet, S., Katsiampa, P., and Lau, C. K. M. (2020a). Measuring quantile dependence and testing directional predictability between bitcoin, altcoins and traditional financial assets. *International Review of Financial Analysis*, 71:101571.

Corbet, S., Larkin, C., Lucey, B. M., Meegan, A., and Yarovaya, L. (2020b). The impact of macroeconomic news on bitcoin returns. *The European Journal of Finance*, 26(14):1396–1416.

Corbet, S., Lucey, B., Peat, M., and Vigne, S. (2018). Bitcoin futures—what use are they? *Economics Letters*, 172:23–27.

Disli, M., Nagayev, R., Salim, K., Rizkiah, S. K., and Aysan, A. F. (2021). In search of safe haven assets during covid-19 pandemic: An empirical analysis of different investor types. *Research in International Business and Finance*, 58:101461.

European Central Bank (2012). Virtual currency schemes. In *Virtual Currency Schemes*, pages 1–55.

Fakhfekh, M., Jeribi, A., Ghorbel, A., and Hachicha, N. (2021). Hedging stock market prices with wti, gold, vix and cryptocurrencies: a comparison between dcc, adcc and go-garch models. *International Journal of Emerging Markets*, (ahead-of-print).

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The journal of Finance*, 25(2):383–417.

Feng, W., Wang, Y., and Zhang, Z. (2018). Can cryptocurrencies be a safe haven: a tail risk perspective analysis. *Applied Economics*, 50(44):4745–4762.

Fousekis, P. and Grigoriadis, V. (2021). Directional predictability between returns and volume in cryptocurrencies markets. *Studies in Economics and Finance*.

Gaies, B., Nakhli, M. S., Sahut, J. M., and Guesmi, K. (2021). Is bitcoin rooted in confidence?– unraveling the determinants of globalized digital currencies. *Technological Forecasting and Social Change*, 172:121038.

Garcia, D., Tessone, C. J., Mavrodiev, P., and Perony, N. (2014). The digital traces of bubbles: feedback cycles between socio-economic signals in the bitcoin economy. *Journal of the royal society interface*, 11(99):20140623.

Gilchrist, S., Yue, V., and Zakrajšek, E. (2019). Us monetary policy and international bond markets. *Journal of Money, Credit and Banking*, 51:127–161.

Glaser, F., Zimmermann, K., Haferkorn, M., Weber, M. C., and Siering, M. (2014). Bitcoin-asset or currency? revealing users' hidden intentions. *Revealing Users' Hidden Intentions (April 15, 2014). ECIS*.

Gregoriou, A. (2019). Cryptocurrencies and asset pricing. *Applied Economics Letters*, 26(12):995–998.

Gürkaynak, R. S., Kara, A. H., Kısacıkoğlu, B., and Lee, S. S. (2021). Monetary policy surprises and exchange rate behavior. *Journal of International Economics*, 130:103443.

Gürkaynak, R. S., Sack, B. P., and Swanson, E. T. (2004). Do actions speak louder than words? the response of asset prices to monetary policy actions and statements. *The Response of Asset Prices to Monetary Policy Actions and Statements (November 2004)*.

Hafner, C. M. (2020). Testing for bubbles in cryptocurrencies with time-varying volatility. *Journal of Financial Econometrics*, 18(2):233–249.

Hillenbrand, S. (2021). The fed and the secular decline in interest rates.

Hull, J. C. (2015). *Options, Futures, and Other Derivative securities*. Person Education, 9 edition.

Huynh, T. L. D., Nasir, M. A., Vo, X. V., and Nguyen, T. T. (2020). "small things matter most": The spillover effects in the cryptocurrency market and gold as a silver bullet. *The North American Journal of Economics and Finance*, 54:101277.

Jareño, F., de la O González, M., Tolentino, M., and Sierra, K. (2020). Bitcoin and gold price returns: A quantile regression and nardl analysis. *Resources Policy*, 67:101666.

