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BITCOIN: A PONZI SCHEME OR AN EMERGING INFLATION-FIGHTING ASSET?

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Abstract. Under the dual impact of the COVID-19 pandemic and the Russian-Ukrainian conflict, the excessive stimulation of monetary policy continuously pushes up global inflation (INF). Therefore, this article explores whether Bitcoin can serve as a safe haven for INF. We apply the rolling-window Granger causality test to solve the issue of parameter instability in vector autoregression (VAR) systems and investigate the time-varying interaction between INF and Bitcoin price (BP). The negative influence of INF on BP means a high inflation shock causes BP to decline, indicating that Bitcoin cannot be a safe asset against INF. This is because investors have decreased their willingness to hold Bitcoin under the high INF expectations and cause BP to fall. This finding is not supported by the Intertemporal Capital Asset Pricing Model, emphasising that INF positively impacts BP. Conversely, BP has positive and negative impacts on INF. The positive effect highlights the effectiveness of Bitcoin in predicting INF fluctuations, but economic factors could undermine this effectiveness. In the context of economic stagnation and market turmoil, investors can adjust their portfolio investments based on Bitcoin. The government should utilise the trend of BP to regulate the dynamics of INF to reduce uncertainty in the financial system.

Keywords: Bitcoin price, inflation, rolling-window, causal relationship.

JEL Classification: C32, E44, G12.

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1. Introduction

This article explores whether Bitcoin can hedge against inflation (INF) and thus clarifies how Bitcoin price (BP) behaves during periods of large fluctuations in economic policy. In times of economic turmoil, investors are affected by economic policy uncertainty, which brings serious consequences such as high inflation and currency depreciation, leading to a decline in their trust in the economy and mainstream currency (Krivoruchko et al., 2018). In the wake of the financial crisis in 2008, Bitcoin appeared to investors worldwide as a secure alternative to the fiat currency (Bouri et al., 2018). Bitcoin is regarded as a hedge against extreme economic uncertainty (Su et al., 2020b; Umar et al., 2021) and financial turmoil (Bouri et al., 2017a), including inflation risks. Specifically, INF significantly reduces the public's real income (Salisu

et al., 2017), and currency purchasing power has also dramatically decreased (ElFayoumi, 2018). At the same time, economic growth will face tremendous downward pressure and cause sustained financial turmoil. In 2020, a sudden COVID-19 pandemic caused changes in global supply chains and consumption patterns, with INF rising across countries (Choi & Shin, 2022). This massive fiscal bailout of the U.S. government has triggered severe high inflation across the country, and investors treat Bitcoin as a safe asset to escape the negative impacts of inflation on purchasing power (Güle, 2021). Hence, the market capitalisation of Bitcoin continues to soar. Until recently, the Russian-Ukrainian military conflict has plunged the world economy into a higher vulnerability; it has affected the global food supply, causing agricultural prices and residents' electricity costs to soar, putting enormous inflationary pressure on various countries (Umar et al., 2022a). In addition, the war has sparked investors to pursue safe-haven assets such as Bitcoin, as evidenced by the sharp rise in BP (Umar et al., 2022b). Evidently, inflation risk has become a growing concern for global governments and monetary authorities; finding an effective hedging tool in the existing high-INF environment and maximising asset returns has become a focus (Miao & Huang, 2022).

Inflation is a crucial measure of economic stability, and its significant fluctuation will severely influence economic development and residents' well-being (Salisu et al., 2017). INF in the U.S. has been relatively stable until 2019, and the Gross Domestic Product (GDP) also shows a steady growth state (Bonaparte & Peron, 2022). However, as the U.S. government cannot solve the supply chain crisis produced by the epidemic, it can only lower interest rates and raise price levels to curb the public's excess demand, which has dramatically disrupted the regular operation of the economy. In the face of rising INF, the risk of stagnation in the U.S. economy has risen sharply and could cause a massive shock in emerging economies, triggering a series of debt crises. Meanwhile, the Russian-Ukrainian conflict has caused a sharp rise in the prices of commodities such as natural gas and crude oil (Umar et al., 2022a). Inadequate global oil and gas supplies and soaring prices have led the U.S. to the worst energy crisis in nearly 50 years and jeopardised national security and residents' lives.

The U.S. monetary policy adjustment has global implications, and its quantitative easing policy will significantly increase INF in some emerging market countries (Feng et al., 2021). Therefore, in the event of a recession and high INF, panic has risen sharply among investors, who need effective safe havens to prevent damage to their assets (Su et al., 2022). Since Bitcoin has anti-inflation characteristics similar to gold, it has become a more viable competitor than gold, commodities, and real estate. Unlike government-controlled traditional monetary, Bitcoin can easily adjust for its inflation with simple code changes (Félez-Viñas et al., 2021). Furthermore, Bitcoin is supported by some investors because it is incredibly resilient in turmoil periods, and it can withstand the downside risks caused by economic uncertainty (Selmi et al., 2018). Hence, Bitcoin can be a shelter for investors to hedge and avoid potential inflation risks (Bouri et al., 2019). However, BP is highly volatile and prone to speculative bubbles (Cheah & Fry, 2015), which can weaken the stability of financial markets and push up global economic risks (Yarovaya et al., 2016). In light of this, with the increasing use of Bitcoin, it becomes especially significant to reveal the inflationary implications behind its price formation (Ahmed, 2022). Moreover, Bitcoin dramatically expands financial innovations in developing countries and connects global economic activity due to its low transaction costs (Krause,

2016; Dumitrescu, 2017), but the role of INF in BP has not been interpreted (Xu et al., 2021). Given the leading role of the U.S. Bitcoin market, it is necessary to explore whether Bitcoin can replace gold as a haven against INF under the dynamic economic situation (Choi & Shin, 2022). Analysing the causal link between the two variables can provide timely policy implications for governments and investors.

