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MEASURING RISK, RETURN AND REPLICATION: AN EMPIRICAL STUDY OF INDIAN GOLD ETFS

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Abstract

India is a developing economy. It has dense population with majority of middle-class people. However, the slow and steady economic growth, rising awareness and increasing financial literacy and digitalization have paved the ways to increase the investors. Gold remains one of the priorities for the investors in India. The present study aims to investigate the performance of selected Indian Gold ETFs over two distinct periods i.e. 2020 to 2024 and 2022 to 2024 using various financial metrics. It also examines tracking error in relation to physical gold prices. The findings reveal that while some ETFs outperform in terms of return and stability, others show high volatility and significantly long-term tracking deviations. The study highlights the need for comprehensive evaluation of financial metrics and tracking error ability when selecting gold ETFs for investment purposes. The study is significant from risk management and investment perspectives.

Keywords: *Risk Management, Investment, India Stock Market, Gold ETFs*

1. Introduction

Gold continues to remain as one of the most popular investment vehicles across the globe since time immemorial, and with the advent of novel technology and trading products, the Indian Gold Exchange Traded Fund (ETF) market has evolved as a major investment for Indian Investors during the past two fantastic decades, and it has provided investors a transparent, cost effective and flexible alternative to traditional physical gold holdings. Gold ETFs offer an asset class that combines almost equity or share-like liquidity with gold-like security–so it stands to reason that as households and institutional investors have sought to diversify portfolios, increase meaningful exposure to an asset class that has historically (and frequently) served to hedge inflation and market turmoil, gold ETFs have proven popular in both segments of the market. That said, while these instruments are growing in attractiveness to normal investors, there is no systematic academic work to the best of our knowledge that seeks to study the determinants of the performance of these Indian gold ETFs. Given the rapidly evolving financialization of the commodities market, significant for our understanding of their risk–return profile and replication efficiency with respect to the prices of spot gold for both investors and policy makers. Gold as an asset class, holds intrinsic value and is traditionally favored as a hedge against inflation and market volatility. However, investing in physical gold presents challenges related to storage, safety and liquidity. To address these issues, Gold Exchange Traded Funds (GETFs) have emerged as a feasible option, offering convenient exposure to gold. They are listed on major national stock exchanges and backed by actual gold.

Over the years, GETFs have been garnering attention from both, retail and institutional investors in India. Despite this, there exists a need for deeper evaluation using comprehensive metrics. Although previous studies have utilized standard performance metrics, they have often been restricted to smaller time frames and/or limited GETFs. Moreover, the aspect of tracking error has received relatively little attention. This research seeks to bridge these gaps by examining seven prominent Indian GETFs across two periods, employing a blend of benchmark-independent and benchmark-dependent based measures, along with a focused analysis of tracking error.

2. Literature Review

(Sathish Kumar & Ram Raj, 2019) investigated the performance of 10 Gold ETFs traded on the NSE and other platforms for a period from 2015 to 2018. They summarized that GETFs outperformed gold in physical asset for nearly 50% of the sampling period and that they are less volatile than physical asset. They also pointed out that due to negative alpha values, the returns generated by GETFs is very low as compared to physical gold.

(Rao, 2015) analyzed the financial performance of 12 ETFs listed and traded on BSE whose underlying asset was gold for the sampling period of 2010 to 2019 using the Sharp ratio, Treynor ratio and Jensen Alpha. They reached the conclusion that SEBI must step in and impose regulations on the trading of GETFs as their performances show stark differences.

(Dr. S.C.B. Samuel Anbu Selvan & G Ramraj, 2021)evaluated the performance of 8 Gold ETFs during Covid-19 that are traded on the NSE. They surmised that as the gold prices escalated during the pandemic, the investor's invested more in the GETFs after taking into consideration the risk-adjusted returns.

(Goverdhan, 2022)conducted a pre and post covid analysis on 10 Gold ETFs listed on the NSE. They selected tools like Sharpe's Index, Sortino ratio, FAMA measure, Treynor's Index and Jensen's Alpha. The ETFs were ranked according to the values obtained. They concluded that, given the rising price of gold, more investors were investing in gold ETFs, indicating a potential for further investment in these funds.

