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Will Bitcoin become the 21st century gold? Spillover effect of return and volatility between digital and traditional assets

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***Abstract**: This study aims to examine the spillover effects of return and volatility between three different assets (Bitcoin, Gold, and Nasdaq) using GARCH-ARMA models. The data is taken from monthly closing prices from January 2015 to February 2024 through Investing.com. The analysis focuses on understanding how these three assets interact regarding the spillover effect of return and volatility, particularly during periods of economic uncertainty. Our findings indicate that spillover effects of return are visible from Bitcoin to Nasdaq, Nasdaq to Bitcoin, and Nasdaq to Gold. In addition, spillover effects of volatility are visible from Gold to Bitcoin, Bitcoin to Nasdaq, Nasdaq to Bitcoin, and Nasdaq to Gold. Our finding highlights the dynamic relationship between traditional and digital assets, emphasizing Bitcoin's potential role as a financial hedge likely to Gold and Nasdaq.*

***Keywords**: Spillover Effect, Return, Volatility, Gold, Bitcoin, Nasdaq*

Hoće li Bitcoin postati zlato 21. veka? Efekat prelivanja povrata i volatilnosti između digitalne i tradicionalne imovine

***Apstrakt**: Ova studija ima za cilj da ispita efekte prelivanja prinosa i volatilnosti između tri različita sredstva (Bitcoin, zlato i Nasdaq) koristeći GARCH-ARMA*

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modele. Podaci su uzeti iz mesečnih cena zatvaranja od januara 2015. do februara 2024. preko Investing.com. Analiza se fokusira na razumevanje načina na koji ova tri sredstva međusobno deluju u vezi sa efektom prelivanja povrata i volatilnosti, posebno tokom perioda ekonomske neizvesnosti. Rezultati pokazuju da su efekti prelivanja prinosa vidljivi sa Bitcoin-a na Nasdaq, Nasdaq -a na Bitcoin i Nasdaq -a na zlato. Pored toga, efekti prelivanja volatilnosti vidljivi su sa zlata na Bitcoin, Bitcoin na Nasdaq, Nasdaq na Bitcoin i Nasdaq na zlato. Naš nalaz naglašava dinamičan odnos između tradicionalnih i digitalnih sredstava, naglašavajući potencijalnu ulogu bitkoina kao finansijske zaštite od zlata i Nasdaq-a.

***Ključne reči**: Efekat prelivanja, prinos, volatilnost, zlato, bitkoin, Nasdaq.*

1. Introduction

Since long ago, Gold has served as a symbol of riches, and now it's used as a global currency recognized worldwide. This metal has become a highly valued commodity or asset traded globally (Ramlan et al., 2017). During the Gold standard era before the 1930s, Gold was used as a reserve currency to support any amount of money that central banks around the globe issued. After the Gold standard was abandoned in the half of the 20th century, these precious metals are still traded on the stock market and serve as safe havens during political, financial, or economic turmoil (Chirwa & Odhiambo, 2020). According to Wu and Duan (2017), economic crises are the most important times to increase demand for Gold because investors and other economic actors prefer to protect the value of their money and investments from volatility, which is why they dislike the volatility of Gold prices.

The primary reason why investors purchase Gold is that it can reduce portfolio risk, which helps investors protect asset values from unpredictable global economic conditions (Ramlan et al., 2017). Gold has a zero-inflation nature, which indicates that the price of Gold will rise as the inflation rate rises. In other world, Gold will maintain its value despite inflation. The higher the inflation rate, the higher the price of Gold (Rahmansyah & Rani, 2021). One of the main factors influencing changes in Gold prices (returns) is interest rate fluctuations, and rising rates cause a decline in the price of Gold. Interest rates are dynamic because they significantly affect leveraged investors, corporations, investment portfolio strategies, and macroeconomic policy. Proactive managers use these changes to predict financial impact in the future (Choudhry et al., 2015).

In recent decades, there has been a steady increase in the volume and value of financial markets and the variety of financial instruments. Due to this expansion, the financial system is now at greater risk, which may mean that

investors now require a safe haven (Baur & Lucey, 2010). According to Kim et al. (2020), the emergence of cryptocurrency as an investment tool results from technological advancement. Cryptocurrency is a digital or virtual currency exchanged between peers without needing a third party. The emergence of cryptocurrencies as a new class of financial assets offers an excellent opportunity to explore several as-yet-unexplored aspects of them. Although cryptocurrencies have many advantages, there are also sources of risk that can be detrimental to investors due to high price volatility in the market (Karimi et al., 2023).

