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Risk Management in the Area of Bitcoin Market Development: Example from the USA

Laeeq Razzak Janjua [1,*], Iza Gigauri [2,3,*], Agnieszka Wójcik-Czerniawska [4] and Elżbieta Pohulak-Żołędowska [5]

1 Faculty of Science, WSB University, 41-300 Dąbrowa Górnicza, Poland
2 School of Business, Computing and Social Sciences, St. Andrew the First-Called Georgian University, Tbilisi 0179, Georgia
3 Women Researchers Council, Azerbaijan State University of Economics (UNEC), Baku AZ1001, Azerbaijan
4 College of Management and Finance, Warsaw School of Economics (SGH), 02-554 Warsaw, Poland; awojci5@sgh.waw.pl
5 Faculty of Economics and Finance, Wroclaw University of Economics and Business, 53-345 Wroclaw, Poland; elzbieta.pohulak-zoledowska@ue.wroc.pl
* Correspondence: laeeq.janjua@wsb.edu.pl (L.R.J.); i.gigauri@sangu.edu.ge (I.G.)

Abstract: This paper explores the relationship between Bitcoin returns, the consumer price index, and economic policy uncertainty. Employing the QARDL method, this study examines both short- and long-term dynamics between macroeconomic factors and Bitcoin returns. Our analysis of monthly time series data from January 2011 to November 2023 reveals that volatile US economic policy indicators, such as high economic policy uncertainty, volatile inflation, and rising interest rates, have recently exerted a negative impact on Bitcoin returns. This study shows that these results are true not only for traditional money but also for cryptocurrencies such as Bitcoin, despite their cardinal features. Its decentralized nature, indicating that it has no physical representation, is not tied to any authority or national economy and relies on a complex algorithm to track transactions. Further, it yields volatile returns that depend on macroeconomic indicators.

Keywords: risk; financial risk management; digital economy; digital transformation; challenges in digital environment; investment decisions; financial markets

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1. Introduction

An investment manager makes decisions related to running the enterprise and investment based on his skills and in-depth risk analyses (Chong 2004). Asset managers today must have good economic reasoning, comprehensive vision, and knowledge of global macroeconomics and geopolitics in order to make any investment decision (Papic 2020). Besides other financial instruments, crypto investment presents unique challenges and risks for investment managers due to high volatility, price fluctuations, and regulatory and compliance risks (Arsi et al. 2022). Similarly, cryptocurrencies have features similar to other financial instruments: they are subject to valuation and the medium of exchange (Baer et al. 2023). However, due to the high risk and high volatility of value, it is difficult to estimate the contribution assuming its invariable value, which is a guarantee for creditors. Additional risk results from the fact that investment tokens are not regulated by national or international law and investors who decide to purchase or trade in such assets are not covered by the protection that occurs in the case of investments in a regulated financial market. Further, there is an additional difficulty in governing the relationship between the client and the entity using the cryptocurrency (Garrido 2023). Hence, the decision to treat cryptocurrencies as an element of capital contribution to the company should be preceded by an in-depth analysis. This requirement for detailed analysis and risk mitigation should arise, especially when an entity is in financial trouble (Blandin et al. 2020). Therefore, specific activities are indicated in terms of the assessment of the degree of economic risk taken by the manager, the most important of which are as follows (Petropoulos et al. 2022).

Considering this, individual investors or asset managers need to focus on the volatility risk of crypto assets fluctuating in a very short time span to make their investment decisions (Bianchi 2020). Similarly, the regulatory and compliance environment of investing countries also determines the volumes and risks of cryptocurrency investments (Cumming et al. 2019). Likewise, the major concern of investment in the cryptocurrency market also depends on technological awareness and cyber security threats (Ghosh et al. 2020). Furthermore, other factors, such as the investment atmosphere, economic stability, and saving habits, determine the overall investment and return of crypto assets (Sun et al. 2020).

Similarly, many studies have examined the relationship between economic uncertainty, inflation, and financial assets, including cryptocurrencies (Barnett et al. 2020; Khan et al. 2021; Choi et al. 2022); however, there is a research gap on the relationship between Bitcoin returns, the consumer price index (CPI), and economic policy uncertainty in the USA investment market. Therefore, the aim of this paper is to assess the relationship between Bitcoin returns, the consumer price index, and economic policy uncertainty by using monthly data from the USA. This paper analyzes the relationship between economic uncertainties, inflation, and Bitcoin returns and discusses the influence of economic policy and legal risk on investments. To achieve its aims, this paper is organized as follows. The next section discusses the relevant literature, followed by a description of research methods, including empirical analysis. Section 4 is dedicated to research results and a discussion. Finally, conclusions and implications are presented.

2. Literature Review

2.1. Risk and Investment Capital Management on the Cryptocurrency Exchange

Cryptocurrencies such as Bitcoin, Ethereum, and Ripple as digital currencies are supported by cryptography to manage the trades of digital currencies (Marella et al. 2020). By comparison, fiat currencies are traditional paper currencies backed by governments. Cryptocurrencies are the equivalent of traditional currencies but are used for online transactions. Three primary features differentiate cryptocurrencies from fiat money. First, since they lack a centralized authority, they are shielded from intervention by the government (Scott 2016). Second, the foundation of cryptocurrencies is the blockchain, which is a consensus-based database with high levels of security and transparency (Zheng et al. 2017). This chain is updated and synchronized across the network to protect data from manipulation. Consensus algorithms validate and confirm transactions, removing intermediaries and increasing trust and transparency. Beyond cryptocurrencies, this new system can manage supply chains, smart contracts, and decentralized finance. Third, cryptocurrencies are easily utilized and exchanged worldwide due to their digital nature.

Since the introduction of Bitcoin in 2009, the cryptocurrency market has experienced remarkable progress. Especially, 2020–2021 boosted the use of digital currencies, when the number of its owners increased from 66 million to 295 million (Bruhn and Ernst 2022; Hon et al. 2022; Wang 2021). In addition to cryptocurrencies, non-fungible-tokens (NFTs) have also been adopted (Bruhn and Ernst 2022).

Non-fungible tokens (NFTs) are blockchain-verified digital assets that prove ownership or authenticity of art, music, or collectibles. They are unique and cannot be reproduced or exchanged like Bitcoin or Ethereum. Because of their originality and authenticity, NFTs are valuable and attractive, allowing producers and artists to securely monetize their work and collectors to possess and exchange exclusive digital assets. Furthermore, Decentralized Finance (DeFi) protocols use blockchain technology, especially Ethereum, to operate without banks or brokers. These protocols enable peer-to-peer financial services, including lending, borrowing, trading, and asset management through smart contracts, which are self-executing contracts with coded terms. DeFi protocols have smart contract vulnerabilities, liquidity issues, and regulatory difficulties. Therefore, participants should investigate and use DeFi platforms carefully.

Since digital currencies are relatively different assets, not much is acknowledged about how they react to various general market circumstances.

Investors have not had the opportunity to see how cryptocurrencies react during a severe financial crisis. With this in mind, it is important to implement a prudent trading strategy based on sound risk management (Chiu and Koeppl 2022).

