# Research on the Impact of ESG Performance on Financial Performance Based on a Panel Data Fixed-Effects Model

Sukun Chen*

School of Public Administration MPA Education Center, Shanxi University of Finance and Economics, Taiyuan, China

* Corresponding Author Email address: 2098159084@qq.com

**Abstract.** With the continuous deepening of the concept of sustainable development and responsible investment practices, the impact mechanism of Environmental, Social, and Governance (ESG) performance on corporate financial performance has become an important topic in corporate finance and capital market research. Based on the traditional two-way fixed effects panel model, this paper builds a dynamic multidimensional extended fixed effects model, introducing lagged terms of the dependent variable to characterize the dynamic persistence of financial performance while controlling for individual company effects and time effects, adding ESG squared terms to test for nonlinear effects, and incorporating financing constraints and innovation investment into a mediation effect framework. At the same time, it identifies heterogeneous moderating effects through the interaction terms of ownership nature, market competition, and ESG. To address issues such as reverse causality, omitted variables, and cross-sectional correlation, further corrections and tests are conducted using the instrumental variable method, system GMM estimation, and robust standard errors. The research results indicate that ESG performance has a significant positive effect on corporate financial performance, and that this effect exhibits both nonlinear and heterogeneous characteristics.

**Keywords:** ESG Performance, Financial Performance, Panel Data, Fixed-Effects Model, Corporate Heterogeneity

## 1 Introduction

In recent years, as the concept of sustainable development has continued to deepen worldwide, corporate objectives have gradually shifted from the sole pursuit of short-term profit maximization to a more comprehensive development model that integrates economic, social, and environmental value [1]. In this context, Environmental, Social, and Governance (ESG), referring to Environmental and Social, has become an important framework for measuring corporate sustainability and non-financial performance, and has attracted growing attention from regulators, investors, corporate managers, and scholars. In capital markets, ESG performance is not only regarded as an


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important reflection of a firm's fulfillment of social responsibility and governance quality, but is also increasingly incorporated into investment decision-making, risk assessment, and enterprise valuation [2]. Therefore, examining whether and how ESG performance affects corporate financial performance has become a key issue in corporate finance, accounting research, and sustainable development studies.

From a theoretical perspective, the relationship between ESG performance and financial performance is not simple, one-directional, or purely linear [3]. On the one hand, strong ESG performance may enhance corporate reputation, strengthen stakeholder trust, reduce agency costs and financing costs. On the other hand, continuous investment in environmental protection, employee welfare, and governance improvement may increase operating expenses in the short run and place pressure on profitability.

From a practical perspective, the demand for long-term value creation has increased substantially as economies pursue high-quality development and enterprises undergo transformation and upgrading [4][5]. Compared with traditional financial indicators, ESG indicators are better able to reflect a firm's overall quality in resource allocation, risk control, institutional construction, and long-term strategic planning [6]. Under rising external uncertainty, intensifying pressure for green transition, and changing investor preferences, whether a firm demonstrates strong ESG performance is increasingly likely to affect its access to financing, capital market recognition, and operational stability.

## 2 Related Work

Recent panel-data studies largely suggest that ESG is financially relevant, although the magnitude and timing of the effect vary across settings. Dou and Yin [7] report a significant positive association between ESG scores and financial performance. Ray and Goel [8] show that ESG affects multiple financial indicators mainly with time lags. Extending the discussion to Asian economies, Khalil et al. [9] further indicate that ESG-related environmental innovation can improve both firm value and environmental outcomes, highlighting innovation as an important transmission channel.

At the industry level, Erol, Unal, and Coskun [10] show that the ESG–financial performance nexus is not uniform across market-based measures and sub-dimensions. Demiraj, Dsouza, and Demiraj [11], focusing on the European tourism industry, also confirm that sector characteristics matter when interpreting ESG effects. In a related financial-sector setting, Zournatzidou et al. [12] use dynamic panel models with fixed effects and suggest that ESG may matter not only for profitability but also for earnings resilience and risk absorption.

Mechanism-oriented research further enriches this literature. Using panel data from Chinese listed firms, Meng et al. [13] find that ESG performance improves company reputation and that investor attention plays a mediating role, with stronger effects for non-state-owned firms. Overall, the recent literature points to a broad consensus that ESG has material economic consequences, but the direction, strength, and channels of

influence remain contingent on sample composition, sectoral context, model specification, and the choice of performance indicators.

## 3 Methodologies

Let $i = 1, \ldots, N$ denote firms and $t = 1, \ldots, T$ denote years. $FP_{it}$ represents corporate financial performance, $ESG_{it}$ denotes ESG performance, and $X_{it}$ is a vector of control variables. The empirical strategy is organized into two parts including model construction and identification-correction.

### 3.1 Dynamic Multi-Dimensional Extended Fixed-Effects Model

Before introducing the core regression equations, the ESG variable is centered. This step is necessary because the empirical design includes quadratic and interaction terms, and centering reduces non-essential multicollinearity while preserving the substantive interpretation of nonlinear effects.

$$\widetilde{ESG}_{it} = ESG_{it} - \bar{ESG}, \tag{1}$$

In Equation (1), $\widetilde{ESG}_{it}$ is the mean-centered ESG score and $\bar{ESG}$ is the sample mean of ESG.