Jeribi, A. and Ghorbel, A. (2021). Forecasting developed and brics stock markets with cryptocurrencies and gold: generalized orthogonal generalized autoregressive conditional heteroskedasticity and generalized autoregressive score analysis. *International Journal of Emerging Markets*, 17(9):2290–2320.

Kallinterakis, V. and Wang, Y. (2019). Do investors herd in cryptocurrencies–and why? *Research in International Business and Finance*, 50:240–245.

Kankanam Pathiranage, H. S., Xiao, H., and Li, W. (2021). The inefficiencies of bitcoins in developing countries. *Applied Economics Letters*, 28(5):408–412.

Karau, S. (2021). Monetary policy and bitcoin. *Deutsche Bundesbank Discussion Paper*.

King, T. and Koutmos, D. (2021). Herding and feedback trading in cryptocurrency markets. *Annals of Operations Research*, 300:79–96.

Kinkyo, T. (2022). Hedging capabilities of bitcoin for asian currencies. *International Journal of Finance & Economics*, 27(2):1769–1784.

Köchling, G., Müller, J., and Posch, P. N. (2019). Does the introduction of futures improve the efficiency of bitcoin? *Finance Research Letters*, 30:367–370.

Kroencke, T. A., Schmeling, M., and Schrimpf, A. (2021). The fomc risk shift. *Journal of Monetary Economics*, 120:21–39.

Kumar, A. (2021). Empirical investigation of herding in cryptocurrency market under different market regimes. *Review of Behavioral Finance*, 13(3):297–308.

Kuttner, K. N. (2001). Monetary policy surprises and interest rates: Evidence from the fed funds futures market. *Journal of monetary economics*, 47(3):523–544.

Lee, D. K. C., Guo, L., and Wang, Y. (2017). Cryptocurrency: A new investment opportunity? *Available at SSRN 2994097*.

Lee, S., El Meslmani, N., and Switzer, L. N. (2020). Pricing efficiency and arbitrage in the bitcoin spot and futures markets. *Research in International Business and Finance*, 53:101200.

Li, Y., Urquhart, A., Wang, P., and Zhang, W. (2021). Max momentum in cryptocurrency markets. *International Review of Financial Analysis*, 77:101829.

Liu, W., Liang, X., and Cui, G. (2020). Common risk factors in the returns on cryptocurrencies. *Economic Modelling*, 86:299–305.

Liu, Y. and Tsyvinski, A. (2021). Risks and returns of cryptocurrency. *The Review of Financial Studies*, 34(6):2689–2727.

Ma, C., Tian, Y., Hsiao, S., and Deng, L. (2022). Monetary policy shocks and bitcoin prices. *Research in International Business and Finance*, 62:101711.

Majdoub, J., Ben Sassi, S., and Bejaoui, A. (2021). Can fiat currencies really hedge bitcoin? evidence from dynamic short-term perspective. *Decisions in Economics and Finance*, pages 1–28.

Naeem, M., Bouri, E., Boako, G., and Roubaud, D. (2020). Tail dependence in the return-volume of leading cryptocurrencies. *Finance Research Letters*, 36:101326.

Naeem, M. A., Farid, S., Balli, F., and Hussain Shahzad, S. J. (2021). Hedging the downside risk of commodities through cryptocurrencies. *Applied Economics Letters*, 28(2):153–160.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Decentralized business review*, page 21260.

Pyo, S. and Lee, J. (2020). Do fomc and macroeconomic announcements affect bitcoin prices? *Finance Research Letters*, 37:101386.

Raimundo Júnior, G. d. S., Palazzi, R. B., Tavares, R. d. S., and Klotzle, M. C. (2022). Market stress and herding: a new approach to the cryptocurrency market. *Journal of Behavioral Finance*, 23(1):43–57.

Rehman, M. U. and Apergis, N. (2019). Determining the predictive power between cryptocurrencies and real time commodity futures: Evidence from quantile causality tests. *Resources Policy*, 61:603–616.

Rehman, M. U. and Vo, X. V. (2020). Cryptocurrencies and precious metals: a closer look from diversification perspective. *Resources Policy*, 66:101652.