(Eswara, 2015)conducted Descriptive Analysis and Multiple Regression to measure the performance of 5 Gold ETFs in the post-2008 financial crisis period. Then, all 5 of the selected ETFs for the study, were performing better as compared to other ETFs, mutual funds, etc. The number of gold ETFs has doubled since then. It currently stands at 27 as updated on NSE as on 27th May 2024. This presents the researchers with a wider scope to enhance.

(Leung & Ward, 2015)examines the tracking error of Leveraged ETFs (LETFs) compared to gold spot and futures prices. The researchers found that LETFs underperform their leveraged benchmarks, with tracking errors worsening over longer holding periods. It highlights that dynamic portfolios using short-term gold futures offer superior tracking performance. The research provides insights into price dependencies and volatility effects, emphasizing the need for better replication strategies for leveraged investments.

(Kumar, 2024)assesses the risk-return profile of gold ETFs using the statistical metrics previously mentioned. The study finds that gold ETFs offer competitive returns with moderate to high volatility, making them a viable investment option. It highlights their role in portfolio diversification and inflation hedging as well. The scope of research, however, is limited to 5 gold ETFs in India.

(Nargunam & Anuradha, 2017) found that gold ETFs showcase price inefficiencies with weak-form inefficiency suggesting that future prices can be influenced by past prices. They

concluded that while gold ETFs offer diversification benefits, they suffer from market inefficiencies.

(Tskhoidze et al., 2021)highlight that ETFs aid in portfolio diversification, liquidity and cost efficiency, and are effective hedging tools when short-selling strategy is utilized. Analysis of the selected sample from US markets using Sharpe ratio, Jensen's Alpha and Fama French 3 factor Model indicate that the ETFs generally underperform their underlying asset at lower cost and higher liquidity.

3. Objectives of Study

A review of the existing literature reveals that while several studies have assessed the performance of Gold ETFs using traditional financial metrics such as Sharpe ratio, Treynor ratio, and Jensen's Alpha, the scope of these evaluations has been limited to select ETFs or outdated timeframes. Similarly, although tracking error has been discussed in the context of price inefficiencies and leveraged ETFs, a focused analysis comparing the tracking performance of Indian Gold ETFs against physical gold is still lacking. Moreover, despite frequent references to the volatility of Gold ETFs during periods of market uncertainty, advanced econometric approaches such as GARCH models have not been applied to quantify or forecast this volatility. The present study has the following three objectives: -

1. To assess the standalone performance of Gold ETFs using benchmark-independent measures like return and Sharpe ratio
2. To analyze the tracking error of Gold ETFs in comparison to Gold
3. To evaluate the market-relative performance of Gold ETFs using benchmark-based metrics such as Beta, Treynor ratio, and Jensen's Alpha

4. Research Methodology

The present study is empirical in nature. The authors have used the secondary data to achieve the predefined objectives of study i.e. to examine the performance of some Indian Gold Exchange-Traded Funds (ETFs) for two different time horizons (2020–2024 and 2022–2024). Daily closing prices of gold ETFs as well as the domestic gold spot prices were obtained from published sources like NSE & AMFI. The research examines mean return, standard deviation, beta, Sharpe ratio and coefficient of variation as key performance indicators to evaluate risk–return characteristics per ETF. Tracking error analysis was also performed to assess the level of divergence between ETF return and benchmark gold prices and thus its replication effectiveness. MS was used to perform correlation analysis and regression modeling, which are statistical tools.

- **Data Collection and Analysis**

Daily prices of the following Gold ETFs and Gold were sourced from the Bombay Stock Exchange historical records and investing.com, respectively. The only criterion was that the ETF's inception date was before 2015. The data of gold ETFs was taken in 2 time frames as follows to discount the effect of COVID-19: -

1. 5 years: 1st January 2020 to 31st December 2024
2. 3 years: 1st January 2022 to 31st December 2024

The risk-free rate was taken as the yield rate of 5-year government bonds issued in India as on 1st January 2020 and 1st January 2022 for respective periods.

