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Evaluating Pricing and Tracking Efficiency of an ESG ETF: Insights from Mirae Asset Nifty 100 ESG Sector Leaders ETF

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Abstract:
The increased popularity of social and communal investing has led to an increase in the demand for ESG based financial products, like ETFs. The purpose of this research is to evaluate the viability of these types of ESG investments through ETFs within the context of the Indian Equity market by examining the risk-return profile of the Mirae Asset Nifty 100 ESG Sector Leaders ETF. The results show that ESG ETF have consistent returns relative to the benchmark and a slight decrease in volatility as compared to the underlying index, thus displaying good risk management. The regression results indicate lower sensitivity to the market, with the analysis of tracking error presenting evidence of good tracking efficiency both for the ETF trading prices and the NAV returns. The persistence analyzes further establishes that tracking error fluctuations are mean-reverting and highly transitory, thus confirming market efficiency.

Keywords: Exchange Traded Fund, Net Asset Value, Pricing efficiency, Sustainability, Tracking efficiency.

JEL Classification: G10, G11, G14, G17, Q51

Introduction

Environmental, Social, and Governance (ESG) investing represents a transformative shift in the philosophy of capital allocation, where financial decision-making extends beyond traditional risk-return considerations to incorporate sustainability and ethical dimensions. The roots of ESG investing can be traced back to Socially Responsible Investing (SRI), which historically relied on exclusionary screening strategies -avoiding investments in industries such as tobacco, alcohol, or weapons. Over time, this values-based approach evolved into a more systematic and data-driven framework that integrates measurable environmental, social, and governance indicators into financial analysis.

The environmental component of ESG focuses on how firms manage natural resources, carbon emissions, energy efficiency, climate risk, and environmental compliance. Growing global concern over climate change, particularly following the Paris Agreement, has intensified investor demand for climate-conscious portfolios. Investors increasingly assess exposure to transition risks, regulatory risks, and physical risks associated with environmental degradation.

The social dimension evaluates a company's relationships with employees, customers, suppliers, and communities. Issues such as labour practices, diversity and inclusion, human rights, data privacy, and community engagement have gained prominence in investment analysis. Corporate scandals and reputational crises have demonstrated that social mismanagement can significantly affect firm valuation and investor confidence.

Governance, the third pillar, examines corporate leadership, board structure, executive compensation, shareholder rights, transparency, and ethical conduct. Governance failures, especially those highlighted during the Global Financial Crisis, reinforced the importance of strong oversight mechanisms in ensuring long-term corporate sustainability and protecting investor interests.

Background of ESG Investing

ESG Investing has its deep roots in earlier forms of Socially Responsible Investing (SRI) and ethical finance and only recently became a mainstream, data-driven part of global market. SRI is a well-worn term that grew in prominence during the 1980s and 1990s, but its roots trace back two millennia, shaped by civil-rights-era thinkers, faith-based organizations, and women. SRI in this period relied mainly on values-based negative screening, often led by churches, NGOs, and activist groups, and remained a niche practice. The modern SRI process stands on three pillars: 1. Values-based avoidance screens 2. Proactive sustainability-focused analytics colloquially referred to as "ESG investing" and 3. Corporate engagement and impact investing. (Camilleri, 2021; Martini, 2021; Townsend, 2020). During the 1990s, ESG began to be framed as financially material risk factors, linking environmental, social, and governance issues to portfolio risk and performance rather than only ethics. Corporate Social Responsibility (CSR) and the broader idea of "sustainability" provided the bridge from ethical concerns about external impacts to investor-focused ESG risk–return analysis (MacNeil & Esser, 2022). The term ESG itself was popularized by the UN's 2004 "Who Cares Wins" report and then embedded in the UN Principles for Responsible Investment (UN PRI, 2006), which asked institutional investors worldwide to incorporate ESG into decisions (MacNeil & Esser, 2022; Martini, 2021; Matos, 2020; Senadheera et al., 2022).

