International Journal of Advanced Multidisciplinary Application | IJAMA
Volume 3 Issue 11 Nov 2026
ISSN No: 3048-9350

Gold ETFs as a Proxy for Gold: An Empirical Analysis of Their Relationship with Gold Prices and Indian Equity Indices

N.C.V Neekir[1], Navdeep Rebba[2] and Sreenidhi Konduru[3]

[1]Student, B.Com (Hons) Business Analytics (Third Year), Bhavan's Vivekananda College of Science, Humanities and Commerce, Sainikpuri, Secunderabad, Telangana, India. Email:neekir.nc@gmail.com
[2]Student, B.Com (Hons) Business Analytics (Second Year), Bhavan's Vivekananda College of Science, Humanities and Commerce, Sainikpuri, Secunderabad, Telangana, India. Email: navadeeprebba2007@gmail.com
[3]Student, B.Com (Hons) Business Analytics (Second Year), Bhavan's Vivekananda College of Science, Humanities and Commerce, Sainikpuri, Secunderabad, Telangana, India. Email: sreenidhi.k35@gmail.com

Abstract

Gold Exchange-Traded Funds (ETFs) are widely promoted as a convenient substitute for physical gold and as a diversifier for equity portfolios, yet evidence on how well they perform both roles in India remains limited. This study examines whether Gold ETFs in India effectively reflect gold price movements and evaluates their relationship with the NIFTY 50 and the Sensex. Secondary monthly data from January 2022 to August 2026 were analysed for ten Gold ETFs, gold prices and the two equity indices using Python. Descriptive statistics, correlation analysis, tracking difference, tracking error, annualised volatility and Markowitz Efficient Frontier analysis based on 5,000 simulated portfolios were applied. The results show that the ETFs follow gold closely, with correlations of 0.84 to 0.88 and mean tracking differences between -0.02% and -0.06%. Kotak Gold ETF recorded the lowest tracking error (2.27%), while Aditya Birla Sun Life Gold ETF recorded the highest (2.80%). Gold and the Gold ETFs showed almost no correlation with the NIFTY 50 and the Sensex (between -0.05 and 0.02), and their annualised volatility (15.34% to 17.08%) was higher than that of the equity indices (about 13%). A portfolio of 50% UTI Gold ETF and 50% NIFTY 50 achieved a Sharpe ratio of 1.007, the maximum Sharpe ratio portfolio reached 1.223, and the least volatile portfolio had a volatility of 11.30%. The study concludes that Gold ETFs are a reliable proxy for gold and can improve the risk-adjusted performance of equity-oriented portfolios.

Keywords: *Gold ETFs, Gold Price Movements, Tracking Efficiency, Equity Market Volatility, Portfolio Diversification*

1. INTRODUCTION

Gold has traditionally been considered an important investment asset because of its store-of-value characteristics and its potential to provide stability and diversification during periods of market uncertainty. The introduction of Gold Exchange-Traded Funds (ETFs) has provided investors with a convenient way to gain exposure to gold without directly holding physical gold. However, the effectiveness of Gold ETFs as a proxy for gold depends on how closely their returns track movements in gold prices. At the same time, understanding their relationship with equity markets is important for assessing their potential diversification benefits. In the Indian context, examining the relationship between Gold ETFs, gold prices and major equity indices such as the NIFTY 50 and the Sensex can provide useful insights into their tracking efficiency and risk characteristics. This study therefore evaluates the extent to which Gold ETF returns reflect gold price movements, examines their relationship with Indian equity-market returns, compares the volatility of the selected assets, and assesses the potential diversification benefits of Gold ETFs in relation to Indian equity markets.

1.1 Review of Literature

Mathew and Sulphey (2018) examined the price discovery process and tracking performance of two major Indian gold ETFs, GoldBeES and SBI Gold ETF, over the period 2009–2016 using Johansen cointegration and the Vector Error Correction Model. The results showed that spot gold prices led ETF prices in the price discovery process, and tracking error analysis found

that the ETFs neither significantly outperformed nor underperformed physical gold. The study concluded that the small price gap between gold ETFs and spot gold was mainly attributable to fund management fees rather than any structural inefficiency.

