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Gold versus Bitcoin: A Comparative Analysis of Risk, Return, and Risk-Adjusted Performance

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Abstract: This study compares the investment performance and risk characteristics of gold and Bitcoin over a five-year period. Daily historical price data for Gold futures (GC=F) and Bitcoin (BTC-USD) were obtained from Yahoo Finance and analyzed using a quantitative approach. Investment performance was evaluated using Compound Annual Growth Rate (CAGR), while risk was assessed through daily volatility, the Sharpe ratio, and maximum drawdown. The results show that gold achieved a higher CAGR of 19.13%, compared with 11.31% for Bitcoin. Gold also demonstrated lower daily volatility (0.0115 versus 0.0282), a higher annualized Sharpe ratio (1.00 versus 0.37), and a substantially smaller maximum drawdown (−20.43% versus −76.63%). These findings indicate that gold provided a more favorable risk–return profile during the period examined. However, the results are specific to the selected observation period and should not be interpreted as evidence of permanent superiority. The study highlights the importance of considering both return and risk when comparing traditional and digital assets.

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1. Introduction

Gold has traditionally been considered one of the most important assets for preserving wealth and reducing investment risk, particularly during periods of economic and financial uncertainty. Its long history as a store of value, relatively stable market structure, and role in portfolio diversification have made it an important asset for both individual and institutional investors. The emergence of Bitcoin has, however, introduced a new alternative. Since its introduction as a decentralised digital currency, Bitcoin has developed into a major financial asset and is frequently described as "digital gold" because of its limited supply and independence from traditional monetary systems. As a result, whether Bitcoin can provide investment benefits comparable to, or greater than, those of gold has become an important question in financial research.

Gold and Bitcoin nevertheless have very different risk and return characteristics. Gold is generally associated with stability and safe-haven behaviour, whereas Bitcoin has experienced substantial price increases together with periods of extreme volatility and large losses. Existing research generally supports the defensive characteristics of gold but provides less consistent

evidence for Bitcoin. Kumar & Padakandla, (2022), for example, found that gold demonstrated relatively consistent safe-haven properties during the COVID-19 period, while Bitcoin produced mixed results. Dutta et al., (2020) similarly found gold to be a safe haven for crude-oil markets, whereas Bitcoin mainly served as a diversifier. Fabris & Ješić, (2023) confirmed safe-haven properties for gold in European markets but rejected the same hypothesis for Bitcoin. Let & Siemaszkiewicz, (2020) also found gold to be a safe haven during periods of market stress, while the performance of Bitcoin depended more strongly on the investment horizon.

However, Bitcoin should not simply be regarded as an ineffective alternative to gold. Its investment role appears to change considerably according to market conditions. Bahloul et al., (2023) found that Bitcoin provided strong hedging properties for some markets during the COVID-19 pandemic. Su et al., (2026) showed that Bitcoin exhibited safe-haven characteristics during COVID-19 and at longer horizons during the Russia–Ukraine war. Hoque et al., (2023) further demonstrated that the behaviour of both gold and Bitcoin changes between short- and long-term horizons. Cheng et al., (2025) also found that the hedging properties of gold and Bitcoin vary across financial assets and market conditions. These findings suggest that the relative attractiveness of the two assets cannot be evaluated independently of the period and market environment being examined.

Recent financial crises have further increased interest in comparing these assets. Ustaoglu, (2023) found that gold generally provided better hedging and more stable diversification benefits than Bitcoin during the Russia–Ukraine war. Manzli & Jeribi, (2024) similarly reported that gold was a stronger safe haven than Bitcoin during major crises, particularly the Russia–Ukraine war and the Silicon Valley Bank collapse. Manzli & Jeribi, (2024a) found that gold also outperformed Bitcoin as a diversifier and safe haven against commodities during crisis periods. Evidence from BRICS Plus economies presented by Belguith et al., (2025) further indicates that gold provides more consistent protection during market downturns, although Bitcoin can offer safe-haven benefits in particular countries.