ESG adoption accelerated as institutional investors and asset managers began integrating ESG into standard portfolio processes; ESG became the "financial model" of responsible investment worldwide (MacNeil & Esser, 2022; Matos, 2020). The UN Global Compact (2000), UN PRI (2006), and other voluntary codes built global norms, while evidence accumulated that climate, labour, and governance risks were financially relevant (Gao, 2025; Gupta, 2025; Martini, 2021; Matos, 2020). The Paris Agreement (2015) and UN Sustainable Development Goals (2015) anchored ESG within a broader sustainable finance agenda and spurred regulatory action, especially in Europe. Global assets managed with responsible or ESG strategies exceeded $22–30 trillion by the mid-2010s, representing a large share of professionally managed assets (Martini, 2021; Umar et al., 2020). Europe and the US emerged as the largest ESG markets, with rapid growth in Japan, Canada, Australia, and emerging economies; ESG equity indices and funds expanded globally (Cunha et al., 2020; Umar et al., 2020). Regulatory frameworks such as the EU Sustainable Finance Disclosure Regulation (SFDR), national taxonomies, and disclosure rules (e.g., TCFD-aligned regimes) aim to standardize ESG reporting and curb greenwashing (Gao, 2025; Ivanitsk & Petrenko, 2021; Janki Devi Memorial College, University of Delhi, Delhi, India. & Sinha, 2024).

Literature & Contribution

Growth of ESG ETFs

ESG and SDG-linked ETFs have evolved significantly in scope and sophistication, expanding beyond simple exclusionary screening strategies to encompass broad-market indices, climate-focused funds, thematic "megatrend" strategies, and SDG or impact-oriented products. This transition reflects the increasing use of advanced data analytics, ESG scoring models, and technology-enabled portfolio construction techniques, allowing asset managers to design more targeted and outcome-driven sustainable investment products. (Naffa & Fain, 2020) analyses the risk-adjusted financial performance of ESG-themed megatrend investment strategies in global equity markets using megatrend factor portfolios based on signalling theory and formulate a novel measure for stock megatrend exposure, based on the relative fund flows into the corresponding thematic ETFs. The findings show that each environmental megatrend, as well as the disruptive technologies megatrend, yielded positive and significant alphas relative to the passive strategy. (Sourd & Safaee, 2021; Umar et al., 2020; Xu et al., 2024) studied that the European

ESG ETF market has grown significantly, exceeding the United States in both Assets Under Management (AUM) and number of products, even though overall ETF ownership of European stocks is only about half that of U.S. stocks. In 2021, 55% of European ETF users were already investing in SRI/ESG products, while 68% of non-ESG investors indicated plans to integrate ESG into their portfolios. Additionally, 67% of respondents used ETFs specifically to incorporate ESG exposure, and 60% expressed interest in further development of ESG and low-carbon ETFs, highlighting strong quantitative evidence of sustained growth and investor demand.

The empirical studies (De Sousa Gabriel et al., 2025; Marín-Rodríguez et al., 2025; Naffa & Fain, 2020) indicate that these funds are highly interconnected both among themselves and with traditional ETFs. This interconnectedness becomes particularly pronounced during periods of financial stress, suggesting that while ESG ETFs play a systemically important role within capital markets, their diversification benefits may diminish during crises. Nevertheless, their strong linkage with broader financial markets underscores their integration into mainstream investment frameworks rather than remaining a niche segment. (Banerjee, 2024; Ullah et al., 2024; Xu et al., 2024) suggest that ESG-themed ETFs alone could surpass $500 billion in assets under management by 2030, indicating sustained expansion from what is still considered a relatively young and rapidly developing market segment. Collectively, these trends highlight the structural maturation and long-term growth trajectory of ESG ETFs in global financial markets.

