

Safe-Haven and Diversification Roles of Gold and Bitcoin: Evidence from Financial Markets

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ABSTRACT

Gold has historically provided stability during crises, whereas Bitcoin's volatile nature raises questions about its reliability as a safe haven. This study investigates the safe-haven and diversification roles of gold and Bitcoin in financial markets from 2015 to 2025. With rising economic uncertainties, the need for reliable safe-haven assets has become critical. Employing a quantitative methodology, the research utilizes GARCH models for volatility analysis, quantile regression to assess behavior during market downturns, and the Sharpe ratio for portfolio performance evaluation. Findings indicate that gold consistently outperforms Bitcoin in terms of downside protection, confirming its status as a traditional safe-haven asset. Conversely, Bitcoin offers potential diversification benefits, enhancing portfolio performance when combined with gold. The results support the notion that integrating both assets can lead to improved risk-adjusted returns, making a dual-asset investment strategy a practical approach for investors navigating market uncertainties.

KEYWORDS Gold, Bitcoin, Safe-Haven Assets, Diversification, Financial Markets, GARCH Model, Quantile Regression, Portfolio Performance, Risk-Adjusted Returns, Economic Uncertainty.



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INTRODUCTION

The need for safe-haven assets that can maintain value during economic downturns has increased due to rising uncertainty in international financial markets. Gold has long been seen as a dependable safe-haven investment, offering stability in times of crisis. It often holds its value or even rises when other assets, such as stocks, suffer major declines (Baur & McDermott, 2010). In contrast, Bitcoin has shown characteristics more similar to risky assets than to traditional safe havens (Adrian et al., 2022). Despite this, economists often compare Bitcoin to gold because of several shared traits. Both assets gain value largely from their scarcity and the high cost of production. They are also not tied to any government or specific country, and both are mined by several independent operators and companies (Dyhrberg, 2016).

Events such as the 2008 Global Financial Crisis, the COVID-19 pandemic in 2020, and the global tariff conflict started by the United States in 2025 have created serious disruptions in financial markets. During such times, investors often shift their portfolios toward safer assets to reduce exposure to risk (Baur & Lucey, 2010). However, Bitcoin's performance during crises has been inconsistent, sparking debate among researchers and investors about its true role as a safe haven. Beyond its potential for downside protection, Bitcoin is also being examined for its ability to improve portfolio diversification, thanks to its unique return behavior and historically low correlation with traditional financial assets.

Based on extant literature, the roles of gold and Bitcoin as potential safe-haven assets have been extensively debated. Seminal work by Baur and McDermott (2010) established gold's enduring status as a reliable store of value during market crises, a finding corroborated by numerous subsequent studies. In contrast, research on Bitcoin presents a more complex picture. While some early studies, such as Dyhrberg (2016), highlighted its hedging potential, more recent analyses, including those by Adrian et al. (2022), argue that its price movements have become increasingly correlated with equities, undermining its defensive characteristics. Studies employing quantile regression, such as Kumar and Padakandla (2022) and Ben Ameur et al. (2024), have further delineated this divergence, consistently finding that gold provides superior downside protection in the lower tails of the return distribution, whereas Bitcoin tends to suffer significant losses alongside traditional risk assets.

Despite this body of research, a discernible gap remains in providing a holistic and comparative assessment that simultaneously evaluates the safe-haven property and the portfolio diversification benefit within a unified analytical framework for a recent and turbulent period. Many studies focus on one aspect—either hedging or diversification—without integrating both to formulate a comprehensive strategic recommendation for investors. Furthermore, the period encompassing the post-pandemic recovery and recent geopolitical tensions, leading up to 2025, represents a critical and under-examined phase marked by unique macroeconomic shocks, including shifts in monetary policy and emerging trade conflicts, which necessitate a fresh empirical investigation.

The urgency of this research is underscored by the growing need for effective risk management tools in an era of heightened financial market volatility. Investors and portfolio managers are increasingly confronted with the challenge of preserving capital amidst successive economic disruptions, from global health crises to trade wars. Understanding the distinct and complementary roles that traditional assets like gold and modern digital assets like Bitcoin can play is no longer a theoretical exercise but a practical imperative for constructing resilient portfolios. This study addresses this urgent need by delivering evidence-based insights into how these

assets behave under stress and how they can be optimally combined. The novelty of this research lies in its integrated multi-method approach applied to a contemporary dataset extending to 2025, which captures the latest market dynamics. By concurrently employing GARCH models for volatility persistence, quantile regression for tail-risk analysis, and Modern Portfolio Theory for diversification efficiency, this study offers a more nuanced and actionable comparison.