Another important issue is the increasing connection of Bitcoin and gold with other financial markets. Gkillas et al., (2022) identified spillovers among Bitcoin, gold, and crude oil markets, demonstrating that relationships between these assets can affect investment risk. Zhang et al., (2022) showed that COVID-19-related news produced return and volatility spillovers in oil, gold, and Bitcoin markets, with Bitcoin playing an important role in risk transmission. Zhu et al., (2022) also demonstrated that gold and Bitcoin respond differently to pandemic-related news sentiment. Zeng et al., (2023) identified changing relationships between gold, Bitcoin, and Asian equity markets following COVID-19, while Shaik et al., (2024) showed that volatility connectedness between gold, Bitcoin, equities, bonds, oil, and geopolitical risk changed during COVID-19 and the Russia–Ukraine war.

Other studies have examined these assets from portfolio, forecasting, and market-efficiency perspectives. S. Kumar, (2024) found changes in the market efficiency of both gold and Bitcoin during COVID-19. Li et al., (2022), Xie et al., (2023), Xue et al., (2022) examined investment and trading strategies involving gold and Bitcoin and demonstrated the importance of their different price and volatility characteristics for portfolio decisions. X. Su & Li, (2020) identified time-varying sentiment spillovers between Bitcoin, gold, and oil, while Badshah et al., (2023) found that the COVID-19 pandemic increased volatility in both gold and Bitcoin.

More recent evidence continues to demonstrate that the relationship is complex. Terraza et al., (2024) found that Bitcoin provided diversification opportunities during COVID-19, while Joo & Park, (2024) showed that gold can provide hedging benefits against Bitcoin. Wang et al., (2024) highlighted the importance of gold as a stabilising asset under bearish market conditions, whereas Choudhary et al., (2024) demonstrated increasing integration between Bitcoin and conventional financial markets. Khan & Faryal, (2025) found negative relationships between Bitcoin and gold in some periods and confirmed the comparatively stable hedging role of gold. Gokgoz et al., (2025) also reported that gold offered better hedging effectiveness than Bitcoin against blue and green financial assets.

The literature therefore provides no single conclusion regarding the superiority of gold or Bitcoin. Gold generally appears to provide greater stability and more consistent safe-haven properties, while Bitcoin can provide high returns, diversification benefits, and hedging opportunities under particular market conditions. The effectiveness of both assets depends on the selected period, market conditions, investment horizon, and measure of risk. Even gold's traditional role should not be treated as unconditional. For example, Ergul & Karakas, (2024) find only partial evidence that gold acts as an inflation hedge, while finding no statistically significant relationship between Bitcoin and gold prices in their analysis.

Despite the growing literature, many studies concentrate on safe-haven properties, correlations, spillovers, or asset behaviour during individual crises. A simpler but important question remains relevant for investors: when gold and Bitcoin are evaluated over the same investment period, which asset provides the better balance between return and risk? Comparing returns alone may be misleading because an asset generating high returns may also expose investors to substantially greater volatility and losses. A meaningful comparison should therefore consider both investment performance and the amount of risk required to achieve that performance.

Accordingly, this study provides a direct quantitative comparison of Gold futures (GC=F) and Bitcoin (BTC-USD) over a five-year period. Investment performance is evaluated using Compound Annual Growth Rate (CAGR), while risk is assessed through daily return volatility, the Sharpe ratio, and maximum drawdown. These measures allow the two assets to be compared from both return and risk perspectives. The study therefore addresses two main research questions: (1) Which asset provides superior annualised returns over the five-year period? and (2) Which asset provides a more favourable risk and risk-adjusted performance profile? By addressing these questions within a common analytical framework, the study provides straightforward empirical evidence that can support investment and portfolio-allocation decisions.

2. Materials and Methods

2.1 Data

This study employs daily historical price data for two major investment assets: gold and Bitcoin. Gold is represented by the continuous gold futures contract (GC=F), while Bitcoin is represented by its US dollar spot price (BTC-USD). The data were obtained from Yahoo Finance using the Python yfinance library. The analysis covers a five-year observation period, allowing both assets to be evaluated over the same investment horizon. Daily closing prices are used as the basis for calculating returns and risk measures. An important difference between

the two markets is their trading frequency. Gold futures are primarily traded on weekdays during established market hours, whereas Bitcoin trades continuously, 24 hours a day and seven days a week. To improve comparability between the two series, the analysis restricts observations to weekday closing prices. Missing observations are handled using forward-fill imputation. This procedure creates comparable daily series, although excluding weekend Bitcoin observations may slightly underestimate its measured volatility. The study follows a descriptive quantitative research design and focuses on the historical risk–return characteristics of the two assets rather than forecasting future prices. Four indicators are used: Compound Annual Growth Rate (CAGR), volatility, Sharpe ratio, and maximum drawdown (MDD). CAGR measures long-term annualised performance, while the remaining indicators capture different dimensions of investment risk and risk-adjusted performance.

