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ESG Ratings, Profitability and Cost of Capital: A Firm-Level Analysis

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Abstract

This study investigates the relationship between Environmental, Social, and Governance (ESG) ratings and firm financial performance across a comprehensive global sample of over 10,000 companies from more than 80 countries observed in 2015–2022. Using panel data analysis, we examine how overall ESG scores and their components affect the Return on Assets (ROA), Return on Equity (ROE), and Weighted Average Cost of Capital (WACC). We employ several econometric approaches designed for panel data, including the univariate approaches; static (Pooled OLS; Fixed Effects) and a multivariate approach (Panel Vector Autoregression; PVAR) to address potential endogeneity concerns and provide robust findings. Our results revealed a complex relationship between ESG performance and financial outcomes. While OLS models generally show positive associations between ESG scores and profitability measures, Fixed Effects models indicate some negative relationships, suggesting that unobserved firm-specific factors are crucial. PVAR results highlight important dynamic interactions between ESG performance and financial metrics over time. These findings contribute to stakeholder theory by demonstrating that the financial implications of ESG performance are contingent on methodological approaches, time horizons, and specific contexts. Our research has important implications for corporate managers, investors, and policymakers seeking to understand the financial consequences of sustainability practices.

Keywords: ESG; sustainability; firm performance; cost of capital; panel VAR

1. Introduction

The relationship between Environmental, Social, and Governance (ESG) performance and firm-level financial outcomes has emerged as one of the most contested empirical questions in corporate finance and sustainability research. An extensive body of work spanning more than two decades and over 2000 empirical studies [1], but the direction, magnitude, and consistency of the ESG–financial performance nexus remain unresolved. A fundamental challenge in this literature is methodological heterogeneity. Studies employing cross-sectional pooled estimations often report positive associations between ESG scores and profitability, while studies exploiting within-firm estimations frequently document weaker or even negative relationships. This divergence suggests that the empirical ESG–financial performance relationship is sensitive to how unobserved firm heterogeneity and endogeneity are handled, a concern that has not been adequately addressed in a unified, large-scale, multi-country empirical framework. This study directly addresses this gap.



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The broader policy context motivating this inquiry is the Paris Agreement and the United Nations Sustainable Development Goals (SDGs), both adopted in 2015, which have catalyzed a global shift in corporate behavior, investor preferences, and regulatory frameworks toward sustainability. As of 2026, major economies including the European Union (CSRD), the United States (SEC climate disclosure rules), the United Kingdom, Singapore, China, and Brazil require ESG reporting for large publicly listed firms [2]. Global sustainable investment assets have surpassed \$30 trillion [3], and 85% of individual investors express interest in sustainable investments [4].

Despite this momentum, the link between ESG performance and financial outcomes remains complex and contested in academic research. This study seeks to address this gap by examining the relationship between ESG ratings and firm financial performance, with a focus on Return on Assets (ROA), Return on Equity (ROE), and Weighted Average Cost of Capital (WACC). Specifically, we investigate how overall ESG ratings and their individual pillars, Environmental, Social, and Governance, relate to these financial measures. We also explore the possible variations across different econometric methodologies.

This study uses a dataset of over 10,000 companies across 83 countries observed from 2015 to 2022. Our empirical strategy employs multiple econometric techniques, Pooled OLS, Fixed Effects models and multivariate Panel Vector Autoregression (PVAR). This multi-method approach enables us to deliver comprehensive insights into the ESG–financial performance nexus.

The contributions of this study are as follows. First, we offer a comprehensive analysis of ESG and financial performance, leveraging a large and diverse global sample spanning 83 countries, including 39 emerging-market economies, that substantially enhances the generalizability across developed and emerging economies, although this study does not directly test whether the ESG–financial performance relationship is itself moderated by the cross-country institutional differences. Second, by explicitly comparing three econometric frameworks (Pooled OLS, Fixed Effects, and PVAR) within a single study, we provide methodological benchmarking evidence that documents how the direction and magnitude of ESG effects are contingent on estimation approach, a contribution to the ongoing debate about the reliability of ESG–financial performance research. Third, our analysis distinguishes between the overall ESG rating and its environmental, social, and governance dimensions, providing a nuanced understanding of how specific aspects of sustainability affect financial outcomes across both static and dynamic specifications. Fourth, the Panel Vector Autoregression framework captures bidirectional, time-lagged feedback effects between ESG performance and financial outcomes that unidirectional regression frameworks cannot detect, providing insights into the dynamic structure of the ESG–financial performance nexus.

The remainder of this paper proceeds as follows: Section 2 provides the literature review and theoretical background, discussing the evolution from shareholder to stakeholder theory and summarizing prior empirical findings. Section 3 details our data, variables, and methodological approach. Section 4 presents empirical results, including descriptive statistics, main findings, and robustness checks. Section 5 discusses theoretical and practical implications. Finally, Section 6 concludes, and Section 7 provides suggestions for future research directions.

2. Literature Review and Hypotheses Development

2.1. From Shareholder Theory to Stakeholder Theory: The Theoretical Foundation

For much of the twentieth century, corporate governance was dominated by shareholder theory, which posits that a firm's primary objective is to maximize shareholder

wealth. Friedman [5] argued that ‘the social responsibility of business is to increase its profits,’ emphasizing financial returns as the sole performance criterion.

However, stakeholder theory [6] broadened this perspective by asserting that firms create value not only for shareholders but also for employees, customers, suppliers, communities, and the natural environment. Firms operate within complex socio-economic systems, and their long-term viability depends on maintaining cooperative relationships with multiple stakeholder groups [7,8] further advanced this logic through the concept of shared value and Eccles et al. [9] documented that firms with strong sustainability practices outperform peers in both stock market and accounting performance over the long term.

Within this theoretical framework, ESG performance becomes a measurable proxy for how effectively firms internalize stakeholder interests. If stakeholder theory holds, stronger ESG performance should enhance firm profitability and reduce financial risks. The Stakeholder theory provides the primary mechanism linking ESG performance to profitability (ROA, ROE) through relational capital accumulation. Firms that invest in stakeholder relationships build trust, reduce transaction costs, and gain competitive advantages that manifest in improved operational efficiency. Critically, this mechanism operates most visibly at the cross-sectional level between firms with different accumulated levels of “ESG capital” rather than necessarily within a single firm over short annual windows.

2.2. ESG Ratings as a Strategic Mechanism

ESG ratings represent a structured and increasingly institutionalized mechanism for assessing firms’ sustainability practices and long-term risk exposure. Major rating agencies, including MSCI, Sustainalytics, Refinitiv, and Bloomberg, aggregate corporate disclosures, regulatory filings, and third-party data to generate ESG scores. These ratings function as signals of non-financial performance, risk management quality, and long-term strategic orientation. From a signaling theory perspective, firms with superior ESG ratings reduce information asymmetry and communicate commitment to responsible management practices, thereby influencing investor perception and capital allocation decisions [10,11].

The environmental dimension evaluates carbon emissions, energy efficiency, climate risk management, and environmental compliance. Strong environmental practices can mitigate regulatory exposure and reputational damage [12], particularly in carbon-intensive industries where transition risk is significant [13,14]. The social dimension captures labor practices, employee well-being, diversity, and community engagement. Strong social performance is associated with higher productivity and superior innovation outcomes [15,16]. The governance dimension encompasses board structure, executive compensation, and shareholder rights. Effective governance mitigates agency conflicts and improves capital allocation efficiency, reducing both equity and debt financing costs [17,18].

The Signaling theory most directly connects ESG ratings to the cost of capital (WACC) with the assumption that firms with superior ESG scores credibly signal lower informational risk and downside exposure to capital markets, leading investors to demand lower risk premiums. This mechanism operates through market pricing channels and is expected to be more immediate and consistent than the operational efficiency channel linking ESG to profitability. Agency theory specifically predicts that governance improvements reduce equity agency costs, contributing to lower cost of equity and improved ROE through more efficient capital allocation. These distinct theoretical pathways generate the prediction that ESG pillars will affect financial outcomes heterogeneously.

2.3. ESG Performance and Profitability

The relationship between ESG performance and firm profitability has received substantial scholarly attention. Friede et al. [1], synthesizing over 2000 empirical studies, report that

nearly 90% find a non-negative relationship between ESG and financial outcomes. From a theoretical perspective, stakeholder theory provides the primary explanation: firms that invest in environmental responsibility, social engagement, and governance quality build stronger relationships with key stakeholders, enhancing organizational legitimacy, trust, and reputational capital. These intangible assets can translate into competitive advantages improving profitability. Resource-based theory suggests that ESG capabilities may function as strategic intangible resources that are valuable, rare, and difficult to imitate [19].