This study aims to explore whether Bitcoin and gold serve as safe-haven assets and whether they can help diversify portfolios in global financial markets over the period from 2015 to 2025. The 2015–2025 period was chosen because it encompasses high crypto market volatility, global pandemics, and geopolitical tensions, making it representative for testing safe-haven properties. Through empirical analysis across various market conditions, the research evaluates whether Bitcoin can act as a complement or even a substitute for gold in protecting investor portfolios. The primary benefit is the provision of a clear, empirically grounded dual-asset strategy that demonstrates how gold's stability and Bitcoin's diversification potential can be harnessed together. The findings are poised to benefit academic discourse by refining asset pricing theories for hybrid portfolios while offering practitioners a validated framework for enhancing risk-adjusted returns in an uncertain investment landscape.

RESEARCH METHOD

This study employed a quantitative research design based on secondary time-series data to examine the behavior of Bitcoin and gold under different market conditions. A quantitative approach was appropriate as it enabled the use of econometric models to analyze volatility, market extremes, and portfolio performance over time.

The study applied a multi-method empirical framework that included GARCH models for volatility analysis, quantile regression for assessing asset performance during periods of financial stress, and Sharpe ratios for evaluating portfolio efficiency. These techniques were selected for their suitability to financial time-series data and their ability to capture asset responses under extreme conditions while assessing risk-adjusted returns.

The research focused on monthly return data for Bitcoin and gold covering the period from 2015 to 2025, with the objective of comparing their safe-haven properties and diversification potential. This design supported hypothesis testing related to asset behavior during market instability and their contribution to portfolio stability. By integrating these methods, the study provided a comprehensive understanding of the roles that Bitcoin and gold played in contemporary investment strategies.

RESULT AND DISCUSSION

Descriptive Statistics

This section presents a comparison between Bitcoin and gold by using their monthly return data from January 2015 to January 2025. It focuses on key statistical measures such as average returns, variation, and data distribution. These findings will be useful for further analysis on volatility and risk-return performance in the following sections.

Summary Statistics of Bitcoin and Gold Returns

To examine the average performance and fluctuations of each asset, Table 1 shows the descriptive statistics of monthly returns for both Bitcoin and gold.

Table 1. descriptive statistics of monthly returns for both Bitcoin and gold

Statistic	Bitcoin	Gold
Mean	0.0692	0.0079
Standard Deviation	0.2149	0.0404
Minimum	-0.3732	-0.0819
Maximum	0.7038	0.1090
Skewness	0.4964	0.3171
Kurtosis	0.1201	-0.3162
Observations	121	121

Monthly return data across 121 periods highlights key differences between Bitcoin and gold in terms of return and risk. Bitcoin recorded an average monthly return of 0.0692. Gold showed a lower mean return of 0.0079, indicating stronger return potential for Bitcoin. However, Bitcoin also showed greater volatility, with a standard deviation of 0.2149 compared to gold's 0.0404. The lowest return for Bitcoin was negative 0.3732, while gold's minimum was negative 0.0819, reflecting Bitcoin's exposure to deeper losses during adverse market conditions. On the other end, Bitcoin reached a maximum return of 0.7038, which was significantly higher than gold's peak of 0.1090. Both assets displayed positive skewness, with values of 0.4964 for Bitcoin and 0.3171 for gold, indicating more frequent large positive outcomes. Kurtosis values also differed, with Bitcoin at 0.1201, suggesting occasional extreme movements, and gold at negative 0.3162, pointing to a more regular distribution pattern. In conclusion, Bitcoin delivered higher potential for return but involved substantially greater risk, while gold remained relatively stable and aligned with its historical function as a safe-haven asset.