The Bitcoin price rally in the autumn of 2023 was initiated by the prospect of an imminent turnaround in the US Federal Reserve's interest rate policy. On 10 January 2024, the Exchange-Traded Funds (ETF) were approved by the US Securities and Exchange Commission (SEC). Lower interest rates would have increased investors' risk appetite and the spot ETF approval would have opened the floodgates to Wall Streets for Bitcoin. The halving of the Bitcoin will take place in mid-April. The current limit of 900 Bitcoin per day will be cut to 450 Bitcoin per day. Bitcoin's price level is not an indicator of its sustainability. No economic fundamental data or fair value can be derived from a serious forecast (Bindseil & Schaaf, 2024).

The market capitalization of Gold and Bitcoin represents contrasting features of the global financial environment. Gold with its long history as a tangible asset and a medium of exchange, holds a market capitalization that reflects its deep-rooted role as a safe haven. Geopolitical uncertainty has cemented its status as a cornerstone asset in a diversified investment portfolio. Gold has a market capitalization of $15.454 trillion, making it the number one asset with the largest market capitalization, ranked by Infinite Market Cap.

On the other hand, Bitcoin has rapidly ascended to prominence since its inception in 2009. It has $1.284 trillion in market capitalization, making it the number nine asset with the largest market capitalization. With its decentralized nature and limited supply, it capped at 21 million coins. Bitcoin has garnered attention as a digital alternative to traditional currencies and a speculative investment. Bitcoin Market capitalization reflects the nascent yet rapidly evolving nature of the cryptocurrency market. Born out of technological innovation and fueled by decentralized networks, Bitcoin's market capitalization has surged in recent years, driven by speculative uncertainty, institutional adoption, and growing recognition as a hedge against inflation and fiat currency depreciation. Both of these instruments are among the top 10 assets with the largest market capitalization in the world, which highlights the ongoing paradigm shift in the global financial landscape where traditional assets converge with emerging digital alternatives, reshaping investment strategies and portfolio diversification approaches.

In particular, when it comes to cryptocurrencies, some media and data sources like Bloomberg, Investing, Yahoo Finance, and Trading Economics have called Bitcoin the New Gold. Research that studies the potential and volatility of the price of Gold and Bitcoin as an investment instrument has been carried out by many researchers worldwide. Bhanja et al. (2023) examined the potential portfolio diversification by examining diverse categories of assets like crypto, equity, and precious metal by applying a frequency-based spillover transmission mechanism. The findings of the total spillover of Bitcoin are good diversification. Guesmi et al. (2019) employed a multivariate GARCH model to support the assumption that Bitcoin can offer diversification and hedging benefits to investors. The same finding was found with Dyhrberg (2015) and Bouri et al. (2017c), who employed the threshold GARCH model, where Bitcoin possessed some of the same hedging abilities as Gold. Bitcoin volatility returns are higher than Gold and foreign exchanges (Dwyer, 2015).

However, another viewpoint on the role of Bitcoin suggests the opposite. Alkhazali et al. (2018) reject the claim that Bitcoin and Gold are similar. They demonstrate that the return and volatility of Gold react to macroeconomic news, whereas Bitcoin mostly does not respond similarly. Yaya et al. (2022) examined returns and volatility spillovers from Bitcoin to the Gold and Silver markets. They applied the CCC-VARMA-GARCH method. Their results specify the non-existence of spillovers among the Bitcoin and Gold (or Silver) returns.

Bouri et al. (2017b) found a positive correlation using the DCC model regarding the relationship between global uncertainty and Bitcoin. This shows that the role of Bitcoin as a hedging asset for uncertainty is not apparent. Bouoiyour and Selmi (2015) used the optimal-GARCH model to explore the relationship between precious metal and Bitcoin prices with high fluctuations in financial markets. They found that these assets are not fixed over time. Also, it is noted that Bitcoin is a weak safe in the short run and a hedge in the long run.

It's still debatable whether Bitcoin is a type of currency, a commodity, a digital currency, or an investment asset because it shares many characteristics with other significant asset classes, including the Dollar, Gold, Stocks, and Bonds. The ambiguity around Bitcoin's status has made it a hot issue for financial academic research (Kwon, 2020). The volatility of Bitcoin is extreme. Prices fluctuate considerably over longer horizons and on a daily basis. Documents find that the volatility of Bitcoin is around eight times higher than that of stocks (Harvey, 2018). Corbet et al. (2018) and Smales (2018) have observed similar results more recently.

Although there has been a lot of research on Gold commodities as a safe haven and investment instrument, there is still limited information on Bitcoin, one of the assets that has emerged due to technological advancements. In our analysis, we assess the potential of Bitcoin as a digital Gold in the 21st century

and become one of the investment options to minimize risk in global uncertainty. The current research contribution is that it is likely one of the few studies to provide a thorough understanding of the spillover effects of return and volatility between cryptocurrency, commodity market, and stock price index. The potential for estimating return and volatility spillover effects, particularly the largest ones, can be of great value to investors, traders, and academicians to trade their portfolios.