The analysis starts from the standard two-way fixed-effects panel model. This benchmark specification identifies whether changes in ESG within a firm, after removing firm-specific and year-specific unobservables, are associated with changes in financial performance by Equation (2).

$$FP_{it} = \alpha_0 + \alpha_1 \widetilde{ESG}_{it} + \alpha_2' X_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \tag{2}$$

where $\mu_i$ captures time-invariant firm heterogeneity, such as managerial culture or long-term strategic orientation, while $\lambda_t$ captures common macro shocks and policy changes. $\alpha_1$ measures the average within-firm effect of ESG on financial performance under the static linear framework.

A static specification is insufficient because financial performance is typically persistent over time and the effect of ESG may be nonlinear. To capture both dynamic persistence and possible diminishing or increasing marginal returns of ESG, the model is extended as follows Equation (3).

$$FP_{it} = \rho FP_{i,t-1} + \beta_1 \widetilde{ESG}_{it} + \beta_2 \widetilde{ESG}_{it}^2 + \gamma' X_{it} + \mu_i + \lambda_t + u_{it}, \tag{3}$$

where $\rho$ reflects the dynamic persistence of financial performance, and a positive $\rho$ indicates path dependence in firm outcomes. $\beta_1$ and $\beta_2$ jointly determine whether ESG has a linear effect or a nonlinear effect, such as a U-shaped or inverted-U-shaped relationship.

To interpret the nonlinear structure rigorously, the marginal effect of ESG must be derived from the estimated equation rather than inferred only from coefficient signs. Equation (4) clarifies how the impact of ESG changes across different ESG levels and whether a turning point exists.

$$\frac{\partial FP_{it}}{\partial \widetilde{ESG}_{it}} = \beta_1 + 2\beta_2 \widetilde{ESG}_{it}, \widetilde{ESG}^* = -\frac{\beta_1}{2\beta_2}, \tag{4}$$

The first expression gives the conditional marginal effect of ESG on financial performance, which varies with the current ESG level. The second expression gives the turning point, if $\beta_2 < 0$, the relationship is inverted U-shaped, whereas if $\beta_2 > 0$, the relationship is U-shaped.

The first mediation Equation (5) tests whether ESG can systematically alter firms' financing frictions, which is a key mechanism through which ESG may affect profitability and valuation.

$$FC_{it} = a_0 + a_1 \widetilde{ESG}_{it} + a_2 \widetilde{ESG}_{it}^2 + \theta' X_{it} + \mu_i + \lambda_t + \nu_{it} \tag{5}$$

where $FC_{it}$ denotes financing constraints, which may be measured by indices such as SA, KZ, or WW. Coefficients $a_1$ and $a_2$ indicate whether ESG influences financing conditions linearly or nonlinearly, after controlling for firm and year fixed effects.

The second mediation Equation (6) examines whether ESG affects innovation input. This step is theoretically important because ESG engagement may improve stakeholder trust, strategic commitment, and long-horizon investment incentives.

$$INNO_{it} = b_0 + b_1 \widetilde{ESG}_{it} + b_2 \widetilde{ESG}_{it}^2 + \phi' X_{it} + \mu_i + \lambda_t + \omega_{it} \tag{6}$$

where $INNO_{it}$ denotes innovation input, commonly proxied by R&D intensity or innovation expenditure. $b_1$ and $b_2$ capture the effect of ESG on innovation activity.

### 3.2 Endogeneity Treatment and Estimation Strategy

Although fixed effects reduce omitted-variable bias, they do not fully eliminate reverse causality or residual endogeneity. Firms with better financial performance may have more resources to invest in ESG, so an instrumental-variable strategy is introduced to isolate the exogenous component of ESG variation by Equation (7).

$$\begin{aligned} \widetilde{ESG}_{it} &= \pi_0 + \pi_1 Z_{it} + \pi_2' X_{it} + \mu_i + \lambda_t + e_{it}, \\ FP_{it} &= \theta_0 + \theta_1 \widehat{\widetilde{ESG}}_{it} + \theta_2 \widehat{\widetilde{ESG}}_{it}^2 + \theta_3' X_{it} + \mu_i + \lambda_t + \zeta_{it}, \end{aligned} \tag{7}$$

where $Z_{it}$ denotes the instrument set, such as peer ESG excluding the focal firm, lagged ESG, or exogenous regional ESG-related institutional variables. The first stage tests instrument relevance, while the second stage uses the fitted ESG component $\widehat{\widetilde{ESG}}_{it}$ to recover the causal effect of ESG on financial performance.