When thinking about investing money, the first parameter that comes to mind is the rate of return. There is a strong and inseparable relationship between the rate of return and the risk taken, which novice and inexperienced investors cannot see. This problem is visible in the cryptocurrency market, which tempts people who have not previously had contact with financial markets (Kozak and Gajdek 2021). It allures with a high rate of return and the prospect of both quick and long-term returns, almost certain enrichment.

In 2017 alone, the most popular cryptocurrency, Bitcoin, increased in dollar terms by almost 800% (taking into account the opening rate from the first session and the maximum rate until November 15) (Higgins 2017). After all, this beat the return of the risky stock market. This is because of the fact that it is currently a very one-sided market—a clear and extremely dynamic upward trend gives the impression that investing in Bitcoin is not burdened with any risk at all because the price has to keep growing. Every now and then, we come across forecasts pointing to Bitcoin's immediate achievement of USD 20,000 (the level of USD 10,000 was broken earlier than expected by many optimists), and in the following years, USD 100,000, 200,000, 500,000, or even 1,000,000. The participants of this market do not care whether the price is falling or rising. "If it grows then good—I earn, if it falls, then even better—I will buy it cheaply". All the time, we see potential profits being detached from the risk taken. Thus, the key principle of investing in the cryptocurrency market seems simple: sell high, buy low. In other words, one should buy assets when the bear market reaches its bottom and sell assets when the bear market reaches its peak.

Yet, it is impossible to know if this is already the peak and should be sold or if it is already the bottom of the hole and should be bought. Moreover, human nature and emotions are prone to panic, which can induce investors to sell assets when prices fall and FOMO (fear of losing) when soaring. To better manage risk, investors should follow the famous narrative—buy only funds they can afford to lose. As a result, they are more likely to avoid hasty decisions in the event of a sharp drop, and panic sales and huge losses will not occur.

2.2. Uncertainties and Risks

The risk of managing a given enterprise depends primarily on the nature of the enterprise, its size, structure, and many other elements. In each of them, legal risk is assessed as one of the basic risks related to management. The concept of risk related to management is very broad; it covers both macro and micro risk. In terms of the macroenvironment for the conducted business activity, we can distinguish the following risks: political; technical; as well as economic, climate, and environmental risk.

Political risk is primarily related to power structures, social groups, and their relations, as well as international relations between states and establishing legal rules for entrepreneurship. The second, technical risk, consists mainly of the degree of modernization of the enterprise, having the know-how, and development of the machine park. The third risk—economic—covers the broadest category, which includes interest rates, exchange rates, economic prosperity, wages, and taxes. This list of risks is not complete, as is economic life. In addition, this list should be constantly supplemented because economic life is more and more diverse, and thus new areas of action and risk appear. The more detailed the risks are described, the more they can be analyzed and minimized, and, above all, their effects can be reduced. The effects of risk assessment are particularly visible in the case of new technologies, new financial instruments, and the involvement of management boards in new financial instruments (Sahid et al. 2023).

Undoubtedly, cryptocurrencies are instruments that arouse interest and, at the same time, a sense of increased risk. On the one hand, they tempt with high profit. On the other hand, they raise doubts as to their character. Due to the fact that these are financial instruments generated outside the control of banks stimulating and controlling the issuance of new securities, the risk related to trading in such instruments can be considered in several dimensions (Haq et al. 2021; Koutmos et al. 2021). First of all, the basic point of consideration is the answer to the question of whether we are dealing with risk or with uncertainty.

The management literature asks about the boundary between uncertainty and risk. Uncertainty occurs when a given event cannot be described by means of the probability theory, and therefore, the associated risk cannot be determined. Uncertainty results from the unpredictability and variability of the environment over a long period. As a counterbalance, risk is allocated to activity over a foreseeable period (Rana et al. 2023). There are also statements that uncertainty and risk are the same concepts and can be used interchangeably (Almeida et al. 2022; Settembre-Blundo et al. 2021). Therefore, when assessing cryptocurrencies in this regard, it should be stated that both terms are justified—both risk and uncertainty. Therefore, in order to minimize the state of uncertainty and assess risk, when investing, one should follow certain rules that are aimed at reducing risk and thus the liability of the managing body. Undoubtedly, the area of cryptocurrency as an instrument is interesting for at least two reasons. First, it is an economic risk, and second, it is a legal risk (Makurin 2020). First, the decision to buy cryptocurrencies is preceded by an economic analysis. Secondly, there is an assessment of the legal risk and, therefore, an analysis of the manager's behavior. As part of the legal risk, there is an analysis of regulations, including the admissibility of cryptocurrency trading, conditions of certainty of trading, price stability, and responsibility for the manager's transaction. All these elements constitute a legitimate economic risk analysis.

In any trade, risk is the probability of losing some of the capital invested in a trade, and risk management is the ability to determine that probability and control the financial loss from failed trades. Trading cryptocurrencies using spread betting or a CFD[1] trading account can be much safer than investing directly in crypto with a digital wallet for a number of key reasons (Rodgers 2023).

When investors own coins in any cryptocurrency, they are at the mercy of price fluctuations that can be sudden and significantly alter the value of their investments. They will also need to open a digital wallet, which can be difficult to set up, complex to manage, and must balance the risk of potential cyber attacks on coin exchanges. However, when managers trade cryptocurrencies as CFDs or Spread Bets, they have access to the same intelligent risk management tools as when trading our other major assets. This can help them take advantage of the same market opportunities with less exposure to risk (Rudys and Svogun 2023).

Cryptocurrencies can be particularly volatile. Their price movement can be greater than many other assets. For this reason, risk management is crucial, and holding a position (also at night) can be riskier.

The Day Trading strategy aims to take advantage of the market volatility in shorter, several-hour time frames, not periods spanning days and weeks (Lundström 2019).

Day Trading can be time-consuming and involves great flexibility and the ability to respond to a rapidly changing market environment. Using intelligent risk management tools such as Guaranteed Stop Losses can be essential for Day Trading.

While there are fewer data and recurring market trends compared to some of the more established assets in the case of cryptocurrencies, research is still extremely important (Chokor and Alfieri 2021). Much of the cryptocurrency trading strategy will center around market news, speculation, and a deep understanding of market sentiment. Cryptocurrency markets often do not move based on traditional market forces such as decisions about central bank interest rates, political turmoil, or issues like supply and demand. Rather, as completely new, decentralized assets, they can be particularly sensitive to news regarding regulation, potential hard fork events, and attempted attacks on exchanges. There is a wide variety of independent cryptocurrency discussion forums, social networking sites, and forums to follow. You should also remember to regularly monitor your position and the entire market. For assets whose prices can change suddenly throughout the day, having tools to track trends and anticipate major market movements is crucial.

2.3. Bitcoin Return Relationship with Economic Uncertainty

In general, cryptocurrency is known to cause risks (Shahbazi and Byun 2022; Corbet et al. 2019), especially taking into account its role in increased financial crimes (Fan et al. 2021; Hacioglu et al. 2021). However, cryptocurrency is still considered as a risk management tool against economic policy uncertainty (EPU). Previous studies confirmed that Bitcoin can perform against unforeseen severe shocks (Wang et al. 2019; Demir et al. 2018). On the contrary, Hasan et al. (2022) compared the influence of cryptocurrency policy uncertainty on Bitcoin and gold and concluded that Bitcoin is not a safe haven, but gold is. Researchers argue that Bitcoin can serve as a safe haven against economic or political uncertainties but warn that this advantage will be reduced (Haq et al. 2021). It should be noted that Bitcoin prices do not act as gold prices (Choi et al. 2022).