2.2 Return Measurement

The annualised performance of gold and Bitcoin is evaluated using the Compound Annual Growth Rate (CAGR). CAGR represents the constant annual rate at which an investment would have grown from its initial value to its final value over the observation period and is calculated as:

$$CAGR = \left(\frac{V_T}{V_0}\right)^{1/n} - 1 \tag{1}$$

where $V_T$represents the asset value at the end of the observation period, V_0represents its initial value, and $n$denotes the number of years. CAGR is particularly useful for comparing assets because it incorporates compounding and provides a standardised annual measure despite differences in their absolute price levels.

2.3 Daily Returns and Volatility

Daily log returns are calculated from consecutive closing prices as:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \tag{2}$$

where $P_t$and P_{t-1}represent the closing prices at time $t$and $t-1$, respectively. The use of returns rather than price levels enables a more meaningful comparison between gold and Bitcoin despite their substantially different price scales. Investment risk is first evaluated using the standard deviation of daily returns:

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{t=1}^{N}(r_t - \bar{r})^2} \tag{3}$$

where $r_t$denotes the daily return, $\bar{r}$is the mean daily return, and Nrepresents the number of observations. A higher standard deviation indicates greater price variability and therefore

greater volatility. This approach is consistent with the treatment of volatility as a measure of investment risk within the portfolio framework of Markowitz, (1952).

2.4 Risk-Adjusted Performance

To compare the return generated relative to the risk undertaken, the study employs the Sharpe ratio (Sharpe, 1966, 1994). It is expressed as:

$$SR = \frac{R_p - R_f}{\sigma_p} \tag{4}$$

where $R_p$represents the return of the asset, $R_f$is the risk-free rate, and $\sigma_p$represents the standard deviation of returns. A higher Sharpe ratio indicates that an asset generates a greater return relative to the level of risk assumed. Following the original analytical design, the risk-free rate is assumed to be 0%. The daily Sharpe ratio is annualised using 252 trading days. Accordingly, the annualised measure can be represented as:

$$SR_{annual} = \frac{\bar{r}}{\sigma_r}\sqrt{252} \tag{5}$$

where $\bar{r}$and $\sigma_r$denote the mean and standard deviation of daily returns, respectively. The zero risk-free-rate assumption simplifies the comparison but represents a limitation because actual risk-free interest rates varied during the observation period.

2.5 Maximum Drawdown

The analysis further incorporates Maximum Drawdown (MDD) to capture downside risk. Unlike volatility, which measures the overall dispersion of returns, MDD identifies the largest observed decline from a previous price peak to a subsequent trough:

$$MDD = \min_t \left(\frac{P_t - P_t^{peak}}{P_t^{peak}} \right) \times 100 \tag{6}$$

where P_t^{peak}represents the highest asset value reached before the subsequent decline. A more negative MDD indicates a greater historical capital loss and therefore higher downside exposure. MDD complements volatility and the Sharpe ratio because it directly captures the severity of losses that an investor could have experienced during the observation period.

2.6 Analytical Procedure

All calculations are performed using Python, with pandas and NumPy employed for data processing and numerical calculations. After retrieving the daily prices, the series are cleaned and aligned, daily returns are calculated, and the four performance indicators are estimated separately for gold and Bitcoin. The results are then compared directly to determine which asset generated the stronger annualised return and which exhibited the more favourable risk and risk-adjusted performance profile. The methodology is intentionally transparent and descriptive. It

does not employ forecasting models or formal hypothesis testing; instead, it provides a consistent framework for comparing the historical investment characteristics of gold and Bitcoin over the selected five-year period. This design also means that the findings should be interpreted as period-specific rather than universal, particularly because Bitcoin's performance measures can change substantially depending on the selected start and end dates.

