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Revisiting the ESG-performance Nexus: Evidence of Non-linear and Asymmetric Effects on the Profitability and Risk of Nifty 500 Indian Firms

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1. Introduction

The convergence of Environment (E), Social (S), and Governance (G) has attained global significance, becoming the primary benchmark for measuring corporate performance. There is an established perception within the realms of academia and the finance industry that excellent ESG performance will lead to greater profitability and lower risk levels. Nonetheless, such a consensus is founded on the premise of linear assumptions and largely based on information from advanced economies that do not address the multifaceted considerations involved in resource allocation in emerging countries, such as India.

Linear assumptions and mean estimations have dominated the current body of literature, neglecting any thresholds or distributions in emerging Indian markets. Still, empirical support for the assertions is highly fragmented. There remains a substantial gap in the literature review in the consideration of any possible nonlinear relationship between ESG and corporate performance, where significant levels of investment in ESG are required to generate benefits. Additionally, conventional studies overlook the asymmetrical consequences. For example, there are different implications for ESG investments among companies making high profits and those underperform.

In this study, an attempt is made to study the relationship between the performance of firms and their ESG practices using this model for the Nifty 500 index. This study uses balanced panel data of 404 firms from the Nifty 500 index covering a nine-year period (2016-2024). This study uses Panel Data Models and Quantile Regression Techniques to identify the real determinants of ROA and Risk. The primary objective of the study is to genuinely determine whether ESG serves as a driver of financial value or merely a non-value-adding compliance expenditure in emerging markets where resources are limited.

By explicitly testing for nonlinearity and asymmetrical distributions, this study aims to make a definitive contribution to the literature. This study tries to contribute to ongoing debates in stakeholder theory and neoclassical economics. The empirical findings suggest that, for the sampled firm and time frame, ESG may operate more as a necessary compliance metric rather than as a direct driver of financial performance, even after controlling for core financial fundamentals such as size and leverage.

1.1 Objectives of the Study

Building on diverse findings in the recent empirical literature, this study explores the nuances

of the ESG performance nexus among Nifty 500 firms. To provide a comprehensive analysis of the incorporation of sustainability initiatives with traditional financial fundamentals, the following objectives are specified:
To examine whether the relationship between ESG performance and Return on Assets (ROA) follows a linear trajectory or a non-linear (U-Shaped) pattern, which contributes to the present debate on initial costs VS long-term benefits of ESG incorporation.
To evaluate whether there is any asymmetric financial impact on ESG investment distributions, by way of assessing the different firm performance levels (i.e., quantiles).
To identify the potential role of ESG practices in mitigating corporate risk, with a specific focus on whether higher ESG scores correlate with reduced earnings volatility when controlling for firm size and leverage.

1.2 Hypothesis of the study

H1: ESG performance exhibits a non-linear (U-shaped) relationship with firm profitability (ROA).
H2: The relationship between ESG and firm profitability varies asymmetrically across different quantiles (e.g., the 25th, 50th, and 75th percentiles).
H3: Higher corporate ESG ratings are associated with a significant reduction in earnings volatility (Risk_Vol).

2. Review of Lecture

2.1 ESG and Firm Profitability: The Linear Perspective

A substantial portion of the existing literature explores the relationship between Environmental, Social, Governance (ESG) practices and corporate financial performance through a linear lens. Several studies point to the possibility that incorporating sustainability factors could result in favorable financial outcomes in terms of corporate reputation, stakeholder trust, and easier access to capital markets. To give an example, empirical research on emerging markets such as India and other BRICS economies points to a favorable link between ESG disclosures and accounting profitability ratios like Return on Assets (Kumar & Firoz, 2022; Bilivogui & Iqbal, 2025; David et al., 2025). Similar positive linear relationships and value co-creation benefits have been observed in other markets, including China, Latin America, and Indonesia (Jiang & Lin, 2026; Useche et al., 2026; Surya et al., 2025).
However, this linear perspective is not universally supported, and the literature presents a highly mixed narrative, particularly when analyzing specific regions or individual ESG pillars. Several researchers report that ESG expenditures may not always translate into immediate financial gains, sometimes resulting in negative or insignificant impacts on firm performance (Zahid et al., 2022; Giannopoulos et al., 2022; Yip et al., 2025). Studies exploring Southeast Asian banks and East Asian industrial firms note that the financial impact of sustainability practices is often highly dependent on the specific ESG pillar being measured, with environmental and governance factors sometimes moving in opposite directions regarding their impact on firm value (Gutiérrez-Ponce & Wibowo, 2023; El Khoury et al., 2023; Kim, 2024). Moreover, there is evidence from research done in the Indonesian market that low ESG ratings may not necessarily reduce profitability, indicating that conventional financial factors can still be significant in some instances (Hermansyah et al., 2025). The difference presents an

explicit need for exploring the relationship in specific indices such as the Nifty 500.