Gold has long been perceived as an effective tool to hedge against INF; people invest in gold to reduce losses from INF (Conlon et al., 2021). Bitcoin has similar features to gold, such as limited supply, a proven store of value, and a safe haven asset (Selmi et al., 2018). There is substantial literature that has proved Bitcoin's ability to hedge INF. Many studies support the view that Bitcoin is a digital currency with a fixed circulation, and the total supply has been determined to be a 21 million, making it an effective anti-inflation tool (Sarkodie et al., 2022). Compared to gold, the supply of Bitcoin is fixed and transparent (Wang & Hausken, 2022), thus, it can avoid inflation risks and be able to become a refuge for investor wealth (Selmi et al., 2018). Hence, Bitcoin can be considered a kind of "digital gold" due to its mechanical growth and limited quantity supply, which can protect investors from expansionary monetary policy (Karau, 2021; Tao et al., 2022). Therefore, Bitcoin's independence has made it a better emerging safe haven instrument than gold. From a macroeconomic perspective, these restrictions appeal to countries with high inflation, such as Argentina, the U.S., and the U.K. (Wu et al., 2014). The main reason is that the mining and trading of Bitcoin without government control, its value can be dependent on the central bank's monetary policy and is not disturbed by INF (Baur et al., 2018). Abdulrahman and Carlsson (2021) also claim that Bitcoin is currency protection that could help investors avoid inflation risks caused by the expansionary behaviour of central banks. Moreover, Lyócsa et al. (2020) demonstrate that the volatility of BP is dependent on government inflation announcements and corresponding monetary policy, thus, Bitcoin is perceived as an attractive investment option for hedging INF. Conlon et al. (2021) assert that the forward inflation rate positively impacts BP, which confirms the role of Bitcoin in hedging inflationary risks. Karau (2021) discusses the impact of monetary policy shocks on BP and discovers a positive correlation between BP and INF, consistent with the concept that Bitcoin is digital gold. Marmora (2022) reveals that investors are more inclined to use Bitcoin to combat inflation risks due to deep concerns about inflationary pressure. Wang et al. (2022) also point out that the traditional enterprise MicroStrategy Inc. has invested more than $1 billion in Bitcoin to hedge against the inflationary risk and low-yield environment, suggesting that Bitcoin can hedge high INF.

However, some studies have raised significant doubts about Bitcoin's ability to hedge against INF due to there is no clear evidence of the value of Bitcoin in hedging INF. Burghelea (2008) highlights that investors cannot regard Bitcoin as a shelter for INF by investors. Baek and Elbeck (2015) emphasise that the volatility of the Bitcoin market is about 26 times that of the stock market, which means that Bitcoin is filled with risky and speculative, and macroeconomic factors will weaken its capacity to hedge inflation risk. Conlon et al. (2020) also observe that BP is influenced by macro factors similar to traditional assets and exhibits high volatility; thereby, Bitcoin cannot be a credible hedge against INF. Andrean (2019) notes that short-term and long-term INF negatively affect Bitcoin's price. Specifically, BP will fall by $7.8 when INF increases by 10%. Karau (2021) notices that the Federal Reserve System (Fed)'s

tightening monetary policy has promoted BP's rise, meaning that Bitcoin is considered a poor and inadequate hedging instrument in the INF. Lally et al. (2022) suggest that the enforced cap on Bitcoin's total supply triggers a frenzy of speculation among investors, making it impossible to serve as a hedge against INF. In general, Bitcoin's hedging function against INF has not been clearly explained. Given that the volatility of BP will affect market portfolio allocation, asset pricing and other fields, it is urgent to analyse Bitcoin and INF (Yi et al., 2022).

Additionally, other studies have surprisingly denoted that Bitcoin's role as a haven for INF is time-changing and highly dependent on other elements. Bouri et al. (2017b) ascertain that the liquidity of Bitcoin investment is much lower than other traditional assets, and the high volatility of BP will cause its risk diversification ability to change over time. Bouoiyour et al. (2018) discover that the role of Bitcoin as a haven against INF is not static because this ability is subject to factors such as policy and economic factors. Bouri et al. (2020) report that the discrepancies in Bitcoin's role as a hedging instrument are driven by the low-interest rate and monetary policy changes. Through investigating the hedging nature of gold and Bitcoin against INF, Abdulrahman and Carlsson (2021) advocate that Bitcoin should be used together with other hedging tools to prevent inflation risk and that use alone is futile. Ma et al. (2022) reveal that due to Bitcoin's low liquidity and high volatility, its role in hedging INF is time-changing, especially during high inflation triggered by COVID-19.

In summary, existing research has yet reached a consensus on Bitcoin's ability to hedge INF due to their mixed interrelationship. For one thing, Bitcoin is independent of monetary policy and appreciates after the positive impact of INF, so investors see Bitcoin as a trusted hedge against INF. For another thing, the rapid rise in BP has led to frequent Bitcoin bubbles and crash events; thereby, it has no same function as gold to withstand INF. Meanwhile, the current studies have ignored the temporal dynamic causal link between BP and INF. Hence, we use bootstrap sub-sample rolling window test to explore the correlation between BP and INF, and further investigate Bitcoin's role in hedging INF.

This paper makes contributions in the following ways. Firstly, investors' risk aversion due to high inflation concerns has caused them to look for suitable hedging tools. Therefore, this paper examines Bitcoin's role as a safe haven for INF under the violent fluctuations of economic policy. Understanding the two-way impact of Bitcoin and INF can help investors choose practical tools and optimise their asset management to prevent losses in times of high INF. Secondly, the Granger causality between BP and INF may change over time, indicating that Bitcoin's role as a haven against INF is variable. Hence, we apply the rolling-window causality approach to improve the accuracy of outcomes (Su et al., 2017, 2020a, 2020b, 2020c, 2021d; Yuan et al., 2022). Empirical results show that INF negatively affects BP, indicating that Bitcoin cannot be used as a haven to hedge INF and is inconsistent with the Intertemporal Capital Asset Pricing Model, which ascertains that INF positively affects BP. There are positive and negative effects that stem from BP towards INF. The positive impact indicates that Bitcoin is a leading signal which can be used to analyse the variations of INF. But this claim is not always confirmed, suggesting that Bitcoin's capability to predict INF is not entirely effective. Moreover, we provide some enlightenment for investors who can incorporate Bitcoin into

their portfolio, thus achieving their goal of diversifying risk and maintaining wealth. The government should grasp BP's tendency to formulate corresponding monetary policies to prevent commodity price fluctuations and inflationary risks and thus support the sustainable development of the economy.

The rest of this paper is structured as follows. Section 2 explains the interaction mechanism. Section 3 demonstrates theoretical methodology. Sections 4 and 5 show the data and results. The last section concludes the study.