3. Results

This section presents the empirical comparison of gold and Bitcoin over the five-year observation period. The analysis focuses on four dimensions: annualised return, daily volatility, risk-adjusted performance, and maximum drawdown. The results are reported in Table 1: Comparative Performance and Risk Metrics for Gold and Bitcoin, while the graphical analysis is presented in Figure 1: Cumulative Returns of Gold and Bitcoin over the Five Years and Figure 2: Distribution of Daily Returns for Gold and Bitcoin.

3.1 Return Performance

The results indicate a clear difference in the annualised performance of the two assets. As reported in Table 1: Comparative Performance and Risk Metrics for Gold and Bitcoin, gold recorded a CAGR of approximately 19.13%, compared with 11.31% for Bitcoin. Thus, over the specific five-year period examined, gold generated the higher annualised return.

Table 1. Comparative Performance and Risk Metrics for Gold and Bitcoin

Performance/Risk Measure	Gold (GC=F)	Bitcoin (BTC-USD)
CAGR	19.13%	11.31%
Daily Volatility	0.0115	0.0282
Annualised Sharpe Ratio	1.00	0.37
Maximum Drawdown	−20.43%	−76.63%

Note: CAGR = Compound Annual Growth Rate. The Sharpe ratio is calculated using a 0% risk-free rate.

However, interpret the performance difference within the specific observation period. Bitcoin's performance is particularly sensitive to the choice of starting and ending dates because the period includes substantial market fluctuations, including the severe decline associated with its 2022 bear market. The original analysis therefore recognises that the relative performance identified here should not be interpreted as evidence that gold will systematically outperform Bitcoin across all investment periods.

This difference is also evident in Figure 1: Cumulative Returns of Gold and Bitcoin over the Five Years. The cumulative-return trajectories show that gold followed a comparatively more stable upward path with moderate corrections, whereas Bitcoin experienced much larger fluctuations, including strong upward movements followed by substantial declines.

Figure 1. Cumulative Returns of Gold and Bitcoin over the Five years

3.2 Volatility

The risk analysis reveals an even greater difference between the two assets. As shown in Table 1, the standard deviation of daily returns is 0.0115 for gold and 0.0282 for Bitcoin. Bitcoin's daily volatility is therefore approximately 2.45 times higher than that of gold. This result indicates substantially greater day-to-day price uncertainty for Bitcoin. While gold's daily returns fluctuate by approximately 1.15% relative to their mean, the corresponding value for Bitcoin is approximately 2.82%. Investors holding Bitcoin during the observation period were therefore exposed to considerably larger short-term price movements.

The difference is illustrated in Figure 2: Distribution of Daily Returns for Gold and Bitcoin. Bitcoin's return distribution is considerably wider and exhibits heavier tails than that of gold, reflecting the greater occurrence of extreme positive and negative daily movements. Gold's returns, in comparison, are more concentrated around the centre of the distribution.

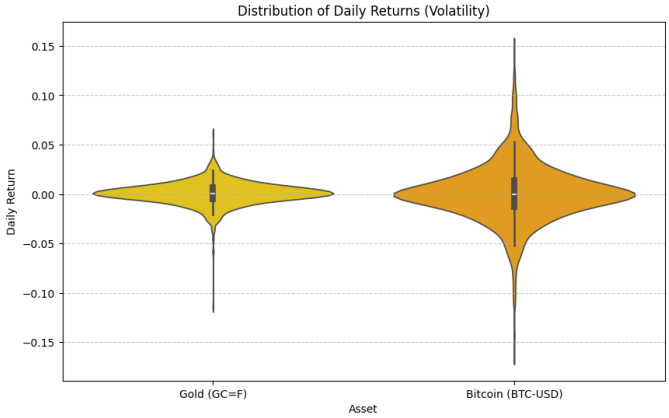

Figure 2. Distribution of Daily Returns for Gold and Bitcoin

3.3 Risk-Adjusted Performance

The Sharpe ratio provides further evidence of differences in the risk-return profiles of the two assets. Gold achieved an annualised Sharpe ratio of 1.00, compared with only 0.37 for Bitcoin. Gold therefore generated approximately 2.7 times more return per unit of risk during the observation period. The higher Sharpe ratio suggests that gold provided a substantially more favourable balance between return and volatility. Bitcoin generated a positive return but

required investors to accept much greater variability in daily returns. Importantly, this finding relates specifically to the five years examined and does not imply that Bitcoin always produces weaker risk-adjusted performance. Its Sharpe ratio can vary considerably across different market cycles.