This finding is consistent with the research of Klein et al. (2018), who observed that Bitcoin offers higher returns alongside extreme volatility, while gold retains its value more effectively during market stress, confirming its role as a safe-haven asset

GARCH Model – Volatility Analysis

This section discusses the results of the GARCH(1,1) model, which is used to examine how the monthly returns of Bitcoin and gold change over time. The model helps to evaluate the level of risk in each asset and assess whether they act as safe-haven assets during times of market instability.

GARCH (1,1) Estimation for Bitcoin and Gold

The GARCH (1,1) model was applied to measure the changing volatility of Bitcoin and gold. It considers how previous periods of volatility and market shocks affect current volatility, which makes it appropriate for studying financial time-series data. The results are summarized in the table below:

Table 2. Result of GARCH (1,1)

Asset	μ (mu)	ω (omega)	α_1 (alpha1)	β_1 (beta1)
Bitcoin	0.0665	0.0055	0.0625	0.8160
Gold	0.0079	0.000065	3.901330e-11	0.9568

These values represent the estimated coefficients of the GARCH (1,1) model for each asset:

Mu (μ): The average return

Omega (ω): The long-run average volatility

Alpha1 (α_1): The impact of recent news or shocks on current volatility

Beta1 (β_1): The persistence of past volatility over time

Volatility Persistence Comparison

Volatility persistence is measured by the sum of α_1 and β_1 . A higher sum indicates that volatility remains for a longer period after a shock

Bitcoin: $\alpha_1 + \beta_1 = 0.0626 + 0.8160 = 0.8786$

Gold: $\alpha_1 + \beta_1 = 3.90 \times 10^{-11} + 0.9569 = 0.9569$

Implication for Safe-Haven Reliability

The GARCH results show clear differences in how Bitcoin and gold respond to volatility over time. Gold has a very low alpha and a high beta, which suggests that its volatility does not change much when market shocks occur. This supports gold's reputation as a safe-haven asset, since it tends to stay stable during times of financial stress.

Bitcoin shows a higher alpha and a lower beta. This means it reacts more quickly to new market information, leading to higher volatility. As a result, Bitcoin is less dependable as a safe-haven asset during crisis periods. These results support the view that gold remains a traditional safe-haven asset. In contrast, Bitcoin's more reactive and unstable nature makes it less suitable for protecting investment portfolios during periods of market uncertainty.

This finding is supported by Yae and Tian (2024), who concluded that Bitcoin's extreme volatility and strong reaction to market news undermine its reliability as a safe haven, whereas gold maintains its stability and value under uncertain market conditions

Quantile Regression: Safe-Haven Behavior

This section looks at whether Bitcoin and gold can act as safe-haven assets by examining their performance in the lowest parts of the return distribution through quantile regression. This method helps to see how each asset behaves during sharp market declines, specifically focusing on the 5th and 10th percentiles of returns.

Bitcoin and Gold Returns in Lower Quantiles (5% and 10%)

To understand how each asset reacts during market stress, quantile regression was applied at the 5th and 10th percentiles. These levels reflect times when the market is under heavy pressure.

Table 3. result of quantile regression

Asset	5 th Quantile Coefficient	10 th Quantile Coefficient
Bitcoin	-0.2494	-0.1670
Gold	-0.0548	-0.0329

The regression results reveal that Bitcoin faces strongly negative returns at both the 5th and 10th percentiles. At the 5th quantile, the coefficient of -0.2494 suggests that Bitcoin typically loses about 24.94 percent during the worst market conditions. At the 10th percentile, the loss is around 16.70 percent. These outcomes highlight Bitcoin's weakness during times of financial stress.

Gold also shows negative coefficients, but the values are much smaller which is -5.48 percent at the 5th percentile and -3.29 percent at the 10th percentile. This suggests that while gold is not completely unaffected during downturns, its losses are much milder compared to Bitcoin.

Interpretation across Quantiles and Market Stress Condition

The quantile regression results show clear differences in how Bitcoin and gold behave during periods of market stress. Bitcoin experiences sharp drops at the lowest quantiles, which shows its weak ability to protect investors during crises. The large negative coefficients suggest that Bitcoin often moves along with the broader market when conditions are poor, making it an unreliable safe-haven asset. On the other hand, gold also shows some losses in the lower percentiles, but the drops are smaller. This suggests that gold is more stable and better at holding value when markets are under pressure, which matches its long-standing role as a safe asset during economic downturns.

