Bitcoin: Risk-on or Risk-off Asset? A Dynamic Correlation and Comparative Analysis with Gold, US Equities, and DXY

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ABSTRACT

This study employs the DCC-FIGARCH model to analyze Bitcoin's evolving relationship with NASDAQ, S&P 500, gold, and DXY from January 2013 to June 2025. The findings reveal substantial volatility spillovers and long-memory volatility in Bitcoin. Over time, Bitcoin has been developing to be more positively correlated with the equities market as institutional adoption grows, although periods of decoupling are also observed. Bitcoin's weak yet persistent positive correlation with gold and significant negative correlation with DXY indicate its potential as an inflation hedge in the case of a weakening US dollar. Overall, Bitcoin displays relatively low, time-varying correlations with both risk-on and risk-off assets, suggesting its unique, hybrid qualities. In addition, Bitcoin shows the best long-term risk-adjusted return, which, coupled with its somewhat low correlations, affirms Bitcoin's potential to enhance portfolio performance.

Keywords: Bitcoin, Gold, NASDAQ, S&P 500, DXY, DCC-FIGARCH, Sharpe ratio

JEL Codes: C32, G11, G15, Q02

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1. Introduction

The global financial landscape is undergoing a profound transformation with the rise of cryptocurrencies, particularly Bitcoin. Originally introduced by Nakamoto (2008) as a decentralized peer-to-peer cash system, Bitcoin has transcended its early perception as a speculative novelty to emerge as a major financial instrument. Today, it commands the attention of institutional investors, central banks, and multinational corporations, indicating a growing recognition of its potential role within mainstream financial systems.

One of the most notable institutional endorsements of Bitcoin has been by MicroStrategy, which strategically adopted the cryptocurrency as a treasury reserve asset in response to concerns over fiat currency debasement and long-term inflation (Sedliačik & Ištok, 2022). On a national scale, El Salvador's historic move in 2021 to adopt Bitcoin as legal tender represented a turning point in the legitimization of digital assets in sovereign monetary policy (Alvarez, Argente, & Patten, 2023). These developments underscore Bitcoin's emerging dual role as both a store of value and a hedge against macroeconomic risks.

Bitcoin's resilience in the face of rising interest rates, geopolitical instability, and concerns over inflation has intensified the debate surrounding its classification within traditional risk frameworks. Early empirical studies by Dyhrberg (2016) and Bouri et al. (2017) proposed that Bitcoin exhibits inflation-hedging qualities similar to gold due to its capped supply and decentralized nature. However, recent research paints a more complex picture. For instance, Long et al. (2021) and Choi and Shin (2022) found that Bitcoin tends to underperform traditional safe havens like gold during periods of heightened market stress. In contrast, Blau et al. (2021) highlight that Bitcoin may influence inflation expectations, bolstering its appeal as a hedge in some contexts. Rodriguez and Colombo (2024) further argue that Bitcoin's effectiveness as a safeguard asset is highly dependent on the broader economic and geopolitical environment, pointing to its context-sensitive nature.

Central to the debate is whether Bitcoin behaves more like a risk-on or risk-off asset. Chari et al. (2023) define risk-on assets as those preferred during periods of market optimism and high risk appetite, while risk-off assets are favored in times of uncertainty for their relative stability. As shown in a 2024 report by BlackRock (Mitchnick, Brownback, & Cohen, 2024), although Bitcoin has frequently correlated with equities during bullish market phases, its long-term correlation with traditional asset classes remains low, suggesting diversification benefits. The same report from BlackRock challenges binary classifications of Bitcoin, emphasizing its unique behavioral profile that reflects both risk-on and risk-off characteristics depending on macroeconomic conditions.

A pivotal shift in 2025 came with the US government's announcement of a Strategic Bitcoin Reserve. According to a March 2025 executive order (The White House, 2025; Krause, 2025), this initiative involves converting lawfully forfeited Bitcoin into a national reserve asset. This initiative not only underscores the state's growing confidence in Bitcoin as "digital gold"

but also highlights the evolving role of cryptocurrencies in national economic security and financial strategy.

Parallel to sovereign initiatives, corporate treasuries have accelerated their adoption of Bitcoin. Within just months of early 2025, 61 publicly traded companies collectively acquired nearly 100,000 BTC for their balance sheets (Partz, 2025). This corporate shift has been catalyzed by improved regulatory clarity, greater technological infrastructure, and a recognition of Bitcoin's potential for risk mitigation and portfolio diversification (Bambysheva, 2025). As legacy adopters such as MicroStrategy are joined by a growing roster of institutional players, the cryptocurrency's strategic importance within corporate finance continues to rise.

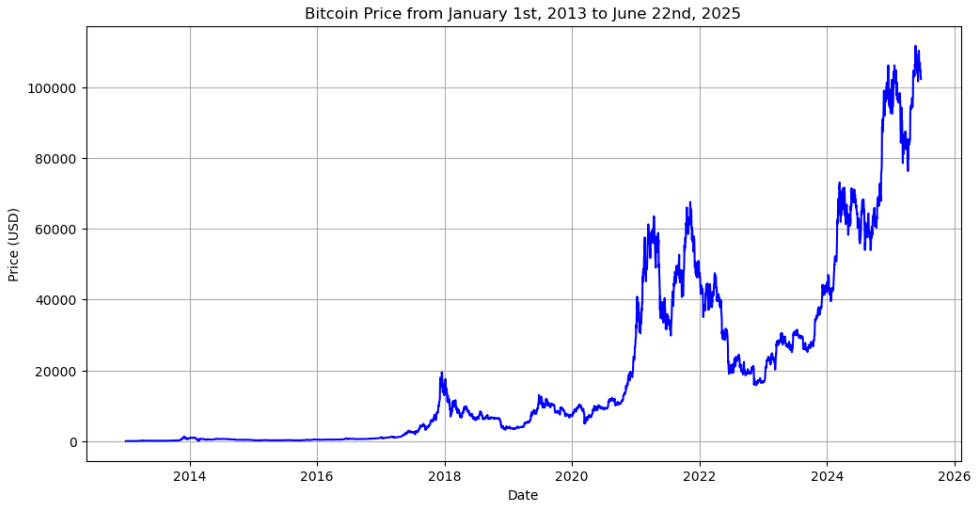

Figure 1. Bitcoin Price from January 1st, 2013 to June 22nd, 2025

Investor sentiment around Bitcoin remains bullish. In May 2025, the cryptocurrency reached an all-time high of over US$112,000, driven by strong ETF inflows, deepened institutional participation, and a global search for non-sovereign stores of value (Kharpal, 2025). Its fixed supply of 21 million coins and independence from central bank policies have reignited comparisons to gold as a long-term store of value (Baur, Karlsen, Smales, & Trench, 2024). Previous studies, such as Guesmi et al. (2019) and Akhtaruzzaman et al. (2020), demonstrate that Bitcoin's high returns and low correlation with traditional assets can enhance portfolio efficiency. Likewise, Pho et al. (2021) argue that while Bitcoin increases overall portfolio volatility, it delivers superior returns for risk-seeking investors compared to gold.