Risk-adjusted Performance of ESG ETFs

Across markets, ESG ETFs generally deliver risk-adjusted returns similar to, and sometimes slightly below, conventional ETFs, with pockets of out- and under-performance depending on region, timing, and fund selection. (Rompotis, 2025) studied 525 equity ETFs over a period 2013-2022. The findings revealed high-ESG-score ETFs have better raw returns and lower risk, but the performance edge weakens once other factors (fees, age, volatility) are controlled; the ESG–performance link is not robust in cross-sectional regressions. (Kanuri, 2020) examined the performance of ESG ETFs from February 2005 to July 2019 by comparing them with broad market benchmarks such as the iShares Russell 3000 ETF and the SPDR Global Dow ETF. The study finds that ESG portfolios outperformed these benchmarks in certain bull and bear sub-periods but underperformed over the full sample period in both absolute and risk-adjusted terms. However, the results suggest that ESG ETFs can still provide diversification and risk-reduction benefits, allowing investors to align their portfolios with sustainability preferences without significantly compromising overall stability.

A study (Vasiliauskaitė et al., 2025) compared the ESG and traditional ETFs in the United States and Europe for the period 2020-2025, covering the COVID-19 pandemic period, found notable regional differences in performance. Traditional U.S. ETFs delivered higher returns and risk-adjusted performance, while European ESG ETFs showed lower downside risk. U.S. ESG ETFs performed similarly to traditional funds, suggesting that ESG integration does not necessarily compromise returns and that outcomes vary by region. (Rompotis, 2024) examined ESG and non-ESG ETFs in Hong Kong from December 2022 to February 2024 evaluates performance using raw returns, tracking error against the Hang Seng Index, and risk-adjusted measures such as Sharpe, Treynor, Modigliani–Modigliani, and Information Ratios. The findings reveal that ESG ETFs underperformed their non-ESG counterparts in both daily and cumulative returns.

(Feng, 2024) studied ESG ETFs in Mainland China examines whether they outperform, match, or underperform conventional ETFs using measures such as annualized volatility, daily returns, Sharpe ratio, Information ratio, and tracking error. The findings indicate that within an annualized volatility range of 0.6% to 0.8%, ESG ETFs demonstrate competitive performance and stronger resilience during negative market conditions. However, the study highlights significant challenges, including unclear ESG definitions, inconsistent evaluation standards, and disparities in ESG ratings. It emphasizes the need for standardized ESG frameworks and improved disclosure systems to enhance the reliability and effectiveness of ESG ETF assessments in the Chinese market. (Landi et al., 2024) is of the opinion that

higher ESG standards (lower ESG "risk") are associated with better Sharpe ratios across U.S. and European ETFs, with some shift from equities to bonds as ESG risks rise.

Research Gap

It would appear that the majority of academic research regarding ESG investment products focuses on ethical justifications for investing in such products, the creation of ESG score systems to rate certain investments based on their expected ESG criteria, as well as on long-term portfolio performance. However, there is relatively little empirical study examining the microstructure of equity exchange-traded funds (ETFs) with respect to ESG criteria, especially for developing markets such as India. Most prior research has centred on ESG mutual funds and composite indices, while the characteristics of ETFs including their premiums/discounts, their tracking efficiencies, and persistence of pricing discrepancies have not seen a significant amount of attention within the field of sustainable finance. In India, there is very little research available on how ESG ETF allow for sustainable capital allocation. The proposed study is intended to fill that gap by conducting an empirical analysis at the individual fund level (i.e., ETF) that considers factors related to both sustainability and finance i.e., risk-return performance, pricing efficiency, tracking efficiency in order to provide a greater understanding of how ESG ETFs function as instruments within today's financial markets.

Research Objectives

- To examine the risk and return characteristics of the Mirae Asset Nifty 100 ESG Sector Leaders ETF.
- To examine the intraday and overnight return and volatility of Mirae Asset Nifty 100 ESG Sector Leaders ETF.
- To analyze the pricing efficiency through premium/discount behaviour.
- To evaluate the tracking efficiency and persistence of tracking errors of the Mirae Asset Nifty 100 ESG Sector Leaders ETF.

Research Methodology

The study employs a range of statistical tools and techniques to support the analysis and achieve the stated objectives. These methods are briefly described to provide an understanding of their relevance to the study, with equations included to substantiate the analysis.