Table 1: Gold ETFs selected for analysis

Name of the ETF	Ticker	Inception date
HDFC Mutual Fund - HDFC Gold Exchange Traded Fund	533230	13-08-2010
ICICI Prudential Gold ETF	533244	24-08-2010
Birla Sun Life Mutual Fund - Birla Sun Life Gold ETF	533408	13-05-2011
Axis Mutual Fund - Axis Gold Exchange Traded Fund	533570	10-11-2010
NIPPON INDIA ETF GOLD BEES	590095	08-03-2007
SBI Mutual Fund - SBI Gold Exchange Traded Scheme - Growth Option	590098	18-05-2009
Quantum Gold Fund - Exchange Traded Fund (ETF)	590099	22-02-2008

5. Data Analysis and Interpretation

1.1: 5-year analysis

Descriptive analysis

ICICI Prudential Gold ETF (ICICI) and NIPPON INDIA ETF GOLD BEES (Nippon) are the only 2 ETFs offering a positive average daily return indicating slight profitability while the other ETFs showcase a very minor loss. Variance and standard deviation of Quantum Gold Fund - Exchange Traded Fund (Quantum), Birla Sun Life Mutual Fund - Birla Sun Life Gold ETF (Birla) and Axis Mutual Fund - Axis Gold Exchange Traded Fund (Axis) are relatively higher, showcasing higher price fluctuations.

Annualized Descriptive Statistics

ICICI and Nippon garner nearly the same annualized positive return while HDFC Mutual Fund - HDFC Gold Exchange Traded Fund (HDFC) and SBI Mutual Fund - SBI Gold Exchange Traded Scheme - Growth Option (SBI) showcase slight negative returns and Axis, Quantum, Birla show highly negative returns. A highly unstable price is noticed in the ETFs of Birla, Axis, and Quantum while moderate movements are observed in HDFC and SBI and relatively stable prices are observed in ICICI and Nippon.

Sharpe Ratio

The Sharpe Ratio is the highest for ICICI and Nippon at 0.4376 making them the best risk-adjusted performers. However, Axis, Quantum, and Birla are in sharp contrast to these ETFs with negative Sharpe ratio. HDFC and SBI reflect a negative Sharpe ratio as well but, not as poor as the previous 3

1.2: 3-year analysis

Descriptive analysis of gold ETFs

SBI and Quantum are the only 2 ETFs offering a negative average daily return indicating slight losses while the other ETFs showcase a very minor profit. Variance and standard deviation of SBI and Quantum ETFs are relatively higher, showcasing higher price fluctuations.

Annualized Descriptive Statistics

In tandem with the daily observation, SBI and Quantum are the only 2 ETFs with negative returns and highly unstable price movements while the remaining ETFs show similar annualized returns and price movements.

Sharpe Ratio

Just like previous statistics, HDFC, ICICI, Birla and Axis show the same positive measure of Sharpe ratio while SBI and Quantum are on the other side of the number scale and equal.

2: Tracking Error

Tracking Error serves as a vital indicator of how effectively an ETF mirrors the performance of its underlying benchmark – in this case, physical gold. This analysis examines daily tracking error data across the chosen ETFs.

2.1: 5-Year Analysis

Over the 5-year horizon, the tracking error is substantially wide for most ETFs. Notably, Birla (52.01%), HDFC (49.72%), Axis (49.31%) and SBI (49.53%) all exhibited long-term deviations nearing or exceeding 50%. Meanwhile, ICICI and Nippon maintained relatively lower 5-year TEs (21.47% and 21.37%, respectively), suggesting greater consistency in managing tracking efficiency.

2.2: 3-Year analysis

Most ETFs demonstrated relatively moderate TEs, ranging between 17% and 21%, with the exception of SBI Gold ETF, which recorded an anomalously high tracking error of 59.43%. This disparity may be attributable to fund-specific factors such as portfolio rebalancing frequency, cash holdings or operational inefficiencies.

3: Risk-dependent metrics analysis

3.1: 5-year analysis

Beta Calculation

The Beta values of an asset measure the sensitivity to the price movements in the market. HDFC, ICICI, Nippon and SBI showcase diversification benefits with lower sensitivity to gold prices and Birla and Axis have a comparatively higher sensitivity to the changing gold prices.