The current research contribution is that it is likely one of the few studies to provide a thorough understanding of the spillover effects of return and volatility between cryptocurrency, commodity market, and stock price index. This study was motivated by the possibility of predicting the spillover effects of return and volatility, particularly the largest effects, which can be of great interest for traders, investors, and academicians alike.

This article was divided into the following sections. Section 2 includes the literature review and the hypotheses among the established variables. Section 3 reports on the variable measurement and research technique. Section 4 contains the discussions and empirical results. The last section describes the conclusion, limitations, and suggestions for future research.

2. Literature review and hypotheses development

2.1. Portfolio Theory

According to CFI Team (2022), the law of one price is one of the most important theories in financial market investment. It states that the price of identical goods in different markets must be the same after considering the exchange rate of currencies. This law applies to assets traded in financial markets. Balbas and Munoz (1998) argued that certain prices with different characteristics can demonstrate the fulfillment of this law in the financial markets. Moreover, this law refers to the consistency of two identical prices or the same price index. In legal theory, Cournot (1927) said that a price should be the price of a similar product or commodity on different markets is the same. From the point of view of the capital market, the absence of administrative barriers and information would make the risk-adjusted return of an asset equal across the market so as not to result in arbitration. Arbitration has a very close relationship with hedging, a strategy to reduce or eliminate risk, and is an action taken to lock profits (Billingsley, 2006). By buying or selling an asset of an investment instrument, investors can reduce the risks associated with the investment portfolio. This section examines research on the information on volatility and returns shared between Gold, Bitcoin, and Stock index.

2.2. Spillover effect of return and volatility

In general, researching spillover effects in return and volatility models helps risk management, portfolio diversification, comprehension of market integration, policy decision guidance, and improving trading and forecasting techniques. It helps stakeholders make wise decisions in a complex and dynamic environment by offering insightful information about how financial markets are interconnected. A thorough framework for examining the dynamics of returns and the volatility of financial time series data is provided by the GARCH-ARMA model, which combines the ARMA model for returns with the GARCH model for volatility. It is frequently used to evaluate risk, forecast, and model the prices of financial assets, and comprehend how financial markets behave.

A new financial instrument called Bitcoin was first proposed by Nakamoto in 2008. Bitcoin is an open-source software-based online payment system. All transactions are stored digitally and recorded in a shared ledger data technology known as blockchain (Balcilar et al., 2017). The security of an algorithm that tracks every transaction underpins the value of Bitcoin rather than any physical asset or nation's economy (Urquhart & Zhang, 2019).

Economists have frequently compared Bitcoin and Gold because of their many similarities. Bitcoin and Gold's scarcity and high extraction costs account for most of their respective values. They are not part of any country or under the control of any government (Dyhrberg, 2016). Popper (2015) considers Bitcoin to be digital Gold. Then, Balcilar et al. (2017) and Hoang et al. (2016) highlight some valuable Bitcoins as investments and hedging characteristics. According to Baur et al. (2018), Bouri et al. (2017a), Corbet et al. (2018), Guesmi et al. (2019), and Ji et al. (2018), the weak correlation of Bitcoin with traditional assets makes it a very potent diversification tool and a valuable hedge against equities.

Conversely, Klein et al. (2018) compare Bitcoin, Gold, and stock indices from an econometric perspective with the return-volatility relationship and concentrate. Regarding the economic aspects of cryptocurrencies as an investment asset, find the similarities between Bitcoin and Gold. However, there is no evidence of Bitcoin having stable hedging capabilities, and their findings indicate that Bitcoin is not the new Gold. Bitcoin may only be diversified, not as a hedge (Bouri et al., 2017b). Since Bitcoin's market capitalization is large in terms of economic transactions, it functions more like a speculative investment than a currency and has no intrinsic value (Yermack, 2015). Moreover, it finds that the volatility of Bitcoin has a negative impact on its utility as money. Conrad et al. (2018) analyze the factors influencing Bitcoin's long-term volatility and compare them with those of other asset classes, such

as Gold. The authors discover that, in contrast to other asset classes, Bitcoin volatility is distinct

When analyzing the potential future use and acceptance of Bitcoin, it's important to analyze the growth path of Bitcoin supply. The supply of Bitcoins is perfectly predictable and will continue to decrease until 2040, remaining at the 2040 level ad infinitum. Since the demand for Bitcoins is in contrast to its supply, the demand for Bitcoins will be unpredictable shortly and beyond 2040. So, it is difficult to forecast the future value and usage of Bitcoins (Tiwari, 2017). However, if the demand increased steadily, the demand would eventually become larger than the supply, leading to rising prices of Bitcoin and thus deflationary effects. Using different methodologies may also have different results. Overall, the hedging capabilities of Gold and Bitcoin in many situations are controversial. Even with traditional and ancient safe-haven assets such as Gold, the hedging function may not work in different situations (Baur et al., 2017). As a result, three pairs of general hypotheses were proposed in this study. The first pair is ranging from $H1_{a1}$ to $H1_{b2}$. The second pair is ranging from $H2_{a1}$ to $H2_{b2}$. The last pair is ranging from $H3_{a1}$ to $H3_{b2}$.