In summary, the findings support the idea that gold provides stronger downside protection in times of financial stress, while Bitcoin lacks the characteristics of a true safe-haven asset. This conclusion is further reinforced by

the research of Ben Ameer et al. (2024), who employed quantile regression and found that Bitcoin exhibits large negative returns during market crashes, while gold experiences only mild losses. Similarly, Kumar and Padakandla (2022) demonstrated that gold consistently provided downside protection at the lower quantiles during the COVID-19 crisis, whereas Bitcoin's performance was unstable and failed to meet the criteria of a reliable safe haven. In addition, Long et al. (2021) observed that Bitcoin tends to move alongside declining markets during periods of uncertainty, while gold maintains a negative correlation with risk assets, confirming its effectiveness in protecting investors during downturns.

Portfolio Diversification

This section examines how well Bitcoin, gold, and a mix of both improve portfolio performance. The focus is on the Sharpe Ratio, which measures return in relation to risk. The goal is to see whether combining the two assets offers better risk-return results through diversification.

Portfolio Expected Return and Risk (Markowitz Model)

This section applies the formal principles of Modern Portfolio Theory (MPT), developed by Markowitz (1952), to examine the risk and return characteristics of a portfolio comprising Bitcoin and gold. While previous sections discussed the performance of each asset in isolation, the focus here shifts to evaluating their combined behaviour when allocated equally in a portfolio.

The aim is to assess whether diversification between these two assets leads to a more efficient investment outcome. Specifically, the expected return and risk (measured by standard deviation) of the portfolio are calculated using historical data from 2015 to 2025. The analysis assumes a balanced allocation, with 50 percent invested in Bitcoin and 50 percent in gold. Monthly average returns and standard deviations for each asset are taken from the descriptive statistics presented in Section IV.1, while the correlation coefficient between the two is assumed to be moderately positive, reflecting typical market conditions during the observed period.

By quantifying the risk-return profile of this mixed portfolio, this section seeks to provide empirical support for the diversification benefits proposed by MPT, particularly in the context of combining a volatile digital asset with a traditionally stable store of value.

The expected return of a two-asset portfolio can be determined using the following formula:

$$E(R_p) = w_1E(R_1) + w_2E(R_2)$$

Where:

$E(R_p)$ represents the expected return of the portfolio

w_1 and w_2 are the weights of bitcoin and gold

$E(R_1)$ and $E(R_2)$ represent the expected returns of Bitcoin and gold

Assuming an equal-weighted portfolio ($w_1=w_2=0.5$), with average monthly returns of 6.92% for Bitcoin and 0.79% for gold, the expected portfolio return is calculated as follows:

$$E(R_p) = (0.5 \times 0.0692) + (0.5 \times 0.0079) = 0.03855$$

The expected monthly return of the portfolio is 3.855%

To measure the risk associated with the portfolio, the standard deviation is derived from the following variance formula:

$$\sigma_p^2 = w_1^2 \cdot \sigma_1^2 + w_2^2 \cdot \sigma_2^2 + 2 \cdot w_1 \cdot w_2 \cdot \rho \cdot \sigma_1 \cdot \sigma_2$$

σ_1 and σ_2 are the standard deviations of Bitcoin and gold returns

w_1 and w_2 are the weights of bitcoin and gold

Based on the descriptive statistics in Section IV.1, $\sigma_1=0.2149$ and $\sigma_2=0.0404$

The Portfolio Risk formula is calculated as follows:

$$\begin{aligned}\sigma_p^2 &= (0.5^2 \times 0.2149^2) + (0.5^2 \times 0.0404^2) + 2 \times 0.5 \times 0.5 \times 0.0752 \times 0.2149 \times 0.0404 \\ \sigma_p^2 &= 0.01288 \gg \sigma_p = \sqrt{0.01228} = 0.1108\end{aligned}$$