2. Bitcoin price and inflation interaction mechanism

2.1. The influence mechanism from INF to BP

We investigate the interaction mechanism of INF on BP by constructing the intertemporal capital asset pricing model (ICAPM). The model assumes that informed and feedback investors dominate the Bitcoin market, and the systemic risk cannot be eliminated by diversifying investments, which INF denotes. The informed buyers who can accurately predict the trend of BP according to the INF's fluctuations will consider the amount invested in Bitcoin. Hence, the demand for Bitcoin can be expressed by Eq. (1):

$$I_t^d = \frac{E_{t-1}(BP_t) - BP^f}{\mu(INF_t)}, \tag{1}$$

where the percentage that informed traders invest in Bitcoin is represented by the I_t^d. $\mu(INF_t) > 0$ indicates that the value is positive, and $\mu'(INF_t) > 0$ shows that the rise of INF results in an increase in $\mu(INF_t)$. When the value of INF is 0, we can obtain the value of BP^f. $E_{t-1}(BP_t)$ shows the conditional expectation of BP, within the time period expressed in $t - 1$. Furthermore, BP_t implies an ex-post BP at time t. We also suppose that there are only informed investors exist on the Bitcoin market, then $I_t^d = 1$. Hence, we could transform the Eq. (1) into the Capital Asset Pricing Model (CAPM), expressed by the Eq. (2):

$$E_{t-1}\left(BP_t\right) = BP^f + \mu\left(INF_t\right). \tag{2}$$

We can observe that BP is positively affected by INF, demonstrating that the rise of INF will cause an increase in BP. This means Bitcoin can act as a haven against INF. Then the ICAPM treats feedback traders as another different type of investors. Therefore, the Bitcoin amount bought by feedback traders can be constructed:

$$F_t^d = \theta BP_{t-1}, \tag{3}$$

where $\theta > 0$. Adding feedback traders to the Bitcoin market, then we can get $I_t^d = 1 - F_t^d$. In this regard, Eq. (1) can be rewritten as follows:

$$E_{t-1}(BP_t) = BP^f + \mu(INF_t) - \theta\mu(INF_t)BP_{t-1}. \tag{4}$$

The additional item in Eq. (4) is expressed by $-\theta\mu(INF_t)BP_{t-1}$, which highlights the feedback traders' behaviour will have a shock to the Bitcoin market. $1 - \theta BP_{t-1}$ is the coefficient of

$\mu(INF_t)$, and it is a positive value as $\theta BP_{t-1} = F_t^d < 1$. Therefore, the positive effect from INF to BP can be proved by ICAPM. High INF demonstrates that the inflation level has spiked sharply under the influence of expansionary monetary policy and production costs have increased (Jordà et al., 2022). Whenever expansionary monetary policy, financial crisis, and inflationary problems break out, the public will lose confidence in fiat currency and traditional assets, turning to the Bitcoin market to save their wealth from damage. For instance, the pandemic in 2020 has resulted in investors preferring the Bitcoin investment to prevent INF, which triggered a rise in BP. Therefore, the public is willing to purchase Bitcoin to prevent losses triggered by inflation-related risks, further proving its function in hedging INF.

2.2. The influence mechanism from BP to INF

There are two main explanations for the influence mechanism of BP on INF. The positive effect can be explained by the wealth effect. Changes in asset prices can affect investors' consumption and investment behaviour, causing changes in aggregate social demand, which significantly impacts INF. Consistent with other assets (e.g., gold, house and oil), the rise in the price of Bitcoin means an increase in investor wealth, stimulating their consumption demand and increasing the overall price level. This suggests that the movement of BP precedes INF, and the continued growth of INF is related to the rise in the price of Bitcoin (Blau et al., 2021). The negative impact of BP on INF suggests that under the impact of uncertainty, the rise in BP is not always considered a major factor in the formation of INF, and INF is often associated with the macroeconomic policies and economic structure.

Based on the above analyses, we propose the following two Hypotheses:

H1. *INF positively impacts BP, meaning investors can regard Bitcoin as an INF hedge.*

H2. *BP has positive and negative impacts on INF, indicating that INF is influenced by BP.*

3. Methodology

3.1. Bootstrap full-sample causality test

For the traditional vector auto-regressive (VAR) model, the Granger causal test must obey the standard asymptotic distributions. The residual-based bootstrap (*RB*) test created by Shukur and Mantalos (1997) can avoid results bias and enhance the Granger causality tests. Furthermore, the *RB* method is suitable for tests with standard asymptotic distribution and even small samples. They also developed the likelihood ratio (LR) test, which can be modified according to the features of power and size (Shukur & Mantalos, 2000). We explore the interrelationship between BP and INF by adopting the *RB*-based modified-*LR* statistics. Accordingly, the VAR (*p*) model is expressed in Eq. (5) below:

$$Z_t = \eta_0 + \eta_1 Z_{t-1} + \ldots\ldots + \eta_p Z_{t-p} + \nu_t,\ t = 1, 2, \ldots, T, \tag{5}$$

where *p* denotes the optimal lag order based on Schwarz Information Criterion (SIC). Z_t in the VAR (*p*) model can be divided into BP and INF, indicating $Z_t = (BP_t, INF_t)'$. Also, due to the U.S. dollar index (USDX) negatively influences BP and INF (Umar et al., 2021; Su et al., 2020c),

which will affect the interaction between these two variables, thus we use USDX as a control variable, as shown in the Eq. (6):

$$\begin{bmatrix} BP_t \\ INF_t \end{bmatrix} = \begin{bmatrix} \eta_{10} \\ \eta_{20} \end{bmatrix} + \begin{bmatrix} \eta_{11}(L) & \eta_{12}(L) & \eta_{13}(L) \\ \eta_{21}(L) & \eta_{22}(L) & \eta_{23}(L) \end{bmatrix} \begin{bmatrix} BP_t \\ INF_t \\ USDX_t \end{bmatrix} + \begin{bmatrix} \rho_{1t} \\ \rho_{2t} \end{bmatrix}, \quad (6)$$

where the $\rho_t = (\rho_{1t}, \rho_{2t})'$ represents a white-noise process. $\eta_{ij}(L) = \sum_{k=1}^{p} \eta_{ij,k} L^k$, $i = 1, 2, ..., j = 1, 2, 3$ and L is a lag operator, then we can get $L^k Z_t = Z_{t-k}$.

The null hypothesis that BP cannot cause INF can be verified by additional constraints like $\eta_{12,k} = 0$ for $k = 1, 2, ..., p$. Likewise, another hypothesis INF has no effect on BP $\eta_{21,k} = 0$ for $k = 1, 2, ..., p$ can be tested as well.

3.2. Parameter stability test

It is unrealistic to assume that the parameters of the VAR model are unchanged in the full-sample causality test. When the parameters have structural changes and are unstable, it will affect the inaccuracies of the full-sample test. We have applied the *Sup-F*, *Ave-F*, and *Exp-F* tests (Andrews, 1993; Andrews & Ploberger, 1994) to enhance the stability of parameters. Moreover, we conduct the L_c statistics method (Hanson, 1992; Nyblom, 1989) to explore whether the parameters obey the random walk process. We can use the above tests to assess the stability of BP and INF to avoid structural changes. In this regard, this paper applies the sub-sample test to overcome the instability of the parameters (Qin et al., 2021).