Eswara (2015) analysed the performance of five gold ETFs in India during the period following the 2008 financial crisis using correlation and regression analysis. The results showed that gold ETF returns had an inverse relationship with Nifty returns. The study concluded that gold ETFs tended to perform better precisely when the equity market declined, positioning them as a counter-cyclical investment option in the Indian context.

Pathak, Upadhyay, Shah and Thakkar (2025) applied the Markowitz mean-variance framework to compare the risk-return profiles of ten Indian gold ETFs over a five-year period, evaluating returns, standard deviation and Sharpe ratios. The results showed meaningful performance differences across the funds. The authors concluded that careful fund selection, rather than treating gold ETFs as a homogeneous asset class, was important for maximising portfolio outcomes.

Manuj (2021) tested whether gold served as a hedge or safe haven against stock price risk in the U.S. and Indian markets using linear regression and GARCH techniques applied to monthly return data on the S&P 500, BSE Sensex and gold prices from 1980 to 2020. The results showed that gold did not consistently function as a hedge or safe haven for long-term investors in either market, a finding that held true across multiple sub-periods including major financial crises. The study concluded that the popular assumption of gold as a reliable portfolio hedge required more cautious, time-period-specific interpretation.

Umamaheswari and Lakshmi (2024) examined the relationship between stock market indices and gold prices in India using correlation and regression analysis. The results showed a statistically significant but modest positive correlation between the two variables. The study concluded that gold prices affected stock market movements to some extent, but not substantially enough to be a major driver of index performance.

1.2 Need for the Study

In the Indian economy, gold occupies a unique status as a cultural asset, a store of value and a favoured hedge against financial uncertainty. The introduction of Gold ETFs in 2007 gave investors an opportunity to invest in gold without the difficulties of storing physical gold, checking its purity and paying making charges. As a result, the Gold ETF market in India has grown significantly since its inception, and the assets under management have risen steadily along with increasing awareness of these instruments among investors. However, the market environment for gold and Indian equities has changed considerably in recent years because of changes in global monetary policy, movements in currency exchange rates and events such as the coronavirus pandemic. Several studies have analysed how Gold ETFs track the price of gold and how they relate to the stock market, but continuous re-evaluation in the light of changing economic conditions is essential.

An analysis of Gold ETF tracking and of their correlation with Indian equity indices such as the NIFTY 50 and the Sensex can provide valuable information to investors and portfolio managers who must decide whether to include Gold ETFs in an investment portfolio. It is crucial for understanding whether Gold ETFs can serve as a diversifier and whether their relationship with equity markets has weakened or strengthened. Since the existing literature shows considerable disagreement on this issue, the study is necessary to provide an up-to-date empirical analysis of Gold ETF performance and its relationship with the Indian equity market.

1.3 Research Gap

Although there is an abundance of literature on the performance of Gold ETFs and the role they play in relation to gold prices and equity markets, several gaps remain. First, most studies concentrate on the early period of Gold ETFs in India and cover only one or two funds, and recent developments are largely ignored. Second, most studies analyse tracking efficiency, the gold-equity link or the diversification benefit separately, and a joint analysis of all three aspects is rarely carried out. Third, there is little evidence on the relationship between a wide range of Indian Gold ETFs and both the NIFTY 50 and the Sensex. The present study attempts to fill these gaps.

1.4 Objectives of the Study

1. To examine the extent to which Gold ETF returns reflect gold price returns and evaluate their tracking efficiency.
2. To examine the relationship between Gold ETF returns and the returns of the NIFTY 50 and the Sensex.
3. To compare the volatility behaviour of Gold ETFs, gold prices, the NIFTY 50 and the Sensex.
4. To assess the potential diversification benefits of Gold ETFs in relation to Indian equity-market movements.

2. MATERIAL AND METHODS

This study is based on secondary data collected from reliable financial and market data sources. Monthly data from 1 January 2022 to 1 August 2026 were used for the analysis, covering ten selected Gold ETFs, gold prices, the NIFTY 50 and the Sensex. The selected Gold ETFs are Nippon India ETF Gold BeES, ICICI Prudential Gold ETF, HDFC Gold ETF, SBI Gold ETF, Kotak Gold ETF, Axis Gold ETF, UTI Gold ETF, Aditya Birla Sun Life Gold ETF, Quantum Gold Fund and Invesco India Gold ETF. Monthly price data were used to calculate returns and to compare the performance and behaviour of the selected assets over the study period.