A further complication arises from the inclusion of the lagged dependent variable in a fixed-effects panel. To address the resulting dynamic-panel bias and additional endogeneity, the study employs system GMM, combining the differenced equation with internal lag instruments and moment restrictions by Equation (8).

$$\begin{aligned} \Delta FP_{it} &= \rho \Delta FP_{i,t-1} + \beta_1 \Delta \widetilde{ESG}_{it} + \beta_2 \Delta \widetilde{ESG}_{it}^2 + \gamma' \Delta X_{it} + \Delta u_{it}, \\ E\left(FP_{i,t-s} \Delta u_{it}\right) &= 0, E\left(\widetilde{ESG}_{i,t-s} \Delta u_{it}\right) = 0, s \geq 2, \end{aligned} \tag{8}$$

First differencing removes the firm fixed effect, and deeper lags serve as valid internal instruments under the orthogonality conditions. In practice, the system GMM estimator is complemented by AR(2) and Hansen tests, while Driscoll-Kraay robust standard errors are additionally reported in the fixed-effects and IV estimations.

# 4 Experiments

## 4.1 Experimental Setup

This paper selects LSEG ESG Scores as the dataset and, based on this, constructs a company-year level panel sample. This dataset is officially released by LSEG, covering nearly 16,000 public and private companies worldwide, with a time series tracing back to 2002. It also provides standardized overall ESG scores and sub-dimensional indicators, characterized by wide coverage, long time span, and strong comparability of indicators, thus being able to well meet the estimation requirements of the two-way fixed effects and dynamic panel models.

## 4.2 Experimental Analysis

Figure 1 presents the estimated coefficients and 95% confidence intervals for the core explanatory and control variables in the ESG–financial performance regression model. The coefficient of ESG is significantly positive, while the coefficient of $ESG^2$ is significantly negative, indicating a significant nonlinear relationship between ESG performance and financial performance.

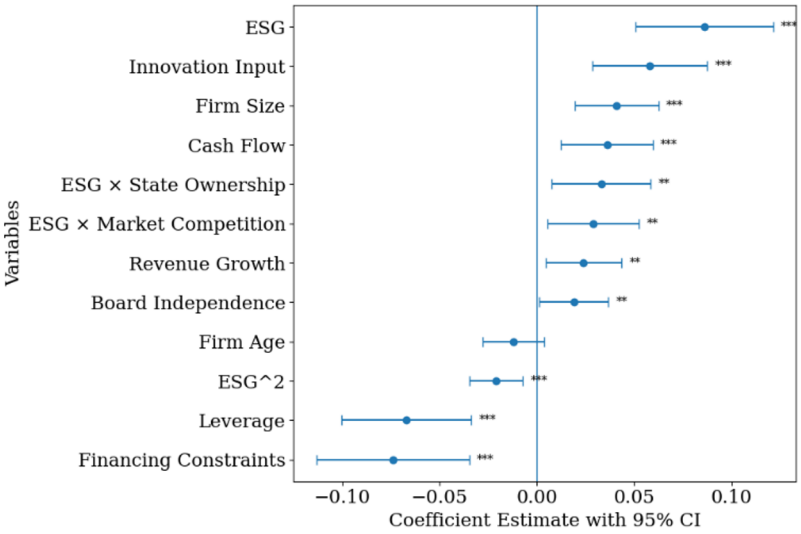


**Fig. 1.** Coefficient Estimates and 95% Confidence Intervals for ESG–Financial Performance.

Figure 2 shows two complementary visualizations of the empirical results.

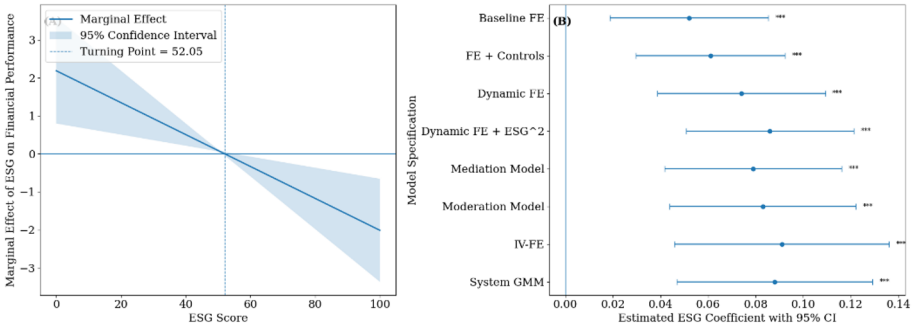


**Fig. 2.** Nonlinear Marginal Effect and Forest Plot of ESG Coefficients.

Figure 2(A) presents the nonlinear marginal effect of ESG on financial performance and its 95% confidence interval, showing that the marginal contribution of ESG decreases as ESG scores rise and crosses zero near the turning point, which supports the existence of a nonlinear relationship implied by the quadratic term. Figure 2(B) reports a forest plot of ESG coefficient estimates across different model specifications, including the baseline fixed-effects model, dynamic model, mediation model, moderation model, IV-FE model, and System GMM model.

## 5 Conclusion

In conclusion, this study examines the impact of ESG performance on corporate financial performance by extending the traditional two-way fixed-effects model into a dynamic and multidimensional panel framework. Future research can broaden the sample scope, refine ESG sub-dimensions, and combine controversy data, textual analysis, and machine-learning methods to further explore the long-term mechanisms through which ESG affects corporate outcomes.

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