2.2 Exploring Non-Linearity and Distributional Asymmetries

Understanding the inconsistent results of linear models, new theories in this area have started to focus on more complicated non-linear processes in the ESG-performance relationship. A recently developed theory suggests that the investments made in sustainability can be U-shaped. According to this theory, the first stages of implementing and adopting sustainable practices require significant capital resources, which can decrease accounting profit. Financial gains would be achieved when the firm passes a certain threshold level of maturity in sustainability processes. Recent researches conducted in both international and Indian contexts confirm the U-shape effect on performance measures, including Tobin's Q and ROA, as both metrics initially have negative values but become positive in the long run (Dayal et al., 2024; Dwibedi et al., 2024).
As important as non-linear models are for further analysis, most of the research uses them to measure the "average" firm through regressions. There exists no literature on the possible asymmetry of results related to this concept. Asymmetrical effects are highly possible because ESG implementation is likely to affect firms in the leading position in the industry differently than firms lagging behind. This problem should be explored with respect to various performance quantiles.

2.3 Risk Mitigation Perspectives

In addition to its profit potential, another salient topic in modern literature is the assessment of the risk mitigation value of ESG. According to theoretical models, environmental initiatives and governance measures can act as buffers against economic turmoil and help avoid financial trouble. Based on empirical findings from emerging economies, high levels of ESG can minimize bankruptcy risks, shape capital structures, and enhance debt financing possibilities (Faqera et al., 2026; Pain et al., 2026; Useche et al., 2026).
Nevertheless, the effectiveness of ESG in risk reduction may be situation-specific as well. Several studies conducted in developed countries have demonstrated that during prosperous periods, additional expenses related to enhancing corporate social responsibility may outweigh the resulting advantages, thus raising the risk of bankruptcy instead of reducing it (Habermann & Fischer, 2023). Thus, testing conflicting risk theories under the conditions of the Nifty 500 stock index can serve as an excellent method to establish whether increased ESG scores decrease earnings variance after adjusting for purely financial metrics.

3. Data and Methodology

3.1 Sample and Data Collection

This study used a well-balanced panel dataset of 404 firms listed on the Nifty 500 index over a nine-year period from 2016 – 2024. The initial observations were from the Nifty 500 index. After cleaning the datasets for firms that have incomplete or missing sustainability data, the final sample yielded 2,469 firm-year observations. The extractions of Firm-level financial fundamentals are from Prowess IQ, and ESG ratings are from Capitaline AWS. This specific timeframe captures the integration of modern ESG reporting frameworks in the Indian market

while providing a robust sample size for dynamic panel modeling.

3.2 Variable Measurement

In this study, the firm's performance has been evaluated using two distinct dependent variables to capture both profitability and risk. Firstly, Return on Assets (ROA) represents short-term accountability profit. Secondly, Risk_Vol, calculated as the standard deviation of earnings, represents financial volatility.
The primary independent variable is the firm's composite ESG_Rating of the firm. To test the hypothesis of a Non-Linear (U-shaped) relationship, the squared term of ESG rating (ESG^2) is included in the models. The model incorporates two control variables for isolating the specific financial impact of sustainability practices and to avoid omitted variable bias. They are, Firm Size (calculated as the natural logarithm of total assets) and Leverage (measured as the Total Debt to Equity ratio).

3.3 Econometric Models

To address unobserved firm-specific heterogeneity inherent in corporate datasets, Panel Data regression models are employed. A Hausman-specification test is used to determine the application of Fixed Effects (FE) VS Random Effects (RE) estimations. The baseline equation for testing both lin ear and non-linear impacts on profitability is specified as follows:

$$ROA_{it} = \beta_0 + \beta_1(ESG\_Rating_{it}) + \beta_2(ESG^2_{it}) + \beta_3(Size_{it}) + \beta_4(LEV_{it}) + \mu_{it}$$

To examine the possibility of the presence of any distributional asymmetry in the case of various levels of performance, Quantile Regression is employed at the 25th, 50th, and 75th percentiles. Unlike the results obtained from Ordinary Least Squares models that only provide the results for the mean value of the dependent variable, Quantile Regression provides the facility to assess the impact of independent variables at various levels of the dependent variable's distribution, thereby ensuring that the results are highly robust.
Lastly, to test the risk-mitigation hypothesis, the Fixed Effects Panel model is employed, with Risk_Vol replacing ROA as the dependent variable.