The analysis was carried out using Python, and several statistical and portfolio-analysis techniques were employed. Descriptive statistics and annualised volatility were used to examine the return characteristics and risk of the selected assets, while correlation analysis was used to assess the relationships between Gold ETF returns, gold price returns, NIFTY 50 returns and Sensex returns. Tracking difference and tracking error, together with the mean absolute error (MAE) and root mean square error (RMSE), were calculated to evaluate how closely Gold ETF performance follows gold price movements. Finally, Markowitz Modern Portfolio Theory was applied through Efficient Frontier analysis to assess the potential diversification benefits of Gold ETFs when combined with Indian equity-market assets.

3. RESULT AND DISCUSSION

3.1 Descriptive Statistics

Table 1 presents the descriptive statistics of monthly returns (in per cent) of gold and the selected Gold ETFs.

Table 1: Descriptive Statistics of Gold Prices and Selected Gold ETFs

Asset	Mean	Median	Std Dev	Minimum	Maximum	Skewness	Kurtosis
Gold	2.20	1.77	4.82	-12.03	15.04	-0.09	1.25
UTI	2.17	1.38	4.43	-9.82	14.72	0.14	1.29
SBI	2.16	1.84	4.69	-9.88	20.09	0.78	3.59
Quantum	2.16	1.47	4.59	-9.79	19.01	0.64	2.98
Kotak	2.14	2.04	4.48	-9.91	17.59	0.36	2.41
ICICI	2.16	1.55	4.89	-9.78	22.16	1.05	4.67
Invesco	2.18	2.32	4.79	-9.84	20.81	0.83	3.76
HDFC	2.16	1.63	4.67	-9.83	19.83	0.72	3.47
Nippon	2.14	1.52	4.59	-9.86	19.08	0.63	3.09
Axis	2.15	2.00	4.51	-9.83	17.70	0.40	2.53
Aditya Birla	2.18	1.50	4.93	-9.81	22.93	1.12	5.24

The results show that gold has the highest mean return (2.20%), while the mean returns of the ETFs are closely aligned, ranging from 2.14% to 2.18%. Aditya Birla (4.93%) and ICICI (4.89%) have the highest volatility, whereas UTI (4.43%) has the lowest. Most ETFs exhibit positive skewness, with Aditya Birla (1.12) and ICICI (1.05) showing the strongest positive skewness. The positive kurtosis across all assets indicates heavier tails and a greater likelihood of extreme returns. Overall, the ETFs demonstrate return patterns broadly similar to gold, with moderate differences in risk.

3.2 Co-movement of Gold and Gold ETFs

Figure 1 shows the monthly returns of gold and the selected Gold ETFs.