Empirical evidence supports this mechanism. Xie et al. [20] document a positive association between ESG engagement and accounting-based performance in developed markets, and Lins et al. [16] show that firms with high social capital outperform during crisis periods. Moreover, Edmans [15] demonstrates that firms with high employee satisfaction deliver superior long-run stock returns, implying that stakeholder-oriented practices can generate tangible financial gains.

Drawing on corporate investment theory [21] and organizational learning theory [22], we propose that within-firm ESG improvements involve measurable adjustment costs such as employee training programs, process redesign, audit and certification expenditures, enhanced reporting compliance infrastructure, and the diversion of managerial time and attention from core operational activities. These costs are front-loaded, incurred immediately upon ESG investment, while the operational and reputational benefits of improved ESG performance accumulate gradually over years. This temporal asymmetry generates an assumption that within-firm (Fixed Effects) ESG profitability relationships could be negative or insignificant in the short run but positive over longer horizons. This ‘adjustment cost hypothesis’ distinguishes between two empirically valid but conceptually distinct approaches; the cross-sectional ESG premium (captured by Pooled OLS, reflecting accumulated ESG capital) and the within-firm ESG adjustment path (captured by Fixed Effects, reflecting the transition cost of ESG improvement). Both are theoretically grounded and expected in a world where ESG genuinely creates value in the long run but entails costs in the short run.

Accordingly, we propose the following hypotheses:

Hypothesis 1. *ESG scores are positively related to Return on Assets (ROA). ROA reflects a firm’s efficiency in utilizing its asset base to generate earnings. ESG-oriented firms are expected to optimize resource allocation, reduce operational risks, and improve cost efficiency, thereby enhancing asset productivity.*

We expect this positive association to be most clearly visible in the between-firm, cross-sectional (Pooled OLS) specification, reflecting an accumulated ESG capital premium; the corresponding within-firm (Fixed Effects) association may be negative or insignificant in the short run, which could be interpreted cautiously as potentially consistent with an adjustment-cost dynamic rather than as evidence against Hypothesis 1 itself.

Hypothesis 2. *ESG scores are positively related to Return on Equity (ROE). ROE captures the returns generated for shareholders. If ESG investments strengthen reputation, stakeholder trust, and competitive positioning, they should enhance earnings capacity and long-term shareholder value creation.*

As with Hypothesis 1, we expect this positive association to be most clearly visible between firms (Pooled OLS), with the within-firm (Fixed Effects) relationship potentially differing in sign or significance for the reasons discussed further in the study.

2.4. ESG Performance and Cost of Capital

Early evidence by El Ghouli et al. [17] shows that firms with stronger CSR performance benefit from a lower cost of equity, while Goss and Roberts [23] document that socially irresponsible firms face higher loan spreads. Similarly, Chava [24] finds that firms exposed to environmental concerns face higher expected returns, reflecting an elevated cost of capital. Recent studies strengthen this evidence by showing that firms with strong CSR performance exhibit lower cash flow volatility [25]; that ESG preferences can reduce expected returns [26]; and that ESG characteristics explain cross-sectional risk differences [27].

From a theoretical perspective, ESG performance reduces perceived risk through multiple channels: governance mitigates agency conflicts; environmental performance reduces regulatory and transition risk; and social performance enhances stakeholder trust. Together, these mechanisms lower information asymmetry and downside risk exposure, leading investors and creditors to demand smaller risk premiums.

The ESG–WACC channel is the most theoretically robust of the three financial outcome pathways because it operates through market pricing mechanisms that are more immediate and less subject to within-firm adjustment cost effects than the operational profitability channels. The signaling and risk-reduction mechanisms that link ESG to WACC are expected to manifest consistently across both cross-sectional and within-firm estimations, though their magnitude may be stronger in markets with more ESG-aware institutional investors and for the environmental pillar, where climate risk is now systematically priced in credit and equity markets [13,24].

Accordingly, we propose the following:

Hypothesis 3. *ESG scores are negatively related to the Weighted Average Cost of Capital (WACC).*

Firms with higher ESG scores are expected to face lower financing costs because investors perceive them as less risky and more resilient, resulting in improved capital market conditions and reduced required returns across both equity and debt financing channels.

Empirical support for Hypothesis 3 is, in fact, mixed and pillar-specific rather than uniform across estimators. The aggregate ESG score does not show a consistent negative association with WACC across both the Pooled OLS and Fixed Effects specifications, and we discuss this directly rather than treating the hypothesis as confirmed.

Hypothesis 4. *The environmental pillar score is more consistently and negatively associated with WACC than the social or governance pillar scores.*

This pillar-specific prediction derives from the theoretical discussion, and because environmental and transition risk is increasingly priced by capital markets and regulators, we expect the environmental pillar to carry the clearest and most consistent cost-of-capital signal among the three ESG pillars.

2.5. Methodological Gaps and Contribution

The three theoretical traditions reviewed above generate complementary but distinct predictions. The stakeholder theory predicts positive ESG–ROA/ROE effects, most visible cross-sectionally; the signaling theory predicts negative ESG–WACC effects, most visible in market-based estimations and developed markets; and the agency theory predicts that governance improvements specifically reduce cost of equity and improve ROE through conflict mitigation. Critically, these theories jointly predict that OLS and Fixed Effects estimates might diverge not as a methodological artifact but as a reflection of two genuinely different economic phenomena: which are the ESG capital premium (between-firm, long-

run) captured by OLS, and the ESG adjustment cost (within-firm, short-run) captured by FE. This integrated framework transforms the OLS–FE divergence from an econometric puzzle into a theoretically interpretable finding; both estimates are ‘correct’ in that they each measure something real, but they measure different aspects of the ESG–financial performance relationship at different time horizons.

Despite extensive research, several gaps remain. First, much of the literature focuses on developed markets. Second, endogeneity concerns complicate causal inference [28]. Third, many studies aggregate ESG into a single index without examining dynamic feedback mechanisms. Fourth, the majority of studies using Refinitiv or Bloomberg ESG data focus on single markets, leaving cross-country institutional heterogeneity variation in legal origins, financial development, and ESG disclosure regimes largely unaddressed. Fifth, few studies simultaneously compare multiple econometric frameworks within a single unified dataset, making it difficult to assess whether conflicting findings in prior literature reflect genuine heterogeneity or methodological artifacts. The integrated conceptual framework presented above directly addresses the fifth gap by generating theoretical predictions for why different estimation methods could yield different results.

To address these limitations, we employ our global sample and utilize Pooled OLS, Fixed Effects, and PVAR frameworks. Critically, this study also directly addresses methodological sensitivity by comparing all three estimators within a unified framework, providing support on how methodological choices shape conclusions. A contribution that directly responds to calls for greater methodological rigor [28,29].

3. Data and Methodology

3.1. Data

This study analyzes 58,689 firm-year observations from 10,247 companies across 83 countries observed in the years 2015–2022. ESG ratings (0–100 scale) and financial data (ROA, ROE, WACC) were sourced from Refinitiv Eikon and Bloomberg. Control variables (size, beta, cost of debt, debt level, Z-score) were also obtained from these databases. We excluded firms with missing ESG or financial data and winsorized variables at the 1st and 99th percentiles to address outliers.

We clarify the construction of several variables in Table 1. WACC, the cost-of-debt component (waccdebt), firm size, lnDebt, and the Altman Z-score are sourced directly from Refinitiv Eikon’s pre-constructed firm-level fields rather than calculated independently from raw financial-statement line items. Refinitiv constructs WACC as the post-tax weighted average of the cost of equity and the cost of debt, weighted by the market values of equity and debt; the cost of debt field (waccdebt) is computed as effective interest expense scaled by total debt; and the Altman Z-score follows the standard Altman discriminant formula based on working capital, retained earnings, EBIT, market value of equity, and sales, each scaled by total assets or total liabilities as specified in the original formula. We report these as Refinitiv-constructed fields because we did not independently verify or recompute them from firm-level financial statements. Throughout this paper, we distinguish between a raw monetary variable (e.g., Total Assets or Total Debt, reported in USD) and its log-transformed counterpart used in the regressions ($\text{Size} = \ln(\text{Total Assets})$; $\ln\text{Debt} = \ln(\text{Total Debt, USD thousands})$).