Scope of the study

The study is based on a single ETF sample, the Mirae Asset Nifty 100 ESG Sector Leaders ETF, which was launched on 20 November 2020 and is recognized as India's first ESG ETF. The sample period covers four financial years, from 2021–22 to 2024–25. The data for the study is secondary in nature. The daily closing prices of ETFs were obtained from the National Stock Exchange, while the daily Net Asset Values (NAVs) of ETFs were sourced from the Association of Mutual Funds in India (AMFI).

Model Formation

The methods used in this study to calculate returns, assess pricing efficiency, and evaluate tracking efficiency are based on (Bahadar, 2019) research. The computational methods and model structure used here are based on (Bahadar, 2019) work, which examined similar factors in evaluating how ETFs perform. By using this well-established method, this study ensures consistency in its approach and allows for comparison with previous research. However, the analysis uses a different dataset and time period, which are appropriate for the goals of this research.

Daily return and volatilities of ETFs

The researcher calculates the returns of ETFs based on both trading prices and NAVs to determine if there is a significant difference between the two-return series. Additionally, the study examines the differences in the volatilities of trading price returns and NAV returns. To compare the performance of ETFs with their corresponding benchmark indices, the returns and volatilities of the benchmark indices are also calculated. The return of ETFs in trading prices is calculated as below:

$$R_{ETF,t} = log(CP_{ETF,t})/log(CP_{ETF,t-1})$$

However, the return of ETFs in NAV is calculated as below:

$$R_{NAV,t} = log(CP_{NAV,t})/log(CP_{NAV,t-1})$$

Finally, the return of benchmark index is calculated as below:

$$R_{Ind,t} = log(CP_{Ind,t})/log(CP_{Ind,t-1})$$

Whereas, $R_{ETF,t}$ is the ETF return in trading prices estimated as the ratio of closing price at day t ($CP_{ETF,t}$) and closing price at day t-1 ($CP_{ETF,t-1}$), R_{NAV} is the ETF return in NAV estimated as the ratio of closing NAV at day t ($CP_{NAV,t}$) and closing price at day t-1 ($CP_{NAV,\ t-1}$), $R_{Ind,t}$ is the return of benchmark index estimated as the ratio of closing value at day t ($CP_{Ind,t}$) and closing value at day t-1 ($CP_{Ind,t-1}$). The corresponding risk associated with each return type are the return volatilities represented as σ_{ETF}, σ_{NAV}, σ_{Ind} in table 2, which are measured as the standard deviation of the daily return of ETF in trading prices, ETF return in NAV and benchmark index respectively.

Overnight and Intraday return and volatility of ETF

To identify the difference in volatilities between trading and non-trading hours and its causes, we compare the standard deviations of intraday and overnight returns of international ETFs. Previous literature (Bahadar, 2019) attributes volatility in assets traded on stock markets to three main factors: the release of accumulated public information, increased noise trading during trading hours, or the release of more private information. Specifically, return volatility is either linked to trading activity such as noise trading or the release of private information or to the flow of information such as the release of accumulated public information. The reason for the former is synchronous trading hours, while the latter is due to asynchronous trading hours between ETFs and their benchmarks.

Therefore, if volatility is driven by the release of accumulated public information, the overnight return volatility will be greater than the intraday return volatility for ETFs, which have asynchronous trading hours compared to their benchmark indices. Conversely, for ETFs with synchronous trading hours with their benchmarks, the intraday return volatility will be higher than the overnight return volatility. If volatility is attributed to noise trading or the release of private information, then the intraday return volatility will be greater than the overnight return volatility of ETFs.

The Intraday return is computed as below:

$$R_{day} = log(CP_{ETF,t}) - log(OP_{ETF,t})$$

The overnight return is computed as below:

$$R_{night} = log(OP_{ETF,t}) - log(CP_{ETF,t-1})$$

Whereas, $R_{day,t}$ is the intraday return computed as the log difference between closing price of ETF at day t ($CP_{ETF,t}$) and the opening price of ETF at day t ($OP_{ETF,t}$), $R_{night,t}$ is overnight return computed as the ($OP_{ETF,t}$) and closing price of ETF at day t-1 ($CP_{ETF,\,t-1}$).