Given these multifaceted developments, ranging from sovereign strategic initiatives and the proliferation of corporate treasury adoption to record-breaking market performance in the fisrt half of 2025, a comprehensive reassessment of Bitcoin's risk profile relative to assets such as gold, US equities, and the US dollar index (DXY) is both timely and essential. Employing time series and comparative analyses, this research aims to scrutinize whether Bitcoin is solidifying its position as a risk-on asset, a risk-off asset, or perhaps a blend of both, thus contributing to the discourse on its future approaches in asset allocation, portfolio management, and corporate financial strategy.

2. Data and Methodology

This study employs five data series, including Bitcoin, NASDAQ, S&P 500, gold, and the US Dollar index (DXY). NASDAQ and S&P 500 are chosen to represent the risk-on assets of choice for most people, while gold and the DXY represent the risk-off assets usually chosen in uncertain times. The primary data used in this study are the daily and weekly returns for Bitcoin, NASDAQ, S&P 500, gold, and DXY from January 2nd, 2013 to June 22nd, 2025, derived from *CoinMarketCap* and *Yahoo Finance*. There are 4555 daily (including the holidays) and 650 weekly (a 7-day week for Bitcoin and a 5-day week for other assets) observations in total.

A broad time series and comparative analyses are conducted. Firstly, descriptive statistics, returns, unit root tests, and correlation matrices based on daily returns are shown, where the daily returns are obtained as the difference between the natural logarithm of two consecutive daily price data (Mensi, Rehman, Maitra, Al-Yahyaee, & Sensoy, 2020; Chkili, Rejeb, & Arfaoui, 2021).

$$r_t = ln\, P_t - ln\, P_{t-1} \tag{1}$$

Next, to analyze the evolution and direction of Bitcoin over time, an investigation of the time-varying relationship between Bitcoin and the chosen risk-on assets (NASDAQ & S&P 500) and risk-off assets (Gold & DXY) is conducted. Following previous studies (Akhtaruzzaman, Boubaker, & Sensoy, 2021; Corbet, Hou, Hu, Lucey, & Oxley, 2021; Mariana, Ekaputra, & Husodo, 2021; Chkili, Rejeb, & Arfaoui, 2021), this research utilized the Dynamic Conditional Correlation (DCC) process developed by Tse and Tsui (2002), combined with the Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity (FIGARCH) volatility model of Baillie et al. (1996) that is able to capture the long memory aspect of volatility. In addition, based on the results of Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Shibata Information Criterion (SIC), and Hannan-Quinn Criterion, we found AR (1) to be most suitable for the DCC-FIGARCH model.

Following Chkili et al. (2021), the conditional mean equation can be written as follows. Let y_t represent a return series written as

$$y_t = c + \theta y_{t-1} + \epsilon_t \;\; and \;\; \epsilon_t = H_t^{1/2}\eta_t \tag{2}$$

where y_t is the vector of returns on Bitcoin, NASDAQ, S&P 500, Gold, and DXY, θ is the vector of estimated coefficients, ϵ_t is the vector of error terms, and H_t is the conditional variance-covariance matrix. Following Tse and Tsui (2002) and Chkili et al. (2021), this matrix is defined as:

$$H_t = D_t R_t D_t \tag{3}$$

where R_t is the $N \times N$ symmetric matrix of conditional correlations, and D_t is the $N \times N$ diagonal matrix of conditional standard deviations, defined as:

$$D_t = \text{diag}\left(\sqrt{h_{11t}}, \ldots, \sqrt{h_{NNt}}\right) \tag{4}$$

The h_t values are assumed to follow a univariate FIGARCH process:

$$h_t = \omega + \beta(L)h_t + [1 - \beta(L)]\epsilon_t^2 - \phi(L)(1 - L)^d \epsilon_t^2 \tag{5}$$

Where d is the fractional differencing parameter that must satisfy $0 \leq d \leq 1$ to ensure the existence of the variance. $(1 - L)^d$ is the fractional differencing operator. $\beta(L)$ and $\phi(L)$ are polynomials in the lag operator of orders p and q, respectively. The matrix R_t is defined as:

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{6}$$

where $Q_t$is a symmetric positive definite conditional variance-covariance matrix:

$$Q_t = (1 - a - b)Q + a\epsilon_{t-1}\epsilon_{t-1}^T + bQ_{t-1} \tag{7}$$

and Q_t^* is a diagonal matrix containing the elements of Q_t.

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11t}} & \ldots & 0 \\ \ldots & \ldots & \ldots \\ 0 & \cdots & \sqrt{q_{NNt}} \end{bmatrix} \tag{8}$$

Moreover, $\bar{Q}$ represents the unconditional covariance of the standardized errors from the univariate FIGARCH model, determined as:

$$\bar{Q} = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_t \varepsilon_{t-1}^T \tag{9}$$

Furthermore, the DCC between assets i and j is then calculated as:

$$\rho_{ij,t} = \frac{q_{ij,t}}{(\sqrt{q_{ii,t}})(\sqrt{q_{jj,t}})} \tag{10}$$

In addition, due to the nature of the Bitcoin market, which never closes, there will be data discrepancies in the daily analysis. Hence, to complement the daily DCC analysis, a one-year rolling conditional correlation of Bitcoin and the other assets' weekly returns based on the FIGARCH model residuals is conducted as a robustness test. Lastly, following previous studies (Liu & Chen, 2020; Platanakis & Urquhart, 2020; Gerritsen, Bouri, Ramezanifar, & Roubaud, 2020; Nagy & Benedek, 2021), a rolling Sharpe ratio to compare the risk-adjusted return of Bitcoin and the other assets is shown as a comparative analysis, while the pairwise correlation

of the Sharpe ratio changes can also act as a robustness test. The Sharpe ratio (SR), as proposed by Sharpe (1966), is a key metric for assessing performance by evaluating the excess return of a fund or asset over the risk-free rate, adjusted for its risk. In this research, considering the full Bitcoin halving cycle (Jiménez, Mora-Valencia, & Perote, 2024), the rolling Sharpe ratio will be for four-year holding period returns, with a 4-year-adjusted US one-year treasury yield acting as the risk-free rate.

3. Results and Discussion

Based on Table 1, our descriptive statistics reveal that Bitcoin exhibits the highest mean daily return (0.0034) compared to NASDAQ (0.00047), S&P 500 (0.00036), Gold (0.00019), and DXY. However, the high average return is accompanied by significantly higher volatility, as evidenced by Bitcoin's standard deviation (0.0683). It is worth highlighting that Bitcoin's higher mean and standard deviation can be attributed to its market never closing, while other assets' values are also higher when holidays are excluded, as can be compared in exhibits (A) and (B) on Panel A.