3.3. Bootstrap sub-sample rolling-window causality test

Based on the rolling-window method (Balcilar et al., 2010), we assume the extent of the whole sample is S and the rolling- window width is l, then we can obtain S-l+1 sub-samples. By applying for the *LR* statistics based on *RB*, each section will get a Granger causality result. $N_b^{-1} \sum_{k=1}^{p} \hat{\eta}^*_{12,k}$ and $N_b^{-1} \sum_{k=1}^{p} \hat{\eta}^*_{21,k}$ are the parameters of bootstrap estimations, which indicates the influence from BP to INF and the influence from INF to BP, respectively. N_b is the repetition numbers, $\hat{\eta}^*_{12,k}$ and $\hat{\eta}^*_{21,k}$ are estimations according to Eq. (6). In addition, we use a 90% confidence interval, and 95th and 5th quantile (Su et al., 2022).

4. Data

We select monthly data from 2010: M7 to 2022:M4 to examine the causality between BP and INF so as to investigate whether Bitcoin can be regarded as a safe haven for INF. In July 2010, the tech media Slashdot Bitcoin first reported the Bitcoin, which brought a great many investors to Bitcoin (Su et al., 2022). Shortly afterwards, the demand for Bitcoin increased dramatically (Umar et al., 2021). The high liquidity and stability of the U.S. dollar make it play an essential role in the global economy and trading transactions (Feng et al., 2021). As a worldwide convention, we use the U.S. dollar-denominated Bitcoin price[1] (BP) to denote

[1] The price of Bitcoin in U.S. dollars is obtained from the Yahoo Finance Database.

changes in the international Bitcoin market (Su et al., 2020b). The inflationary expectation is a crucial cause of INF, and Falck et al. (2021) discover there is a positive correlation between the two variables. Once the public perceives this expectation, they will change their consumption and investment behaviour, ultimately leading to high inflation (Coibion et al., 2020). Hence, we choose the 5-year Forward Inflation Expectation Rate[2] (T5YIFR) to reflect the U.S. inflation level (Blau et al., 2021). Sarkodie et al. (2022) present that the excessive printing of money by the central bank and injection of much liquidity into the market can result in high INF. In addition, since high INF can seriously affect the public's lives and reduce their credibility with the government, thus INF can reflect public attitudes towards the macroeconomic situation and uncertainties (Grinberg, 2011). As the Bitcoin market matures, it has been widely recognised to hedge against uncertainty brought about by INF (Spade, 2018). Since the U.S. dollar prices BP, loose monetary policy and high inflation may result in depreciation, exacerbating BP's rise. Therefore, the U.S. dollar index (USDX) can influence the movement of BP and thus affects the correlation between BP and INF, so we employ USDX as a control variable (Su et al., 2020c). Figure 1 displays the trends of INF and BP.

We can clearly note that the direction of the movement of BP and INF is not always the same. In the early days of Bitcoin's issuance, BP is relatively low owing to the lack of formal trading venues, although INF is higher (Su et al., 2020b). On October 28, 2010, the first Bitcoin short sell trade was launched, and its low transaction and service costs aroused public enthusiasm for investment (Dumitrescu, 2017). Meanwhile, with the increase in the public's acceptance and trust of Bitcoin, the frenzied investment demand has driven BP to show an upward trend. In order to stimulate the economic recovery, the U.S. government introduced a four-stage consecutive quantitative easing policy[3] from 2008 to 2012, which renders contin-

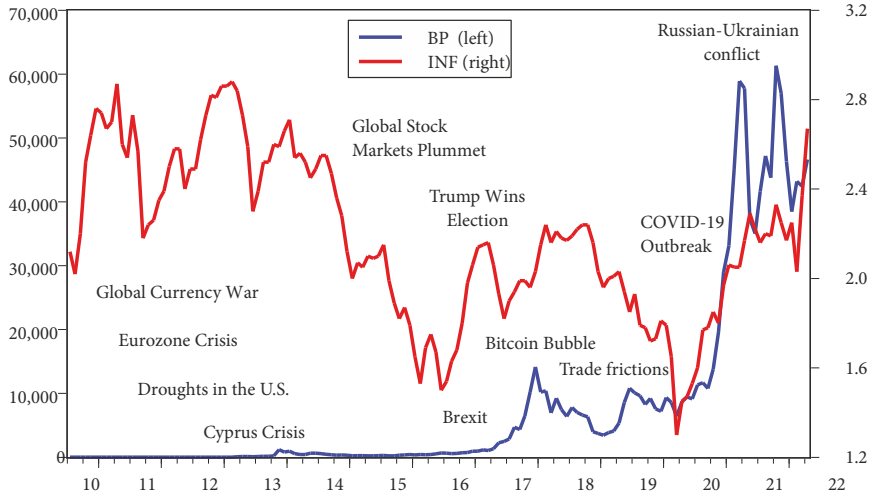

Figure 1. The trends of BP and INF

[2] These data are retrieved from FRED at https://fred.stlouisfed.org/series/T5YIFR.

[3] Quantitative easing mainly refers to the central bank's purchase of government bonds, increasing the money supply, and injecting a large amount of liquidity into the market to encourage residents' spending and borrowing.

ued growth of INF (Su et al., 2020a; Qin et al., 2021). In addition, the Greece sovereign debt crisis in 2010 spread to other European countries, resulting in more significant uncertainty in the global economy and heavy disruption to the U.S. stock market (Su et al., 2017). The second round of quantitative easing was launched in November 2010, which caused an upward tendency in the INF from November 2010 to July 2012. BP has remained at a low level, and its fluctuation was relatively stable before 2013. However, the outbreak of the Cyprus crisis in 2013, the recovery of global markets and the influx of substantial Chinese investors, all of these events have driven a sharp rise in BP (Qin et al., 2021). The U.S. government continues to ease the money supply to enhance the global competitiveness of goods, leading global commodity prices to rise and trigger worldwide inflation and a bubble economy. Since 2014, the uncertainty brought about by the Russian-Ukrainian conflict and the deterioration of the Middle East situation, as well as the sharp depreciation of the euro, have expanded the space for the U.S. dollar to appreciate (Su et al., 2020b). Under the influence of rising geopolitical risks and the appreciation of the U.S. dollar, the public abandons their investment in Bitcoin and turns to the U.S. dollar, which causes BP to plummet (Su et al., 2020a).