Pricing Efficiency

Measures of Pricing efficiency

The ETFs generally have two prices. One is the closing price of ETF and the other one is NAV. If ETF trade more than its NAV then it's a premium and if ETF trade at lesser than its NAV then it's a discount. To calculate the premium/discount the following formula has been applied.

$$Premium_t = \frac{CP_{ETF,t} - CP_{NAV.t}}{CP_{NAV,t}}$$

where $premium_t$ represents the magnitude of premium or discount at which international ETFs trade on day t; $CP_{ETF,t}$ is the trading price of the international ETFs on day t and $CP_{NAV,t}$ is the respective NAV of the fund on the same day.

To measure the price discrepancies in ETF, the closing price of an ETF is regressed with its NAV using Ordinary Least Square (OLS) method.

$$CP_{ETF,t} = \alpha + \beta CP_{NAV,t} + \varepsilon_t$$

Second order Autoregressive model of premium/discount

To examine the persistence of price deviation, the second-order autoregressive model (AR (2)) is applied by regressing the tracking error on the values of two lagged days as follows:

$$Premium_t = \alpha + \beta_1 Premium_{t-1} + \beta_2 Premium_{t-2} + \varepsilon_t$$

Where, $Premium_t$ represent the magnitude of premium/Discount at which ETF trade on day t.

Tracking Efficiency

Measures of tracking efficiency

The tracking error represents the difference between the actual returns of the fund and those of the benchmark index it has its underlying stocks in. The tracking errors for the trading prices are computed using three methods. $TE1_{ETF,\,t}$ is the average absolute difference between trading price return of ETF and their corresponding benchmark index return; $TE2_{ETF,\,t}$ is the standard deviation of the difference between trading price return of ETF and their corresponding benchmark index return, $TE_{ETF,\,t}$ is the average of $TE1_{ETF,\,t}$ and $TE2_{ETF,\,t}$. However, $TE1_{NAV,\,t}$ is the average absolute difference between NAV return of ETF and their corresponding benchmark index return; $TE2_{ETF,\,t}$ is the standard deviation of the difference between NAV return of ETF and their corresponding benchmark index return, $TE_{NAV,\,t}$ is the average of $TE1_{NAV,\,t}$ and $TE2_{NAV,\,t}$.

Second order Autoregressive model of tracking errors

To examine the persistence of tracking error, the second-order autoregressive model (AR (2)) is applied by regressing the tracking error on the values of two lagged days as follows:

$$TE1_{ETF,t} = \alpha + \beta_1 TE1_{ETF,t-1} + \beta_2 TE2_{ETF,t-2} + \varepsilon_t$$
$$TE1_{NAV,t} = \alpha + \beta_1 TE1_{NAV,t-1} + \beta_2 TE2_{NAV,t-2} + \varepsilon_t$$

Where, $TE1_{ETF,\ t}$ is the average absolute difference between trading price return of ETF and their corresponding benchmark return, and $TE1_{NAV,\ t}$ is the average absolute difference between NAV of ETF and their corresponding benchmark return. α indicates a constant portion of replication inefficiency remains unexplained by the lagged values of tracking error and β_1 and β_2 coefficient implies persistence or lack of persistence of tracking error for one or two days.