3.4 Maximum Drawdown

The biggest difference in downside risk is observed in maximum drawdown. Bitcoin recorded a maximum drawdown of −76.63%, compared with −20.43% for gold. Bitcoin's maximum loss from a previous peak was therefore approximately 3.75 times greater than that experienced by gold. The magnitude of Bitcoin's drawdown demonstrates the substantial downside risk associated with the asset. An investor exposed from a local Bitcoin peak to the subsequent trough could have experienced a loss exceeding three-quarters of the investment's value before recovery. Gold also experienced periods of decline, but its maximum drawdown was considerably smaller.

Taken together, the results consistently favour gold within the selected five-year period. Gold generated a higher CAGR (19.13% versus 11.31%), exhibited lower daily volatility (0.0115 versus 0.0282), achieved a higher Sharpe ratio (1.00 versus 0.37), and experienced a substantially smaller maximum drawdown (−20.43% versus −76.63%). Therefore, the findings answer both research questions consistently: gold generated the higher annualised return and exhibited the more favourable risk profile during the period examined. Nevertheless, these findings remain specific to the selected observation window, particularly given Bitcoin's sensitivity to market cycles and start/end-date selection.

4. Discussion

The findings provide a clear comparison between gold and Bitcoin in terms of return, volatility, risk-adjusted performance, and downside risk. Overall, gold performed more favourably across all four indicators during the five-year period examined. Gold recorded a higher CAGR of 19.13%, compared with 11.31% for Bitcoin, while also exhibiting lower daily volatility, a higher Sharpe ratio, and a substantially smaller maximum drawdown. These results suggest that, within the selected period, the higher volatility associated with Bitcoin was not compensated by superior returns.

The return results are particularly interesting because Bitcoin is often associated with high growth potential. However, the findings show that its performance depends strongly on the period under consideration. The five-year observation window includes substantial fluctuations in the Bitcoin market, including the 2022 bear market, when Bitcoin experienced a severe decline. Gold followed a comparatively more stable trajectory during the same period. Therefore, the results demonstrate the importance of considering market cycles when comparing the long-term performance of traditional and digital assets.

The findings are broadly consistent with previous studies that identify gold as the more stable safe-haven and hedging asset. Kumar and Padakandla (2022) found that gold consistently demonstrated safe-haven characteristics across most of the markets examined, while Bitcoin produced mixed results. Similarly, Dutta et al. (2020) identified gold as a safe haven for crude-oil markets during COVID-19, whereas Bitcoin primarily acted as a diversifier. Fabris and Ješić (2023) also confirmed the safe-haven role of gold for European equity markets but rejected the

same hypothesis for Bitcoin. These studies support the present finding that gold provides a more stable risk-return profile than Bitcoin.

The volatility results provide further evidence of the substantial difference between the two assets. Bitcoin's daily volatility of 0.0282 was approximately 2.45 times greater than gold's 0.0115. The wider distribution of Bitcoin's daily returns shown in Figure 2: Distribution of Daily Returns for Gold and Bitcoin also reflects its greater exposure to extreme price movements. This finding is consistent with Badshah et al. (2023), who documented substantial volatility in both Bitcoin and gold and showed that their dynamics were affected by the COVID-19 crisis. Gkillas et al. (2022) also emphasised the importance of volatility and higher-order risk relationships between Bitcoin, gold, and other financial markets.

The Sharpe ratio provides an important additional perspective because return alone does not indicate whether investors were adequately compensated for the risk they assumed. As reported in Table 1: Comparative Performance and Risk Metrics for Gold and Bitcoin, gold achieved a Sharpe ratio of 1.00, compared with 0.37 for Bitcoin. This indicates that gold generated substantially greater return relative to its level of volatility during the observation period. The result strengthens the argument that investment performance should not be evaluated only through price appreciation. An asset can generate positive returns while still providing relatively weak risk-adjusted performance when those returns are accompanied by substantial volatility.

Maximum drawdown provides an even clearer indication of the difference in downside risk. Bitcoin experienced a maximum drawdown of −76.63%, whereas gold's maximum drawdown was −20.43%. This difference is economically important because large drawdowns can expose investors to substantial losses even when an asset ultimately generates positive long-term returns. The result is consistent with Ustaoglu (2023), who found that gold generally provided better hedging and more stable diversification benefits than Bitcoin during the Russia–Ukraine war. Manzli and Jeribi (2024b) similarly identified gold as the more prominent safe-haven asset during major periods of financial stress.