4. Results and Discussions

4.1 Descriptive Statistics and Preliminary Diagnostics

Table 1 presents the descriptive statistics and correlation matrix for the Nifty 500 index sample. Variance Inflation Factor (VIF) tests confirmed the absence of multicollinearity among the independent variables. Furthermore, a Hausman specification test indicated that the Fixed Effects (FE) model is the appropriate econometric approach for this panel data.

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Table 1: Descriptive Statistics and Correlation Matrix

Variables	Mean	Std. Dev.	Min	Max	1	2	3	4
1. ROA	0.07	0.105	-3	1	1			
2. ESG_Rating	62.39	8.728	30	90	0.073***	1		
3. Size (Log_Assets)	9.22	1.782	-3	16	-0.160***	0.250***	1	
4. Leverage (LEV)	0.18	0.217	0	2	-0.289***	0.014	0.215***	1

Note: *** $p < 0.01$. VIF values for all independent variables (ESG_Rating = 1.068, Size = 1.120, LEV = 1.051) are well below the acceptable threshold of 5, confirming the absence of multicollinearity. Valid N = 2,469.

4.2 Panel Data Regression (Fixed Effects) - Testing H1

Table 2 presents the Fixed Effects panel regression results evaluating the impact of ESG performance on corporate profitability (ROA). The coefficients for both the linear ESG score ($p = 0.704$) and the non-linear ESG^2 term ($p = 0.249$) are statistically insignificant. Such findings suggest that there is no significant effect of ESG performance on ROA, and neither does it show any form of an inverse U-shaped curve; hence, hypothesis one was rejected. On the other hand, the conventional finance-based variables proved to be quite explanatory, as Firm Size positively influences profitability ($\beta = 0.0723$, $p < 0.01$), whereas Leverage negatively influences profitability ($\beta = -0.1838$, $p < 0.01$).

Table 2: Panel Data Regression (Fixed Effects) - Dependent Variable: ROA

Variables	FE Coefficient	p-Value
Constant	-0.5361***	< 0.001
ESG_Rating	0.0008	0.704
ESG^2	-1.93E-05	0.249
Size	0.0723***	< 0.001
Leverage (LEV)	-0.1838***	< 0.001

Observations	2,469	
R-squared	0.1617	
Entity Effects	Yes	

Note: *** p < 0.01, ** p < 0.05, * p < 0.10. Model estimated using Fixed Effects (FE) Panel OLS.

4.3 Distributional Asymmetries and Quantile Effects (Testing H2)

Table 3 details the Quantile Regression estimates to test for asymmetric effects across the 25th, 50th, and 75th percentiles of profitability. Consistent with the baseline Fixed Effects model, neither ESG_Rating nor ESG² yield statistically significant coefficients at any conditional quantile. This confirms that ESG investments do not produce differential financial returns for high-performing versus underperforming firms, resulting in the rejection of H2. Firm Size and Leverage maintain highly significant negative relationships with ROA across all observed quantiles.

Table 3: Quantile Regression Results - Dependent Variable: ROA

Variables	Q25 Coefficient (p-value)	Q50 Coefficient (p-value)	Q75 Coefficient (p-value)
Constant	0.0627 (0.140)	0.1117** (0.018)	0.1384** (0.019)
ESG_Rating	0.0015 (0.256)	0.0020 (0.192)	0.0022 (0.232)
ESG²	-3.06e-06 (0.777)	-3.35e-06 (0.778)	-5.88e-06 (0.693)
Size	-0.0109*** (< 0.001)	-0.0150*** (< 0.001)	-0.0142*** (< 0.001)
Leverage (LEV)	-0.0663*** (< 0.001)	-0.0846*** (< 0.001)	-0.1051*** (< 0.001)
Observations	2,469	2,469	2,469
Pseudo R²	0.1005	0.1596	0.1715

Note: *** p < 0.01, ** p < 0.05. Models estimated across the 25th, 50th, and 75th percentiles.