Analysis & Interpretation

Table 1: Descriptive Statistics of Mirae Asset Nifty 100 ESG Sector Leaders ETF

	Index	NAV	ETF	Premium/Discount
Mean	0.0005	0.0005	0.0005	-0.1823
Standard Error	0.0003	0.0003	0.0003	1.0721
Median	0.0009	0.0009	0.0007	-0.7807
Mode	0.0000	0.0110	0.0000	-1.0000
Standard Deviation	0.0088	0.0086	0.0086	33.7319
Sample Variance	0.0001	0.0001	0.0001	1137.8434
Kurtosis	3.3176	3.5531	3.1218	353.8486
Skewness	-0.6391	-0.5597	-0.5107	14.2808
Range	0.0901	0.0915	0.0864	1141.2480
Minimum	-0.0514	-0.0561	-0.0530	-340.3113
Maximum	0.0387	0.0354	0.0334	800.9366
Sum	0.48	0.49	0.49	-180.4653
Count	990.00	990.00	990.00	990.00

(source: researcher's calculation)

From the descriptive statistics discussed here, it shows that the Mirae Asset Nifty 100 ESG Sector Leaders ETF has generated modestly and progressively earns returns each year. The average return of the Index, NAV and ETF are also identical to each other (mean return = 0.0005). Therefore, it can be concluded that the ETF is tracking its ESG Index very closely and is being managed well. The standard deviation of the ETF's return data is 0.0086 which demonstrates its moderate volatility, but slightly lower than that of its underlying Index, thus suggesting lower investment risk related to investing in an ESG ETF. The presence of a negative skewness in returns signifies that there are very few extreme downward price movements of the ETFs. Additionally, the kurtosis values of the ETF's return data contain kurtosis values greater than three indicating both fat-tailed and leptokurtic distributions which is indicative of financial return data series.

Table 2: Risk & Return Analysis of Mirae Asset Nifty 100 ESG Sector Leaders ETF

Return

ETF Name	R_{Ind}	R_{ETF}	R_{NAV}	R_{ETF}/R_{NAV}	R_{Day}	R_{Night}	R_{Day}/R_{Night}
ESG ETF	0.0486	0.0497	0.0497	1.0000	-0.00436	0.00401	-1.0859

Risk

ETF Name	σ_{Ind}	σ_{ETF}	σ_{NAV}	$\sigma_{ETF}/\sigma_{NAV}$	σ_{Day}	σ_{Night}	$\sigma_{Day}/\sigma_{Night}$
ESG ETF	0.8776	0.8584	0.8637	0.9939	0.0136	0.0137	0.9905

(source: researcher's calculation)

The analysis of the risk/return characteristics of the Mirae Asset Nifty 100 ESG Sector Leaders ETF shows that returns (0.0497) for the ETF are slightly greater than those of the underlying index (0.0486) and are equal to returns based on NAV, as demonstrated by the 1.0000 ratio of returns for the ETF to the NAV. Therefore, it can be said that the ETF is very efficient in replicating the underlying index, thus indicating a very low level of tracking error, thus confirming the effectiveness of the ETF structure. In terms of the day/night return breakdown of the ETF, day returns (–0.00436) are negative, while night returns (0.00401) are positive. The negative day/night return ratio indicates that much of the return from this product is being generated outside of traditional trading hours and is therefore attributable to international dispersion of information and to overnight market adjustments due to that information.
The ETF's volatility (0.8584) is somewhat lower than that of both the index (0.8776) and the NAV (0.8637), suggesting that the ESG ETF demonstrates a marginally reduced risk relative to its benchmark. The ETF–NAV risk ratio of 0.9939 further substantiates precise tracking and efficient risk management. The day-night risk comparison reveals roughly equivalent volatility levels, with a day-to-night risk ratio approximating unity (0.9905), indicating an equitable risk distribution across trading and non-trading periods. The findings indicate that the ESG ETF provides benchmark-comparable returns with slightly reduced risk, thereby affirming its position as a safe and financially sound ESG investment vehicle.