The sample spans six geographic regions: North America (United States, Canada, Mexico; approximately 3100 firms), Europe (the United Kingdom, Germany, France, Sweden, The Netherlands, Switzerland, and 18 additional countries; approximately 3200 firms), Asia-Pacific (Japan, China, Australia, South Korea, India, Hong Kong, Singapore, and 14 additional countries; approximately 2800 firms), Latin America (Brazil, Chile, Colombia, Peru, Argentina; approximately 400 firms), Middle East and Africa (South Africa, Israel, Saudi

Arabia, UAE, Qatar, and others; approximately 350 firms), and Eastern Europe (Poland, Hungary, Czech Republic, Romania; approximately 150 firms). The sample window of 2015–2022 reflects two landmark events that fundamentally transformed the global ESG landscape: the adoption of the Paris Agreement on climate change and the United Nations’ Sustainable Development Goals (SDGs). These frameworks catalyzed widespread institutionalization of ESG disclosure and rating practices, making 2015 a theoretically motivated and widely recognized starting point for ESG research. The end year of 2022 reflects the availability of complete, verified Refinitiv Eikon and Bloomberg data at the time of data collection.

Table 1. Variable Definitions and Construction.

Variable	Definition/Construction	Source
ROA	Net Income/Total Assets	Refinitiv Eikon
ROE	Net Income/Book Equity	Refinitiv Eikon
WACC	Refinitiv WACC construction	Refinitiv Eikon
ESG	Refinitiv ESG combined score (0–100)	Refinitiv Eikon
EScore	Refinitiv Environmental pillar score (0–100)	Refinitiv Eikon
SScore	Refinitiv Social pillar score (0–100)	Refinitiv Eikon
GScore	Refinitiv Governance pillar score (0–100)	Refinitiv Eikon
Size	$\ln(\text{Total Assets})$	Refinitiv Eikon
Beta	market beta	Refinitiv Eikon
Z-Score	Altman Z-score (see text for formula)	Refinitiv Eikon
lnDebt	$\ln(\text{Total Debt, USD thousands})$	Refinitiv Eikon

3.2. Methodology

This study employs a set of firm-level variables to examine the relationship between corporate sustainability practices and financial performance. Financial outcomes are captured through ROA, ROE, and WACC. The sustainability dimensions are assessed using Refinitiv ESG scores (overall and pillar-level). Control variables include log total assets (size), beta, cost of debt, log total debt, and Altman Z-score.

All static panel specifications (Pooled OLS and Fixed Effects) include firm fixed effects, year fixed effects, and country fixed effects. Firm fixed effects absorb time-invariant firm-level heterogeneity. Year fixed effects control for common macroeconomic shocks. Country fixed effects absorb time-invariant cross-country heterogeneity, including legal origin differences [30]. The PVAR framework employs mean-differencing to remove firm-level fixed effects.

Panel Vector Autoregression (PVAR) Model

According to Love and Zicchino [31], the PVAR model is recommended when endogenous variables exhibit dynamic inter-dependencies, which applies to our setting where financial performance variables may causally influence one another over time. PVAR provides asymptotic normal distribution parameter estimates employing Generalized Method of Moments (GMM) and simultaneously captures feedback effects among all model variables. Here, GMM refers to the internal estimation algorithm used by the standard panel-VAR procedure itself; this study does not estimate a separate, standalone GMM-based dynamic panel model (e.g., Arellano–Bond or Blundell–Bond).

Before PVAR estimation, all variables are tested for panel stationarity, accounting for cross-sectional heterogeneity in the autoregressive process. Results confirm that all key variables (ROA, ROE, WACC, ESG score) are stationary in levels, satisfying the stationarity assumption for level-PVAR estimation. For variables that show marginal non-stationarity,

first-differenced transformations are applied. Optimal lag order is selected based on two panel information criteria, AIC (Akaike) and BIC (Bayesian).

It is important to note that the PVAR framework documents statistical Granger-causality within the observational panel structure using the predictive power of lagged ESG values for future financial outcomes and vice versa.

The four-equation PVAR is specified as in Equations (1)–(4): ROA, ROE, ESGScore, and WACC are each modeled as a function of their own lags and the lags of all other variables, plus firm-level controls X_{it} ($Size_{it}$ $\ln Total Assets$ of the firm i at time t) and individual fixed effects α_i . The PVAR approach captures temporal dynamics and bidirectional feedback among ESG and financial variables.

The four-equation PVAR model is specified as follows:

$$ROA_{it} = \alpha_i + \beta_1 ROA_{it-1} + \beta_2 ROE_{it-1} + \beta_3 ESGScore_{it-1} + \beta_4 WACC_{it-1} + \gamma_i X_{it} + \varepsilon_{1it} \quad (1)$$

$$ROE_{it} = \alpha_i + \beta_1 ROA_{it-1} + \beta_2 ROE_{it-1} + \beta_3 ESGScore_{it-1} + \beta_4 WACC_{it-1} + \gamma_i X_{it} + \varepsilon_{2it} \quad (2)$$

$$ESGscore_{it} = \alpha_i + \beta_1 ROA_{it-1} + \beta_2 ROE_{it-1} + \beta_3 ESGScore_{it-1} + \beta_4 WACC_{it-1} + \gamma_i X_{it} + \varepsilon_{3it} \quad (3)$$

$$WACC_{it} = \alpha_i + \beta_1 ROA_{it-1} + \beta_2 ROE_{it-1} + \beta_3 ESGScore_{it-1} + \beta_4 WACC_{it-1} + \gamma_i X_{it} + \varepsilon_{4it} \quad (4)$$

4. Results

4.1. Descriptive Analysis

To estimate our equations, first we put forward the descriptive results of our data to better understand the spread and position of different variables. descriptive statistics for the variables used in our analysis, covering 58,689 firm-year observations for financial metrics and 44,669 for ESG scores. This large dataset provides a strong basis for examining the links between ESG performance and firm outcomes.

The average Return on Assets (ROA) is 2.44% (SD = 0.1756), reflecting notable variation in profitability. Return on Equity (ROE) averages 5.04% (SD = 1.5789), highlighting diverse capital structures and efficiency levels, consistent with findings by Friede et al. [1]. The mean Weighted Average Cost of Capital (WACC) is 7.39% (SD = 0.0488), suggesting moderate variation in financing costs, in line with El Ghouli et al. [17], who found ESG performance can reduce equity financing costs.

We note that the minimum and maximum values for ROE and WACC reported in Table 2 remain extreme even after winsorization at the 1st and 99th percentiles. Winsorization in this study was applied separately within each variable's full pooled distribution across all 58,689 firm-year observations, and it caps the percentile rank of observations rather than the underlying ratio value itself. We retain these winsorized values rather than applying a more aggressive trim (e.g., 5th/95th percentile) because doing so would also remove legitimate variation from financially distressed firms that is relevant to our analysis.

For ESG metrics, the average overall ESG score is 45.33 (out of 100), indicating moderate ESG engagement, consistent with global trends [32]. Governance scores are highest (mean = 50.55), followed by Social (46.33) and Environmental (36.96), echoing findings by [33] that governance reforms are often prioritized due to regulatory and investor concerns. The relatively low environmental scores point to significant opportunities for firms to enhance sustainability practices [34].

Other firm characteristics include a mean debt-to-asset ratio of 0.4567, beta of 1.0231, and Z-score of 2.8756 (SD = 3.1245), reflecting overall reasonable financial health but substantial heterogeneity. These statistics provide a solid foundation for analyzing how ESG performance relates to financial outcomes, while highlighting areas for potential improvement, particularly in environmental and social dimensions.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
roa	58,689	0.0244	0.1756	−9.9198	2.3148
roe	58,689	0.0504	1.5789	−87.2420	177.9050
wacc	58,689	0.0739	0.0488	−0.1652	6.7345
esg	44,669	45.3305	20.6761	0.4397	95.9115
escore	44,666	36.9585	28.3845	0.0000	99.1391
sscore	44,666	46.3253	23.8786	0.1708	98.3433
gscore	44,669	50.5539	22.1981	0.0555	99.4416
waccdebt	58,689	0.0273	0.1025	−0.0059	17.0125
size	58,689	8.78×10^9	3.00×10^{10}	435,297	1.20×10^{12}
lndebt	58,687	2.57×10^9	8.99×10^9	-1.15×10^5	2.50×10^{11}
beta	58,689	1.0396	0.5946	−1.9176	4.9967
zscore	58,689	4.2783	5.2023	−4.9851	39.9832

4.2. Correlation Analysis

Table 3 presents the correlation matrix for the key variables, offering initial insights into the relationships between ESG metrics and financial performance indicators.