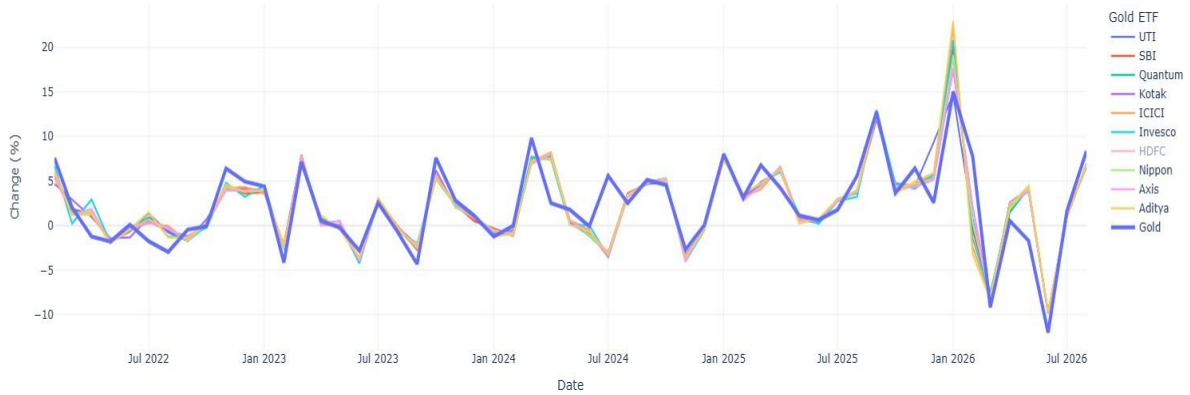


Figure 1: Monthly Returns of Gold and Selected Gold ETFs

The chart indicates a strong co-movement between gold and all the selected Gold ETFs, as the ETF returns generally move in the same direction as gold throughout the study period. The returns show considerable fluctuations, with both positive and negative movements. Higher positive movements are particularly visible around early 2026, followed by a sharp decline, highlighting periods of increased market volatility. The ETFs closely follow gold during these movements, suggesting good tracking of the underlying gold price movements. However, minor differences in the magnitude of returns across ETFs can be observed, which may arise from factors such as tracking costs, expense ratios and fund-level differences. Overall, the graph provides an initial indication that the selected Gold ETFs effectively replicate the broad movement of gold prices.

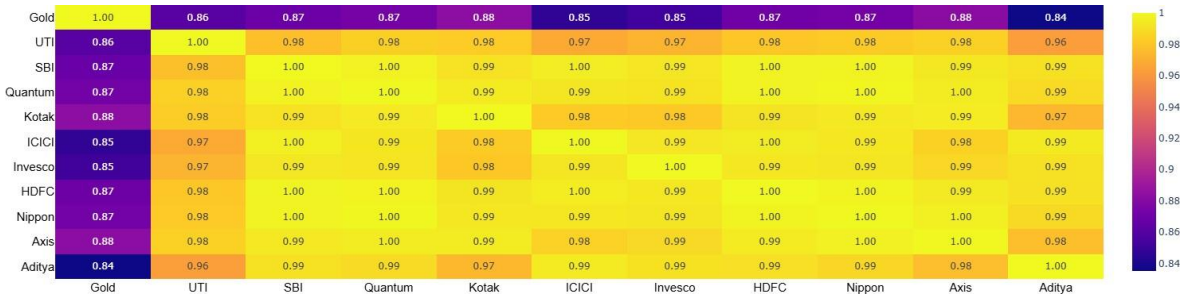


Figure 2: Correlation Matrix of Gold and Selected Gold ETFs

Figure 2 shows a strong positive relationship among all the selected Gold ETFs, with correlations ranging from approximately 0.96 to 1.00, indicating that the ETFs move very closely with each other. The correlation between gold and the ETFs ranges from 0.84 to 0.88, with Kotak and ICICI showing relatively strong correlations of 0.88, while Aditya Birla has the lowest correlation with gold at 0.84. Overall, the results indicate that the selected ETFs closely replicate each other's movements and maintain a strong relationship with gold prices, supporting their effectiveness as instruments for gaining exposure to gold.

3.3 Tracking Performance

Table 2 reports the tracking performance of the selected Gold ETFs relative to gold.

Table 2: Tracking Performance of Selected Gold ETFs

ETF	Correlation with Gold	Mean Tracking Difference (%)	Tracking Error (%)	MAE (%)	RMSE (%)
UTI	0.86	-0.03	2.46	1.58	2.44
SBI	0.87	-0.04	2.44	1.60	2.41
Quantum	0.87	-0.05	2.38	1.56	2.36
Kotak	0.88	-0.06	2.27	1.53	2.25
ICICI	0.85	-0.04	2.69	1.68	2.67
Invesco	0.85	-0.02	2.61	1.68	2.59
HDFC	0.87	-0.05	2.42	1.57	2.40
Nippon	0.87	-0.06	2.38	1.58	2.36
Axis	0.88	-0.05	2.28	1.54	2.26
Aditya Birla	0.84	-0.02	2.80	1.71	2.77

The results show that the mean tracking differences are small and negative, ranging from -0.02% to -0.06%, indicating that ETF returns are marginally below gold returns. Kotak has the lowest tracking error (2.27%), followed closely by Axis (2.28%), indicating better consistency in tracking gold prices. In contrast, Aditya Birla has the highest tracking error (2.80%), along with the highest MAE (1.71%) and RMSE (2.77%), indicating greater deviation from gold returns. Overall, Kotak Gold ETF demonstrates the best tracking performance, while Aditya Birla shows the highest deviation among the selected ETFs.