Rognone, L., Hyde, S., and Zhang, S. S. (2020). News sentiment in the cryptocurrency market: An empirical comparison with forex. *International Review of Financial Analysis*, 69:101462.

Rubbaniy, G., Polyzos, S., Rizvi, S. K. A., and Tessema, A. (2021). Covid-19, lockdowns and herding towards a cryptocurrency market-specific implied volatility index. *Economics Letters*, 207:110017.

Sebastião, H. and Godinho, P. (2020). Bitcoin futures: An effective tool for hedging cryptocurrencies. *Finance Research Letters*, 33:101230.

Sensoy, A. (2019). The inefficiency of bitcoin revisited: A high-frequency analysis with alternative currencies. *Finance Research Letters*, 28:68–73.

Shrotryia, V. K. and Kalra, H. (2022). Herding in the crypto market: a diagnosis of heavy distribution tails. *Review of Behavioral Finance*, 14(5):566–587.

Tadi, M. and Kortchemski, I. (2021). Evaluation of dynamic cointegration-based pairs trading strategy in the cryptocurrency market. *Studies in Economics and Finance*, 38(5):1054–1075.

Taylor, J. B. (2007). Housing and monetary policy. Technical report, National Bureau of Economic Research.

Trimborn, S., Li, M., and Härdle, W. K. (2020). Investing with cryptocurrencies—a liquidity constrained investment approach. *Journal of Financial Econometrics*, 18(2):280–306.

Urom, C., Abid, I., Guesmi, K., and Chevallier, J. (2020). Quantile spillovers and dependence between bitcoin, equities and strategic commodities. *Economic Modelling*, 93:230–258.

Wang, G.-J., Xie, C., Wen, D., and Zhao, L. (2019). When bitcoin meets economic policy uncertainty (epu): Measuring risk spillover effect from epu to bitcoin. *Finance Research Letters*, 31.

Wang, P., Zhang, H., Yang, C., and Guo, Y. (2021). Time and frequency dynamics of connectedness and hedging performance in global stock markets: Bitcoin versus conventional hedges. *Research in International Business and Finance*, 58:101479.

White, L. H. (2009). Federal reserve policy and the housing bubble. *Cato J.*, 29:115.

Xiong, J., Liu, Q., and Zhao, L. (2020). A new method to verify bitcoin bubbles: Based on the production cost. *The North American Journal of Economics and Finance*, 51:101095.

Zhang, W. and Li, Y. (2023). Liquidity risk and expected cryptocurrency returns. *International Journal of Finance & Economics*, 28(1):472–492.

APPENDICES

Figure 5: Study Sample: Bitcoin Spot and Future Price vs. Federal Funds Rate (Upper Bound)
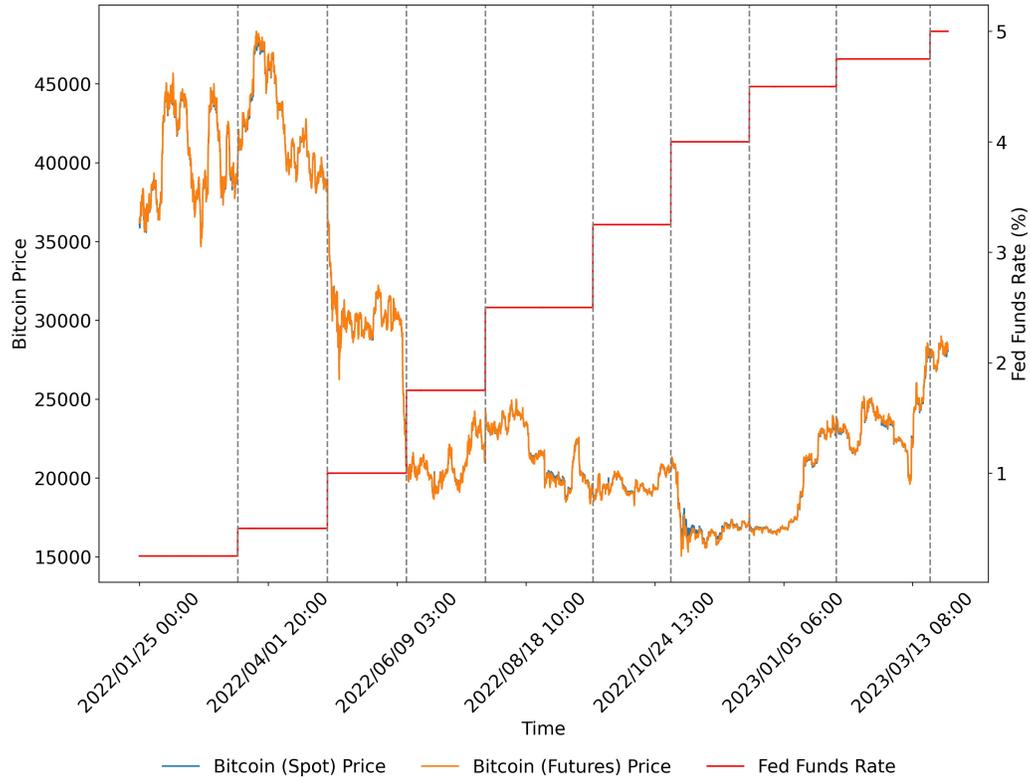
Table 12: Individual Event Date 3-day Window Regression: Bank Failure