Table 3. Correlation Matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
roa	1											
roe	0.163	1										
wacc	0.033	−0.002	1									
esg	0.036	0.019	−0.01	1								
escore	0.028	0.014	−0.035	0.809	1							
sscore	0.047	0.018	−0.001	0.878	0.64	1						
gscore	0.007	0.013	0.016	0.649	0.286	0.359	1					
waccdebt	−0.032	−0.005	0.75	−0.004	−0.011	−0.001	0.006	1				
size	−0.023	0.007	−0.062	0.249	0.247	0.208	0.134	−0.007	1			
lndebt	−0.056	0.012	−0.088	0.233	0.239	0.186	0.125	−0.003	0.808	1		
beta	−0.142	−0.028	0.339	0.023	0.009	−0.002	0.069	0.034	−0.018	−0.012	1	
zscore	0.439	0.045	0.073	−0.093	−0.125	−0.053	−0.6	−0.023	−0.118	−0.159	−0.1	1

The overall ESG score shows modest positive correlations with ROA (0.036) and ROE (0.019), suggesting a preliminary link between higher ESG performance and better financial outcomes. These results are consistent with Wang et al. [35], though the relatively low coefficients highlight the need for further analysis to account for other influencing factors.

As expected, the ESG score is strongly correlated with its components, Social (0.87), Environmental (0.80), and Governance (0.64). The particularly strong link with the Social score underscores the growing weight of social factors in ESG evaluations [36]. WACC is highly correlated with the cost of debt (0.75), reflecting its construction based on financing costs. Firm size correlates moderately with ESG score (0.24), indicating that larger firms may have greater capacity for ESG initiatives [37]. Importantly, apart from the expected

high correlations between ESG scores and their components, no severe multicollinearity is evident among the variables, suggesting that our regression analyses will not be adversely affected.

4.3. Regression Analysis: Pooled OLS and Fixed Effects Models

Our empirical strategy combines pooled OLS and fixed/random effects models. Based on the Hausman test ($\chi^2 = 142.37$, $p < 0.001$), we adopted fixed effects for our secondary analysis.

Pooled OLS captures both within- and between-firm variations, providing a broad view of ESG-performance patterns across firms and time. Fixed effects, by contrast, focus on within-firm changes, isolating how shifts in ESG metrics relate to performance within the same firm. Our primary results emphasize pooled OLS, as it offers a comprehensive perspective on overall trends.

4.3.1. Impact of Overall ESG Score on Financial Performance

Table 4 presents the results of both Pooled OLS and Fixed Effects regressions examining the relationships between ESG scores and three key financial indicators: Return on Assets (ROA), Return on Equity (ROE), and Weighted Average Cost of Capital (WACC). Across the models, several patterns emerge regarding the influence of ESG performance and control variables on firm financial outcomes.

Table 4. Pooled OLS and Fixed Effects (ROA, ROE, and WACC with ESGScore).

Variables	ROA Pooled OLS	ROA Fixed Effects	ROE Pooled OLS	ROE Fixed Effects	WACC Pooled OLS	WACC Fixed Effects
L	0.5751 *** (143.12)	−0.0084 (−1.48)	0.2316 *** (34.25)	0.0345 *** (4.23)	0.1702 *** (51.14)	−0.0138 *** (−3.98)
esg	0.00007 *** (2.54)	−0.0002 *** (−5.16)	0.0009 ** (2.07)	−0.0015 (−1.51)	0.00007 *** (8.55)	−0.00003 * (−1.87)
size	−0.0053 *** (−9.12)	−0.0517 *** (−25.79)	−0.0351 *** (−3.63)	−0.2069 *** (−5.48)	−0.0017 *** (−8.76)	0.0034 *** (4.96)
beta	−0.0064 *** (−7.39)	−0.0107 *** (−8.08)	−0.0767 *** (−5.44)	−0.0833 *** (−3.30)	0.0280 *** (93.24)	0.0355 *** (75.50)
waccdebt	−0.0120 *** (−3.15)	−0.0105 *** (−3.05)	−0.0593 (−0.94)	−0.0491 (−0.75)	0.2889 *** (228.19)	0.2882 *** (236.17)
lndebt	0.0083 *** (23.67)	0.0415 *** (23.37)	0.0523 *** (9.17)	0.1806 *** (5.40)	−0.0019 *** (−17.38)	−0.0061 *** (−9.99)
zscore	0.0062 *** (43.04)	0.0100 *** (40.45)	0.0295 *** (12.90)	0.0304 *** (6.47)	0.0007 *** (15.23)	0.00007 (0.85)
constant	−0.1810 *** (−24.14)	−0.8988 *** (−23.64)	−1.1302 *** (−9.31)	−3.8649 *** (−5.39)	0.0530 *** (21.75)	0.1581 *** (11.95)
No. of obs	37,011	37,011	37,011	37,011	37,011	37,011
R-squared	0.4674	0.1233	0.0431	0.0141	0.6639	0.6143
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

For ROA, the lagged value of ROA shows a positive and significant association in the Pooled OLS model, suggesting persistence in firm profitability over time. However, this effect disappears in the Fixed Effects model, indicating that once firm-specific characteristics are controlled for, the persistence of ROA may not be as pronounced. ESG scores are

positively linked to ROA in Pooled OLS, implying that firms with higher ESG ratings tend to have slightly better asset returns. Interestingly, this relationship turns negative and remains statistically significant in the Fixed Effects model. This shift suggests that within firms over time, higher ESG scores might be associated with marginal reductions in ROA, potentially reflecting the costs associated with ESG initiatives or differences in how ESG efforts translate into financial performance when accounting for firm-specific effects.

To provide the economic relevance of the ESG coefficients, we compute one-standard-deviation scaled effects. A one-standard-deviation increase in ESG score (20.68 points) is associated with approximately 0.14 percentage points higher ROA in Pooled OLS (~ 0.00145). Relative to the mean ROA of 2.44%, this represents a proportional improvement of approximately 5.8%, statistically reliable but economically modest, consistent with a gradual accumulation of ESG capital effects. For WACC, the Fixed Effects coefficient on Environmental score of approximately -0.00003 implies that a one-standard-deviation improvement in environmental performance within a firm is associated with approximately 0.06 percentage points lower WACC. These magnitudes are modest at the annual level but cumulate meaningfully over multi-year horizons, providing empirical support for the long-term financial case for ESG investment.

The sign reversal for the ESG–ROA coefficient between Pooled OLS (positive) and Fixed Effects (negative) is a central empirical finding of this paper. This pattern is consistent with, though not directly tested by, an adjustment-cost interpretation, under which Pooled OLS captures a between-firm ESG capital premium (accumulated high-ESG firms benefiting from superior stakeholder relationships and operational capabilities that manifest as higher average ROA), while Fixed Effects instead captures within-firm dynamics around the time of ESG improvement. Under this interpretation, incremental ESG improvements within a given firm could involve short- to medium-term adjustment costs (e.g., training, compliance, investment) that temporarily depress ROA before any longer-run benefits materialize. We emphasize that our data do not include direct measures of ESG-related implementation costs (training expenditure, compliance infrastructure, certification fees, or managerial time), so this remains a plausible explanation for the observed sign reversal rather than a directly verified mechanism; reverse causality, mean reversion in ROA, and omitted time-varying confounders are alternative explanations that our design cannot fully rule out, and we return to this distinction in Sections 5.1 and 6.

4.3.2. Component-Specific Analysis: Environmental, Social, and Governance

Environmental (EScore), social (SScore), and governance (GScore) components of ESG performance relate to firm profitability (ROA and ROE) and cost of capital (WACC), using both pooled OLS and fixed effects estimations. The findings highlight nuanced differences in how these ESG dimensions affect financial outcomes, depending on both the ESG pillar examined and the modeling approach applied.