Panel B reveals that the Jarque-Bera test strongly rejects the null hypothesis of normality for the daily return distributions of all assets under investigation. This deviation from normality likely stems from features such as volatility clustering and sharp market rallies, driven by macroeconomic shocks, shifts in liquidity conditions, and investor sentiment, including episodes of exuberance and fear. The presence of such non-Gaussian characteristics suggests that conventional statistical tools relying on normal distribution assumptions—particularly standard deviation-based risk measures—may be insufficient for accurate modeling and risk management. Moreover, results from both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests confirm the stationarity of all return series. This property ensures that the data's statistical moments, such as mean and variance, remain stable over time, thereby providing a solid foundation for further econometric analysis and model development.

Table 2 shows the pairwise correlations of Bitcoin with the other four instruments. In the entire sample period (January 2, 2013, to June 22, 2025), Bitcoin exhibits weak positive correlations with both the NASDAQ (0.0972) and S&P 500 (0.0867), while displaying negligible correlations with Gold (0.0096) and a very weak negative correlation with the DXY (-0.0089). This suggests that Bitcoin's price movements might have some degree of alignment with those of major stock indices, but minimal association with traditional safe-haven assets like Gold and the US Dollar.

Further, the table presents the pairwise correlations of Bitcoin with the other selected financial instruments across three distinct periods, segmented according to key macroeconomic and institutional developments. Period 1, the Pre-Pandemic Era, spans from January 2, 2013, to December 31, 2019, encompassing Bitcoin's early price discovery phase, marked by retail speculation and limited institutional engagement, with a total of 2,555 observations. Period 2, the Pandemic & Early Institutional Adoption, covers January 1, 2020, through December 31, 2023, a period characterized by extraordinary monetary stimulus, heightened market volatility, and the first wave of institutional interest in Bitcoin, comprising 1,461 observations. Lastly, Period 3, the Post-Spot ETF Approval, runs from January 1, 2024, to June 22, 2025, with 539 observations, reflecting Bitcoin's evolving role as a regulated investment vehicle following the

SEC's approval of spot Bitcoin ETFs. This segmentation enables a more nuanced understanding of how Bitcoin's correlation with traditional assets may have shifted across these structurally different regimes.

During Period 1, Bitcoin exhibits near-zero negative correlations with the other assets, except for the weak positive correlation with the DXY. It is worth highlighting that Bitcoin experienced the highest daily return (around 336%), the highest conditional volatility, and the highest increase of supply during this period. These patterns imply that, in its early stage, Bitcoin's price discovery was largely driven by early adopters and independent of traditional markets, as institutional and mainstream investors had yet to recognize its legitimacy as an investable asset.

Table 1

Panel A: Descriptive statistics of Bitcoin (BTC), NASDAQ, S&P500, Gold, and DXY daily returns from January 2, 2013 to June 22, 2025

	(A) Including the holidays (ie. change = 0)					(B) Excluding the holidays for stocks, gold, and DXY				
	Bitcoin	NASDAQ	S&P500	Gold	DXY	Bitcoin	NASDAQ	S&P500	Gold	DXY
Mean	0.0034	0.0005	0.0004	0.0002	0.0001	0.0036	0.0007	0.0005	0.0003	0.0001
Median	0.0015	0.0000	0.0000	0.0000	0.0000	0.0015	0.0011	0.0007	0.0003	0.0001
Maximum	3.3675	0.1216	0.0952	0.0595	0.0205	3.3675	0.1216	0.0952	0.0595	0.0205
Minimum	-0.5721	-0.1232	-0.1198	-0.0935	-0.0237	-0.5721	-0.1232	-0.1198	-0.0935	-0.0237
Std. Dev.	0.0683	0.0109	0.0090	0.0082	0.0036	0.0714	0.0131	0.0109	0.0099	0.0043
Observations	4555	4555	4555	4555	4555	4555	3137	3137	3137	3137

Panel B: Normality, Stationarity, and Unit Root Tests (all daily observations)

	Bitcoin		NASDAQ		S&P500		Gold		DXY	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Skewness	27.5533	-	-0.2320	-	-0.3911	-	-0.4044	-	-0.1230	-
Kurtosis	1321.4065	-	17.6430	-	26.8704	-	12.7277	-	6.9469	-
JB	330471425	0.0000	40735.41	0.0000	108258.934	0.0000	18083.934	0.0000	2968.0219	0.0000
ADF	-23.3522	0.0000	-13.9914	0.0000	-13.8356	0.0000	-69.9536	0.0000	-68.1657	0.0000
PP	-68.2347	0.0000	-75.3967	0.0000	-75.6954	0.0000	-70.2307	0.0000	-68.2834	0.0000

Note: The table shows descriptive statistics of daily returns for Bitcoin, NASDAQ, S&P 500, Gold, and DXY from January 2, 2013 to June 22, 2025. It also shows the results of normality, stationarity, and unit root tests. JB is the Jarque-Bera test of normality. Two unit root tests are conducted: ADF and PP, which are the augmented Dicky-Fuller and Phillp-Perron tests, respectively.

Table 2

Pairwise correlations of Bitcoin, NASDAQ, S&P500, Gold, and DXY for all samples and different periods

(A) All Daily Data

January 2, 2013 - June 22, 2025

	Bitcoin	*NASDAQ*	*S&P500*	*Gold*	*DXY*
Bitcoin	1.0000				
NASDAQ	0.0972	1.0000			
S&P500	0.0867	0.9482	1.0000		
Gold	0.0096	0.0236	0.0235	1.0000	
DXY	-0.0089	-0.0674	-0.0775	-0.3945	1.0000

(B) Period 1: Pre-Pandemic Era

January 2, 2013 - December 31, 2019

	Bitcoin	*NASDAQ*	*S&P500*	*Gold*	*DXY*
Bitcoin	1.0000				
NASDAQ	-0.0065	1.0000			
S&P500	-0.0124	0.9455	1.0000		
Gold	-0.0201	-0.1018	-0.1031	1.0000	
DXY	0.0275	0.0670	0.0461	-0.3857	1.0000

(C) Period 2: Pandemic & Early Institutional Adoption

January 1, 2020 - December 31, 2023

	Bitcoin	*NASDAQ*	*S&P500*	*Gold*	*DXY*
Bitcoin	1.0000				
NASDAQ	0.3874	1.0000			
S&P500	0.3550	0.9463	1.0000		
Gold	0.1211	0.1292	0.1232	1.0000	
DXY	-0.1531	-0.2349	-0.2305	-0.3972	1.0000

(D) Period 3: Post-Spot ETF Approval

January, 1 2024 - June 22, 2025

	Bitcoin	*NASDAQ*	*S&P500*	*Gold*	*DXY*
Bitcoin	1.0000				
NASDAQ	0.3294	1.0000			
S&P500	0.3184	0.9684	1.0000		
Gold	0.0471	0.0446	0.0630	1.0000	
DXY	-0.0166	0.0781	0.0748	-0.4220	1.0000

Moreover, Period 2 marked a pivotal transformation in Bitcoin's market relationships. Amid the global economic disruption caused by COVID-19 and the unprecedented wave of

monetary stimulus that followed, Bitcoin's correlations with NASDAQ (0.3874) and S&P 500 (0.3550) strengthened and became positive, indicating a growing alignment with the stock market and liquidity cycle in general. Interestingly, a weaker positive correlation with Gold (0.1211) also emerged during this period, while its correlation with DXY turned negative and became more pronounced (-0.1531). Witnessing early institutional adoption of Bitcoin led by MicroStrategy and El Salvador, this period saw Bitcoin's strongest overall correlation with the other assets, compared to the other periods.