Date	Type of Event	Log BTC Return		Log BTC Spread	
		Event 3-day Window	Constant	Event 3-day Window	Constant
13/03/2023	Bank Failure	0.067037***	-0.001289	0.0086428	-0.0005071
		(2.889)	(-0.560)	(0.777)	(-0.460)
17/03/2023	Bank Failure	0.048074**	-0.001102	0.0055276	-0.0004765
		(2.058)	(-0.476)	(0.497)	(-0.432)
Observations	305				

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown
in parentheses. The observation is on a daily basis. The dates are arranged in chronological order.

Table 13: Individual Event Date 3-day Window Regression: Positive Fed Expectation

Date	Type of Event	Log BTC Return		Log BTC Spread	
		Event 3-day Window	Constant	Event 3-day Window	Constant
04/05/2022	Positive Fed Expectation	-0.016085	-0.000471	-0.0017914	-0.0004045
		(-0.684)	(-0.202)	(-0.161)	(-0.366)
31/05/2022	Positive Fed Expectation	0.0027338	-0.0006561	0.0072760	-0.0004937
		(0.116)	(-0.281)	(0.654)	(-0.447)
07/07/2022	Positive Fed Expectation	0.0230118	-0.0008556	0.001215	-0.000434
		(0.980)	(-0.367)	(0.109)	(-0.393)
19/07/2022	Positive Fed Expectation	0.0361975	-0.0009853	0.0109891	-0.0005302
		(1.545)	(-0.424)	(0.988)	(-0.481)
28/07/2022	Positive Fed Expectation	0.045144*	-0.001073	-0.0010372	-0.0004119
		(1.931)	(-0.463)	(-0.093)	(-0.373)
10/11/2022	Positive Fed Expectation	-0.0362648	-0.0002725	-0.0171139	-0.0002538
		(-1.548)	(-0.117)	(-1.543)	(-0.231)
12/01/2023	Positive Fed Expectation	0.043076*	-0.001053	0.0027029	-0.0004487
		(1.841)	(-0.454)	(0.243)	(-0.406)
17/01/2023	Positive Fed Expectation	0.0337689	-0.0009614	-0.0010787	-0.0004115
		(1.441)	(-0.414)	(-0.097)	(-0.373)
20/01/2023	Positive Fed Expectation	0.0348009	-0.0009715	0.007009	-0.000491
		(1.485)	(-0.418)	(0.630)	(-0.445)
15/02/2023	Positive Fed Expectation	0.043051*	-0.001053	0.0040867	-0.0004623
		(1.840)	(-0.454)	(0.367)	(-0.419)
Observations	305				

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis. The dates are arranged in chronological order.