Nevertheless, the results should not be interpreted as evidence that Bitcoin has no diversification or safe-haven value. Previous research demonstrates that its role varies considerably across markets and periods. Bahloul et al. (2023), for example, found that Bitcoin provided strong hedging properties in some markets during COVID-19, while Su et al. (2026) identified safe-haven characteristics for Bitcoin at different time horizons and during different crisis periods. Belguith et al. (2025) similarly found that Bitcoin demonstrated safe-haven characteristics for certain BRICS Plus markets, although gold generally provided more consistent protection. This mixed evidence suggests that Bitcoin's investment characteristics are more dependent on market conditions than those of gold.

The findings therefore have practical implications for portfolio decisions. During the period analysed, gold offered a combination of stronger annualised performance, lower volatility, higher risk-adjusted returns, and substantially lower downside exposure. Bitcoin, in contrast, displayed considerably greater fluctuations and drawdown risk. However, these results do not imply that one asset is universally superior to the other. The original analysis itself recognises that Bitcoin's CAGR and risk measures can change substantially when different five-year windows are selected. The comparison should therefore be interpreted as evidence for the specific market period examined rather than as a permanent ranking of the two assets.

Overall, the findings support the broader literature suggesting that gold remains the more stable investment and risk-management asset, while Bitcoin offers a different risk-return profile whose attractiveness is more sensitive to market cycles and investor risk tolerance. The study also demonstrates why return, volatility, risk-adjusted performance, and downside risk should be considered jointly when comparing traditional and digital assets. Future research could strengthen these findings by applying rolling-window analysis, additional downside-risk measures, and portfolio optimisation techniques to determine whether the relative advantages of gold and Bitcoin remain consistent across different market conditions.

5. Conclusion

This study compared the investment performance and risk characteristics of gold and Bitcoin over a five-year period using four key financial measures: Compound Annual Growth Rate (CAGR), daily volatility, the Sharpe ratio, and maximum drawdown. The results demonstrate clear differences between the two assets in both return and risk. Gold recorded a CAGR of 19.13%, compared with 11.31% for Bitcoin, indicating stronger annualised performance during the period examined. The differences were even more pronounced in terms of risk. Gold recorded daily volatility of 0.0115, compared with 0.0282 for Bitcoin, showing that Bitcoin was approximately 2.45 times more volatile. Gold also achieved a higher annualised Sharpe ratio of 1.00, compared with 0.37 for Bitcoin, indicating better risk-adjusted performance. Furthermore, Bitcoin experienced a maximum drawdown of −76.63%, substantially greater than the −20.43% recorded for gold. Taken together, these findings show that gold provided both higher annualised returns and a more favourable risk profile during the selected observation period.

The findings also highlight the importance of evaluating investment performance beyond returns alone. Although Bitcoin is commonly associated with substantial growth potential, its higher volatility and severe drawdowns can significantly increase investment risk. Gold, in contrast, demonstrated greater stability and generated stronger returns relative to the level of risk undertaken. These findings are broadly consistent with previous research showing that gold tends to provide more consistent safe-haven and hedging characteristics, whereas the role of Bitcoin varies considerably across market conditions and investment horizons. Nevertheless, the results should be interpreted with caution. The comparison is based on a specific five-year period, and Bitcoin's performance is particularly sensitive to the choice of starting and ending dates. The analysis also assumes a zero risk-free rate and does not account for transaction costs, taxation, liquidity constraints, or other factors that may influence actual investment performance. Therefore, the findings should not be interpreted as evidence that gold will always outperform Bitcoin.

Overall, the study concludes that gold provided a superior risk–return profile relative to Bitcoin during the five years examined. At the same time, Bitcoin remains a distinct alternative asset whose performance and diversification benefits may vary considerably across market cycles. Future research could extend the analysis by considering different observation periods, rolling-window estimates, additional risk measures such as Value-at-Risk and the Sortino ratio, and portfolios combining gold and Bitcoin. Such extensions would provide a more comprehensive understanding of the changing role of traditional and digital assets in investment portfolios.

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