Finally, Period 3, the most recent period that saw SEC's approval of spot Bitcoin ETFs and the proliferation of corporations with Bitcoin treasury strategy, demonstrated Bitcoin's positive correlation with the stock markets (NASDAQ: 0.3294, S&P 500: 0.3184), weakening slightly compared to the previous period. This could be attributed to several factors, including Bitcoin's sharp outperformance in early 2024 following the surge in demand from newly launched spot ETFs, price-insensitive accumulation by corporations adopting Bitcoin as part of their treasury strategy, and increased awareness of Bitcoin's potential as a neutral, alternative asset class in general. Notably, this period also saw Bitcoin's correlation with gold (0.0471) and DXY (-0.0166) diminishing to near-zero levels, underscoring its reduced alignment with traditional safe-haven assets.

Table 3

Estimation results for DCC-FIGARCH model

	Bitcoin	NASDAQ	S&P500	Gold	DXY
Panel A: Estimation results					
C(m)	0.0020*** (0.000)	0.0007*** (0.000)	0.0006*** (0.000)	0.0001 (0.000)	0.0001 (0.000)
AR(1)	-0.0155 (0.019)	-0.0638*** (0.016)	-0.0576*** (0.017)	-0.0343** (0.015)	-0.0117** (0.005)
C(v)	0.0001** (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)	0.0000 (0.000)
ARCH	0.0415 (0.030)	0.2775*** (0.057)	0.2762*** (0.029)	0.0001 (0.000)	0.4183*** (0.017)
GARCH	0.7787*** (0.021)	0.7062*** (0.160)	0.7163*** (0.066)	0.9563*** (0.003)	0.8268*** (0.000)
FIGARCH (*d*)	0.9798*** (0.013)	0.5271** (0.228)	0.5943*** (0.083)	0.9563*** (0.000)	0.4819*** (0.012)
Panel B: Estimates of Joint DCC model					
DCCa (α)		0.0096*** (0.003)	0.0108*** (0.004)	0.0059** (0.003)	0.0037*** (0.001)
DCCb (*b*)		0.9892*** (0.004)	0.9875*** (0.005)	0.9876*** (0.005)	0.9952*** (0.002)
Log L		23831.15	24901.63	24369.20	28194.72
Panel C: Diagnostic tests for the DCC model					
AIC		-10.457	-10.927	-10.693	-12.373
BIC		-10.436	-10.906	-10.672	-12.352
SIC		-10.457	-10.927	-10.693	-12.373
HQIC		-10.450	-10.920	-10.686	-12.366

Note: C(m) and C(v) are the constants of the mean and variance equations, respectively. Standard errors are reported in parentheses. Asterisks ***, **and * denote the significance at 1%, 5% and 10% levels, respectively. Diagnostoc tests AIC, BIC, SIC, and HQIC are the Akaike Information Criterion, Bayesian Information Criterion, Shibata Information Criterion, and Hannan-Quinn Information Criterion, respectively.

Furthermore, Table 3 reports the estimation results from the DCC-FIGARCH model applied to the full sample of daily data. The mean equation is specified as an AR(1) process, where the autoregressive term is statistically significant for both the NASDAQ and S&P 500 indices, indicating that their returns exhibit notable persistence and are influenced by their own past values. In contrast, the AR(1) coefficients for Gold and DXY are only marginally significant, suggesting weaker short-term memory effects. For Bitcoin, the AR(1) term is statistically insignificant, implying that its daily returns do not follow a pronounced autoregressive pattern during the sample period. This result highlights the comparatively idiosyncratic behavior of Bitcoin relative to traditional financial assets in terms of return predictability.

Regarding the conditional volatility model estimation, the ARCH parameters are statistically significant for NASDAQ, S&P 500, and DXY, indicating that short-term market volatility in these assets is notably influenced by past shocks. The GARCH terms are significant across all assets, suggesting that volatility clustering is prevalent, and conditional volatility is persistently affected by its own lagged values. Furthermore, the fractional differencing parameters from the FIGARCH model are significant at the 1% level for all assets, except for NASDAQ (significant at the 5% level). This finding points to the presence of long memory behavior in volatility dynamics, implying that shocks have enduring effects that decay slowly over time. Based on this result, Bitcoin's conditional volatility is mainly driven by its past values and tends to persist over the long term. These results are consistent with prior research by Chkili et al. (2021).

Furthermore, the DCC model parameters, denoted as a and b, are predominantly significant at the 1% level, underscoring the robustness of the dynamic correlation structure. The parameter a captures the short-term impact of past standardized residuals on current conditional correlations. Among the assets analyzed, NASDAQ and S&P 500 exhibit the highest a estimates, indicating that short-run volatility shocks in these equity markets exert the strongest immediate spillover effects on Bitcoin. In contrast, Gold and DXY display relatively lower a values, suggesting weaker short-term transmission to Bitcoin's correlation dynamics.

The b parameter reflects the long-term persistence of shocks in the dynamic conditional correlations. These parameters are also highly significant across all assets, with slight variation in magnitude. Notably, DXY registers the highest b coefficient, followed by NASDAQ. This pattern implies that while the US dollar index may have minimal short-run influence on Bitcoin, its long-term effects are more persistent, likely due to its broader role in global liquidity cycles and macroeconomic regimes.

Figure 2 illustrates the dynamic conditional correlations (DCCs) between Bitcoin and four major financial assets from January 2, 2013, to June 22, 2024, with corresponding descriptive statistics summarized in Table 4. Over this period, Bitcoin's correlations with the US equity markets exhibit broadly similar patterns, fluctuating between -0.1972 and 0.5459. The median DCC values are 0.0937 for NASDAQ and 0.0819 for S&P 500, while the means are 0.1356 and 0.1241, respectively. These results suggest a slightly stronger average co-movement between Bitcoin and the technology-focused NASDAQ, compared to the broader S&P 500. The DCC trends also reveal that Bitcoin exhibited weak and predominantly negative correlations with both indices from 2013 through the end of 2017. This was followed by a gradual shift toward weakly positive correlations from 2018 to 2019, signaling early signs of market integration and shifting investor perception during the pre-pandemic era.