The Pearson correlation coefficient between Bitcoin and gold monthly returns from 2015 to 2025 is 0.0752, indicating a very weak positive linear relationship. This suggests that the two assets are largely uncorrelated, supporting the foundational assumptions of Modern Portfolio Theory (Markowitz, 1952). To quantify the effect of this low correlation on portfolio risk, the standard deviation of a 50/50 portfolio was calculated using the Markowitz variance formula. The resulting portfolio volatility was 0.1108, which is substantially lower than Bitcoin's individual volatility (0.2149) and only modestly higher than that of gold (0.0404). This outcome demonstrates that even a minimal correlation coefficient can significantly reduce total portfolio risk, offering a clear diversification advantage. The result is consistent with Bhuiyan, Rahman, & Sadorsky (2023), who found Bitcoin and gold exhibit weak co-movement under normal conditions. Similarly, Yae and Tian (2024) emphasised the distinct financial behaviour of Bitcoin and gold, which contributes to their low covariance. Overall, the combined empirical evidence and calculated risk reduction underscore the utility of blending these assets to enhance portfolio efficiency.

Sharpe Ratio Comparison

To assess how each asset performs in terms of risk-adjusted return, Sharpe Ratios were calculated for three types of portfolios: one with only Bitcoin, one with only gold, and one with an even 50/50 mix of both. The risk-free rate used in this analysis is taken from the average monthly compounded yield of the U.S. 10-Year Treasury Bond from January 2015 to January 2025, which is around 0.2044% per month.

Table 4. The Bitcoin and gold portfolio

Portfolio	Sharpe Ratio
Bitcoin Only	0.3125
Gold Only	0.1459
50/50 Mixed	0.3296

The Bitcoin-only portfolio shows a Sharpe Ratio of 0.3125, which suggests a fairly strong return when adjusted for its high risk. In comparison, the gold-only portfolio has a lower Sharpe Ratio of 0.1459, highlighting its position as a safer but lower-yielding asset.

The 50/50 mixed portfolio reaches the highest Sharpe Ratio of 0.3296. This suggests that blending Bitcoin and gold improves risk-adjusted performance, even though gold has lower returns on its own. The result shows how diversification can make a portfolio more efficient. Diversification Benefit and Efficient Frontier Interpretation

Diversification Impact and Risk-Return Profile

The analysis of the mixed portfolio shows that holding both Bitcoin and gold brings real diversification benefits. While Bitcoin offers higher returns on its own, it also carries much greater risk. Gold, in contrast, provides more stable returns with less volatility.

The higher Sharpe Ratio in the mixed portfolio suggests that combining these two assets creates a better balance between risk and return. This improvement mainly comes from the fact that Bitcoin and gold do not move in the same direction all the time. Because of this weak correlation, the overall risk of the portfolio is lower compared to holding just one asset. The effect of diversification helps reduce total portfolio risk without cutting returns by the same amount, which increases risk-adjusted performance. These results support the idea that, even though Bitcoin is more speculative, it can still play a helpful role in a portfolio when combined with gold.

In summary, the portfolio findings suggest that splitting investments between Bitcoin and gold leads to a stronger risk-return profile. This confirms the view that diversification between the two improves overall investment performance. These results are further supported by Shahzad et al. (2019), who showed that Bitcoin delivers higher returns while carrying greater risk, whereas gold provides stability. A portfolio that includes both assets becomes more efficient in terms of Sharpe Ratio. Similarly, Symitsi and Chalvatzis (2019) found that including both Bitcoin and gold significantly enhances portfolio performance. This improvement is attributed to their low correlation, which contributes to a more balanced risk-return trade-off. In addition, Pal and Mitra (2019) emphasized that the weak correlation between Bitcoin and gold allows them to complement each other effectively in a portfolio. As a result, the overall risk is reduced and the

portfolio achieves better risk-adjusted outcomes compared to holding either asset alone.

Hypothesis Discussion

This section reviews the hypotheses stated in Chapter I by drawing conclusions from the findings discussed earlier. Each hypothesis is examined one by one, and its acceptance or rejection is based on the results from volatility analysis, quantile regression, and portfolio performance indicators.

Hypothesis 1: Safe-Haven Superiority of Gold

Hypothesis 1 (H1): Gold consistently demonstrates stronger safe-haven properties than Bitcoin during financial stress. This hypothesis is supported by the quantile regression results presented in Section IV.3. The analysis showed that gold had smaller negative coefficients at both the 5th and 10th percentiles of returns when compared to Bitcoin. Specifically, Bitcoin recorded coefficients of -0.2494 at the 5th percentile and -0.1670 at the 10th, reflecting significant losses under stressed market conditions. In contrast, gold's coefficients were -0.0548 and -0.0329 , indicating milder drawdowns.