$H1_{a1}$: Spillover effect of return is visible from Bitcoin to Gold.
$H1_{a2}$: Spillover effect of return is visible from Gold to Bitcoin.
$H1_{b1}$: Spillover effect of volatility is visible from Bitcoin to Gold.
$H1_{b2}$: Spillover effect of volatility is visible from Gold to Bitcoin.
$H2_{a1}$: Spillover effect of return is visible from Bitcoin to Nasdaq.
$H2_{a2}$: Spillover effect of return is visible from Nasdaq to Bitcoin.
$H2_{b1}$: Spillover effect of volatility is visible from Bitcoin to Nasdaq.
$H2_{b2}$: Spillover effect of volatility is visible from Nasdaq to Bitcoin.
$H3_{a1}$: Spillover effect of return is visible from Nasdaq to Gold.
$H3_{a2}$: Spillover effect of return visible from Gold to Nasdaq.
$H3_{b1}$: Spillover effect of volatility is visible from Nasdaq to Gold.
$H3_{b2}$: Spillover effect of volatility is visible from Gold to Nasdaq.

3. Research methodology

3.1. Data and sampling

This study uses monthly data from January 2015 to February 2024 on cryptocurrency (Bitcoin), commodity market (Gold), and stock price index (Nasdaq). The monthly closing prices for cryptocurrency, commodity, and stock price index were collected from Investing.com. Our study uses monthly closing

prices because the paper aims to identify the asset's price for long-term investment. The larger the time frame, the greater the accuracy.

3.2. Variable Measurement

The variable utilized in this survey is measured as follows. Table 1 explains how the research variable is measured.

Table 1. Measurement of Research Variable

Variable	Definition	Indicator	Scale
Bitcoin	The biggest virtual currency was created to function as a medium of exchange and money independent of any one person. With the use of this asset, financial transactions no longer require the engagement of a reliable third party (Investopedia, 2024b).	BTC/USD	Ratio
Gold	It is a precious metal with high economic worth because of its scarcity and historical use as the foundation for money (Investopedia, 2022).	XAU/USD	Ratio
Nasdaq	Except for financial services, an index of the top 100 companies by modified market capitalization comprises eight categories (Investopedia, 2024a).	NASDAQ	Ratio

3.3. Analysis Techniques

This study used the ARMA-LM, stationarity, and Lagrange multiplier tests. Additionally, the GARCH-ARMA model explained both GARCH effects and conditional heteroscedasticities. Equations (1) and (2) show the spillover effects of returns for a single nation stock index (Huruta et al., 2021; Lee et al., 2022). The Bitcoin, Gold, and Nasdaq returns model (GARCH-ARMA) can be seen in Equations 1 and 2.

$$R_{i,t}^{e} = \alpha_0 \sum_{i=1}^{\mathfrak{g}} \alpha_i R_{i,t-i}^{e} + \epsilon_{i,t}^{e} + \sum_{i=1}^{s} \theta_i \epsilon_{i,t-i}^{e} \quad (1)$$

$$h_{i,t}^{e} = \alpha_0 \sum_{i=1}^{q} \alpha_i \, \varepsilon_{i,t-1}^{e^2} + \sum_{i=1}^{p} \psi_i \, h_{i,t-i}^{e} \quad (2)$$

Where,

$R_{i,t}^{e}$	:	Bitcoin, Gold, and Nasdaq returns at *t* period
$\sum_{i=1}^{g} \alpha_i \, R_{i,t-i}^{e}$	:	Higher-order for return of autoregressive A.R. (g)
$\epsilon_{i,t}^{e}$	:	Error term of Bitcoin, Gold, and Nasdaq at *t* period
$\epsilon_{i,t}^{e} + \sum_{i=1}^{s} \theta_i \, \epsilon_{i,t-i}^{e}$	:	Higher-order Moving Average MA(s) shows $R_{i,t}^{e}$ process
$\sum_{i=1}^{p} \psi_i \, h_{i,t-i}^{e}$	:	Conditional heteroscedasticity (p order) of GARCH for Bitcoin, Gold, and Nasdaq at *t* period
$\sum_{i=1}^{q} \alpha_i \, \varepsilon_{i,t-1}^{e^2}$	:	ARCH (q order) for Bitcoin, Gold, and Nasdaq at *t*-1 period