During the COVID-19 period (2020–2022), Bitcoin exhibited its highest correlations with US equity indices, marking a sharp departure from earlier patterns. However, this correlation began to decline gradually throughout 2023 and into early 2024. These findings offer an important update to the conclusions of Gil-Alana et al. (2020) and Mariana et al. (2021), which suggested that Bitcoin's correlation with stock markets was predominantly negative before and during the initial phases of the pandemic. In contrast, subsequent market developments, including institutional engagement and macroeconomic shifts, highlighted a structural shift in Bitcoin's behavior, as it became more positively and significantly linked to

traditional risk assets. Following the SEC's approval of spot Bitcoin ETFs in early 2024, Bitcoin's correlation with the stock indices began to rise once more, albeit without reaching the peak levels observed during the pandemic period. This trajectory underscores Bitcoin's evolving role as a hybrid asset, increasingly reactive to liquidity cycles and equity market sentiment, yet still retaining characteristics that distinguish it from conventional risk assets.

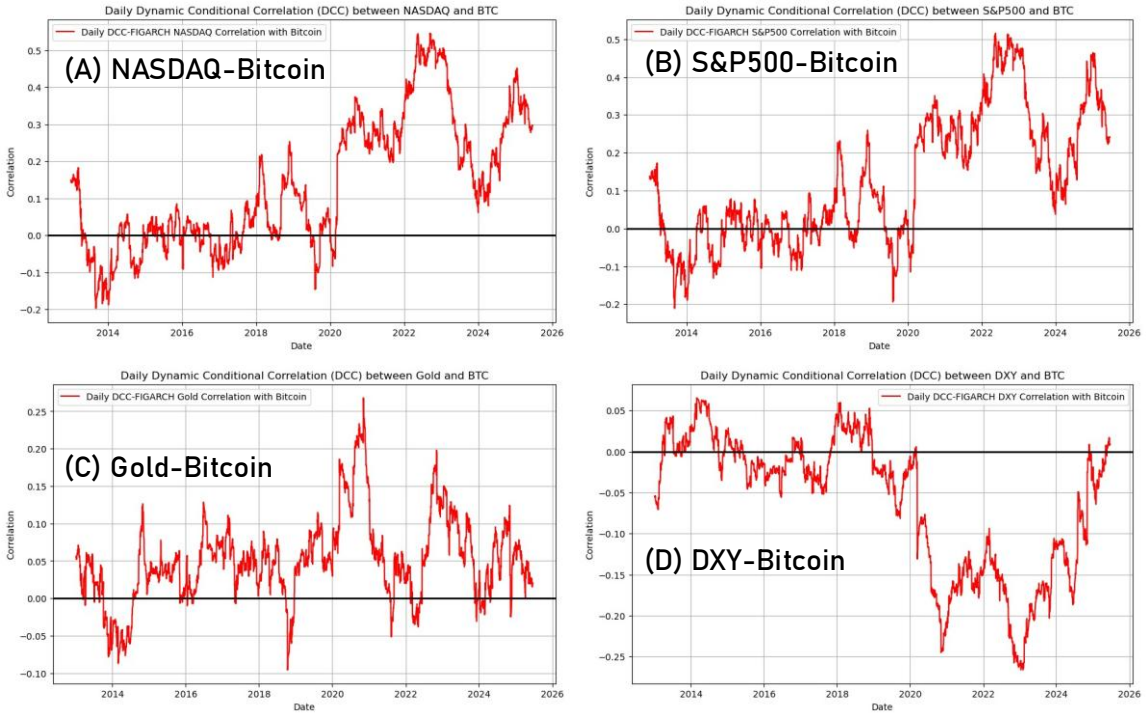

Figure 2. *Daily DCC from January 2nd, 2013 to June 22nd, 2025*

Bitcoin's correlation with gold has remained relatively modest throughout the sample period, fluctuating between -0.096 and 0.268, with a median value of 0.048 and a mean of 0.0505. While generally positive, the correlation tends to hover near zero with the exception of specific episodes such as the early COVID-19 period and the years 2022–2023, suggesting a weak and dynamic relationship. This observation is consistent with the findings of Mariana et al. (2021) and Zhang & Mani (2021), who noted an increased positive correlation between Bitcoin and gold during the pandemic. In addition, a near-zero correlation between gold and Bitcoin was also found by Baur & Hoang (2021), while the persistent positive correlation between Bitcoin and gold aligns with the study by Jareño et al. (2020).

In contrast, Bitcoin's relationship with DXY has been more clearly defined, especially since the onset of the COVID-19 crisis. A notable negative correlation emerged and persisted until early 2024, reflecting Bitcoin's behavior as a liquidity-sensitive and potentially inflation-hedging asset in the context of aggressive monetary easing. This supports the conclusions of Choi & Shin (2022) and Rodriguez & Colombo (2024), who argued that Bitcoin may act as a hedge in environments of US dollar depreciation and loose monetary policy. However, beginning in 2023, this inverse relationship began to weaken after the Federal Reserve shifted to a tightening cycle, prompting a gradual reversion of the correlation toward zero.

Figure 3 presents the one-year rolling correlations based on weekly returns data, largely consistent with the patterns observed in the daily DCC estimates, with several notable

distinctions. Firstly, Bitcoin's correlation with US equity indices declines more sharply entering 2024, even dipping into negative territory. This divergence suggests that while Bitcoin tends to align with equities during major liquidity-driven events, it can also exhibit temporary decoupling, as seen during the spot ETF approval phase, when price movements were largely driven by adoption narratives rather than macro flows. Following the initial wave of institutional ETF-related demand, Bitcoin's correlation with US stock indices gradually recovers, although it remains below previous highs.

Moreover, as for Gold and DXY, their trends in the weekly data generally mirror those in the daily DCC series. However, a key difference emerges: the weekly data displays a stronger reversion in Bitcoin's correlation with the DXY, turning notably more positive in 2025. This suggests that Bitcoin's sensitivity to US dollar movements may be more pronounced over longer horizons, potentially reflecting macroeconomic normalization and shifting investor behavior in a post-tightening environment.