Table 3: Regression result of Premium/Discount of Mirae Asset Nifty 100 ESG Sector Leaders ETF

Premium	-0.1823
Alpha	0.1897
Beta	0.9932
P-value	0.0000
R-Square	0.9919
premium = β1-1	-0.0068

(source: researcher's calculation)

The regression results indicate a very strong and statistically significant relationship between the ETF's closing price and its NAV. The beta coefficient ($\beta = 0.9932$) is extremely close to 1, suggesting that the ETF price moves almost one-to-one with its NAV. The calculated premium ($\beta_1 - 1 = -0.0068$) indicates a very slight average discount relative to NAV, but the magnitude is economically negligible, implying that the ETF is priced very efficiently in the market. The p-value (0.0000) confirms that the relationship is statistically significant at conventional levels. Moreover, the R-square of 0.9919 shows that approximately 99.19% of the variation in ETF closing prices is explained by changes in NAV, indicating extremely high tracking efficiency and strong price-NAV alignment. Overall, the results suggest that the ETF is highly efficient with minimal persistent premium or discount.

Table 4: Regression results for persistence of premium/discount

ETF name	α	β1	β2	R^2
ESG ETF	-0.1849	-0.0190	-0.0014	0.0190

(source: researcher's calculation)

The durability of the price premium/discount throughout time is measured by the second regression; this is a critical determination in order to assess the efficiency of pricing. The intercept ($\alpha = -0.1849$) has a negative coefficient which means that the average price of the ETF remains at a discount. The amount is also low and when accounting for temporal volatility, this indicates that the discount is not substantial and

that it is not actually going up in value in a consistent manner. The first lag's coefficient (β_1=-0.0190) is also negatively skewed and nearly 0 which indicates that there is little influence exerted by previous price deviations on price deviation at present. There is therefore little or no active continuation of price deviations.

The second lag coefficient (β_2 = –0.0014) is negligible, further confirming the lack of long-term reliance in premium/discount fluctuations. The low R-square value (0.0190) signifies that merely 1.9% of the variance in the premium/discount is accounted for by its historical values, implying that deviations from NAV are predominantly random and ephemeral.

Table 5: Result of Tracking Error of ETF and NAV

	Tracking error between R_{ETF} and R_{Ind}			Tracking error between R_{ETF} and R_{Ind}		
ETF Name	$TE1_{ETF,t}$	$TE2_{ETF,t}$	$TE_{ETF,t}$	$TE1_{NAV,t}$	$TE2_{NAV,t}$	$TE_{NAV,t}$
ESG ETF	0.0000	0.0071	0.0036	0.0000	0.0115	0.0058

(source: researcher's calculation)

The tracking error analysis assesses the degree to which the ETF return (trading price) and NAV return align with the returns of the underlying benchmark index. Tracking errors are calculated using two primary methods: (i) the average absolute departure between ETF/NAV returns and benchmark returns, and (ii) the standard deviation of the return discrepancies, with the overall tracking error presented as the mean of these two metrics. The tracking error for ETF trading price returns, calculated using the absolute difference approach (TE ETF,1), is 0.0000, signifying a nearly perfect correlation between ETF returns and index returns on average. The standard deviation-based tracking error (TE ETF,2) is 0.0071, indicating negligible short-term discrepancies from the benchmark attributable to market frictions, including bid–ask spreads and liquidity constraints. The overall tracking error (TE ETF), determined as the average of the two metrics, is 0.0036, indicating a reasonably low value and suggesting strong monitoring efficiency in the ETF's market price.

The tracking error for NAV-based returns, calculated using the absolute difference approach (TE NAV,1), is 0.0000, indicating that the fund's portfolio composition closely mirrors the benchmark index. Although the standard deviation-based NAV tracking error (TE NAV,2) at 0.0115 indicates higher variance in the NAV for index versus trading price return comparisons. However, the overall NAV tracking error (TE NAV) has a value of 0.0058, indicating that it has similarly low value, yet marginally higher tracking error than that associated with trading price returns. Additionally, both NAV returns and trading price return for the both ETFs exhibit similar performance in tracking the benchmark index; NAV returns have a higher tracking error relative to the trading price return of the ETF (TE NAV); however, the difference is relatively small. The results indicate effective portfolio management and support for efficient arbitrage in the ETF marketplace, providing further evidence that the ESG ETF effectively replicates the performance of an ESG index with reliable exposure to ESG-related assets.