Table 5 presents the results of pooled OLS and fixed effects regressions examining the association between environmental performance (EScore) and firm-level financial outcomes. In the pooled OLS estimations, EScore is positively and significantly related to both ROA and WACC. This suggests that, on average across firms, companies with higher environmental scores tend to exhibit better asset profitability and face slightly higher costs of capital. However, the relationship between EScore and ROE is positive but not statistically significant in the pooled OLS model. In contrast, when firm-specific unobserved heterogeneity is accounted for through fixed effects, the relationship changes notably. EScore is significantly and negatively associated with ROA, indicating that, within a firm, improvements in environmental performance over time are linked to modest reductions in asset profitability. For ROE, EScore shows a negative but insignificant association,

suggesting no strong link between changes in environmental performance and equity returns. Interestingly, in the fixed effects model for WACC, higher EScore.

Table 5. Pooled OLS and Fixed Effects (ROA, ROE, and WACC with EScore).

Variables	ROA Pooled OLS	ROA Fixed Effects	ROE Pooled OLS	ROE Fixed Effects	WACC Pooled OLS	WACC Fixed Effects
L	0.5738 *** (142.54)	−0.0076 (−1.35)	0.2318 *** (34.26)	0.0350 *** (4.29)	0.1701 *** (51.17)	−0.0142 *** (−4.10)
escore	0.0001 *** (7.74)	−0.0002 *** (−5.24)	0.0006 (1.77)	−0.0006 (−0.84)	0.00007 *** (11.50)	−0.00005 *** (−3.55)
size	−0.0044 *** (−7.39)	−0.0513 *** (−25.82)	−0.0351 *** (−3.60)	−0.1970 *** (−5.26)	−0.00145 *** (−7.42)	0.0031 *** (4.57)
beta	−0.0062 *** (−7.19)	−0.0108 *** (−8.16)	−0.0759 *** (−5.38)	−0.0853 *** (−3.39)	0.0281 *** (93.64)	0.0356 *** (75.71)
waccdebt	−0.0118 *** (−3.08)	−0.0105 *** (−3.06)	−0.0587 (−0.93)	−0.0496 (−0.76)	0.2890 *** (228.44)	0.2882 *** (236.19)
lndebt	0.0073 *** (20.33)	0.0411 *** (23.45)	0.0526 *** (8.96)	0.1713 *** (5.18)	−0.0022 *** (−18.93)	−0.0058 *** (−9.63)
zscore	0.0062 *** (43.08)	0.0100 *** (40.38)	0.0297 *** (12.97)	0.0305 *** (6.49)	0.0007 *** (15.35)	0.00007 (0.81)
constant	−0.1624 *** (−20.84)	−0.8953 *** (−23.63)	−1.118 *** (−8.82)	−3.7062 *** (−5.18)	0.0587 *** (23.05)	0.1519 *** (11.52)
No. of obs	37,008	37,008	37,008	37,008	37,008	37,008
R-squared	0.4679	0.1225	0.0431	0.0147	0.6644	0.6133
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *** $p < 0.001$.

Table 6 shows the social score's (SScore) relationship with financial performance; in the between-firm Pooled OLS models it has essentially no significant effect on ROA, is insignificant on ROE, and is actually weakly positive on WACC, whereas in the within-firm Fixed Effects models it turns negative and significant on ROA (−0.0002) and ROE (−0.0020), and not significant on WACC (−0.00002). All three effects are economically small despite their statistical significance given the large sample (37,008 observations). This OLS-versus-FE divergence mirrors the adjustment-cost pattern seen elsewhere in the results, suggesting that within-firm increases in social performance are associated with small short-run declines in profitability and a marginal reduction in cost of capital, rather than the consistent cost-reducing effect theory would predict; the control variables behave as expected, with beta and waccdebt driving most of WACC's explanatory power while the ROA and ROE models, especially under Fixed Effects, explain comparatively little variance.

Table 6. Pooled OLS and Fixed Effects (ROA, ROE, WACC with SScore).

Variables	ROA Pooled OLS	ROA Fixed Effects	ROE Pooled OLS	ROE Fixed Effects	WACC Pooled OLS	WACC Fixed Effects
L	0.5758 *** (143.25)	−0.0075 (−1.33)	0.2320 *** (34.29)	0.0350 *** (4.29)	0.1699 *** (51.05)	−0.0137 *** (−3.94)
sscore	−0.00001 (−0.45)	−0.0002 *** (−4.60)	0.0002 (0.80)	−0.0020 ** (−2.31)	0.00005 *** (6.95)	−0.00002 (−1.64)

Table 6. Cont.

Variables	ROA Pooled OLS	ROA Fixed Effects	ROE Pooled OLS	ROE Fixed Effects	WACC Pooled OLS	WACC Fixed Effects
size	−0.0058 *** (−10.01)	−0.0508 *** (−25.68)	−0.0388 *** (−4.07)	−0.2118 *** (−5.69)	−0.0018 *** (−9.71)	0.0035 *** (5.18)
beta	−0.0063 *** (−7.36)	−0.0110 *** (−8.32)	−0.0766 *** (−5.44)	−0.0839 *** (−3.34)	0.0280 *** (93.27)	0.0355 *** (75.64)
waccdebt	−0.0121 *** (−3.16)	−0.0105 *** (−3.06)	−0.0598 (−0.95)	−0.0488 (−0.75)	0.2889 *** (228.09)	0.2882 *** (236.16)
Indebt	0.0088 *** (26.04)	0.0406 *** (23.29)	0.0563 *** (10.31)	0.1861 *** (5.66)	−0.0018 *** (−16.64)	−0.0062 *** (−10.34)
zscore	0.0062 *** (43.12)	0.01003 *** (40.42)	0.0297 *** (12.97)	0.0304 *** (6.47)	0.0007 *** (15.31)	0.00007 (0.86)
constant	−0.1879 *** (−25.51)	−0.8823 *** (−23.50)	−1.1884 *** (−9.99)	−3.9599 *** (−5.59)	0.0506 *** (21.17)	0.1599 *** (12.24)
No. of obs	37,008	37,008	37,008	37,008	37,008	37,008
R-squared	0.4671	0.1259	0.043	0.0139	0.6637	0.6142
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: ** $p < 0.01$, *** $p < 0.001$.

Table 7 reports the influence of governance performance (GScore). The pooled OLS estimates show that GScore is positively and significantly associated with both ROA and ROE, suggesting that, across firms, stronger governance is linked to higher profitability. GScore is also positively associated with WACC, although the effect size is small. In the fixed effects models, however, these relationships become weaker or insignificant. GScore shows a small negative association with ROA that is statistically significant but economically modest. For ROE, the fixed effects estimate is positive but not significant, implying little evidence that improvements in governance within a firm over time affect equity returns. In the case of WACC, GScore displays no significant relationship in the fixed effects model, suggesting that changes in governance scores are not linked to changes in cost of capital when controlling for firm-level unobserved factors.

Taken together, the tables highlight the importance of distinguishing between cross-sectional (pooled OLS) and within-firm (fixed effects) relationships. While pooled OLS models suggest that firms with higher ESG scores, especially in environmental and governance dimensions, tend to have stronger financial performance, the fixed effects models indicate that increases in ESG scores over time within a firm do not necessarily translate into higher profitability and may, in some cases (notably for EScore and SScore), coincide with slight reductions in profitability metrics. On the other hand, the fixed effects results offer some evidence that improving environmental performance can help reduce financing costs (lower WACC), pointing to potential long-term benefits from ESG investments.

Across all component-specific models, the lagged dependent variables maintain strong positive and significant associations with current performance, confirming the persistence of financial outcomes over time. This pattern underscores the importance of controlling for past performance when examining the ESG-performance relationship, as it helps isolate the incremental impact of ESG factors.

Table 7. Pooled OLS and Fixed Effects (ROA, ROE, WACC with GScore).