According to the research results by Dyhrberg (2016), who used GARCH methods, Bitcoin can be effective in risk management, particularly for security-focused investors, to avoid unfavorable market shakes. For this reason, Bitcoin is categorized somewhere between gold and the US dollar in portfolio management (Dyhrberg 2016). Previous research demonstrated that "bitcoin return fluctuations are lower than those of roughly 900 stocks in the S&P1500 and 190 stocks in the S&P500" (Mazur 2022). Scholars emphasize the key advantage of Bitcoin to be its decentralized nature, indicating that it does not have a physical representation, is not associated with any authority or country economy, and is based on a complex algorithm allowing the traceability of transactions (Platanakis and Urquhart 2020). In addition, money supply is constant, as there is only a definite number of Bitcoins (Kristoufek 2015). However, Bitcoin has still experienced fluctuations in price.

Previous research shows that Bitcoin improves the portfolio performance of investors, albeit this is caused by increasing returns and never by decreasing risks (Kajtazi and Moro 2019). Recent studies found that the risk mitigation characteristic of Bitcoin is different among countries, as it depends on the regulatory policies and decisions (Haq et al. 2021). Therefore, investors need to take into consideration country and time contexts when using cryptocurrency as a risk management tool (Haq et al. 2021; Apostu et al. 2023). Researchers revealed that not only the financial and economic factors of a particular country determine the volatility but also the global business cycle and Real Economic Activities Index (Demir et al. 2018). During the COVID pandemic, the volatility of Bitcoin reduced (Mazur 2022).

Moreover, no spillover effect of the economic policy uncertainty on Bitcoin has been found, which implies that cryptocurrency, due to its dissimilarity from traditional financial assets, is detached from the economic and financial ecosystem (Wang et al. 2019). In this regard, Bitcoin can act as a diversified investment within investors' portfolios. Furthermore, the study results explained the negative correlation between Bitcoin price decrease risk and EPU, concluding that cryptocurrency can be understood as a hedge asset (Kalyvas et al. 2020). Wu et al. (2021), analyzing the influence of EPU on cryptocurrencies against extreme uncertainties, arrived at the same conclusion.

In addition, global geopolitical risks favorably impact the Bitcoin price, making them attractive to investors (Aysan et al. 2019). Research results demonstrate that an increase in global geopolitical risks decreases the returns on Bitcoin, indicating that the risks caused by political uncertainty and conflicts affect "the price volatility and the returns of Bitcoin" (Aysan et al. 2019).

2.4. Economic Uncertainty, Inflation, and Bitcoin Return

Choi et al. (2022), exploring the correlation between inflation, uncertainties, and Bitcoin and gold prices, proved that Bitcoin has an inflation-hedging quality, as is expected by investors. Nevertheless, Bitcoin prices decrease against financial uncertainty but not against policy uncertainty shocks (Choi et al. 2022). Moreover, the results show that both

Bitcoin price and gold price have similar responses to inflation shocks, and hence, it can be concluded that Bitcoin can have a safe-haven property (Choi et al. 2022).

Since investors prefer safe assets against inflation, they tend to invest in inflation-hedged assets such as Bitcoin, especially when the inflation rate is expected to rise (Sarker and Wang 2022). Yet, this behavior induces an increase in demand for Bitcoin, causing its price to go up, and thus, a rise in inflation impacts Bitcoin prices by increasing demand (Sarker and Wang 2022).

Cryptocurrencies are described as "extremely speculative and risky assets" by Schmitz and Hoffmann (2020) as a result of their research based on the analysis of the skewness and the kurtosis. Furthermore, researchers using Extreme Value Theory (EVT) concluded that cryptocurrencies are characterized by high risk in comparison to other assets (Chu et al. 2017; Omari and Ngunyi 2021).

Almeida and Gonçalves (2023), through a bibliometric analysis, showed that cryptocurrencies possess the ability to hedge against geopolitical risks and economic policy uncertainty (EPU). However, their research also reflected that investors can take into account gold in order to avoid uncertainties in the cryptocurrency market.

Their research, exploring 10 cryptocurrencies by using the Quantile-on-Quantile Regression (QQR) approach, confirmed that Bitcoin was more stable against the market turmoil triggered by the COVID-19 pandemic (Iqbal et al. 2021). In addition, using the GARCH-EVT model, Bruhn and Ernst (2022) examined 20 cryptocurrencies and concluded that Bitcoin is the most stable among them. However, Almeida et al. (2022), analyzing seven cryptocurrencies by applying Shannon's symbolic entropy, value-at-risk, and conditional value-at-risk approaches, claimed that high uncertainty does not necessarily mean high risks.

2.5. Legal Risk in Risk Management

Legal risk concerns both the functioning of a given enterprise and the consequences of its activity (Gigauri et al. 2023). It is one of the basic risks associated with any type of enterprise. It can be indicated that while the remaining risk areas are related to the specificity of the conducted activity, the risk of incurring legal liability is an integral element of every enterprise, regardless of its size and formal and legal structure.

Legal risk is related to both the macroeconomic and microeconomic situation—and concerns the possibility of a given entrepreneur functioning in a specific economic environment. First of all, these are regulations on taxes and economic conditions, including, for example, the conditions for creating special economic zones and the rules of their functioning, as well as microeconomic regulations, i.e., in the dimension of an individual entrepreneur and his actions taken as part of running an enterprise (Sen 2023; Haq et al. 2021; Mishchenko et al. 2021).

First of all, it should be pointed out that one of the main risks in the area of legal liability is the loss of financial liquidity and the need to file a bankruptcy petition on time. Otherwise, the person managing the entity may be personally liable for the liabilities.

For this reason, legal risk is one of the basic and undoubtedly the most acute areas of responsibility of the managers of a given enterprise. It may happen that in the event of exceeding the limit of acceptable risk, the manager may bear the risk of his own liability under civil, tax, and criminal law. Therefore, it is important each time to evaluate whether the management board operates within the limits of risk and when it exceeds them.

From the management point of view, risk is inherent in business activity. Each enterprise takes risks to achieve the planned results (Durst and Zieba 2020). The free market creates both opportunities for profits and the risk of losses. All business decisions are subject to risk. On the level of economics, the risk is discussed as such, giving it importance in the area of management and systematizing risks in order to eliminate them; in the area of law, it is considered legitimate to define risk as a justified economic risk.

Risk is characterized by uncertainty as to the final result of an action, which is the result of ignorance of all factors that may affect the course of an action, thus shaping its final result.

The risk is related to an objective situation resulting from human activity, characterized by uncertainty as to further development in the sense that it may turn into an effect intended by the actor and beneficial for him or as an unintended and unfavorable effect.