Table 6: Regression results for persistence of tracking errors

ETF name	Dependent Variable $TE_{ETF,1}$				Dependent Variable $TE_{NAV,1}$			
	α	β1	β2	R^2	α	β1	β2	R^2
ESG ETF	0.0001	-0.6885	-0.2853	0.3448	2.95470	-0.2519	-0.1459	0.0686

(source: researcher's calculation)

The persistence analysis of tracking errors investigates whether discrepancies between ETF/NAV returns and benchmark index returns tend to endure over time. Distinct regressions are conducted for ETF price-based tracking error (TE ETF,1) and NAV-based tracking error (TE NAV,1), incorporating lagged tracking errors as explanatory variables. There is a small intercept ($\alpha = 0.0001$) for tracking error based on ETF prices, indicating that the average tracking error from these prices is small. The first lag coefficient ($\beta_1 = -0.6885$) is negative and large in value and is also negative for the next ($\beta_2 = -0.2853$). Therefore, it can be concluded that the tracking error associated with the ETF price has a strong tendency to revert to its mean, meaning the deviations from the benchmark are corrected quickly in future time intervals. The large R-square value (0.3448) indicates that a large portion of the variability in ETF price tracking errors can be explained by their prior values. This result suggests that ETF prices are subject to systematic correction mechanisms, likely due to arbitrage and active participation in the marketplace.

Tracking error based on NAV also has a high intercept ($\alpha = 2.9547$), indicating that on average NAV tracking errors are of a much larger magnitude compared to the ETF price tracking errors. The lag coefficients ($\beta_1 = -0.2519$ and $\beta_2 = -0.1459$) are smaller than the lag coefficients for ETF price tracking error, which indicates there is a lower tendency for NAV tracking errors to revert to their means. In addition, the R-square value (0.0686) is very small, which suggests that only a small amount of the variability in today's NAV tracking errors can be explained by past tracking errors. It is therefore likely that NAV tracking errors are more random and difficult to anticipate compared to tracking errors based on ETF prices. As a result of the persistence analysis, it has been determined that tracking errors based on ETF prices have a higher mean-reverting tendency and thus are more predictable than tracking errors based on NAV.

Conclusion

An empirical study of the risk-return relationship, price efficiency and tracking of the Mirae Asset Nifty 100 ESG Sector Leaders Exchange Traded Fund has been conducted in order to evaluate the financial viability of investing in Exchange-Traded Funds that have been designated as ESG-oriented. The findings demonstrate that the ESG Exchange-Traded Fund continues to generate consistent, highly favourable returns that are comparable to its benchmark index and the Net Asset Value, which suggests that the portfolio is being replicated effectively, and that the investment has been managed well. The comparatively reduced volatility of ETF returns relative to the index underscores the defensive characteristics of ESG investing, rendering these instruments appropriate for risk-averse and long-term investors. The premium/discount study reveals that the ESG ETF primarily transacts at a discount to its NAV, indicative of transient pricing frictions stemming from liquidity and market sentiment. The lack of persistence in premium/discount behaviour indicates that market forces rapidly rectify these aberrations, hence affirming the efficacy of the ETF pricing mechanism. The tracking error study further substantiates elevated tracking efficiency, as both ETF trading price returns and NAV return closely align with benchmark performance. The pronounced mean-reverting characteristic of tracking mistakes highlights the efficacy of arbitrage and market correction mechanisms.

The findings collectively offer robust empirical evidence for the financial feasibility of ESG investment via ETFs. Although ESG ETFs may not reliably produce very high anomalous returns, they provide stable, low-risk, and competitively priced investment opportunities that align financial performance with sustainability factors. The findings of this research indicate that ESG ETF are a strong financial investment option that allows you to invest responsibly without sacrificing financial performance. Future studies may want to build on this work by making extensive comparisons of ESG ETF's performance using multiple sources of ESG ETF performance and/or adding a variable based on ESG ratings.

Declaration

All authors declare that they have no conflicts of interest.

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