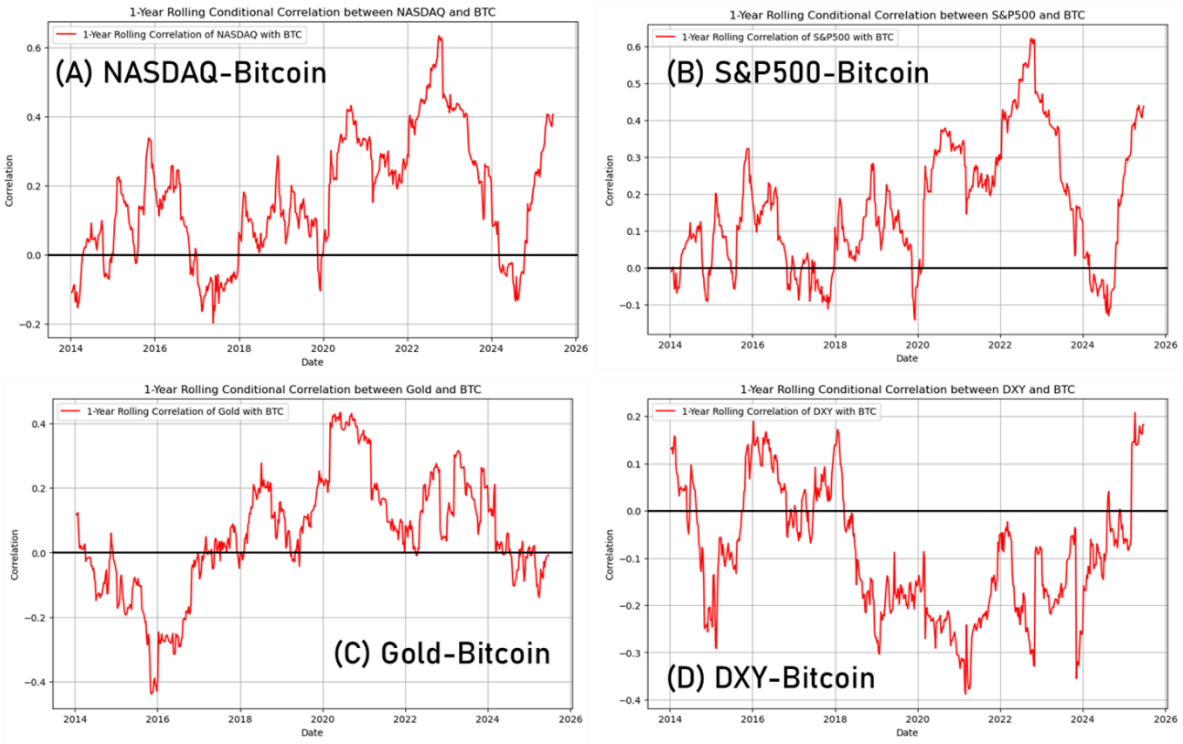

Figure 3. *One-year rolling correlation based on weekly FIGARCH residuals*

Lastly, Figure 4 presents the rolling four-year holding period Sharpe ratio charts, with descriptive statistics and pairwise correlations summarized in Table 5. The results reveal that despite Bitcoin's well-known episodes of sharp drawdowns and heightened volatility, its risk-adjusted returns over a full-cycle horizon remain consistently higher than those of the NASDAQ, S&P 500, and gold. Notably, however, gold's strong rally in 2025 propelled its Sharpe ratio above those of Bitcoin and the major stock indices, reflecting its resurgence amid shifting macroeconomic conditions.

From 2017 to 2025, Bitcoin's Sharpe ratio ranged from 0.69 to 3.17, with a mean of 2.14, compared to 1.56 for NASDAQ, 1.30 for the S&P 500, and 0.79 for gold. Moreover, based on the rolling Sharpe ratio values from January 2017 to May 2025, Bitcoin exhibits a moderately

positive correlation with NASDAQ (33.8%) and S&P 500 (21.9%), while maintaining a weak negative correlation with gold (-7.33%). These patterns suggest that, in terms of risk-adjusted performance, Bitcoin tends to align more closely with risk-on assets such as equities, whereas its relationship with traditional safe-haven assets like gold remains limited and often inversely related.

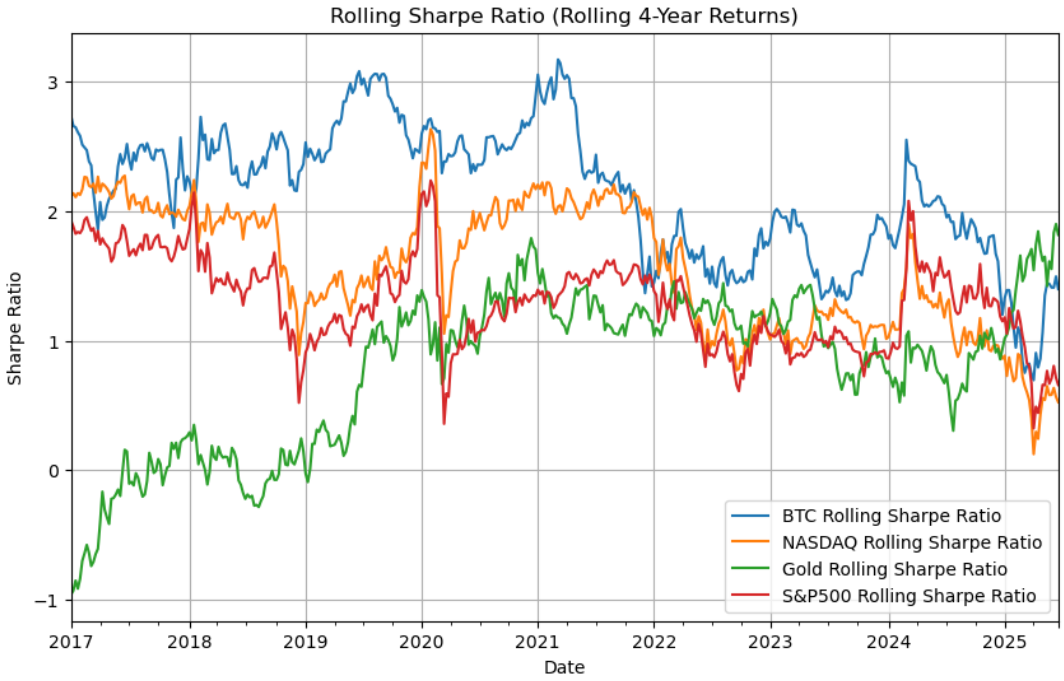

Figure 4. *Rolling Sharpe ratio of four-year returns*

In summary, the findings indicate that Bitcoin has developed a more pronounced positive correlation with risk-on assets, particularly US equities, as it has matured over time. However, these correlations remain dynamic and time-varying, with clear periods of decoupling, especially during asset-specific adoption cycles. As a result, Bitcoin's overall correlation with both risk-on and risk-off assets remains relatively weak. This combination of low cross-asset correlation and consistently high risk-adjusted returns strengthens the case for including Bitcoin in a diversified portfolio. It suggests that Bitcoin may offer valuable diversification benefits, improving overall portfolio efficiency.

These insights align with prior research by Platanakis & Urquhart (2020) and Akhtaruzzaman et al. (2020), which emphasize Bitcoin's potential to enhance multi-asset portfolio performance through its unique risk–return profile. Our findings also suggest that combining Bitcoin and gold, given their high risk-adjusted returns and inverse correlation, can further boost portfolio efficiency. This conclusion is supported by an earlier study by Selmi, Mensi, Hammoudeh, and Bouoiyour (2018), who identify both assets as effective diversifiers during economic and political turmoil, and by a recent BlackRock report describing Bitcoin as a "unique diversifier" (Mitchnick, Brownback, & Cohen, 2024).