Treynor Ratio

Remarkably, the Treynor ratio is the highest for SBI at 8.088 indicating high excess return per unit of systematic risk (beta). However, Axis and Nippon exhibit a strong contrast with a Treynor ratio of -5.77 and -5.16 respectively.

Jensen's Alpha and Appraisal Ratio

ICICI and Nippon show positive Jensen's Alpha i.e. excess return over the expected return predicted by CAPM. The high Appraisal Ratio reinforces this strong performance relative to unsystematic risk. Conversely, Axis and Quantum have the lowest Jensen's Alpha indicating underperformance relative to CAPM. Their low Appraisal ratios indicate poor risk–adjusted excess returns. HDFC and SBI show moderate performance of both, Jensen's Alpha and Appraisal ratio.

3.2: 3-year analysis

Beta calculation

Quantum is the only ETF with a negative beta, showcasing lower sensitivity to gold prices. HDFC, ICICI, Birla, Axis and Nippon move moderately while SBI has the highest beta.

Treynor Ratio

ICICI exhibits highest excess returns per unit of market risk at 3.07 while HDFC, Birla, Nippon, Axis show relatively slightly lower Treynor ratio. SBI is the only ETF that shows poor returns as compared to market risk, suggesting underperformance relative to its beta.

Jensen's Alpha and Appraisal Ratio

ICICI, HDFC, Nippon exhibit high Jensen's Alpha and Appraisal ratio indicating best return compared to expectations and strong risk-adjusted performance. On the contrary, SBI and Quantum's statistics are negative, meaning that they've underperformed relative to CAPM expectations and poor risk-adjusted returns. Birla and Axis are offering moderate returns.

Table 2 Summary Table (5 years)

Name of the ETF	Return	Beta	Sharpe	Treynor	Jensen's Alpha	Appraisal Ratio
HDFC Mutual Fund - HDFC Gold Exchange Traded Fund	-0.049156	-0.0758	-0.22492	1.49645148	-0.12206	-0.24197
ICICI Prudential Gold ETF	0.1342465	-0.0229	0.437859	-3.0539817	0.071548	0.447888
Birla Sun Life Mutual Fund - Birla Sun Life Gold ETF	-0.222853	0.13851	-0.37924	-2.0732307	-0.24738	-0.32671
Axis Mutual Fund - Axis Gold Exchange Traded Fund	-0.261092	0.05639	-0.44518	-5.7706274	-0.30704	-0.42008
NIPPON INDIA ETF GOLD BEES	0.1342465	-0.0136	0.437859	-5.1562253	0.070895	0.443799

SBI Mutual Fund - SBI Gold Exchange Traded Scheme - Growth Option	-0.049156	-0.014	-0.22492	8.08824772	-0.11505	-0.22807
Quantum Gold Fund - Exchange Traded Fund (ETF)	-0.242213	0.14181	-0.41935	-2.1613794	-0.26305	-0.35988

Findings of Study

The ICICI Prudential Gold ETF and NIPPON INDIA ETF GOLD BEES stand out with the highest returns (13.43%) and Sharpe ratio (0.4379), indicating strong performance and better risk-adjusted returns. Their Jensen's Alpha values reinforce their ability to generate excess returns. However, their Treynor Ratios suggest poor performance when adjusted for systematic risk.

SBI Gold ETF and HDFC Gold ETF show identical negative returns, low beta and negative Sharpe ratios signalling weak returns and high risk. However, SBI Gold ETF has the highest Treynor ratio, indicating strong compensation for systematic risk.

Axis Gold ETF and Quantum Gold ETF are the worst performers with deeply negative returns, Sharpe ratios, Jensen's Alpha and Appraisal ratio, confirming severe underperformance.