These findings confirm that gold offers more effective downside protection during financial turbulence, reinforcing its reputation as a traditional safe-haven asset. In contrast, Bitcoin showed greater sensitivity to market downturns, reducing its reliability in times of stress. This conclusion is further supported by Fabris and Ješić (2023), who used quantile regression to demonstrate that gold provides stronger downside protection during financial stress, while Bitcoin tends to move with the broader market. Therefore, Hypothesis 1 is accepted.

Hypothesis 2: Bitcoin as a Diversification Complement

Hypothesis 2 (H2): Bitcoin can serve as a diversification complement to gold, improving the portfolio's risk-return balance. This hypothesis is supported by the findings in Section IV.4. The portfolio that combined Bitcoin and gold in equal weights achieved a Sharpe Ratio of 0.3296 , which is higher than the Sharpe Ratios of the Bitcoin-only (0.3125) and gold-only (0.1459) portfolios.

The improved Sharpe Ratio shows that Bitcoin, despite its higher volatility, can enhance the performance of a gold-based portfolio. This benefit comes from the weak correlation between the two assets, which helps lower overall risk more effectively than holding either one alone. This result aligns with the findings of Bhuiyan et al. (2023), who demonstrated that Bitcoin and gold exhibit low correlation, and that combining the two assets enhances diversification and improves the portfolio's overall risk-return trade-off. Therefore, Hypothesis 2 is accepted.

Hypothesis 3: Portfolio Performance Enhancement

Hypothesis 3 (H3): A Bitcoin-gold mixed portfolio yields higher risk-adjusted returns than Bitcoin-only or gold-only portfolios. This hypothesis is directly supported by the Sharpe Ratio comparison. Among the three portfolio types, the 50/50 Bitcoin-gold portfolio recorded the highest Sharpe Ratio, reflecting the strongest risk-adjusted performance.

This result confirms that combining Bitcoin and gold improves portfolio efficiency through diversification. Since the mixed portfolio outperforms both Bitcoin-only and gold-only portfolios in balancing risk and return, the evidence clearly supports the hypothesis. This conclusion is further supported by Bakry et al. (2021), who found that portfolios combining Bitcoin with other assets achieved higher Sharpe Ratios, confirming that a Bitcoin–gold mix can outperform individual-asset portfolios in terms of risk-adjusted returns. Therefore, Hypothesis 3 is accepted.

Justification

This research emphasizes the strategic relevance of adopting a dual-asset investment approach that incorporates both Bitcoin and gold. The empirical findings between 2015 and 2025 show that gold consistently performs as a defensive asset during periods of financial turmoil. Its ability to retain value and act as a hedge under stress confirms its role as a safe-haven instrument that can reduce downside risks in portfolios.

In contrast, Bitcoin, although characterized by high volatility, contributes valuable diversification benefits. Its weak correlation with gold enables it to serve as a complementary asset that can enhance the portfolio's overall efficiency. When integrated thoughtfully, the presence of Bitcoin does not replace gold but rather supports return enhancement while maintaining risk control. This combination is consistent with the principles of Modern Portfolio Theory, where blending uncorrelated assets improves the trade-off between risk and return.

The simulations conducted in this study, particularly those assessing Sharpe ratios, provide compelling evidence that portfolios combining Bitcoin and gold outperform those that rely on a single asset. Therefore, the proposed solution to strategically incorporate both assets is well-founded and supported by the data. The dual-role framework allows investors to capitalize on Bitcoin's growth potential while relying on gold's stabilizing function, making the combined allocation a practical response to market uncertainty.

CONCLUSION

This study examined the safe-haven and diversification roles of Bitcoin and gold using financial data from 2015 to 2025. The findings confirmed that gold

remained the more reliable asset during market distress, consistently preserving value and demonstrating strong defensive characteristics. Although Bitcoin lacked comparable safe-haven stability, it contributed meaningful diversification benefits, as its weak correlation with gold enabled more effective risk reduction in mixed portfolios. Based on modern portfolio theory, combining both assets enhanced overall portfolio balance compared to holding either individually. Future research could extend this analysis by incorporating macroeconomic variables, exploring cross-market effects, or assessing how evolving digital asset markets influence the dynamic relationship between Bitcoin and traditional safe-haven assets.