The Bitcoin, Gold, and Nasdaq returns model (GARCH-ARMA) can be summarized in Equations 3 and 4.

$$R_{i,t}^{m} = \beta_0 \sum_{i=1}^{g} \beta_i \, R_{i,t-i}^{m} + \epsilon_{i,t}^{m} + \sum_{i=1}^{s} \gamma_i \, \epsilon_{i,t-i}^{m} \quad (3)$$

$$h_{i,t}^{m} = \beta_0 \sum_{i=1}^{q} \beta_i \, \varepsilon_{i,t-i}^{m^2} + \epsilon_{i,t}^{m} + \sum_{i=1}^{p} \xi_i \, h_{i,t-i}^{m} \quad (4)$$

Where,

$R_{i,t}^{m}$: The i[th] Bitcoin, Gold, and Nasdaq returns at *t* period
$\epsilon_{i,t}^{m}$: The i[th] Bitcoin, Gold, and Nasdaq returns residual at *t* period
$h_{i,t}^{m}$: The i[th] conditional variance of Bitcoin, Gold, and Nasdaq returns at *t* period
γ_i : Unknow parameter

The spillover effect of returns from Bitcoin, Gold, and Nasdaq can be described in Equations 5 until 8.

$$R_{i,t}^{e} = \alpha_0 \sum_{i=1}^{\mathfrak{g}} \alpha_i R_{i,t-i}^{e} + wR_{i,t-1}^{e} + \epsilon_{i,t}^{e} + \sum_{i=1}^{s} \theta_i \varepsilon_{i,t-i}^{e} \quad (5)$$

$$h_{i,t}^{e} = \alpha_0 \sum_{i=1}^{q} \alpha_i \varepsilon_{i,t-1}^{e^2} + \sum_{i=1}^{p} \psi_i h_{i,t-i}^{e} \quad (6)$$

$$R_{i,t}^{m} = b_0 \sum_{i=1}^{\mathfrak{g}} \beta_i R_{i,t-i}^{m} + dR_{i,t-1}^{e} + \epsilon_{i,t}^{m} + \sum_{i=1}^{s} \gamma_i \varepsilon_{i,t-i}^{m} \quad (7)$$

$$h_{i,t}^{m} = b_0 \sum_{i=1}^{q} b_i \varepsilon_{i,t-1}^{m^2} + \sum_{i=1}^{p} \xi_i h_{i,t-i}^{m} \quad (8)$$

From Equations 5 until 8, our model's test was H_0 ($w = 0$; $d = 0$) and H_1 ($w \neq 0$; $d \neq 0$). H_0 means the order does not have a spillover effect of return. In contrast, H_1 indicates the order has a spillover effect of return (Huruta et al., 2021; Lee et al., 2022). In addition, the spillover effect of volatilities from Bitcoin, Gold, and Nasdaq can be highlighted in Equations 9 until 12.

$$R_{i,t}^{e} = \alpha_0 \sum_{i=1}^{\mathfrak{g}} \alpha_i R_{i,t-i}^{e} + \epsilon_{i,t}^{e} + \sum_{i=1}^{s} \theta_i \varepsilon_{i,t-i}^{e} \quad (9)$$

$$h_{i,t}^{e} = \alpha_0 \sum_{i=1}^{q} \alpha_i \varepsilon_{i,t-1}^{e^2} + \sum_{i=1}^{p} \psi_i h_{i,t-i}^{e} + \varepsilon_{i,t-1}^{e^2} + \nu\varepsilon_{i,t-1}^{m^2} \quad (10)$$

$$R_{i,t}^{m} = b_0 + \sum_{i=1}^{\mathfrak{g}} \beta_i R_{i,t-i}^{e} + dR_{i,t-1}^{e} + \epsilon_{i,t}^{m} + \sum_{i=1}^{s} \gamma_i \varepsilon_{i,t-i}^{m} \quad (11)$$

$$h_{i,t}^{m} = b_0 + \sum_{i=1}^{q} b_i \varepsilon_{i,t-i}^{m^2} + \sum_{i=1}^{p} \xi_i h_{i,t-i}^{m} + \iota\varepsilon_{i,t-1}^{e^2} \quad (12)$$

From Equation 9 until 12, we conduct H_0 $(v = 0\,;\, I = 0)$ and H_1 $(v \neq 0\,;\, I \neq 0)$. H_0 means the order does not have a spillover effect of volatility. In contrast, the H_1 reveals order has a spillover effect of volatility (Huruta et al., 2021; Lee et al., 2022).

4. Findings and discussion

This section provides the empirical results that were obtained in several steps. The descriptive data are shown in Table 2.