In 2016, with the improvement of the U.S. economic situation and the sharp rebound in international oil prices, INF showed an upward tendency. Meanwhile, the high INF coupled with uncertain events such as the South Sea dispute and the Syrian crisis has caused panic, stimulating the public to invest in Bitcoin, which can be a risk-hedging tool (Briere et al., 2015). Therefore, BP moves in the same direction as INF. However, INF suffers a substantial drop from March 2016. The weak INF is disturbed by some temporary factors, such as lower communication costs and prescription drug prices. The persistent downturn in housing and automobile markets further weakens the public's willingness to consume, and INF drops dramatically. Hence, lower borrowing costs caused by low inflation have led investors to actively invest in Bitcoin, causing BP to spike (Qin et al., 2021). In 2017, the Trump administration's cancellation of Obamacare sparked a fierce conflict between Democrats and Republicans (Umar et al., 2021), which caused a rise in unemployment and INF shows a declining tendency due to weak consumption. However, high political conflict has rendered investor sentiment fluctuates continuously, and BP shows a rising trend (Pham et al., 2018). The rising BP has further resulted in an investment boom among investors in South Korea, China, and Japan, eventually forming a bubble in December 2017 (Li et al., 2019). This trend does not last long, the U.S. dollar has been appreciating under the influence of the Fed's continuous interest rate hikes in 2018. Then INF falls sharply, and investors firmly believe that the U.S. dollar is an excellent store of value, which results in BP declining. In 2022, the Russian-Ukrainian conflict has further exacerbated the global supply bottleneck under the impact of the epidemic, resulting in a general rise in the prices of commodities such as energy, agricultural products, and metals, and INF also shows an upward trend (Umar et al., 2022b). As investors gradually develop strong high inflation expectations, global risk aversion has heated up further, triggering a heavy shock in the investment market. Concerned about the security of Bitcoin transactions, global investors have begun to sell Bitcoin in large quantities (Umar et al., 2022a). Then BP falls sharply again, with a maximum decline of nearly 10%.

Table 1 shows that the averages of BP, INF and USDX are 6947.262, 2.177 and 89.591, respectively. The positive skewness of BP and INF indicates that they are right-skewed. Skew-

ness is negative for USDX, meaning it is left-skewed. Moreover, BP has a larger kurtosis than 3, indicating that the series satisfies the leptokurtic[4] distribution. Meanwhile, the kurtosis of INF and USDX is less than 3, thereby, the two series satisfy the platykurtic distributions. Furthermore, the Jarque-Bera statistics of BP and USDX present that they are significantly non-normality at a 1% level. Therefore, we apply the *RB* method to overcome the non-normal distributions problem and employ the bootstrap sub-sample rolling window method to examine the time-varying interaction between BP and INF. The potential heteroscedasticity problem can be avoided by performing natural logarithms on BP, INF and USDX. In addition, the first difference form of the three variables is to obtain stationary sequences.

Table 1. Descriptive statistics

	BP	INF	USDX
Observations	142	142	142
Mean	7953.990	2.181	89.813
Median	654.239	2.160	92.935
Maximum	61318.960	2.880	102.390
Minimum	0.060	1.300	72.930
Standard Deviation	14583.78	0.363	8.138
Skewness	2.268	0.006	–0.441
Kurtosis	7.014	2.289	1.708
Jarque-Bera	215.980***	3.020	14.490***

Note: *** denotes significance at 1 percent.

5. Empirical results

The VAR model is applied to explore the full-sample causality between BP and INF based on Eq. (6). We have chosen the optimal lag order as 2 according to SIC. Table 2 shows the result of full-sample causality tests, which can examine whether the parameters in the VAR process will change over time. Based on the bootstrap *p*-values, we find BP does not influence INF and vice versa, which is inconsistent with the previous studies (Spade, 2018; Gozgor et al., 2019) and Hypotheses 1 and 2.

Table 2. Full-sample Granger causality test

Tests	H_0: BP does not cause INF		H_0: INF does not cause BP	
	Statistics	*p*-values	Statistics	*p*-values
Bootstrap *LR* test	1.192	0.530	0.886	0.760

Note: We use 10,000 bootstrap repetitions to calculate *p*-values.

[4] The leptokurtic distribution takes on a high peak and fat tail, which also has a higher probability of extreme events. The opposite is a platykurtic distribution.

It should be noted that the full-sample test in the VAR process assumes that the parameters are stable during the whole sample period, and there is only a single Granger causal relationship in the entire sample. However, structural changes in the VAR system and time series can disturb the causality between BP and INF, causing the causal relationship between the two variables to change over time (Balcilar & Ozdemir, 2013). Thereby, we adopt the *Sup-F*, *Ave-F* and *Exp-F* tests (Andrews, 1993; Andrews & Ploberger, 1994) to examine whether the parameter is stable or not. The L_c statistics test, which is developed by Nyblom (1989) and Hanson (1992), is also employed to enhance the stability of the VAR model.

As shown in Table 3, the *Sup-F* test confirms that BP and INF have a large deviation at a 1% level, while the VAR system is 5%. The *Ave-F* test shows that BP, INF, and VAR models have changed over time at a 1% level. The *Exp-F* test highlights that the parameters will gradually change over time in the INF and VAR system at a 5% level, and BP is 1% level. We find that the L_c statistic test shows the parameters of the VAR model do not follow a random walk process at a 1% level. Therefore, founded on the above stability test results, we observe a non-constant causal relationship between the two variables, which indicates that the full-sample data are inaccurate. Consequently, we use the bootstrap sub-sample rolling-window causality test (Su et al., 2022) to avoid the structural mutations in the parameters and explore the time-varying interaction between BP and INF. Also, we select 24[5] months as the rolling-window width to increase the accuracy of the Granger causality test.

Table 3. Parameter stability test

Tests	BP		INF		VAR system	
	Statistics	*p*-value	Statistics	*p*-value	Statistics	*p*-value
Sup-F	22.291***	0.001	19.187***	0.005	19.675**	0.016
Ave-F	4.867***	0.000	1.524***	0.002	6.113***	0.001
Exp-F	6.595***	0.007	0.290**	0.026	5.525**	0.015
L_c					1.089***	0.000

Notes: We use 10,000 bootstrap repetitions to calculate *p*-values. *** and ** denote significance at the 1 and 5 percent, respectively.

Figures 2 and 3 point out the *p*-values and effects that stem from INF to BP. INF Granger causes BP during 2021: M10-2021: M11, at a significant level of 10%. A negative impact exists from INF to BP, meaning that Bitcoin cannot be relied upon to avoid inflation-related risks, thereby rejecting the claim that Bitcoin is a safe haven for INF (Choi & Shin, 2022).