3. Research Methods

3.1. Economic Policy Uncertainty in the USA

The fluctuation in financial markets sometimes arises from the ambiguity of economic policies (Bloom 2014). Moreover, the financial market in the USA reacts immediately due to small changing circumstances and uncertainties of any economic situation (Sharif et al. 2020). Uncertainty contracts or expands the financial market; thus, it is true to argue that uncertainty can erode investor confidence, leading to cautious decision making or even the withdrawal of funds into cash or safer investments, more epically for the USA, where financial and investment markets appear to be very volatile (Guseva and Rona-Tas 2001). The USA's external policies and overall global situation highly impact the financial investment mechanism (Obstfeld 2019); thus, considerable ambiguity might dissuade enterprises from formulating enduring investment choices, thus impacting capital outlays and economic expansion. Similarly, in the USA, uncertainty can affect consumer mood and investment decisions, causing a decrease in expenditure as consumers become more cautious in their purchasing. This has been especially observed during the COVID-19 pandemic crisis (Faraji-Rad and Pham 2017). Furthermore, more recently, the value of the USA against other stable international currencies experienced fluctuations due to economic policy uncertainty and the demand–supply mechanism in trade (Auboin and Ruta 2011). Likewise, in the USA, domestic regulations also influence the particular dynamics of certain businesses and sectors; such areas may be subject to a variety of different influences, and thus that phenomenon is widely experienced in the virtual current market (Perkins 2020). It is true to argue that the presence of uncertainty can impact the inclination toward innovation and entrepreneurship, as shown recently in the virtual currency market of the USA, since the business landscape has become more unpredictable, hence influencing the establishment of new enterprises and employment prospects (Mikhaylov 2020). The trend of economic policy uncertainty in the USA is shown in Figure 1.

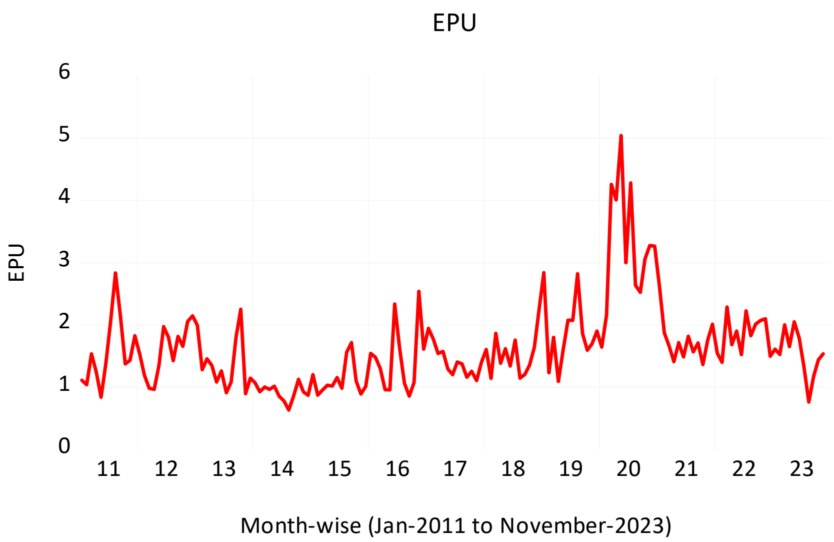

Figure 1. The trend of economic policy uncertainty in the USA.

3.2. Current Crypto Market in USA

The cryptocurrency market in the USA is characterized by its diversity and dynamism since it encompasses a wide range of digital assets (Won and Hong 2021). On the other hand, Bitcoin (BTC) has a substantial market share and is sometimes seen as a standard for the whole cryptocurrency industry (Stavroyiannis and Babalos 2017). In addition to Bitcoin, there is a diverse selection of other cryptocurrencies, also known as altcoins, that are actively traded. Some examples include Ethereum (ETH) and Litecoin (LTC) (Kim et al. 2020). However, on the other hand, the regulatory landscape for cryptocurrencies in the United States is undergoing changes, as authorities are developing frameworks to tackle legal and compliance concerns (Alvarez 2018). Similarly, cryptocurrency exchanges, whether controlled or decentralized, offer venues for the acquisition, disposal, and exchange of digital assets. Likewise, well-known cryptocurrency platforms include Coinbase, Binance, and Kraken (Hougan and Lawant 2021). Cryptocurrency markets are noted for their instability, influenced by market attitudes, regulatory innovations, and macroeconomic trends in the USA. Nevertheless, the USA plays a significant role in expanding decentralized finance sector, with numerous projects providing decentralized lending, trading, and other financial services (Chen and Bellavitis 2020). The growing involvement and financial commitment of institutions in cryptocurrencies, shown by the introduction of Bitcoin ETFs and the development of custody solutions tailored for institutional use, play a significant role in advancing the overall development and stability of the market. Multiple wallet companies offer safe storage options for cryptocurrencies, encompassing hardware wallets for offline storage and software wallets for convenience (Erinle et al. 2023). Moreover, in the United States, there is a noticeable rise in the acceptability and recognition of digital assets, such as cryptocurrencies, as a valid investment choice and, in certain instances, as a means of conducting transactions (Amoroso and Magnier-Watanabe 2012). Similarly, the trend of Bitcoin returns for the USA is presented in Figure 2.

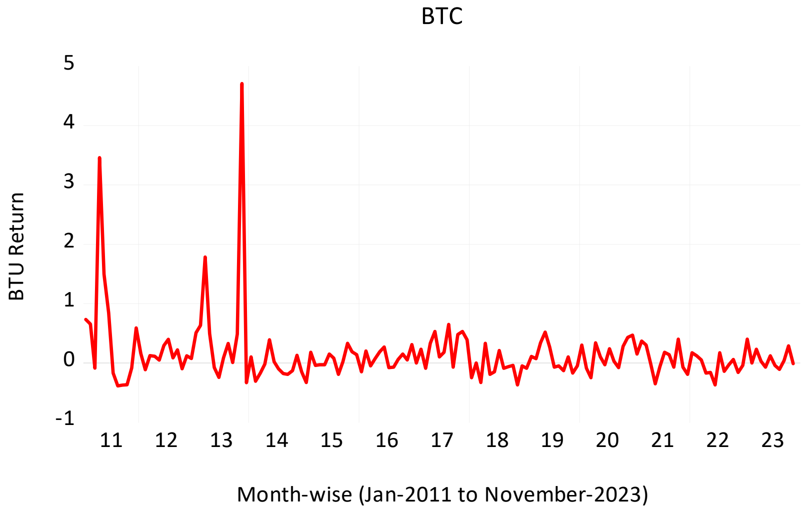

Figure 2. The trend of Bitcoin returns in the USA.