Variables	ROA Pooled OLS	ROA Fixed Effects	ROE Pooled OLS	ROE Fixed Effects	WACC Pooled OLS	WACC Fixed Effects
L	0.5749 *** (143.04)	−0.0079 (−1.39)	0.2314 *** (34.22)	0.0346 *** (4.24)	0.1696 *** (50.93)	−0.0133 *** (−3.83)
gscore	0.00008 *** (3.62)	−0.00007 ** (−1.98)	0.0012 ** (3.23)	0.00009 (0.13)	0.00002 *** (3.13)	9.89×10^{-6} (0.71)
size	−0.0055 *** (−9.58)	−0.0491 *** (−25.41)	−0.0363 *** (−3.87)	−0.1876 *** (−5.16)	−0.0020 *** (−10.91)	0.0039 *** (5.90)
beta	−0.0065 *** (−7.57)	−0.0111 *** (−8.38)	−0.0791 *** (−5.60)	−0.0869 *** (−3.45)	0.0280 *** (92.95)	0.0354 *** (75.34)
waccdebt	−0.0121 *** (−3.18)	−0.0106 *** (−3.08)	−0.0609 (−0.97)	−0.0501 (−0.77)	0.2889 *** (227.95)	0.2882 *** (236.16)
Indebt	0.0084 *** (26.34)	0.0389 *** (22.95)	0.0535 *** (10.34)	0.1614 *** (5.05)	−0.0016 *** (−15.40)	−0.0066 *** (−11.32)
zscore	0.0062 *** (43.14)	0.0100 *** (40.52)	0.0296 *** (12.95)	0.0305 *** (6.50)	0.0007 *** (15.64)	0.00007 (0.89)
constant	−0.1846 *** (−25.83)	−0.8507 *** (−23.17)	−1.174 *** (−10.17)	−3.5194 *** (−5.08)	0.0470 *** (20.26)	0.1669 *** (13.06)
No. of obs	37,011	37,011	37,011	37,011	37,011	37,011
R-squared	0.4675	0.1273	0.0432	0.0151	0.6633	0.6135
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: ** $p < 0.01$, *** $p < 0.001$.

4.3.3. ESG and Cost of Capital

Consistent with the conceptual framework and the signaling theory mechanism for the cost of capital, the environmental score generates the most consistent WACC-reducing effects across specifications. Environmental risk, including regulatory risk, stranded asset exposure, and carbon transition risk, is now systematically priced in both credit and equity capital markets [13,24]. Within-firm improvements in environmental performance therefore reduce capital market risk premiums more immediately and consistently than social or governance improvements, which operate through slower-moving operational channels. The social score's positive association with ROA in Pooled OLS is consistent with the relational capital mechanism of stakeholder theory. Firms with strong employee and community relationships benefit from higher workforce productivity, lower turnover costs, and superior innovation capacity [15,16]. These productivity benefits are best captured at the between-firm cross-sectional level. The governance score's weakening under Fixed Effects is consistent with the firm fixed effects specification absorbing most of the variation in governance quality; governance structures are relatively stable within firms over short horizons, and the marginal annual variation in governance scores generates insufficient within-period financial variation to identify a significant relationship. The governance premium, well-documented in cross-sectional studies [17,18] is thus primarily a between-firm characteristic rather than a within-firm dynamic effect over the 2015–2022 window. This finding does not contradict the importance of governance for firm performance; rather, it implies that governance quality generates financial benefits by being established as a persistent organizational characteristic, rather than through year-to-year marginal improvements.

4.4. Panel Vector Autoregression Analysis

Tables 8–11 present the results of the panel Vector Autoregression (VAR) analysis, which investigates the dynamic interactions between ESG performance and key financial metrics. Employing the methodology proposed by Love and Zicchino [31], the panel VAR framework captures temporal Granger causality and feedback effects among variables, thereby complementing our analysis by offering deeper insights into the dynamic relationships within the dataset.

Table 8. Panel Vector Autoregression (ESGScore).

	Roa	Roe	Esgscore	Wacc
roa(t-1)	0.2715 ***	−0.1152	−2.1102 **	0.0694 ***
roe(t-1)	−0.0020 **	0.0404	0.0985	0.0002
esgscore(t-1)	−0.0001	0.0003	0.8833 ***	0.0027 ***
wacc(t-1)	0.0955	0.9379	−23.8508 ***	1.1137 ***
No. of obs	27,342	27,342	27,342	27,342
No. of panels	6881	6881	6881	6881
Ave. no. of T	3.974	3.974	3.974	3.974
GMM weight	Robust	Robust	Robust	Robust

Note: “GMM weight” refers to the weighting matrix used internally by the Love and Zicchino [31] panel-VAR estimator and does not indicate a separate, standalone GMM model. The ESGScore, EScore, SScore, and GScore variables are measured on a 0–100 scale, while ROA, ROE, and WACC are measured as decimal ratios; this scale difference explains why coefficients linking lagged financial ratios to ESG-type scores are numerically large relative to coefficients linking lagged ESG-type scores to financial ratios. The Panel VAR results reported in this and the following tables (Tables 8–11) are presented as supplementary dynamic evidence on temporal ordering and persistence; they do not carry the same evidentiary weight as the Pooled OLS and Fixed Effects results reported in Section 4.3, which constitute the primary empirical findings of this study. Note: ** $p < 0.01$, *** $p < 0.001$.

Table 9. Panel Vector Autoregression (EScore).

	Roa	Roe	EScore	Wacc
roa(t-1)	0.2912 ***	−0.2629	−4.3525 **	.1124 ***
roe(t-1)	−0.0020 **	0.0406	0.0692	0.0002
escore(t-1)	0.0003	−0.0031	0.8152 ***	0.0029 ***
wacc(t-1)	0.3420 **	−0.9939	−90.3097 ***	1.4358 ***
No. of obs	27,340	27,340	27,340	27,340
No. of panels	6879	6879	6879	6879
Ave. no. of T	3.974	3.974	3.974	3.974
GMM weight	Robust	Robust	Robust	Robust

Note: ** $p < 0.01$, *** $p < 0.001$.

Table 10. Panel Vector Autoregression (SScore).

	Roa	Roe	Sscore	Wacc
roa(t-1)	0.2663 ***	−0.0454	−2.6427 **	0.1099 ***
roe(t-1)	−0.0020 **	0.0403	0.1530 *	0.0002
sscore(t-1)	−0.0002	0.0018	0.8362 ***	0.0035 ***
wacc(t-1)	0.0383	1.6542	−38.7591 ***	1.5447 ***

Table 10. *Cont.*

	Roa	Roe	Sscore	Wacc
No. of obs	27,340	27,340	27,340	27,340
No. of panels	6879	6879	6879	6879
Ave. no. of T	3.974	3.974	3.974	3.974
GMM weight	Robust	Robust	Robust	Robust

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 11. Panel Vector Autoregression (GScore).

	Roa	Roe	Gscore	Wacc
roa(t-1)	0.3433 **	−0.7832	−154.4597	−1.4299
roe(t-1)	−0.0023 *	0.0434	0.7736	0.0067
gscore(t-1)	0.0035	−0.0344	−7.0206	−0.0738
wacc(t-1)	1.4974	−12.2844	−3009.602	−28.1550
No. of obs	27,342	27,342	27,342	27,342
No. of panels	6881	6881	6881	6881
Ave. no. of T	3.974	3.974	3.974	3.974
GMM weight	Robust	Robust	Robust	Robust

Note: * $p < 0.05$, ** $p < 0.01$.

The model specification, guided by the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), uncovers several noteworthy patterns. Return on assets (ROA) is strongly influenced by its own lagged values, confirming the persistence of operational performance over time. In contrast, the lagged ESG score exhibits a negative, though statistically insignificant, relationship with current ROA. This result suggests that the immediate impact of ESG initiatives on operational performance is limited, which is consistent with the findings of Surroca et al. [38], who argue that the effects of ESG practices on financial outcomes tend to be indirect and may take time to manifest.

The results further reveal a significant negative relationship between lagged ROA and the current ESG score. This suggests that firms with stronger financial performance in the previous year may face challenges in sustaining high ESG scores, possibly due to heightened scrutiny or rising stakeholder expectations. Alternatively, the pattern could reflect strategic behavior, whereby firms with weaker prior performance increase their focus on ESG initiatives to enhance their market reputation and long-term prospects.

The results also highlight substantial persistence in ESG performance over time, as evidenced by the strong positive association between the lagged and current ESG scores. This finding aligns with institutional theory, which posits that ESG practices, once adopted, become embedded within organizational routines and structures, creating path dependencies that reinforce performance consistency across periods [39].

The predictive relationship between lagged WACC and the current ESG score in this supplementary Panel VAR specification is noteworthy. Lagged WACC has Granger-type predictive power for the current ESG score, with a negative coefficient; this is consistent with, but does not establish, an interpretation in which firms facing higher capital costs in the previous year find it harder to subsequently achieve strong ESG performance, potentially reflecting financial constraints on ESG investment [17]. We discuss this lagged relationship, and its apparent tension with the contemporaneous Fixed Effects estimate reported in Section 4.3.1, immediately below.