Table 2. Descriptive Statistics

Statistics	Pair 1		Pair 2		Pair 3	
	Bitcoin	Gold	Bitcoin	Nasdaq	Nasdaq	Gold
Jarque-Bera	376.2206	0.209697	376.2206	3.947604	3.947604	0.209697
Prob.	0.00000***	0.900461	0.00000***	0.138928	0.138928	0.900461
Kurt.	9.669054	3.102302	9.669054	3.279879	3.279879	3.102302
Std. Dev.	30.93395	4.455836	30.93395	4.997634	4.997634	4.455836
Skew.	1.677804	-0.071764	1.677804	-0.355843	-0.355843	-0.071764
Mean	8.224815	0.307099	8.224815	1.434136	1.434136	0.307099
Obs.	162		162		162	

*Notes: *** describes statistical significance at 1%.*

Table 2 presents the total observation of the research period as 162. The mean values are positive across all three asset pairs (ranging from 0.307099 to 8.224815), indicating consistent average positive returns for investors across these asset classes. On average, investments in these assets yield positive returns, which encourages portfolio diversification strategies. Bitcoin had the most volatile variable among all research variables (SD = 30.93395). Moreover, Table 3 summarizes the correlation matrix.

Table 3. Correlation Matrix of Research Variable

Variable	Bitcoin	Gold	Nasdaq
Bitcoin	1.000000		
Gold	0.011134	1.000000	
	(0.8882)		
Nasdaq	0.222203	0.173160	1.000000
	(0.0045)***	(0.0276)**	

*Notes: the number below the diagonal represents the Pearson correlation. Values in round brackets () are probability. ** and *** represent statistical significance at 5% and 1%.*

As shown in Table 3, the highest correlation (0.222203) was found between the Nasdaq and Bitcoin, while the lowest correlation was found between the Gold and Bitcoin (0.011134). In addition, Table 4 highlights the model diagnostics.

Table 4. The Summary of Model Diagnostics

Pairs	Assets	ADF	ARMA	AIC	LM	ARCH-LM	GARCH	AIC	ARCH-LM
1	Bitcoin	-10.0272	(3,2)	9.634942	0.313471	4.557219	(2,3)	9.339685	1.819348
	Gold	-13.93474	(3,2)	5.839073	0.111638	5.681882	(2,2)	5.735674	0.889278
2	Bitcoin	-10.0272	(3,2)	9.634942	0.313471	4.557219	(2,3)	9.339685	1.819348
	Nasdaq	-14.0550	(3,3)	6.072830	2.673258	8.958398	(3,1)	5.941526	3.049803
3	Nasdaq	-14.0550	(3,3)	6.072830	2.673258	8.958398	(3,1)	5.941526	3.049803
	Gold	-13.93474	(3,2)	5.839073	0.111638	5.681882	(2,2)	5.735674	0.889278

The results of the ADF unit-root test indicated that the instrument returns supported the alternative of having no unit roots, which validated the time series data. Using the Breusch-Godfrey Lagrange Multiplier (LM) test, no serial correlation was found in any pair samples. Next, we utilized GARCH-ARMA models for diagnostics, which rely on the minimal value of the Akaike Information Criteria (AIC). We tested the ARCH effect and eliminated heteroscedasticity in the volatility of the data using the Lagrange Multiplier test (ARCH-LM). We rejected the null hypothesis that there was no ARCH impact. We strongly accepted the alternative explanation of the ARCH effect for all samples by comparing the pertinent statistics of the ARMA model. Accordingly, the test findings for the GARCH-ARMA models do not indicate the presence of autoregressive conditional heteroskedasticity for any subsample. To sum it up, Table 5 shows the spillover effect of return.

Table 5. Spillover Effect of Return

Pair	Crypto/Commodity/Stock	Gold	Bitcoin
1	Bitcoin/Gold	0.002624 (0.8059)	0.265743 (0.4572)
Pair	Crypto/Commodity/Stock	Nasdaq	Bitcoin
2	Bitcoin/Nasdaq	0.01989 (0.0764)*	1.213521 (0.000)***
Pair	Crypto/Commodity/Stock	Gold	Nasdaq
3	Nasdaq/Gold	0.120991 (0.0853)*	0.09667 (0.2200)