3.3. Inflation in the USA

Inflation is the gradual increase in the cost of products and services across the economy, which reduces the ability of individuals and companies to buy things (De Vries 2013). Similarly, reasonable inflation over time represents stable macroeconomic policies of certain countries (Orphanides 2004). Cryptocurrencies, especially Bitcoin, are commonly seen as a possible safeguard against inflation. Due to their limited quantity and decentralized structure, cryptocurrencies are immune to conventional inflationary forces. On the other hand, several cryptocurrencies, such as Bitcoin, possess a predetermined supply cap, resulting in a scarcity akin to that of precious metals (De Maria 2017). This attribute differs from conventional fiat currencies, which may be susceptible to inflation due to the policies implemented by central banks (Claeys et al. 2018). However, in the United States, cryptocurrencies function on decentralized networks, which diminish the control of central authorities and their capacity to manipulate the value of currency through inflationary tactics (Corbet et al. 2019). Cryptocurrencies function globally, offering a decentralized and easily accessible alternative to conventional currencies. This is especially applicable in areas that are undergoing hyperinflation (Claeys et al. 2018). Furthermore, expectations of future inflation can impact the pricing of cryptocurrencies (Jermann 2021). Likewise, with the decline in the value of conventional currencies, individuals can resort to cryptocurrencies as a method of safeguarding their capital (Tomić et al. 2020). Nevertheless, several investors perceive cryptocurrencies as a means of preserving wealth during periods of inflationary strain, akin to the function of gold. The inherent digitization of these assets allows for a more convenient and readily transportable means of storing value. Moreover, particularly in the United States, the values of cryptocurrencies might be impacted by anticipations of future inflation. Thus, with the decline in the purchasing power of conventional currencies, consumers can resort to cryptocurrencies as a method of safeguarding their capital (Aiello et al. 2023). In the United States, cryptocurrency markets might display speculative tendencies as investors aim to profit from future price surges influenced by fears or predictions over inflation. Similarly, economic volatility and elevated inflation rates in the USA or other interconnected areas might stimulate heightened interest in cryptocurrencies as a substitute financial framework (Hairudin et al. 2022). In the United States, central banks developed Central Bank Digital Currencies (CBDCs) as a direct response to the increasing popularity of cryptocurrencies (Auer et al. 2020). Thus, the objective is to offer a regulated digital alternative while still retaining the ability to utilize monetary policy instruments (Tu and Meredith 2015). Cryptocurrencies have the ability to act as a safeguard against inflation, but they are also notorious for their unpredictable price fluctuations. The unpredictability of inflation and high volatility in the USA might provide difficulties for those who are looking for a reliable means of preserving their wealth in light of increasing inflationary forces (Cogley and Sargent 2005). Furthermore, Figure 3 indicates the trend of inflation in the USA, as during 2022, high inflation was recorded in the USA after post-COVID-19 period.

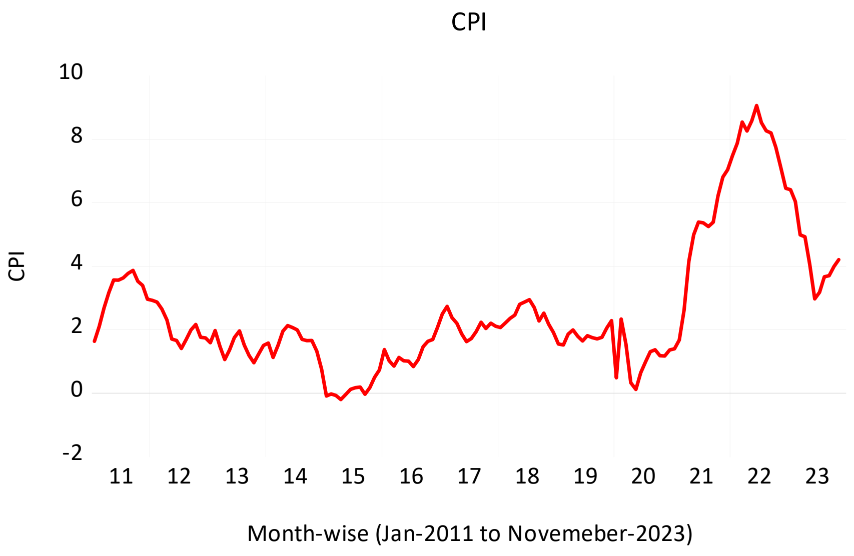

Figure 3. The trend of inflation in the USA.

3.4. Empirical Analysis

This paper investigates the nexus between consumer price index (inflation), economic policy uncertainty, and Bitcoin returns in the USA. This paper is based on monthly time series data fro January 2011 to November 2023.

Bitcoin returns were extracted from Bloomberg, inflation was extracted from the Federal Reserve Bank of the USA, and economic policy uncertainty was extracted from the database of economic policy uncertainty (https://www.policyuncertainty.com (assessed on 1 November 2023)).

Descriptive statistics values and correlation matrix results are presented in Table 1. The maximum return of Bitcoin was 4.709, whereas the lowest was −0.386. Furthermore, the maximum value for EPU was 5.040, and the minimum was 0.639, whereas for inflation, the maximum value was 9.060, and the minimum was −0.200.

Table 1. Descriptive statistics.

Variables	BTC	EPU	CPI
Mean	0.148	1.637	2.622
Median	0.050	1.538	1.978
Maximum	4.709	5.040	9.060
Minimum	−0.386	0.639	−0.200
Std. Dev.	0.549	0.698	2.106
Skewness	5.405	1.935	1.433
Kurtosis	40.682	8.366	4.434
Observations	155	155	155

3.5. Unit Root Tests

It is essential to determine the stationarity level of the series in time series analysis because, in time series data, spurious regression and unit root problems may be encountered (Yurtkuran 2021, p. 1240). Different methods have been developed to test the stationarity of the series against this problem. Augmented Dickey–Fuller (ADF), Phillips-Perron (PP), and Perron structural break unit root tests were used in this study.

3.6. Augmented Dickey–Fuller (ADF) Unit Root Test

The Dickey–Fuller (DF) test developed by Dickey and Fuller (1979) is based on the AR (1) model.

$$\Delta Y_t = \theta Y_{t-1} + \varepsilon_t \quad (1)$$

Here, Yt; t is the value of the variable in time Δ; the difference of the series, t, denotes time, εt; represents the error term. θ in the model is a coefficient, and when $\rho - 1 = \theta$ is assumed, it shows how much the series in the relevant period is affected by the previous period. The series stationarity hypothesis is tested according to whether θ is less than zero.

H_0: $\theta = 0$, $\rho = 1$, the series is not stationary,

H_1: If $\theta \neq 0$, then $\rho < 1$, the series is stationary,

Nevertheless, the DF test has some limitations. For this reason, the ADF test has been developed to test the first-order higher autoregressive process. The ADF test was also developed by Dickey and Fuller (1981). In the ADF test, the lagged values of the variables are added to the model. This way, stationarity testing can be performed in processes higher than the first order. There are three models in the ADF test, just like the DF test. These are intercept, trend, intercept, and none. These models are as follows:

$$\Delta Yt = \theta Y_{t-1} + \sum_{i=1}^{m} \gamma i Y_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta Y_t = \beta_0 + \theta Y_{t-1} + \sum_{i=1}^{m} \gamma i Y_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta Yt = \beta_0 + \beta_{1T} + \theta Y_{t-1} + \sum_{i=1}^{m} \gamma i Y_{t-1} + \varepsilon_t \quad (4)$$

Here, m stands for the optimum lag length. The hypothesis testing of the ADF test is the same as the DF test. The calculated t value is compared with the tau statistic or critical values, thus deciding whether the H_0 hypothesis can be rejected.