3.4 Relationship with Indian Equity Indices

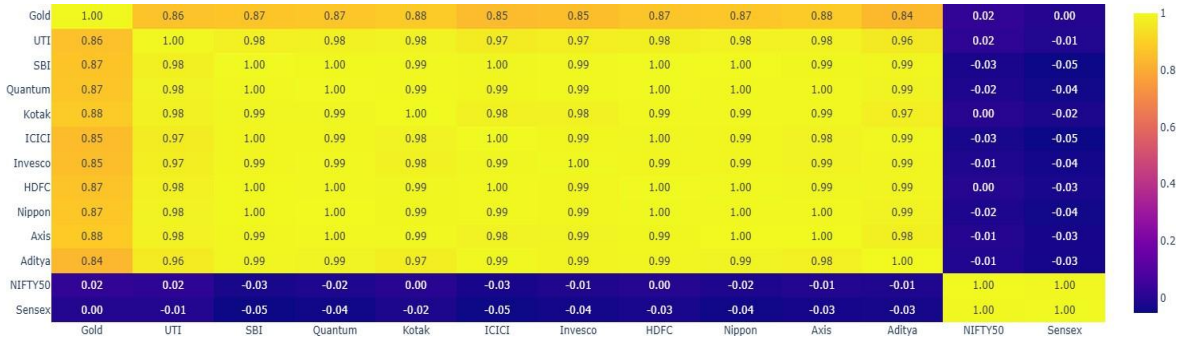


Figure 3: Correlation Matrix of Gold, Gold ETFs, NIFTY 50 and Sensex

Figure 3 shows a very weak relationship between gold and the Indian equity indices, with correlations of 0.02 with the NIFTY 50 and 0.00 with the Sensex. Similarly, the Gold ETFs have correlations ranging from -0.05 to 0.02 with the two equity indices. This indicates that Gold ETFs and Indian equities largely move independently of each other. In contrast, the ETFs maintain strong correlations with gold, as seen in the earlier analysis. Overall, the low correlation with the NIFTY 50 and the Sensex suggests that Gold ETFs may provide diversification benefits when combined with Indian equity-market assets.

3.5 Volatility Behaviour

Table 3: Annualised Volatility of Gold, Gold ETFs and Indian Equity Indices

Asset	Annualised Volatility (%)
Sensex	13.25
NIFTY 50	13.45
UTI	15.34
Kotak	15.51
Axis	15.63
Quantum	15.89
Nippon	15.90
HDFC	16.18
SBI	16.24
Invesco	16.60
Gold	16.68
ICICI	16.92
Aditya Birla	17.08

Table 3 shows that the Sensex (13.25%) and the NIFTY 50 (13.45%) have the lowest annualised volatility, indicating comparatively lower fluctuations than gold and the selected ETFs. Among the ETFs, UTI has the lowest volatility (15.34%), while Aditya Birla has the highest (17.08%). Gold itself has an annualised volatility of 16.68%, with several ETFs showing slightly higher volatility. Overall, the Gold ETFs exhibit moderate to high volatility compared with the equity indices, although their volatility remains relatively close to that of gold.