*Note: * p < 0.1, ** p < 0.05, and *** p < 0.01.*

Table 5 shows an insignificant effect from Bitcoin to Gold (0.002624 and p-value 0.8059). It indicates no spillover effect of return from Bitcoin to Gold ($H1_{a1}$ rejected). Similarly, there is an insignificant effect from Gold to Bitcoin (0.265743 and p-value 0.4572). It indicates no spillover effect of return from Gold to Bitcoin ($H1_{a2}$ rejected). However, there is a positive and significant effect of return from Bitcoin to Nasdaq (0.01989 and p-value 0.0764). It highlights a spillover effect of return from Bitcoin to Nasdaq ($H2_{a1}$ accepted). In addition, there is a positive and significant effect of return from Nasdaq to Bitcoin (1.213521 and p-value 0.000). It underlines a spillover effect of return from Nasdaq to Bitcoin ($H2_{a2}$ accepted). For the last pairs, there is a positive and significant effect of return from Nasdaq to Gold (0.120991 and a p-value of 0.0853). It indicates a spillover effect of return from Nasdaq to Gold ($H3_{a1}$ accepted). Conversely, there is an insignificant effect from Gold to Nasdaq (0.09667 and p-value 0.2200). It reveals no spillover effect of return from Gold to Nasdaq ($H3_{a1}$ rejected). Apart from Table 5, we provide the spillover effect of volatility as presented in Table 6.

Table 6. Spillover Effect of Volatility

Pair	Crypto/Commodity/Stock	Gold	Bitcoin
1	Bitcoin/Gold	-0.009477 (0.1288)	0.827607 (0.0236)**
Pair	Crypto/Commodity/Stock	Nasdaq	Bitcoin
2	Bitcoin/Nasdaq	0.02664 (0.0078)***	1.4723764 (0.021)**
Pair	Crypto/Commodity/Stock	Gold	Nasdaq
3	Nasdaq/Gold	0.17347 (0.0014)***	0.097742 (0.1106)

*Note: * p < 0.1, ** p < 0.05, and *** p < 0.01.*

Based on Table 6, the first pair shows an insignificant effect from Bitcoin to Gold (-0.009477 and p-value 0.1288). It underlines that there is no spillover effect of

volatility from Bitcoin to Gold ($H1_{b1}$ rejected). Conversely, there is a positive and significant effect of volatility from Gold to Bitcoin (0.827607 and p-value 0.0236). It represents a spillover effect of volatility from Gold to Bitcoin ($H1_{b2}$ accepted). Furthermore, the second pair indicates a positive and significant effect of volatility from Bitcoin to Nasdaq (0.02664 and p-value 0.0078). It shows a spillover effect of volatility from Bitcoin to Nasdaq ($H2_{b1}$ accepted).

Similarly, there is a positive and significant effect of volatility from Nasdaq to Bitcoin (1.4723764 and p-value 0.021). It defines a spillover effect of volatility from Nasdaq to Bitcoin ($H2_{b2}$ accepted). The third pair reveals a positive and significant effect of volatility from Nasdaq to Gold (0.17347 and p-value 0.0014). It means there is a spillover effect of volatility from Nasdaq to Gold ($H3_{b1}$ accepted). However, Gold has an insignificant effect on Nasdaq (0.097742 and p-value 0.1106). It indicates no spillover effect of volatility from Gold to Nasdaq ($H3_{b2}$ rejected).

Table 5 reveals the spillover effect of return from Bitcoin to Gold was rejected. This finding aligns with Alkhazali et al. (2018), who also did not find a significant spillover effect from Bitcoin to Gold. This suggests that the return dynamics of Bitcoin do not have a notable impact on Gold. Similarly, the $H1_{a2}$ has the same result as Yaya et al. (2022), who found no significant spillover effect of return. These two assets operate independently and do not significantly influence each other's return. One reason for this alignment is the unique nature of Bitcoin as a decentralized digital currency. This independence makes it an attractive option for investors seeking to hedge against traditional market risk, consistent with the findings of Dyhrberg (2016). However, the spillover effect of volatility from Bitcoin to Gold ($H1_{b1}$) is rejected. These findings contradict Bouri et al. (2017), who suggested potential volatility transmission. This discrepancy may arise from differences in the methodologies used or the time frame periods of the study.

Conversely, the hypothesis of spillover effect of volatility ($H1_{b2}$) from Gold to Bitcoin is accepted. This indicates that volatility in Gold markets can impact Bitcoin due to its role as an emerging asset, which might make it more susceptible to established markets like Gold. The differing investor bases and market maturity levels between Bitcoin and Gold might also contribute to these asymmetrical spillover effects.