Bitcoin's dynamic correlations with both risk-on and risk-off assets can be traced to its fundamentally hybrid nature. As the recent ARK Invest report observes, Bitcoin's dual identity "blurs" the conventional risk-on/risk-off divide, creating a new asset paradigm (Elmandjra,

2024). On one hand, Bitcoin's fixed, transparent supply and bearer-instrument design mirror gold's scarcity and inflation-hedging characteristics, typical of a classic risk-off asset. On the other hand, its digital, permissionless architecture and rapid global adoption more closely resemble disruptive technology plays, driving speculative interest and near-term co-movement with equity markets, the conventional risk-on asset.

Empirical studies corroborate this view. Panagiotidis et al. (2018) identify three primary return drivers: Google search intensity (a proxy for adoption momentum, i.e., risk-on), gold returns (capturing scarcity and hedge appeal, i.e., risk-off), and policy uncertainty (straddling both adoption and regulatory sentiment). More recently, Panagiotidis et al. (2024) highlight that attention and mining difficulty, reflecting network adoption and Bitcoin's scarce supply, remain the dominant determinants of Bitcoin returns. Together, these findings explain why Bitcoin sometimes tracks technology stocks and, at other times, behaves like a digital safe-haven, producing the dynamic, time-varying correlations documented in our analysis.

4. Concluding Remarks

This study utilizes the DCC-FIGARCH model to analyze Bitcoin's evolving relationship with NASDAQ, S&P 500, gold, and DXY from January 2nd, 2013, to June 22nd, 2025. The model estimates reveal substantial volatility spillovers from the four assets into Bitcoin, while showing that its volatility has long memory. Overall, correlational studies show that Bitcoin has been developing moderate, dynamic correlations with NASDAQ and S&P 500, indicating greater market integration as institutional adoption grows. However, despite Bitcoin's increasing alignment with the stock indices post-pandemic, periods of decoupling are also observed, resulting in an overall modest correlation. Moreover, its weak yet persistent positive correlation with gold, and its mostly negative correlation with DXY during periods of low interest rates, might suggest its role as a potential inflation hedge in the case of a weakening US dollar.

Furthermore, we found that Bitcoin shows the best overall long-term risk-adjusted return. Coupled with its relatively low correlation with other assets, this affirms Bitcoin's potential to enhance portfolio performance. Specifically, the study finds that combining Bitcoin with gold, which has a near-zero correlation with Bitcoin and a high Sharpe ratio recently, can further elevate risk-adjusted performance. Lastly, the dynamic profile might be explained by Bitcoin's dual identity: its fixed, scarce supply delivers risk-off qualities akin to gold, while its digital, borderless design fuels adoption and speculative, risk-on behavior similar to technology equities. Together, these qualities drive the time-varying correlations we document, indicating that Bitcoin might have developed into a unique asset class of its own.

Appendix

Table 4

Descriptive statistics for daily DCC-FIGARCH with Bitcoin

	NASDAQ	S&P500	Gold	DXY
Mean	0.1356	0.1241	0.0505	-0.0627
Std. Error	0.0026	0.0025	0.0008	0.0012
Median	0.0937	0.0819	0.0480	-0.0302
Std. Dev.	0.1766	0.1705	0.0561	0.0839
Range	0.7431	0.7267	0.3638	0.3317
Minimum	-0.1972	-0.2110	-0.0958	-0.2662
Maximum	0.5459	0.5157	0.2680	0.0655
Kurtosis	-0.8066	-0.8163	1.1067	-0.8247
Skewness	0.4616	0.4548	0.5402	-0.6075
Observations	4555	4555	4555	4555

Table 5

Statistics and correlation of 4Y rolling Sharpe ratio

	Bitcoin	NASDAQ	Gold	S&P500
Panel A: Descriptive statistics of 4Y rolling Sharpe ratio				
Mean	2.1431	1.5620	1.2958	0.7895
Median	2.2397	1.5774	1.3159	0.9735
Std. Deviation	0.5168	0.4978	0.3488	0.6031
Minimum	0.6942	0.1226	0.3217	-0.9606
Maximum	3.1730	2.6353	2.2379	1.9012
Observations	443	443	443	443
Panel B: 4Y Rolling Sharpe Ratio Change Correlation				
BTC	1			
NASDAQ	0.3375	1		
S&P500	0.2193	0.8045	1	
Gold	-0.0733	0.0438	0.0685	1