The negative influence can be affirmed that Bitcoin cannot act as a safe haven for INF. We can determine the negative impact of INF on BP from three aspects. Firstly, INF has increased significantly since February 2021, mainly because the Fed prints trillions of U.S. dollars and releases abundant liquidity, resulting in a global U.S. dollar surplus. But due to the U.S. lacking a basic domestic industrial system, it must import goods and thus form imported inflation.

[5] We use the rolling-window widths of 20-, 28- and 32- months, respectively. The findings are in line with the 24-month rolling-window.

In order to alleviate the high INF, the continued rise in the federal funds rate has adversely affected the Bitcoin market. Rising INF caused by monetary policy shocks has a huge and lasting impact on BP, and Bitcoin is mainly used for speculative investments and does not have an anti-inflation role (Ma et al., 2022). Thereby, BP has fallen sharply as the U.S. dollar appreciates and market liquidity weakens (Sarkodie et al., 2022). Secondly, due to the soaring INF, persistent labour shortages and supply chain bottlenecks have seriously threatened the public's daily lives and stirred public panic, this situation has made them pessimistic about the economic recovery (Abdulrahman & Carlsson, 2021). Therefore, high inflation expectations have caused investors to be concerned about their enthusiasm for Bitcoin investment, resulting in a significant decline in Bitcoin demand. Moreover, the decline in bond and U.S.

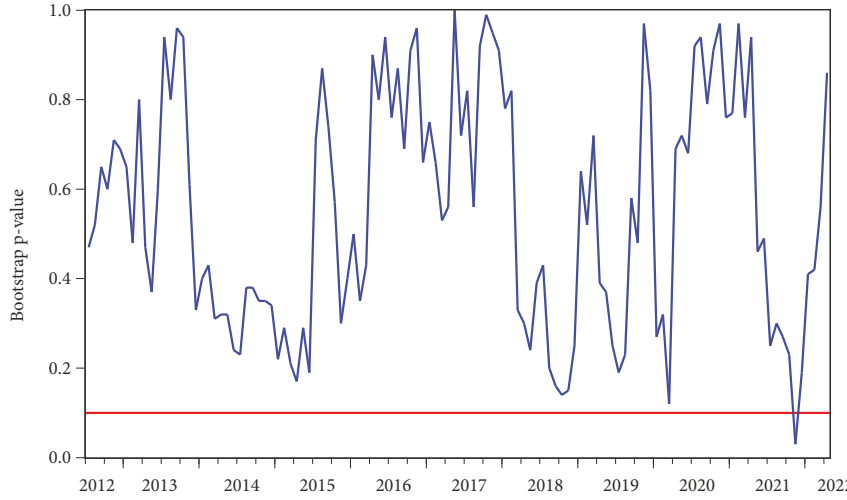

Figure 2. The *p*-values with no influence from INF to BP

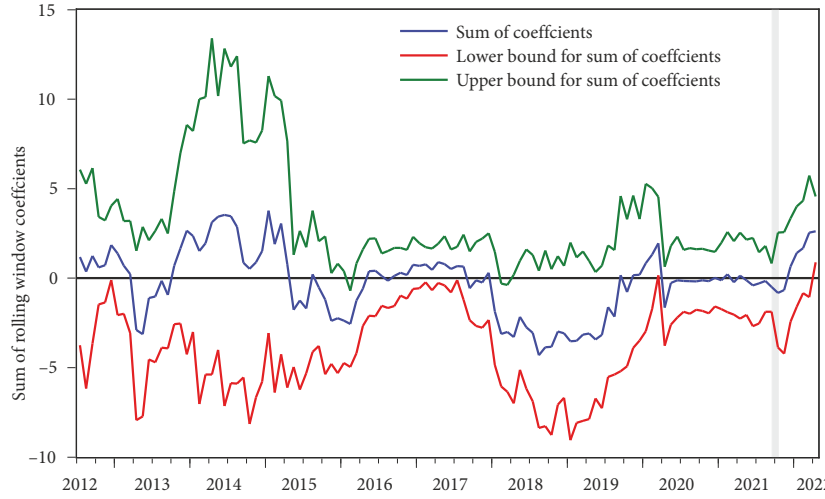

Figure 3. The effect from INF to BP

dollar exchange rates led gold prices to rise by 1.5% within a month, which caused an increasing demand for gold instead of the risky asset Bitcoin (Wen et al., 2022). As a result, BP plummeted by more than 16% within one month. Thirdly, the energy demands required by U.S. business production and household life are growing faster than globalised production with the advent of winter, which has driven a sizable demand for oil and gas. Specifically, the public's living costs will increase when oil prices (OP) rise, and the movement of OP is seen as a practical guide to developing high INF (Wang et al., 2016). The rise in OP has caused investors to flock to the oil market, dramatically weakening their confidence in the Bitcoin market and rendered BP to fall sharply (Wang et al., 2022). Therefore, the negative impact shows that high INF may bring downward pressure to BP, indicating that BP has no hedging ability during 2021: M10-2021: M11. This finding is inconsistent with the results of the ICAPM model, which emphasises that INF has a certain positive effect on BP.

Figures 4 and 5 exhibit the *p*-values and the orientation of the impact from BP to INF. BP Granger causes the INF in the time periods of 2012: M11-2013: M2, 2013: M11-2013: M12, 2017: M3-2017: M5, 2018: M5-2018: M7 and 2018: M10-2019: M5 at a 10% significance level. The positive impact (2012: M11-2013: M2, 2018: M5-2018: M7 and 2018: M10-2019: M5) and the negative influence (2013: M11-2013: M12 and 2017: M3-2017: M5) exists from BP to INF.