The accepted spillover effect of return on the hypothesis ($H2_{a1}$) and ($H2_{a2}$) indicates a positive and significant relationship between Bitcoin to Nasdaq and Nasdaq to Bitcoin. This finding was supported by Guesmi et al. (2019) and Bouri et al. (2017c), who showed that digital asset (Bitcoin) could influence traditional asset (Gold) and vice versa. This mutual influence could be due to the increasing integration of digital assets into mainstream financial markets, where investors diversify their portfolios with both types of assets. In addition,

hypothesis ($H2_{b1}$) proved the spillover effect of volatility from Bitcoin to Nasdaq. This confirms the findings of Conrad et al. (2018), who identified significant volatility spillovers from Bitcoin to traditional markets. It indicates that Bitcoin's high volatility can be transmitted to broader financial markets, possibly due to investor sentiment and market reactions. Similarly, the hypothesis ($H2_{b2}$) there is accepted spillover effect of volatility from Nasdaq to Bitcoin, suggesting a significant bidirectional spillover effect of volatility between these markets. This bidirectional relationship could be driven by interconnected trading strategies, where changes in traditional markets influence digital asset markets and vice versa, reflecting the growing correlation and interdependence between these asset classes.

There are different significant results from the hypothesis ($H3_{a1}$) and ($H3_{a2}$). The first hypothesis ($H3_{a1}$) highlighted an accepted spillover effect of return from Nasdaq to Gold. This result indicated significant interactions between stock indices and commodity markets, which is relevant to the findings of Balcilar et al. (2017). This suggests that movements in the stock market can influence Gold prices due to investor reactions and reallocations during economic changes. While the hypothesis ($H3_{a2}$) has a rejected spillover effect of return from Gold to Nasdaq, suggesting that Gold prices do not significantly affect stock indices return. This may be because Gold is often considered a safe haven, attracting investment during market volatility but not necessarily driving stock market movement. However, the hypothesis ($H3_{b1}$) that there is a volatility spillover effect from Nasdaq to Gold is accepted, showing significant market integration between stock indices and commodities. It supports the notion that stock market volatility can lead to increased uncertainty and fluctuations in Gold prices as investors seek stability and sustainability.

Conversely, the hypothesis ($H3_{b2}$) that there is a volatility spillover effect from Gold to Nasdaq is rejected, aligning with the notion that Gold often acts independently as a safe haven during market turmoil. This hypothesis aligns with the traditional view of Gold as a store of value and a hedge against inflation, as discussed by Lucey et al. (2017). This independence suggests that while gold attracts investment during periods of stock market volatility, it does not directly influence stock market behavior.

The lack of spillover effect of return between Bitcoin and Gold supports the theory that these assets can serve as diversification tools within a portfolio, as highlighted by Baur and Lucey (2010). The rejection of significant spillovers from Gold to Nasdaq reaffirms Gold's status as a safe haven, a theory supported by Choudhry et al. (2015), Baur and Lucey (2010). Understanding these spillover effects can help investors and portfolio managers better manage risk by identifying which assets can hedge against market volatility. The accepted hypothesis of volatility spillovers from Gold to Bitcoin underscores

Gold's role as a stable hedge against more volatile assets like Bitcoin, aligning with the high-risk, high-return principle outlined by Bouri et al. (2017). However, our findings also diverge from those of Klein et al. (2018), who argued that Bitcoin lacks stable hedging capabilities and behaves more like a speculative asset. The divergence can be attributed to the different periods and market conditions considered in the studies. While Klein et al. (2018) focused on a period of extreme market turbulence, our study encompasses a broader timeframe, including periods of relative market stability. This broader perspective may reveal more consistent hedging properties of Bitcoin over the long term.

5. Conclusion

The results of this study provide compelling evidence of return and volatility spillovers between Bitcoin, Gold, and Nasdaq. As a conventional safe haven asset, Bitcoin can impact Gold prices. It provides insight into how different assets interact and demonstrates control over the behavior of the Bitcoin market. These findings underscore the interconnectedness of digital and traditional financial markets.

The present findings have important practical and policy implications. In order for regulators to forecast future contagion and crises, historical data on cryptocurrency, commodity, and stock price index returns as well as volatility transmission is important. A portfolio including Bitcoin should have more Gold and Nasdaq's stock return invested in it for investment and diversification purposes. All things considered, the results offer policymakers and portfolio managers helpful information on the best ways to allocate assets, diversify, hedge, and manage risk. Investors seeking portfolio diversification and hedging strategies to minimize their investment risk should consider these spillover effects. Bitcoin's growing prominence as a digital asset suggests its emerging role as a modern counterpart to Gold, reflecting a paradigm shift in investment strategies. For investors looking to create compelling budgets and portfolios in their chosen competitive markets, these insights are important.

Future research could further explore these dynamics, particularly in the context of global economic changes and technological advancements. The limitation of this research is that the study only deals with assets traded primarily in the United States market. Future studies could include international markets to understand global spillover effects. Future research could also investigate spillover effects involving other major cryptocurrencies, examine the impact of macroeconomic variables like interest rates and inflation, and explore

the role of investor sentiment and behavior in driving these effects. Addressing these areas could enhance understanding asset interactions, aiding portfolio optimization and risk management.

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