3.7. Phillips–Perron (PP) Unit Root Test

Due to some limitations of the DF test, a new test called Phillips and Perrpn (PP) has been developed[2]. This method, developed by Phillips and Perron (1988), ignores autocorrelation. In this method, the error terms are heterogeneous. The modeled version of the PP test is as follows:

$$\Delta Yt \ = \beta_0 + \beta_1(t - \frac{T}{2}) \ + \ \theta Y_{t-1} \ + \ \varepsilon_t \tag{5}$$

Here, T represents the number of observations. The Zα statistic is used in the PP test. In addition, the Zt statistic has been created so that the asymptotic distributions do not affect the coefficients of the autocorrelations. CF was added as a correction factor in the PP test, and Zt and Zα tests were created. The mathematical model of the test is as follows (Pesaran 2015, pp. 339–40):

$$Z_\alpha = T\ (\theta_{T-1}) - CF \tag{6}$$

$$Z_T = (\frac{ST}{SLT})T_{DF} - \frac{1}{2}(S^2{}_{LN} - S_T{}^2)(\frac{1}{SLT}\frac{ST\theta}{ST}) \tag{7}$$

The hypotheses for the PP test and the DF test are the same. Accordingly, the ADF and PP test statistic values are compared with the MacKinnon (1996) critical values, and the H_0 is tested. If the test statistic result exceeds the Mackinnon table value, H_0 is rejected, and the series is considered stationary[3].

For the ARDL test, the stationarity level of the series should not be I(2). This method is applied if the stationarity level is I(0) or I(1). Therefore, unit root test results of ADF (Dickey and Fuller 1981), PP (Phillips and Perron 1988), and Perron (1997) are reported in Table 2. Accordingly, all variables are stationary at the I(0). Thus, none of the series is inactive at the I(1) or either I(2). The fact that the results are the same in all three forms shows the consistency of the unit root results.

Table 2. Unit root test results.

Variable	ADF		PP	
	t Stat.	***p*-Value**	**t Stat.**	***p*-Value**
BTC	−6.26 (0) ***	0.00	−6.26 (2) ***	0.00
EPU	−5.91 (2) ***	0.00	−5.92 (10) ***	0.00
INF	−1.45 (0)	0.55	−1.48 (3)	0.53

Note: ***, indicate 1%, severity. () is the optimal lag length determined according to the Schwarz information criterion. In the Perron (1997) test, the breakage year was determined according to Dickey–Fuller tests. The PP test determined the band gap according to the Newey–West Bandwidth. The intercept model was chosen as the test model.

Table 3 shows the SC and other test results used for determining the lag length using the VAR method. According to the SC, AIC, FPE, and HQ results, the lag length is 4. This study considered the SC information criterion for the ARDL model estimation, and the maximum lag length was determined as 4.

Table 3. Lag selection.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	309.8220	NA	2.06×10^{-16}	−13.41431	−13.09313	−13.29458
1	722.6936 *	660.5945 *	3.98×10^{-23}	−28.91971 *	−26.02905 *	−27.84211 *
2	842.8537	149.5326	4.30×10^{-24} *	−31.41572	−25.95559	−29.38024

Note: * indicates level of significance 5%.

3.8. QARDL

However, previous research has not utilized the QARDL method developed by Cho et al. (2015) to examine both the short- and long-term relationships between a group of macroeconomic factors and U.S. stock values across various market conditions. The

QARDL approach is an expansion of the widely used ARDL model developed by Pesaran and Shin (1995) and Pesaran et al. (2001), specifically designed for application in a quantile framework. Essentially, this method combines the ARDL model with the quantile regression methodology developed by Koenker and Bassett (1978). It enables the analysis of relationships in both the short and long term, spanning different quantiles of the dependent variable's conditional distribution. Within the scope of this study, the QARDL approach offers a thorough understanding of the long-term (cointegrating) connection and the corresponding short-term dynamics between macroeconomic variables and U.S. stock returns. This analysis covers not only the average level but also the complete range of stock returns, encompassing various scenarios in the equity market. The QARDL method is gaining popularity in the literature and has been used in recent studies to examine various relationships.

The QARDL technique expands on the ARDL model by analyzing the long-term relationship and short-term fluctuations of variables over several quantiles of the dependent variable's conditional distribution in a comprehensive parametric framework. The QARDL technique enables the quantile-dependent determination of the long-run connection and also leverages the inherent advantages of the ARDL model. For instance, the QARDL framework may be used regardless of the order in which the variables are integrated. Its results remain reliable even when the sample size is small, and the short- and long-run parameters are estimated simultaneously inside a single equation framework. In addition, the QARDL model offers more flexibility and a comprehensive econometric framework by including variations among quantiles in both the short-term and long-term (cointegration) connections. Furthermore, when the assumption of normality is relaxed, the QARDL model yields more reliable and resilient findings. This is because ignoring the non-normality of variables in the model might lead to a misleading acceptance of the non-cointegration hypothesis.

In order to enhance the understanding of the QARDL method, the ARDL model is initially introduced. The ARDL(p, q) process may be expressed in the error correction form as follows:

$$\begin{aligned}\Delta Y_t = \quad & \alpha_* + \zeta_*(Y_{t-1} - \beta_* X_{t-1}) + \sum_{j=1}^{p-1} \lambda_{j^*} \Delta Y_{t-j} \\ & + \sum_{j=0}^{q-1} \delta_{j^*} \Delta X_{t-j} + U_t,\end{aligned}$$

The symbol Δ represents the first difference operator. Yt is the dependent variable, while Xt is a vector of regressors that are not cointegrated among themselves. Ut represents the error term, defined as the difference between Yt and the expected value of Yt given Ft−1. Ft−1 is the smallest σ-field generated by X0t, Yt−1, X0_t−1, and so on. The variables p and q represent the lag orders of the response variable and the regressors, respectively. The symbol α* represents an intercept, ζ* quantifies the rate at which adjustment occurs toward the long-run equilibrium, β* represents the long-run parameter, and λj* and δj* represent the short-run parameters. Furthermore, all the variables in Equation (1) may be estimated without any endogeneity concerns, as the term ΔXt is explicitly incorporated in the model specification. The QARDL technique is obtained by extending the ARDL(p, q) procedure in Equation (1) to the setting of quantile regression, as demonstrated by Cho et al. (2015). Therefore, the QARDL(p, q) model may be expressed in the subsequent error correction model format:

$$\begin{aligned}\Delta Y_t = \quad & \alpha_*(\tau) + \zeta_*(\tau)(Y_{t-1} - \beta_*(\tau)' X_{t-1}) + \sum_{j=1}^{p-1} \lambda_{j^*}(\tau) \Delta Y_{t-j} \\ & + \sum_{j=0}^{q-1} \delta_{j^*}(\tau)' \Delta X_{t-j} + U_t(\tau)\end{aligned}$$

In this equation, the error term in period t, denoted as Ut(τ), is defined as the difference between Yt and the τth quantile of Yt conditional on the smallest σ-field generated by

X0t, Yt−1, X0_t−1, and so on. The parameter τ is a real number between 0 and 1. The number is 6. In the QARDL approach, the important parameters include the error correction parameter ζ*, which measures how quickly the system adjusts to the long-term equilibrium relationship; the long-term cointegrating parameter β*; the parameter that represents the combined effect of past changes in the dependent variable Yt on the current changes in Yt (λ_ = Pp−1 j = 1λ j_Þ); and the parameters that reflect the combined effect of current and past changes in a given regressor on the current changes in Yt (or δ_ =Pp−1 j = 0δ j_Þ). The BIC (Bayesian information criterion) is employed, as demonstrated in Cho et al. (2015), to determine the most suitable values for the number of lags p and q in the QARDL model.

For example, it has been applied to analyze the connection between the price of Bitcoin and the aggregate commodity index as well as the price of gold (Bouri et al. 2018).