Table 3 Summary Table (3 years)

Name of the ETF	Return	Beta	Sharpe	Treynor	Jensen's Alpha	Appraisal Ratio
HDFC Mutual Fund - HDFC Gold Exchange Traded Fund	0.16318	0.041928	0.65389	2.491332	0.10008	0.626474
ICICI Prudential Gold ETF	0.16318	0.0340756	0.65389	3.065438	0.10090	0.631608
Birla Sun Life Mutual Fund - Birla Sun Life Gold ETF	0.16318	0.0440602	0.65389	2.37077	0.09985	0.625079
Axis Mutual Fund - Axis Gold Exchange Traded Fund	0.16318	0.0484326	0.65389	2.15674	0.09940	0.62222
NIPPON INDIA ETF GOLD BEES	0.16318	0.0357882	0.65389	2.918742	0.10072	0.630488
SBI Mutual Fund - SBI Gold Exchange Traded Scheme - Growth Option	-0.16177	0.2929888	-0.3391	-0.75255	-0.15589	-0.23977
Quantum Gold Fund - Exchange Traded Fund (ETF)	-0.16177	-0.170611	-0.3391	1.292347	-0.25811	-0.397

The HDFC, ICICI, Birla Sun Life, Axis, and Nippon ETFs showcase similar returns (16.14%) and

Sharpe ratio (0.65389), indicating strong returns and well-managed risk-adjusted performance. However, Treynor ratios vary amongst them with ICICI leading at 3.0654, followed by Axis (2.1567), Birla (2.3707), and HDFC (2.4913).

SBI and Quantum's underperformance gets emphasized due to negative returns, lower sharpe ratios, Jensen's Alpha, Appraisal ratio, and Treynor Ratio. This further highlight high volatility and lower compensation for risk.

2. Tracking Error

1. SBI Gold ETF had the highest Tracking Error during both, the 3-year and 5-year tenure (59.43% and 49.53% respectively, indicating long-term deviation from benchmark returns.
2. Quantum, HDFC, and Nippon demonstrated lower short-term tracking errors, all below 18.5%, suggesting efficient short-term replication of gold prices.
3. Over the 5-year period, ICICI and Nippon stood out for maintaining comparatively low tracking errors, implying more consistent long-term performance.
4. Most ETFs showed a sharp increase in tracking error over the 5-year horizon, signaling potential long-term inefficiencies not apparent in short-term data.

Figure 1: Indian Gold Holdings and Pricing (2012-2024)

The above figure represents the data on Indian Gold Exchange-Traded Product (ETP) holdings (in tonnes) alongside gold prices in Indian Rupees per 10 grams (Rs/10g, in thousands) over the period from January 2012 to 2024. The data suggests a growing investor interest in gold ETPs aligned with rising gold prices, potentially reflecting increased demand for gold as a hedge or investment during this period. The sharp rise in both holdings and prices post-2020 may be influenced by macroeconomic factors such as inflation fears, geopolitical uncertainty, and shifts in investment preferences towards gold-backed financial instruments. In other words, there is a strong positive correlation between

gold ETP holdings and gold prices in India, highlighting increasing penetration and investor participation in gold ETFs amid rising gold prices over recent years.

6 Limitations and Future Scope of study

Limitations:

1. The study is limited only to India and therefore, the findings may not be relevant in the long run or even for the same period in different geographies.
2. The study investigates only the ETFs backed by Gold. However, there exist ETFs backed by other indices or ETFs.
3. The study evaluates the ETFs based on a limited time period which may become redundant in the future.

Future Scope of Study:

1. The timeline of the study period can be changed to gain a comprehensive understanding of the prevalent market conditions then.
2. A similar study can be carried out for other ETFs on the exchanges.

7. Conclusion

The analysis reveals significant differences in the performance and tracking accuracy of Gold ETFs in India. ICICI and Nippon consistently emerge as the top-performing funds across both periods, delivering strong average returns and superior risk-adjusted performance as reflected in their Sharpe and Appraisal ratios. Their low tracking error further reinforces their reliability in replicating gold prices. In contrast, ETFs like SBI and Quantum display weaker returns, high volatility, and greater tracking error, indicating inefficiencies in portfolio management or fund structure. The study underscores the importance of evaluating both standalone risk-adjusted performance and benchmark replication when analyzing ETFs. Investors should not rely solely on average returns but must also consider systematic risk exposure and long-term tracking efficiency. Overall, Gold ETFs remain a valuable investment vehicle, but careful selection based on comprehensive performance metrics is essential for optimizing returns and managing risk.

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