The positive effect that stems from BP towards INF suggests that the Bitcoin market effectively reflects inflation fluctuations. There are three reasons to explain the interaction mechanism of 2012: M11-2013: M2. Firstly, Bitcoin ushers in the first reduction day since its creation, and the demand for Bitcoin is far greater than its limited supply, causing the fiat currency depreciation and an increase in the imported goods price, which indicates that BP drives upward on INF (Seetharaman et al., 2017). Meanwhile, the U.S. has experienced the most severe drought and high temperature since 1956, with agriculture and animal husbandry severely affected, while the production of staple foods has also fallen sharply (Sun et al., 2021). The decline in food production has led to U.S. food prices rising significantly, further exacerbating the inflationary pressure throughout all society. Hence, the Bitcoin market can reflect the substantial increase in INF. Secondly, authorised by the French government, the first officially acknowledged Bitcoin central exchange was founded (Su et al., 2020b). The establishment of the exchange reduces the time required for buyers and sellers to conduct transactions and improves market efficiency (Dumitrescu, 2017), which results in increasingly active market trading and causes BP to rise. Moreover, under the influence of the third round of quantitative easing, the labour market and economy have further recovered, and INF also shows a surging trend. Bitcoin is regarded as an attractive option for diversification investment that cannot depreciate by the loose monetary policy (Félez-Viñas et al., 2021). Hence, investors regard Bitcoin as a safe asset to resist high INF, pushing up the volume of Bitcoin transactions and increasing BP (Cheah & Fry, 2015). Thirdly, in January 2013, the eurozone countries demanded a rise in tax congestion on savers in response to the severe impacts of the Cyprus crisis. Due to concerns about sovereign currency and a high inflation environment, Bitcoin has become an alternative to the fiat currency (Qin et al., 2021). The spike in Bitcoin investment has caused BP to move in the same direction, soaring from over $30 to $265 in just a few days. Moreover, INF is also rising at this time, and the INF can be reflected in the Bitcoin market.

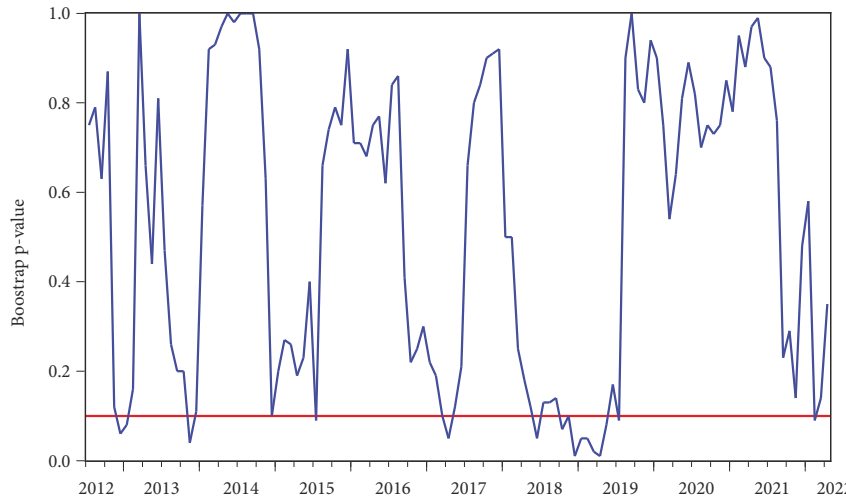

Figure 4. The *p*-values with no influence from BP to INF

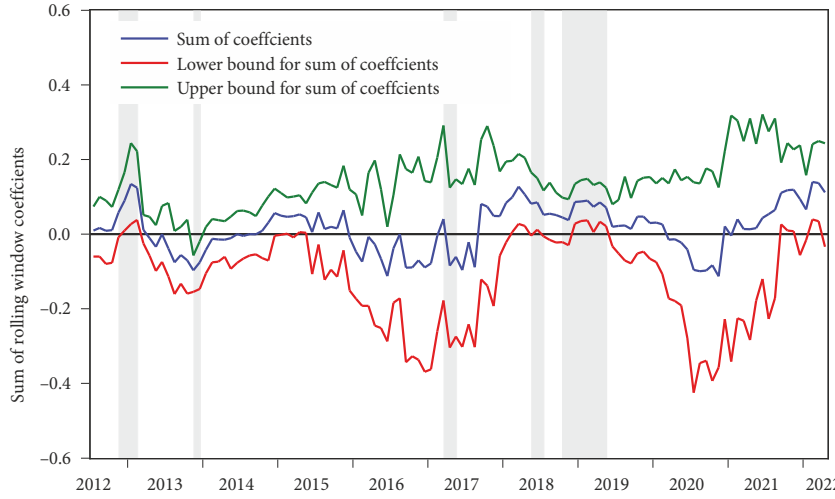

Figure 5. The effect from BP to INF

Sharp plummets in BP during the period of 2018: M5-2018: M7 can be explained in the following aspects. First of all, multiple occurrences of Bitcoin exchange thefts have led investors to doubt its security (Zaghloul et al., 2020), resulting in a downturn in the Bitcoin market and a significant decline in BP. Moreover, a massive sell-off in the Bitcoin market (Su et al., 2022) and the Fed has announced a series of interest rate hikes since March, which caused chaos in the financial market and the Bitcoin market, and then BP and INF continued to plummet. Secondly, there are growing concerns about the continued deterioration of Sino-U.S. bilateral relations, and we can attribute the sharp decline in consumption and INF to the rise of geopolitical risks. The decrease in INF also leads investors to allocate funds to higher-

yielding assets, which reduces their demand for Bitcoin and leads to BP dropping again (Qin et al., 2021). Thirdly, stimulated by the tax reform policy of the Trump administration, the U.S. unemployment rate decreased significantly, and the economy rebounded, with GDP growth reaching 4.2% in the second quarter of 2018. Hence, the Fed announced interest rate hikes in June 2018 that it would reduce the amount of funds to keep the INF stable, subsequently, there was a decline in BP. Hence, we can evidence the positive effect of BP on INF.

In order to maintain its hegemonic status, the U.S. announced it would withdraw from the *Nakajima treaty*[6] in October 2018, and geopolitical tensions between the U.S. and Russia continue to rise, negatively impacting the U.S. financial market and INF level. In addition, the global intensification of trade frictions and the closure of the U.S. government (from December 22, 2018, to January 15, 2019) makes investors tend to decrease their demand for Bitcoin (Umar et al., 2021), which drives BP to drop sharply during 2018:M10-2019:M1. This means BP and INF move in the same direction. However, the end of the government's shutdown has strengthened public trust and increased investment enthusiasm in the Bitcoin market, causing an increase in BP, which also drives the rise of INF (Su et al., 2020a). Furthermore, with the launch of Bitcoin futures contracts in various countries, investors are inclined to invest in assets that have hedging capabilities. As a result, they turn to Bitcoin to acquire higher returns, exacerbating the rise in the price of Bitcoin (Umar et al., 2021). At the same time, the "cold front[7]" swept through the Midwest of the U.S. in January 2019, the extremely cold weather not only affected the public's lives and travel but also caused many casualties, and social life almost came to a standstill. Hence, some states in the U.S. officially raise the minimum wage to maintain workers' livelihoods. As a result, rising wages and tariff uncertainty have become vital factors supporting rising prices, and INF has further increased, like BP. Therefore, we can logically verify the positive effect of BP on INF in 2018:M10-2019:M5.