4. Results and Discussion

Given below are the estimated long-run and short-run results based on the QARDL methodology, as described in the previous section.

Table 4 indicates the long-run dynamics of the impact of economic policy uncertainty and inflation on Bitcoin returns. The finding reveals that a 1 unit increase in the economic policy uncertainty of the USA tends to decrease 0.003 units of Bitcoin returns at a 10% level of significance. Similarly, a 1 unit increase in inflation in the USA causes a fall in the Bitcoin return by 0.024 units at a 5% level of significance.

Table 4. Long run coefficient.

Variable	Coefficient	Standard Error	T-Statistic	Probability
EPU	−0.003	0.038	−0.0974	0.067
INF	−0.024	0.011	−2.147	0.033
Constant	0.121	0.073	1.661	0.098

Similarly, Table 5 indicates the short-term impact of economic policy uncertainty and inflation on Bitcoin returns in the USA. According to the outcome, the impact of economic policy uncertainty indicates a negative association with Bitcoin returns but an insignificant relationship. However, on the other hand, inflation's association with Bitcoin returns shows a negative association with a significant relationship. A 1-unit increase in inflation reduces Bitcoin returns by 0.121 units at a 5% level of significance. Furthermore, at lag(−1) and lag (−2), the association appears to be also negative. Thus, a 1-unit increase in inflation tends to reduce Bitcoin returns by 0.019 units and 0.122 units, respectively, at a 10% level of significance and a 1% level of significance.

Table 5. Short run coefficient.

Variable	Coefficient	Standard Error	T-Statistic	Probability
ΔEPU	−0.054	0.047	−1.135	0.258
ΔEPU(−1)	−0.043	0.062	−0.069	0.486
ΔEPU(−2)	−0.051	0.050	−1.023	0.307
ΔINF	−0.121	0.051	−2.378	0.018
ΔINF (−1)	−0.019	0.053	−0.370	0.071
ΔINF (−2)	−0.122	0.046	−2.621	0.009
ECM(−1)	−0.839	0.166	−5.045	0.000

Figures 4 and 5 indicate the quantile outcome of economic policy uncertainty and inflation whereas Figure 6 indicates the quantile error correction model. On the other hand,

Figure 7 presents the relationship between economic policy uncertainty and bitcoin returns whereas Figure 8 indicates the relationship between inflation and bitcoin return respectively.

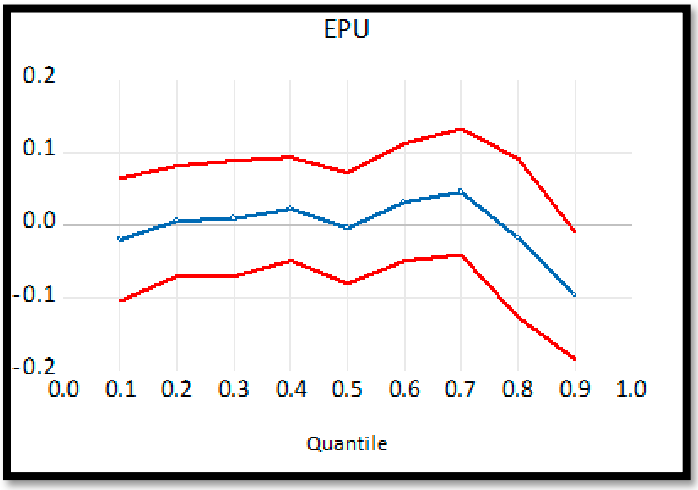

Figure 4. Quantile outcomes—economic policy uncertainty.

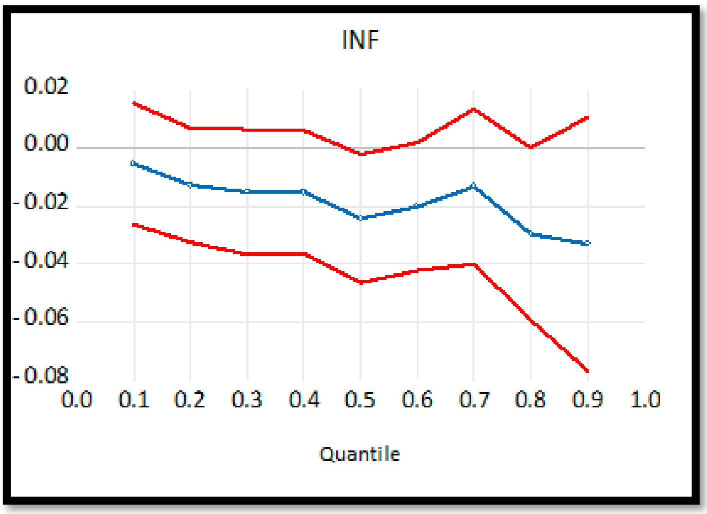

Figure 5. Quantile outcomes—inflation.

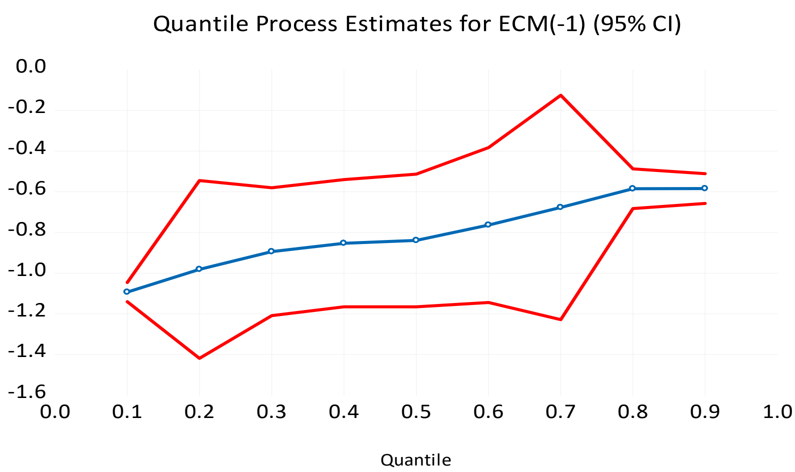

Figure 6. Quantile error correction model.

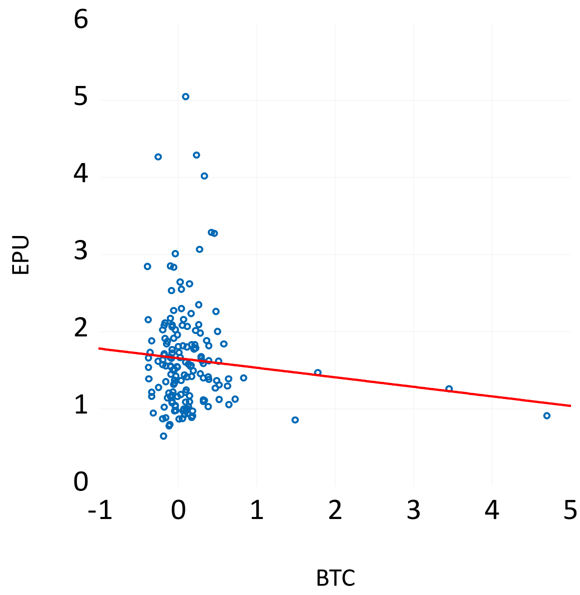

Figure 7. Relationship between Bitcoin returns and inflation.