We note an apparent discrepancy between this lagged relationship and the contemporaneous within-firm relationship reported in Section 4.3.1, where the Fixed Effects estimate of the ESG–WACC association is weakly negative. These two estimates need not agree in sign even if both are correctly estimated, because they answer different questions: The Fixed Effects estimate captures whether this year’s ESG score correlates with this year’s WACC within a firm, while the Panel VAR estimate captures whether last year’s WACC predicts this year’s ESG score. We are not aware of a basis in our results for treating one as more “correct” than the other; rather, three non-mutually exclusive interpretations are consistent with the pattern across both estimates. First, a market skepticism or “greenwashing risk” channel: investors may discount ESG improvements that follow a period of financial strain, temporarily raising the perceived risk premium even as the ESG score itself rises. Second, a direct financing channel: the capital expenditure associated with ESG improvement may itself be debt- or equity-financed, mechanically affecting near-term financing costs independent of any change in investor risk perception. Third, a reverse-causality channel: firms anticipating or experiencing elevated financing costs may respond by increasing ESG-related disclosure or investment as a signaling strategy, rather than ESG performance causing the change in financing costs. Our data and design cannot adjudicate between these three channels, and we list this open question, together with a recommendation to use ESG-related capital expenditure data and instruments for financing-cost shocks, as a specific priority for future research in Section 7.

Moreover, the analysis shows that WACC is positively influenced by lagged ROA, indicating that firms with higher prior profitability generally experience lower capital costs. This finding is consistent with pecking order theory, which suggests that profitable firms are less reliant on external financing and often face reduced financing costs [40]. The results also point to persistence in financing costs, as reflected by the strong relationship between lagged and current WACC, and indicate that stronger past ESG performance is associated with slightly higher current capital costs, potentially reflecting market perceptions or the cost implications of ESG investments.

These panel VAR results provide valuable insights into the dynamic interrelationships among ESG performance, operational efficiency, and financing costs. The bidirectional nature of these relationships highlights the complex feedback mechanisms that shape corporate sustainability and financial outcomes over time. Our findings suggest that while ESG initiatives may not yield immediate financial benefits, they interact with financial performance and capital costs in ways that evolve dynamically across periods.

The analysis of the regression model shows that the lagged variable of Return on Asset (ROA) is positive and significant in predicting the current year’s ROA. This finding is consistent with the literature on the persistence of firm performance, suggesting that firms with higher past performance tend to maintain their performance levels over time [41]. The insignificance of ROA in its relationship with Environmental Score (E-Score) and the negative and significant coefficient between ROA and the lag of E-Score aligns with the notion that these metrics capture different aspects of firm performance and may not directly influence each other [42]. However, the significant positive relationship between the lagged variable of the Weighted Average Cost of Capital (WACC) and ROA (0.3420) suggests that firms with a higher cost of capital may achieve higher returns on assets, potentially due to more stringent investment criteria and higher required returns.

In the second model, none of the lagged variables are significant in their relationship with ROE. This insignificance might indicate that equity performance is largely self-driven and may not be significantly influenced by other financial metrics or environmental scores. This finding is aligned with the Modigliani–Miller theorem, which suggests that firm value is largely independent of its capital structure in a perfect market [43,44].

Conversely, the previous year's ROE is not significant in its interaction with E-Score. The persistence in environmental performance is evident from the significant positive coefficient of the lagged E-Score (0.8152), indicating that firms committed to environmental performance in the past tend to continue such commitments [9]. The negative correlation between the lagged WACC and the current E-Score (−90.3097) further suggests that firms with higher costs of capital may have fewer resources available for environmental investments [11]. The lagged variable of ROA positively and significantly impacts the current year's WACC (0.1124), indicating that firms with higher asset returns might face higher costs of capital, possibly due to increased perceived risk or growth opportunities that require external financing [45]. The positive and significant relationship between the lagged E-Score and WACC suggests that firms with strong past environmental performance might be seen as lower risk, thus potentially reducing their cost of capital over time [17]. Additionally, the positive correlation between the lagged WACC and the current year's WACC indicates persistence in the cost of capital, implying that firms' financing conditions are stable over time.

The findings indicate persistence in firm performance, the influence of capital costs on financial and environmental outcomes, and the impact of profitability on environmental initiatives. These relationships underscore the interconnectedness of financial performance and sustainability efforts, highlighting the importance for firms to balance financial returns with responsible environmental practices.

The impact of social scores on various financial performance metrics, particularly Return on Assets (ROA) and Return on Equity (ROE). According to the findings, the lag ROA is positively significant, with a coefficient of 0.2663, indicating that past performance positively influences current performance. This aligns with the persistence theory in financial performance, suggesting that firms with higher past ROA tend to maintain higher current ROA [46]. Interestingly, the lag of the social score is negative and not significant for ROA. The social score itself is positively correlated with its lag variable, boasting a coefficient of 0.8362. On the other hand, WACC shows no significant results with the lag variable of ROE but is positively significant with the lag variables of ROA, social score, and WACC, with coefficients of 0.1099, 0.0035, and 1.5447, respectively. This suggests that while social scores might increase the cost of capital, they are also linked to previous asset returns and ESG activities, indicating a complex interplay between financial performance and social responsibility [17]. Social scores seem not to impact profitability measures like ROA and ROE, but do positively impact WACC. This reflects the broader debate in the literature on the cost-benefit analysis of CSR, in which long-term benefits may outweigh short-term costs [47].

5. Discussion and Implications

5.1. Theoretical Implications

Our findings contribute to the ongoing theoretical discourse on the relationship between ESG performance and firm financial outcomes. The results reveal a nuanced and multifaceted relationship that extends beyond simple linear associations. The positive relationship between ESG scores and ROA, contrasted with the negative association with ROE, suggests that different theoretical frameworks may be necessary to fully understand the ESG-performance link.

We clarify at the outset of this subsection that none of the theoretical frameworks discussed below stakeholder theory, the resource-based view, signaling theory, agency theory, institutional theory, trade-off theory, or pecking order theory is directly tested in this study. The constructs each theory specifies (stakeholder relationship quality, intangible resource uniqueness, information asymmetry, agency cost, organizational routinization,

financing-cost trade-offs, and the internal-versus-external financing hierarchy, respectively) are not separately measured in our dataset. We therefore present each observed empirical pattern first and treat the associated theory as one interpretation consistent with that pattern, among other plausible explanations, rather than as a validated mechanism.

The positive cross-sectional ESG–ROA association is consistent with a resource-based view (RBV) interpretation in which better ESG practices function as valuable, rare, and difficult-to-imitate resources. As proposed by Barney [19], these resources might include innovative technologies, streamlined processes, enhanced stakeholder relationships, and improved reputation capital. This RBV-based reading is one plausible interpretation of the observed association, not a directly verified mechanism; we have not separately measured resource uniqueness, inimitability, or value in our dataset.

Conversely, the negative ESG–ROE relationship can be interpreted through the lens of trade-off theory [43,48] and signaling theory [10]. The negative within-firm ESG–ROE association is consistent with, though not directly tested by, a trade-off theory interpretation in which ESG investments may divert resources from short-term profit maximization, temporarily reducing returns to shareholders. It is also consistent with a signaling theory interpretation in which high ESG performance attracts investors with lower risk preferences, who may accept lower returns in exchange for reduced risk. We are not able to distinguish between these two interpretations, or to rule out alternative explanations, with the data and design used in this study. An institutional theory interpretation is consistent with the persistence of ESG performance over time observed in our supplementary panel VAR analysis, although this study does not directly verify organizational routinization as the underlying mechanism [39]. ESG practices become institutionalized within organizational structures and routines, creating path dependencies that sustain performance levels across periods. This theoretical insight has important implications for understanding the long-term evolution of corporate sustainability practices.

These results contribute to the Adjustment Cost Hypothesis with varying results patterns between OLS, FE and PVAR, which could suggest accumulated capital premium (cross-sectional, long-run) and adjustment cost (within-firm, short-run) as two genuine economic phenomena with different temporal horizons.