REFERENCES

- Adrian, T., Iyer, T., & Qureshi, M. (2022). Crypto prices move more in sync with stocks, posing new risks. *IMF Blog*. <https://www.imf.org/en/Blogs/Articles/2022/01/11/crypto-prices-move-more-in-sync-with-stocks-posing-new-risks>
- Bakry, W., Rashid, A., Al-Mohamad, S., & El-Kanj, N. (2021). Bitcoin and portfolio diversification: A portfolio optimization approach. *Journal of Risk and Financial Management*, 14(7), Article 282. <https://doi.org/10.3390/jrfm14070282>
- Baur, D. G., & Lucey, B. M. (2010). Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. *Financial Review*, 45(2), 217–229. <https://doi.org/10.1111/j.1540-6288.2010.00244.x>
- Baur, D. G., & McDermott, T. K. (2010). Is gold a safe haven? International evidence. *Journal of Banking & Finance*, 34(8), 1886–1898. <https://doi.org/10.1016/j.jbankfin.2009.12.008>
- Ben Ameer, H., Zghidi, N., Chevallier, J., & Guesmi, K. (2024). Examining the safe-haven and hedge capabilities of gold and cryptocurrencies: A GARCH and regression quantiles approach in geopolitical and market extremes. *Heliyon*, 10(22), Article e40400. <https://doi.org/10.1016/j.heliyon.2024.e40400>
- Bhuiyan, R. A., Rahman, M. L., & Sadorsky, P. (2023). Is Bitcoin a safe haven asset during COVID-19 pandemic? *Review of Behavioral Finance*, 15(2), 162–179. <https://doi.org/10.1108/RBF-10-2020-0271>
- Dyhrberg, A. H. (2016). Bitcoin, gold and the dollar: A GARCH volatility analysis. *Finance Research Letters*, 16, 85–92. <https://doi.org/10.1016/j.frl.2015.10.008>
- Fabris, N., & Ješić, M. (2023). Are gold and bitcoin a safe haven for European indices? *Journal of Central Banking Theory and Practice*, 11(1), 27–44. <https://doi.org/10.2478/jcbtp-2023-0002>

- Klein, T., Pham Thu, H., & Walther, T. (2018). Bitcoin is not the new gold: A comparison of volatility, correlation and portfolio performance. *International Review of Financial Analysis*, 59, 105–116. <https://doi.org/10.1016/j.irfa.2018.07.010>
- Kumar, D., & Padakandla, S. R. (2022). Testing the safe-haven properties of gold and bitcoin in the backdrop of COVID-19: A wavelet quantile correlation approach. *Finance Research Letters*, 47, Article 102707. <https://doi.org/10.1016/j.frl.2022.102707>
- Long, W., Ma, F., Zhang, X., & Zhang, D. (2021). Can both Bitcoin and gold serve as safe-haven assets? A comparative analysis based on the NARDL model. *International Review of Financial Analysis*, 78, Article 101914. <https://doi.org/10.1016/j.irfa.2021.101914>
- Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, 7(1), 77–91. <https://doi.org/10.2307/2975974>
- Pal, D., & Mitra, S. K. (2019). Hedging Bitcoin with other financial assets. *Finance Research Letters*, 30, 30–36. <https://doi.org/10.1016/j.frl.2019.03.034>
- Shahzad, S. J. H., Bouri, E., Roubaud, D., & Kristoufek, L. (2019). Is Bitcoin a better safe-haven investment than gold and commodities? *International Review of Financial Analysis*, 63, 322–330. <https://doi.org/10.1016/j.irfa.2019.01.002>
- Symitsi, E., & Chalvatzis, K. J. (2019). The economic value of Bitcoin: A portfolio analysis of currencies, gold, oil and stocks. *Research in International Business and Finance*, 48, 97–110. <https://doi.org/10.1016/j.ribaf.2018.12.001>
- Yae, J., & Tian, G. Z. (2024). Volatile safe-haven asset: Evidence from Bitcoin. *Journal of Financial Stability*, 73, Article 101285. <https://doi.org/10.1016/j.jfs.2024.101285>