4.4 ESG and Risk Mitigation (Testing H3)

Table 4 illustrates the Fixed Effects regression assessing whether ESG performance mitigates earnings volatility (Risk_Vol). The coefficient for ESG_Rating is statistically insignificant (p = 0.841), indicating that superior ESG practices do not act as a measurable buffer against financial risk for this sample of Nifty 500 firms. Consequently, H3 is rejected. Firm Size emerges as the sole significant risk mitigant in the model (β = -0.0499, p < 0.01), effectively reducing long-term earnings volatility.

Table 4: Panel Data Regression (Fixed Effects) - Dependent Variable: Risk_Vol

Variables	FE Coefficient	p-Value
Constant	0.4634***	< 0.001
ESG_Rating	-0.0005	0.841
ESG²	1.38E-05	0.504
Size	-0.0499***	< 0.001
Leverage (LEV)	0.0126	0.484
Observations	1,669	
R-squared	0.2021	
Entity Effects	Yes	

Note: *** p < 0.01. Model estimated using Fixed Effects (FE) Panel OLS to test the impact of independent variables on earnings volatility.

4.5 Discussion of Findings

The empirical findings of this study challenge the prevailing optimism surrounding ESG integration, demonstrating that for Nifty 500-indexed firms, ESG performance does not currently translate into financial outperformance or risk mitigation. The rejection of H1 and H2 indicates the absence of both linear and asymmetric ESG premiums. Unlike in developed markets, where sustainability often commands a pricing premium or attracts cheaper equity, the Indian firms appear to treat ESG primarily as a regulatory compliance burden (such as SEBI's BRSR mandates) rather than a strategic value driver. The capital-intensive nature of modern operations means that heavy investments in environmental upgrades or social initiatives act as immediate sunk costs that depress short-term Return on Assets (ROA), without yielding proportionate financial returns, even

for firms at the highest percentiles of profitability.

Furthermore, the rejection of H3 reveals that ESG ratings do not act as an effective shield against earnings volatility. In emerging markets, financial risk in the broad market sector is overwhelmingly dictated by macroeconomic cycles, supply chain disruptions, and capital structure. This is evidenced by the highly significant impact of Firm Size and Leverage across all models. The market does not yet view high ESG scores as a proxy for operational resilience. Ultimately, these results align with neoclassical economic theories, suggesting that in the current Indian context, sustainability initiatives are a non-financial necessity for market participation rather than a mechanism for generating alpha.

5. Conclusion and Managerial Implications

5.1 Conclusion

This study empirically examined the financial materiality of ESG integration within the Nifty 500 index from 2016 to 2024. Testing against mainstream sustainability narratives, the analysis investigated linear, non-linear (U-shaped), asymmetric, and risk-mitigating relationships between ESG performance and financial outcomes. The empirical results consistently reject the hypothesis that ESG ratings act as a significant driver of corporate profitability or a shield against earnings volatility in this context.

Whether evaluating the conditional mean via Fixed Effects or the distributional extremes via Quantile Regression, ESG performance failed to demonstrate a statistically significant impact on Return on Assets. Furthermore, no U-shaped maturity threshold was observed, and high ESG scores did not reduce financial risk. Instead, traditional neoclassical determinants—specifically Firm Size and Leverage—remained the overwhelming drivers of financial performance and stability. These findings suggest that for Indian firms across the Nifty 500, ESG currently functions primarily as a non-financial compliance and reporting exercise rather than exhibiting a statistically significant impact within the same period.

5.2 Managerial and Policy Implications

Failure to observe a financial premium associated with ESG integration has profound ramifications on business strategy formulation. Management and board members in the diverse industries need to adopt practical finance-based considerations when engaging in sustainability practices. Although compliance with ESG principles has become imperative for regulatory purposes and integration into the global supply chain network, the decision to embrace sustainability should not be based on its immediate profitability potential within organizations. Investment decisions for ESG practices need to be carefully balanced with debt considerations, which this study shows negatively influence profitability levels.

For policymakers and agencies such as SEBI, this finding illustrates an inherent market issue that needs to be addressed. In the absence of a natural profitability advantage associated with sustainable operations, ESG practices might not progress voluntarily in industries. Financial motivation might need to be encouraged by policymakers in order to achieve financial feasibility in sustainability within the highly resource-intensive industries.

5.3 Limitations and Scope for Future Research

This study is limited to the firms within the Nifty 500 for a duration of nine years. The varying capital requirements across different sectors could conceal the potential advantages of ESG which could be clearer to perceive in other industries such as services and technology. Future studies must break down the overall ESG score into distinct components of the ESG score and find out whether certain pillars such as those related to Governance or Environmental factors produce any

standalone effects on financial performance.

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