However, from the negative impact of BP on INF, we can conclude that Bitcoin cannot serve as a leading indicator for INF. In November 2013, the trading platform "Bitcoin China[8]" announced that it had obtained 5 million in financing, while its free and comprehensive marketing strategy further attracted the U.S. investors' attention, and then BP began to soar. However, the Public Bank of China (PBC) issued the "*Notice on the Prevention of the Bitcoin Risks*", which essentially states that Bitcoin is a specific virtual commodity and cannot be used as a currency in the market. Concerns were raised about Bitcoin after the regulation was issued, making global investors, including the U.S., reduce their holdings of Bitcoin (Cheah & Fry, 2015). Specifically, BP rose 800% in November 2013 but declined by about 50% in December 2013. This high price volatility makes Bitcoin a poor store of value, which dampens the public's enthusiasm and causes BP to plummet (Krause, 2016). The INF continues to rise

[6] The *Nakajima Treaty* stipulates that both the U.S. and Russia will completely destroy and completely ban short- and medium-range missiles. This includes missiles with conventional and nuclear warheads, and land-based launchers for missiles.

[7] As the polar vortex moved south, the average temperature in the entire Great Lakes region dropped to –34 °C to –40 °C, and the temperature near Chicago even dropped to –46 °C, from the Great Lakes region to New England was affected by this super cold wave.

[8] Founded on June 9, 2011, BTC China is a Bitcoin trading platform operated by Shanghai Satussi Network Company, its trading volume has surpassed Mt. Gox and Bit Stamp have officially become the world's largest bitcoin trading platforms.

after the economic recovery gained momentum and the Fed proclaimed the fourth round of quantitative easing[9]. Since then, this expectation has led to investors preferring to invest in physical assets such as houses rather than virtual currency, causing BP to tumble dramatically (Zhu et al., 2017). Therefore, it is evident that INF moves in the opposite trend to BP in 2013: M11-2013: M12.

In 2017, we can analyse the increase in BP from two perspectives. First of all, BP once again broke through $1,000 in March 2017. Then a large number of media reports have brought new investors to the Bitcoin market, which is the main reason for the price increase (Su et al., 2020a). Secondly, some geopolitical events (e.g., Brexit and the tensions in North Korea), as well as the uncertainty of Trump's economic policies, have weakened the public's consumer confidence and made investors plunge into panic (Su et al., 2020b). Hence, BP has been rising due to the combined influence of these events. On the contrary, INF shows the opposite movement from INF, which can be reflected by BP. The rising BP has triggered a boom in public investment, and a large amount of funds has been invested in virtual currency, seriously damaging the health of the U.S. economy. In an effort to curb excessive investment enthusiasm in the Bitcoin market, the Fed declared in March 2017 that it would raise the federal funds rate from 0.75% to 1%, which means that the cost of borrowing has increased significantly, causing a significant decline in INF (Su et al., 2022). Thus, we can conclude that BP and INF move in different directions during 2017:M3-2017:M5.

To summarise, due to the parameters in the VAR system being supposedly constant, the results of the full-sample causality test of BP and INF may be unreliable. The results suggest that BP, INF and VAR models experience structural changes. Therefore, we use the sub-sample approach to revisit the correlation between the two variables. The outcomes indicate that INF negatively impacts BP. The rise in INF renders a drop in BP, demonstrating that Bitcoin cannot avoid risks associated with high INF. The above conclusion contradicts ICAPM, which emphasises that the increase in INF will bring upward BP tendencies. In contrast, BP has positive and negative effects on INF. Positive influence suggests that Bitcoin is a valuable instrument for predicting fluctuations in INF. But the negative impact highlights that this effectiveness could be undermined by factors such as economic policy uncertainty and geopolitical events.

6. Conclusions

This paper explores the interaction mechanism between INF and BP, which helps to understand the effectiveness of Bitcoin as a safe haven from inflation. We examine the causal link between INF and BP by using the sub-sample test. The negative impact of INF on BP suggests that Bitcoin cannot play a hedge similar to gold in dealing with economic turmoil and high uncertainty, thereby rejecting the claim that Bitcoin is a safe haven in a high INF situation. The above results do not comply with the ICAPM model, which indicates that INF positively affects BP. In turn, we find that there are positive and negative impacts that originate from BP and propagate to INF. The positive effect reveals that Bitcoin is a significant sign of monetary

[9] To boost the economy and increase employment, starting in 2013, the Federal Reserve plans to buy $45 billion a month in long-term Treasuries to replace the "operation of reversal" (OT) tool that matured at the end of December 2012.

policy and INF changes, but this statement cannot be confirmed when the negative effects are considered.

Clarifying the dynamic relationship between BP and INF can provide valuable insights to investors and governments. Firstly, INF has an effect on BP during some periods. Thus, investors who are interested in portfolio diversification, should focus on INF changes and reasonably optimise their asset al.ocation. Holding Bitcoin is an excellent option for investors when INF increases, as diversifying investment risks and maintaining returns can be achieved. Secondly, in times of high inflation, investors' irrational expectations will lead them to hold more Bitcoin, which drives BP upward. Therefore, the government should manage public expectations according to the changes in INF so as not to cause market panic and economic chaos. In this way, the related authorities can maintain the stability of the Bitcoin market. From another point of view, INF is positively affected by BP during specified time periods. This indicates that monetary authorities should grasp the changing trend of BP to prevent fluctuations in commodity prices, thereby maintaining the steady development of the financial system. Moreover, relevant departments must innovate cryptography and strengthen network security supervision to maintain the stability of the Bitcoin market so that it can accurately reflect the fluctuations of INF.

We have discovered some vital results through empirical research, while this paper has the following limitations. Firstly, we only analyse Bitcoin, the dominant cryptocurrency, but ignore a detailed analysis of other mainstream cryptocurrencies. Future research could be extended to other cryptocurrencies (e.g., Ethereum and Techer); the comparative analysis of the hedging capabilities of Bitcoin and these cryptocurrencies is also worth exploring. Secondly, our study is based solely on the U.S. dataset and does not further explore Bitcoin's hedging function in other high-inflation countries (e.g., Argentina, Venezuela and the U.K.). These countries face the malignant effects of high inflation due to geopolitical conflicts, supply chain bottlenecks and fiscal stimulus packages. Therefore, whether Bitcoin can become an INF hedge for investors in these countries deserves further exploration. As a result, future research could extend the analysis to these high-inflation countries.

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