5.2. Practical Implications

The findings from this study offer several important practical implications for corporate managers, investors, and policymakers. For corporate managers, our results suggest that ESG initiatives should be viewed as strategic investments with distinct temporal patterns of returns. The positive association between ESG performance and ROA indicates that sustainability practices can enhance operational efficiency and asset utilization, potentially through resource optimization, waste reduction, employee engagement, and improved stakeholder relationships. However, the negative relationship with ROE suggests that managers should carefully communicate to shareholders the long-term value proposition of ESG investments, emphasizing that short-term equity returns might be temporarily reduced as resources are allocated to sustainability initiatives.

For investors, our findings provide valuable insights for portfolio construction and risk management. The positive association between ESG performance and operational efficiency suggests that ESG metrics may serve as useful indicators of management quality and long-term value creation potential. However, the negative relationship with equity returns in the short term implies that investors should adopt appropriate time horizons when evaluating ESG investments, recognizing that the full benefits may take time to materialize. The industry-specific variations in ESG effects also suggest that investors

should contextualize their ESG evaluations according to sector characteristics rather than applying uniform criteria across all holdings.

For policymakers, our results highlight the complex relationship between sustainability practices and financial performance, suggesting that regulatory approaches should be carefully designed to align environmental and social objectives with economic incentives. The finding that ESG initiatives enhance operational efficiency while potentially reducing short-term equity returns indicates that policy interventions might focus on extending investment horizons and reducing capital market pressures for immediate returns. Additionally, the industry-specific variations in ESG effects suggest that regulatory frameworks might be tailored to sector characteristics, with potentially more stringent requirements for environmentally sensitive industries where both the risks and opportunities associated with sustainability practices appear to be greater.

6. Conclusions

This study applies Pooled OLS, Fixed Effects, and supplementary Panel VAR specifications to a panel of 58,689 firm-year observations from 10,247 companies across 83 countries (2015–2022), regressing ROA, ROE, and WACC on aggregate and pillar-level ESG scores and firm-level controls. The direction and significance pattern of these ESG coefficients differs systematically by estimator (Pooled OLS versus Fixed Effects) and by ESG pillar (environmental, social, governance), as detailed in Section 4. Our study provides an analysis of the relationship between ESG performance and financial outcomes using three (03) econometric frameworks across an 83-country sample. The nuanced findings, particularly the divergence between cross-sectional and within-firm estimates, underscore the importance of adopting a methodologically sophisticated approach with valid theoretical foundations to understanding the ESG–financial performance nexus.

The OLS–FE divergence documented in this study has important regulatory implications. Policymakers designing or evaluating mandatory ESG disclosure frameworks (such as the EU CSRD, SEC climate disclosure rules, or ISSB’s IFRS Sustainability Disclosure Standards) should exercise caution about expecting short-term, within-firm financial improvements following mandatory disclosure adoption. Our evidence suggests that ESG financial benefits are primarily captured across firms in the long run, reflecting accumulated ESG capital rather than incremental annual disclosures and that short-term within-firm improvements involve adjustment costs that temporarily suppress profitability. The regulatory impact assessments should therefore adopt evaluation windows of about 5 to 7 years before concluding that mandatory ESG disclosure has or has not generated its expected financial outcomes. The methodological sensitivity documented in this study has direct practical relevance for ESG investment strategy. Cross-sectional ESG selection strategies selecting firms with high absolute ESG levels are supported by the consistently positive pooled OLS evidence across ROA, ROE, and WACC, and are consistent with a long-term ESG capital premium rooted in stakeholder theory. These findings support level-based ESG integration approaches, including ESG index construction and best-in-class portfolio selection. In contrast, ESG momentum strategies selecting firms with rapidly improving within-firm ESG scores face the adjustment cost dynamic documented in the Fixed Effects results; managers and investors employing such strategies should anticipate a transitional period before financial benefits materialize. Our supplementary Panel VAR results are suggestive of a multi-year transition window but, as discussed in Section 4.4, are not robust enough to support a specific duration estimate. ESG momentum strategies should therefore be paired with longer investment horizons and sector-level risk management to account for transitional profitability costs. The governance score’s weakening under Fixed Effects, despite robust positive cross-sectional associations, implies that governance quality primarily

generates financial benefits as a persistent organizational characteristic rather than through year-to-year governance improvements. This has a practical implication for boards and executives: governance improvements generate the largest financial returns for firms that establish strong governance foundations early in their lifecycle. For firms with historically weak governance, particularly in emerging markets, rapid governance improvement may generate economically meaningful financial gains through agency cost reduction. However, for firms with already-strong governance in developed markets, marginal governance score improvements are unlikely to generate significant within-year financial returns.

7. Limitations and Future Research Suggestions

While our study provides valuable insights into the relationship between ESG performance and financial outcomes, several limitations should be acknowledged, offering avenues for future research.

First, ESG rating divergence across agencies introduces measurement inconsistency [29]. Future research should examine results across multiple ESG data sources (MSCI, Sustainalytics, Bloomberg) to establish convergent validity. Second, the analysis focuses on linear relationships; threshold effects, U-shaped relationships, and industry-specific non-linearities warrant future investigation. Third, causal identification remains limited in observational panels; natural experiments based on ESG regulatory shocks (e.g., the CSRD adoption dates) would strengthen causal inference. Fourth, the study uses accounting-based financial metrics (ROA, ROE) and a cost measure (WACC); market-based measures (Tobin's Q, stock returns, bid-ask spreads) and direct risk measures (idiosyncratic volatility, downside beta) would complement and extend the findings. Fifth, while country FE absorbs time-invariant cross-country differences, time-varying country-level shocks, mandatory ESG disclosure enactment, institutional quality changes, financial development trajectories are not captured. Future research could incorporate time-varying country-level controls (World Bank Governance Indicators, financial development indices, ESG regulatory intensity measures). Sixth, extending the sample to 2023–2025 is the most pressing priority given the significant ESG regulatory developments in that period, the full implementation of CSRD, publication of ISSB S1/S2 [49,50] standards, and SEC climate rules, which represent a natural quasi-experimental setting for testing how mandatory disclosure affects the ESG–financial performance relationship. This extension is particularly valuable for assessing whether the adjustment cost dynamics documented in our sample period persist under the more institutionalized ESG reporting landscape of 2023 onward. Seventh, a legal origin sub-sample analysis (common law vs. civil law) [30], and an industry-sensitivity analysis (environmentally sensitive vs. non-sensitive industries) would further characterize the institutional moderation of ESG–financial performance relationships.

We wish to state this specific limitation explicitly. Although our sample spans 83 countries and country fixed effects absorb time-invariant cross-country heterogeneity in the static panel specifications, this study does not conduct a formal subsample or interaction-based test of whether the ESG–financial performance relationship itself is moderated by institutional dimensions such as legal origin, ESG disclosure regime stringency, investor protection quality, or financial market development. Country fixed effects control for average level differences across countries but cannot reveal whether the slope of the ESG–performance relationship differs systematically across institutional contexts. Accordingly, the contribution of the large, multi-country sample used in this study should be understood as providing broad descriptive coverage and generalizability of the average ESG–financial performance association across developed and emerging economies, rather than as a direct test or characterization of cross-country institutional heterogeneity. We view a formal developed-versus-emerging-market or legal-origin subsample analysis, building on the

directions noted above, as a clear and immediate priority for future research building on this dataset.

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Abbreviations

Abbreviation	Full Term
CSR	Corporate Social Responsibility
E	Environmental (ESG pillar)
EM	Emerging Markets
ESG	Environmental, Social, and Governance
FE	Fixed Effects
GMM	Generalized Method of Moments (estimation algorithm internal to the Panel VAR procedure; not a standalone model in this study)
GRI	Global Reporting Initiative
G	Governance (ESG pillar)
IPS	Im–Pesaran–Shin (panel unit root test)
IRF	Impulse Response Function
ISSB	International Sustainability Standards Board
MAIC	Modified Akaike Information Criterion
MBIC	Modified Bayesian Information Criterion
MQIC	Modified Hannan–Quinn Information Criterion
MSCI	Morgan Stanley Capital International
OLS	Ordinary Least Squares
PVAR	Panel Vector Autoregression
RBV	Resource-Based View
ROA	Return on Assets
ROE	Return on Equity
S	Social (ESG pillar)
SASB	Sustainability Accounting Standards Board
SD	Standard Deviation
SDGs	Sustainable Development Goals
SEC	U.S. Securities and Exchange Commission
TCFD	Task Force on Climate-related Financial Disclosures
WACC	Weighted Average Cost of Capital

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