3.6 Diversification and Portfolio Analysis

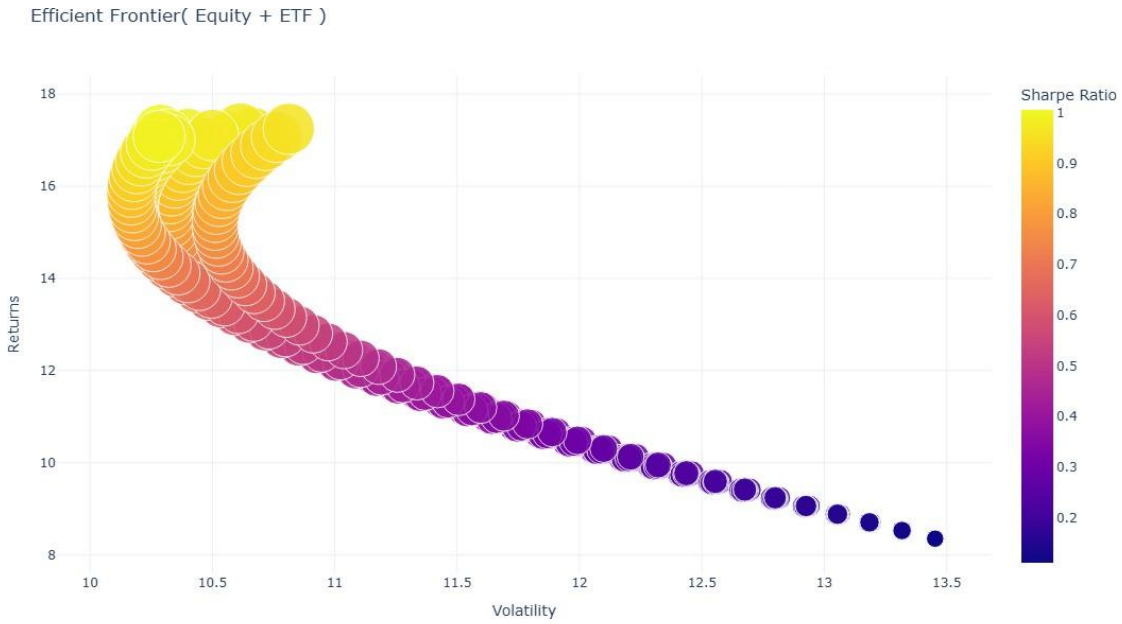


Figure 4: Efficient Frontier of NIFTY 50 and Gold ETF Combinations

Table 4: Highest Sharpe Ratio Portfolio Combination

ETF	Gold ETF Weight (%)	NIFTY 50 Weight (%)	Annualised Return (%)	Annualised Volatility (%)	Sharpe Ratio
UTI	50	50	17.21	10.29	1.007

The Efficient Frontier analysis (Figure 4) examines portfolios combining the NIFTY 50 with individual Gold ETFs, with Gold ETF weights ranging from 0% to 50% and the remaining proportion invested in the NIFTY 50. A risk-free rate of 6.854%, based on the 10-year Government of India bond yield, was used for calculating the Sharpe ratio. The graph indicates that as the proportion of Gold ETFs increases, the Sharpe ratio generally improves, suggesting better risk-adjusted returns from including gold exposure in the portfolio. Among the combinations analysed, the portfolio of 50% UTI Gold ETF and 50% NIFTY 50 produced the highest Sharpe ratio of 1.007, with an annualised return of 17.21% and annualised volatility of 10.29% (Table 4). This indicates that combining Gold ETFs with equities can improve portfolio risk-adjusted performance and provides evidence of their potential diversification benefits.