Table 14: Individual Event Date 3-day Window Regression: Negative Fed Expectation

Date	Type of Event	Log BTC Return		Log BTC Spread	
		Event 3-day Window	Constant	Event 3-day Window	Constant
17/02/2022	Negative Fed Expectation	-0.0315119	-0.0003193	0.0365009***	-0.0007811
		(-1.344)	(-0.137)	(3.337)	(-0.720)
10/03/2022	Negative Fed Expectation	0.0037185	-0.0006658	0.0001002	-0.0004231
		(0.158)	(-0.285)	(0.009)	(-0.383)
11/04/2022	Negative Fed Expectation	-0.0321441	-0.0003131	0.0318012***	-0.0007349
		(-1.371)	(-0.135)	(2.895)	(-0.674)
26/04/2022	Negative Fed Expectation	-0.0037636	-0.0005922	-0.0003094	-0.0004190
		(-0.160)	(-0.254)	(-0.028)	(-0.379)
05/05/2022	Negative Fed Expectation	-0.0149323	-0.0004824	-0.0018779	-0.0004036
		(-0.635)	(-0.207)	(-0.169)	(-0.365)
09/05/2022	Negative Fed Expectation	-0.05393**	-0.00009875	0.0017015	-0.0004388
		(-2.313)	(-0.043)	(0.153)	(-0.397)
11/05/2022	Negative Fed Expectation	-0.0266825	-0.0003668	0.0131622	-0.0005516
		(-1.137)	(-0.158)	(1.185)	(-0.501)
11/07/2022	Negative Fed Expectation	-0.0349416	-0.0002855	-0.0023118	-0.0003993
		(-1.491)	(-0.123)	(-0.208)	(-0.362)
19/08/2022	Negative Fed Expectation	-0.0339121	-0.0002957	-0.0040037	-0.0003827
		(-1.447)	(-0.127)	(-0.360)	(-0.347)
06/09/2022	Negative Fed Expectation	-0.0110402	-0.0005206	-0.0171348	-0.0002535
		(-0.470)	(-0.223)	(-1.545)	(-0.230)
13/09/2022	Negative Fed Expectation	-0.021473	-0.000418	0.0007402	-0.0004294
		(-0.914)	(-0.179)	(0.066)	(-0.389)
Observations	305				

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis. The dates are arranged in chronological order.

Table 15: Individual Event Date 3-day Window Regression: Crypto Failure

Date	Type of Event	Log BTC Return		Log BTC Spread	
		Event 3-day Window	Constant	Event 3-day Window	Constant
13/06/2022	Crypto Failure	-0.1060970***	0.0004143	-0.0015823	-0.0004065
		(-4.670)	(0.184)	(-0.142)	(-0.368)
14/06/2022	Crypto Failure	-0.099966***	0.000354	0.0011626	-0.0004335
		(-4.382)	(0.157)	(0.104)	(-0.393)
30/06/2022	Crypto Failure	-0.013646	-0.000495	-0.0008652	-0.0004136
		(-0.580)	(-0.212)	(-0.078)	(-0.374)
08/11/2022	Crypto Failure	-0.0987753***	0.0003423	-0.010785	-0.000316
		(-4.327)	(0.151)	(-0.970)	(-0.287)
09/11/2022	Crypto Failure	-0.0497692**	-0.0001397	-0.0139207	-0.0002852
		(-2.132)	(-0.060)	(-1.253)	(-0.259)
11/11/2022	Crypto Failure	0.0143500	-0.0007704	-0.0225237**	-0.0002005
		(0.61)	(-0.33)	(-2.036)	(-0.183)
21/11/2022	Crypto Failure	-0.0106668	-0.0005243	-0.0020749	-0.0004017
		(-0.454)	(-0.225)	(-0.186)	(-0.364)
03/03/2023	Crypto Failure	-0.0162045	-0.0004698	0.0038110	-0.0004596
		(-0.689)	(-0.202)	(0.342)	(-0.416)
09/03/2023	Crypto Failure	-0.0305872	-0.0003284	-0.0029084	-0.0003935
		(-1.304)	(-0.141)	(-0.261)	(-0.356)
Observations	305				

Note: *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. t-statistics are shown in parentheses. The observation is on a daily basis. The dates are arranged in chronological order.