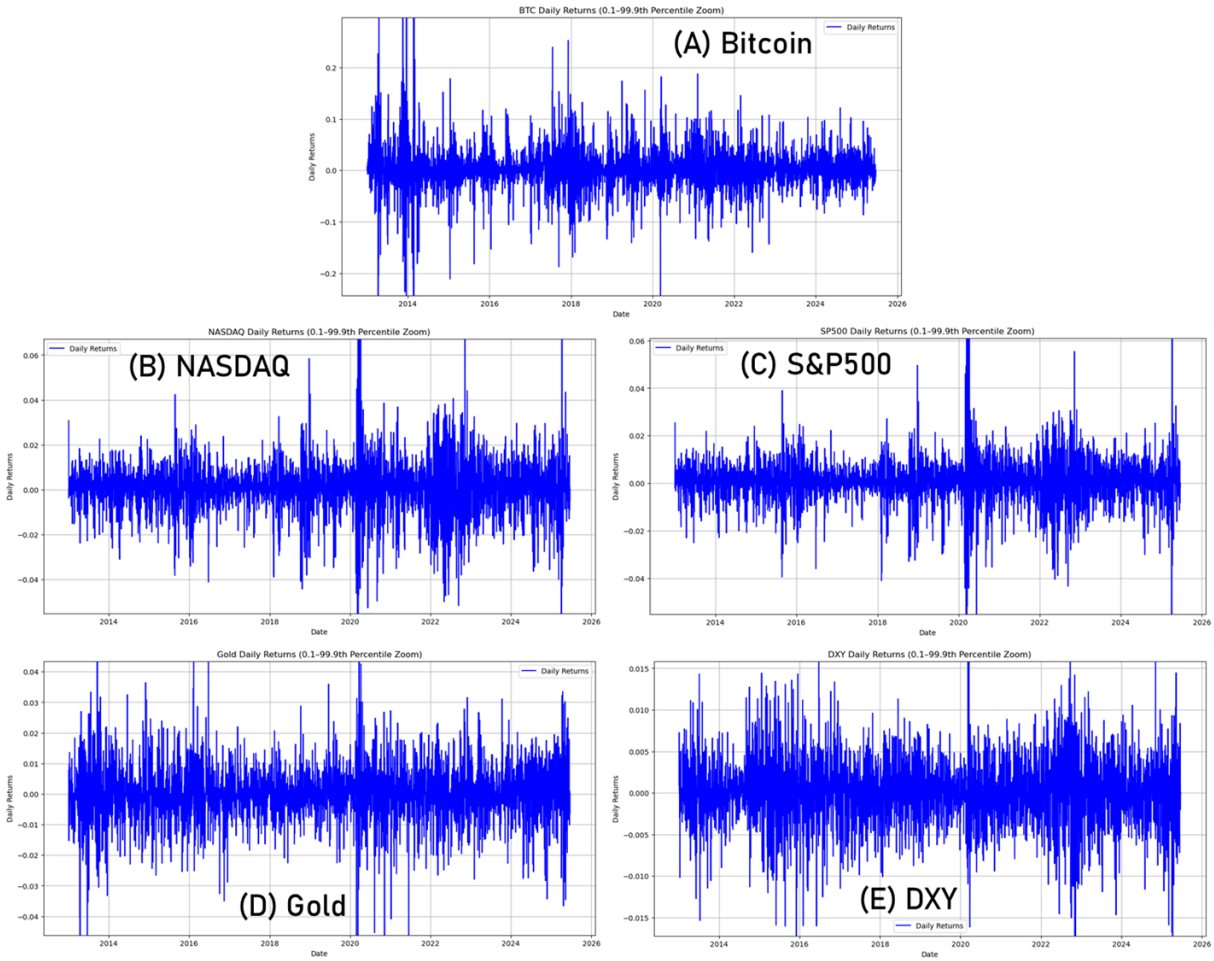

Figure 5. *Daily returns of assets (January 2nd, 2013 - June 22nd, 2025)*

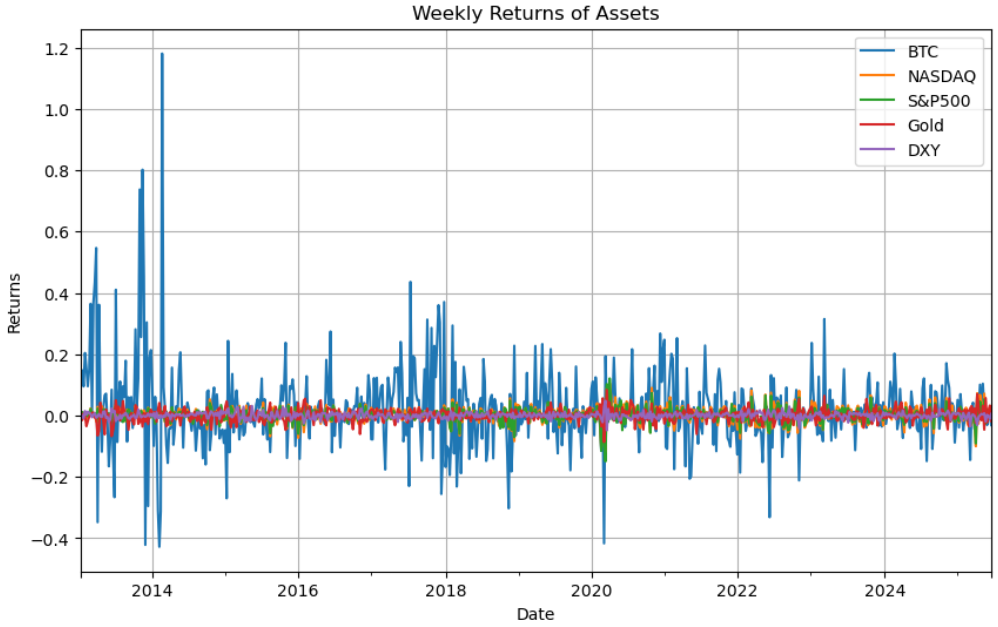

Figure 6. *Weekly returns of assets (January 2nd, 2013 - June 22nd, 2025)*

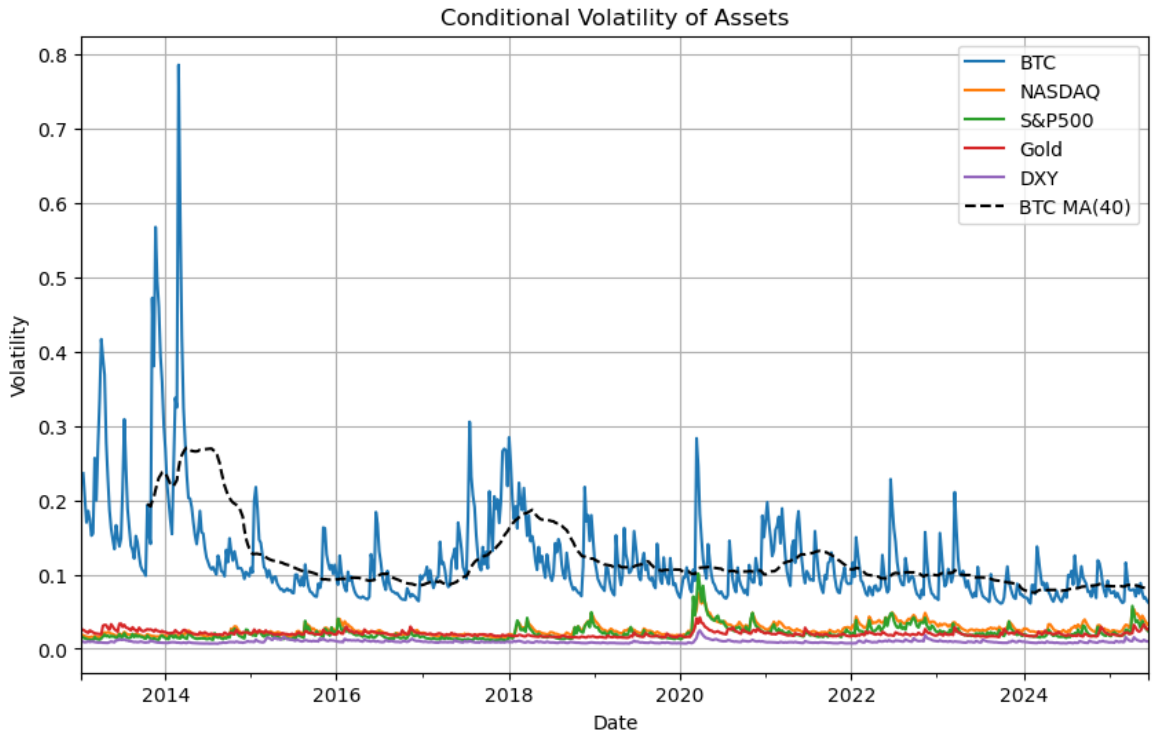

Figure 7. *Conditional volatility of assets (January 2nd, 2013 - June 22nd, 2025)*

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