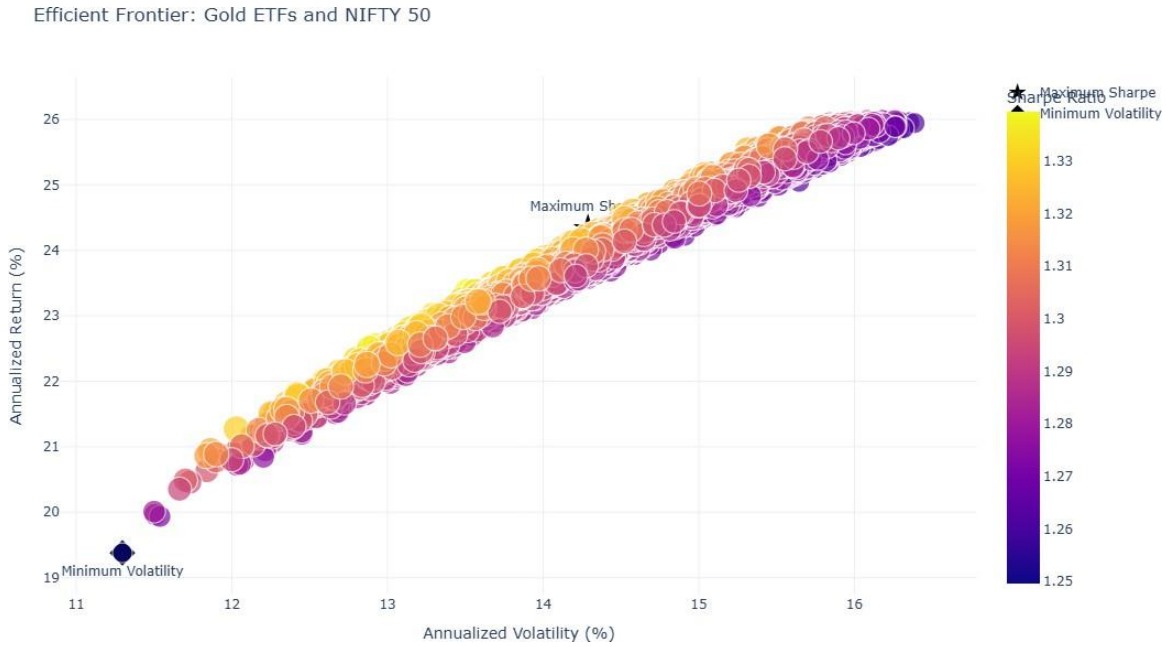


Figure 5: Efficient Frontier and Optimal Asset Allocation

Table 5: Optimal Asset Allocation (Maximum Sharpe Ratio Portfolio)

Asset	Weight (%)
Axis	22.46
UTI	22.27
Quantum	19.33
Kotak	13.99
NIFTY 50	8.83
Nippon	5.75
HDFC	2.94
ICICI	2.68
Aditya Birla	1.13
Invesco	0.51
SBI	0.10

Table 6: Performance of the Maximum Sharpe Ratio Portfolio

Measure	Value
Annualised Return	24.33%
Annualised Volatility	14.29%
Sharpe Ratio	1.223

Table 7: Least Volatile Portfolio Allocation

Asset	Weight (%)
NIFTY 50	37.23
SBI	14.17
ICICI	11.01
Aditya Birla	10.47
Quantum	8.53
Nippon	8.10
Kotak	3.69
UTI	2.84
HDFC	2.03
Invesco	1.79
Axis	0.15

Table 8: Performance of the Least Volatile Portfolio

Measure	Value
Annualised Return	19.38%
Annualised Volatility	11.30%
Sharpe Ratio	1.109

The portfolio optimisation involved generating 5,000 portfolios with randomly assigned weights across the selected Gold ETFs and the NIFTY 50 to identify portfolios with different risk-return characteristics. As shown in Figure 5, the simulated portfolios illustrate the trade-off between risk and return, allowing the maximum Sharpe ratio portfolio and the least volatile portfolio to be identified. The maximum Sharpe ratio portfolio, presented in Table 5, allocates the largest weights to Axis (22.46%), UTI (22.27%), Quantum (19.33%) and Kotak (13.99%), with the NIFTY 50 receiving 8.83%. As shown in Table 6, this portfolio generates an annualised return of 24.33%, with 14.29% volatility and a Sharpe ratio of 1.223, making it the most attractive portfolio in terms of risk-adjusted return among the simulated portfolios.

In contrast, the least volatile portfolio, shown in Table 7, has a higher allocation to the NIFTY 50 (37.23%), followed by SBI (14.17%), ICICI (11.01%) and Aditya Birla (10.47%), with the remaining allocation distributed across the other Gold ETFs. As reported in Table 8, this portfolio achieves an annualised return of 19.38%, with considerably lower volatility of 11.30% and a Sharpe ratio of 1.109. The comparison of the two portfolios shows a clear risk-return trade-off: the maximum Sharpe ratio portfolio provides a higher return and better risk-adjusted performance, while the least volatile portfolio provides greater stability at the cost of lower returns. Overall, Figure 5 and Tables 5 to 8 demonstrate that combining Gold ETFs with the NIFTY 50 can create diversified portfolios with favourable risk-return characteristics, supporting the potential role of Gold ETFs as a diversification instrument in Indian equity portfolios.