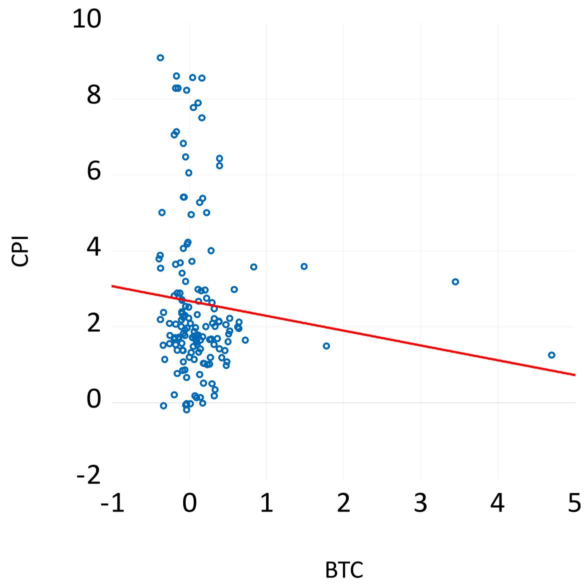

Figure 8. Relationship between inflation and Bitcoin returns.

Table 6 represents the quantile outcomes of the relationship between economic uncertainty policy, inflation, and Bitcoin returns. According to the results at quantile 60, a 1-unit increase in economic policy uncertainty reduces Bitcoin returns in the USA by 0.032 units. However, at a higher quantile, at 80, the coefficient value falls down; thus, a 1-unit increase in economic policy uncertainty decreases Bitcoin returns by 0.016 units (see Figure 4). Furthermore, in terms of inflation, the association also indicates a negative relationship; the coefficient indicates a high trend at the 20th, 30th, 40th, and 80th quantiles. According to these findings, high economic policy uncertainty reduces the confidence of investors in investing in products, and therefore they invest less. In the long-term, the diminished investment in Bitcoin due to economic policy uncertainty reduces the return. These findings were also confirmed by previous studies such as (Demir et al. 2018; Yen and Cheng 2021). Similarly, high inflation indicates the tightening of monetary policy in order to slow the price rises. During high inflation, the central bank increases the interest rate, which tends to decrease the investment mechanism. Therefore, a high inflation rate reduces Bitcoin returns in the USA. Corbet et al. (2020) and Smales (2022) also endorse similar findings that high inflation reduces Bitcoin returns.

Table 6. Quantiles estimation.

Variable	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
EPU	−0.019 (0.043)	0.006 (0.038)	0.009 (0.040)	0.022 (0.036)	−0.003 (0.038)	−0.032 (0.041) **	0.046 (0.044)	−0.016 (0.055) **	−0.096 (0.044)
INF	−0.005 (0.010)	−0.012 (0.010) **	−0.015 (0.010) **	−0.025 (0.010) **	−0.024 (0.011)	−0.020 (0.011)	−0.013 (0.013)	−0.029 (0.015) **	−0.032 (0.022)
Constant	−0.158 (0.068) **	−0.079 (0.068)	−0.048 (0.072)	−0.012 (0.066)	0.121 (0.073)	0.121 (0.076)	0.159 (0.084) **	0.417 0.146) **	0.373 (0.156)

Note: ** indicate 5% significance level.

Table 7 also includes diagnostic test results. The probability values of these tests are more significant than 5%. According to these results, there is no problem with changing variance (BP-G) and autocorrelation (BP-LM) in the model of this study. At the same time, there is no model building error (Ramsey Reset) problem. The model has a normal distribution (Jargua–Bera). It has been decided that there is no specification problem in the model.

Table 7. Post-estimation diagnostic test.

Diagnostic Test	F-Stat	*p*-Values
BP-LM	0.16	0.64
Ramsey Reset	1.00	0.43
Jargua–Bera	0.01	0.97
BP-G	0.47	0.91

5. Conclusions

Providing legal opportunities for investment is the responsibility of every government for macroeconomic stability. This paper examines the cryptocurrency–economic uncertainty–inflation trilemma of Bitcoin returns in the USA. It uniquely contributes to the debate on cryptocurrency investment and macroeconomic stability in the USA. COVID-19 and international business affairs have a high impact on investments in the USA. The findings of this paper reveal that high economic policy uncertainty in the USA and highly volatile recent inflation negatively impact Bitcoin returns in the USA. This is due to the unstable economic atmosphere; investors are highly reluctant to invest in the crypto market, which eventually impacts Bitcoin returns. Furthermore, due to high inflation, the central bank increases the interest rate, which also leads to a decline in investment and cryptocurrency returns for Bitcoin.

The creation of a virtual currency and its functioning on the global market poses new challenges to the authorities and forces the introduction of legal and financial regulations. A key element of this process is to determine the institutional conditions that influence the creation and operation of the cryptocurrency market not only in the US but also in the world.

In many countries, as a result of political forces, an ineffective system of institutions has been built, which results in the inhibition of development and inefficiency in the cryptocurrency market. The introduction of stricter regulations has led to a decrease in market competitiveness and has led to uncertainty related to virtual currency trading. In this regard, building a market and stable trading in virtual currency requires analyzing the institutional determinants of market efficiency, economic policy, real economic convergence, and economic development and cohesion with a social and economic dimension. Poorly developed FinTech infrastructure, including restrictive state policy, will lead to the loss of numerous market opportunities and inhibit the development of this field in the long term. Therefore, building market balance requires the development of social awareness through education and political and administrative apparatuses.

However, reluctance and "fear" of the challenges posed to state institutions by the development of the virtual currency market may bring negative economic consequences in the future. Ensuring the development of the virtual currency market should be dictated by the introduction of appropriate institutional conditions in the legal and economic sphere, as well as economic liberalism and clearly defined criteria for the functioning of the market. Institutional order should be built with respect for the balance between the actions of the authorities and the free functioning of the financial sector in order to take advantage of the entire spectrum of opportunities offered by the development of technology.

Finally, decision makers should take into consideration the current trends in sustainable development to improve financial, environmental, and social returns and contribute to a better future. For this reason, investors should prefer sustainable or green cryptocurrencies. Therefore, further studies can investigate green/dirty cryptocurrencies and their short- and long-term impacts.

The research is based on a narrow goal, only focused on Bitcoin, inflation, and economic uncertainty, which represents a limitation of the study. Future studies will explore more variables and risks, such as cryptocurrencies based on market capitalization (Ethereum, Binance Coin, SOL, ADA, USDT, etc.); various financial and macroeconomic variables, including gold, stock market index, etc.; and a geopolitical risk index that will serve as a control variable. In this regard, the research model extends our study to cover additional variables derived from panel data. In addition, the country context can be taken into account. Thus, the presented study paves the way for further rigorous research.

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Conflicts of Interest: The authors declare no conflicts of interest.

Notes

1. CFD stands for Contract for Difference. A CFD is a contract between two parties that undertakes to settle an amount equal to the difference between the opening and closing prices of a position. Hence the term "contract for difference"—http://www.xtb.com (accessed on 1 November 2023).
2. Phillips and Perron (1988) stated that there were essential findings that the assumptions of the DF test were wrong.
3. Phillips and Perron (1988) did not recommend using the PP test in a model with harmful moving average components, as it causes dimensionality-skewness.

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