3.7 Comparison with Previous Studies

The findings are broadly consistent with earlier work. The small and negative mean tracking differences agree with Mathew and Sulphey (2018), who found that gold ETFs neither significantly outperformed nor underperformed physical gold and attributed the small price gap to management fees. The differences observed across the ten ETFs in tracking error and volatility support the view of Pathak et al. (2025) that Gold ETFs should not be treated as a homogeneous asset class. With

regard to equities, the correlations close to zero found here differ from the inverse relationship reported by Eswara (2015) and from the modest positive correlation reported by Umamaheswari and Lakshmi (2024); they are, however, in line with Manuj (2021), who found that gold did not act consistently as a hedge or safe haven. In this study, Gold ETFs therefore appear to act as a diversifier, because of their near-zero correlation with equities, rather than as a counter-cyclical hedge.

3.8 Key Findings

1. Gold ETFs closely follow gold prices: all the selected ETFs showed a strong relationship with gold, with correlations ranging from 0.84 to 0.88.
2. Tracking performance was generally good: the mean tracking differences ranged from -0.02% to -0.06%, and Kotak Gold ETF performed best with the lowest tracking error of 2.27%.
3. Risk levels were similar to gold: gold had an annualised volatility of 16.68%, while the ETFs ranged from 15.34% to 17.08%.
4. Gold ETFs behave differently from equities: their correlation with the NIFTY 50 and the Sensex ranged from about -0.05 to 0.02.
5. Gold ETFs can help diversify an equity portfolio: because of their low correlation with equities, they can reduce concentration in equity markets and provide an additional source of diversification.
6. UTI performed well when combined with the NIFTY 50: the 50% UTI and 50% NIFTY 50 combination produced the highest Sharpe ratio among single-ETF combinations (1.007), with an annualised return of 17.21% and volatility of 10.29%.
7. Portfolio optimisation improved risk-adjusted performance: among 5,000 simulated portfolios, the maximum Sharpe ratio portfolio achieved an annualised return of 24.33%, volatility of 14.29% and a Sharpe ratio of 1.223.
8. A lower-risk option was also identified: the least volatile portfolio had an annualised volatility of 11.30%, a return of 19.38% and a Sharpe ratio of 1.109, so investors can choose between higher returns and lower risk according to their preference.

4. CONCLUSION

Overall, the study shows that Gold ETFs are a good way to gain exposure to gold while also providing diversification benefits within an investment portfolio. The selected ETFs generally moved closely with gold prices and had relatively small tracking differences, which indicates that they were able to represent the performance of gold reasonably well. Among the ETFs, Kotak showed the strongest tracking performance, while UTI had the lowest volatility.

More importantly, the very low correlation between Gold ETFs and the NIFTY 50 and the Sensex suggests that gold behaves differently from Indian equities. This makes Gold ETFs particularly useful for investors who want to diversify beyond equity investments. The portfolio analysis supports this finding, as both the maximum Sharpe ratio portfolio and the least volatile portfolio produced favourable risk-adjusted results. The ideal allocation depends on the investor's objective: investors seeking better risk-adjusted returns may prefer the maximum Sharpe ratio portfolio, while those prioritising stability may prefer the least volatile portfolio.

The study has certain limitations. It covers about four and a half years of monthly data for ten Gold ETFs, and the portfolio results are based on historical returns, a fixed risk-free rate and randomly simulated weights, so they may not hold in

future periods. Future research may use longer periods and higher-frequency data, apply regression and beta analysis, test out-of-sample portfolio performance and include other asset classes such as debt and silver. Therefore, the study concludes that Gold ETFs can play a meaningful role in portfolio diversification and risk management, rather than being used only as an alternative way of investing in gold.

REFERENCES

1. Eswara, M. 2015. An empirical study on performance of Gold ETFs in India – post crash period. Research Journal of Finance and Accounting 6(13): 75–83.

2. Manuj, H. 2021. Is gold a hedge against stock price risk in U.S. or Indian markets? Risks 9(10): 174. https://doi.org/10.3390/risks9100174

3. Mathew, M. and Sulphey, M.M. 2018. Gold exchange traded fund – price discovery and performance analysis. Scientific Annals of Economics and Business 65(4): 477–495. https://doi.org/10.2478/saeb-2018-0024

4. Pathak, T., Upadhyay, Shah and Thakkar. 2025. Striking gold with precision: an empirical analysis of Gold ETFs through the lens of the Markowitz efficient frontier. [Journal of Marketing & Social Research] 2(4): 355–360.