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Green Talk, Costly Walk: The Financial Cost of Greenwashing

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ABSTRACT

This study investigates the financial consequences of greenwashing, operationalized as the misalignment between ESG disclosure and actual ESG performance. While prior research has explored the reputational and ethical dimensions of greenwashing, its impact on firms' cost of debt remains underexamined. Drawing on a panel of 411 S&P 500 companies over a 10-year period (2014–2023), we construct two firm-level indicators of greenwashing, grESG and gr2ESG, based on z-scores and percentile ranks, respectively. These measures capture the credibility gap between what firms communicate and what they deliver in terms of sustainability. Using random effects within-between (REWB) models, we decompose structural (between-firm) and temporal (within-firm) effects to assess how ESG inconsistency influences debt pricing. Our findings reveal that the between-firm component of greenwashing is positively and significantly associated with the after-tax cost of debt, suggesting that financial markets interpret ESG misalignment as a persistent reputational trait rather than a short-term deviation. The results are robust across alternative specifications, including models that account for ESG-related controversies. The study contributes to the literature by demonstrating that ESG credibility is a priced financial attribute and that symbolic sustainability efforts, defined as disclosure-oriented or reputational gestures without substantive operational changes, may backfire in terms of financing costs.

1 | Introduction

Sustainability has emerged as a strategic imperative in contemporary business, with environmental dimensions often taking precedence within broader frameworks of Environmental, Social, and Governance (ESG) factors (D'Angelo et al. 2022; López-Cabarcos et al. 2025; da Cunha et al. 2025). Despite some recent anti-ESG narratives, firms are increasingly expected to demonstrate responsible environmental behavior—not only to comply with tightening regulations, such as several European Union ESG regulations, but also to meet growing societal expectations around corporate sustainability (Berrone et al. 2017; Szabo and Webster 2021; Li et al. 2023; Santos et al. 2024). As part of broader corporate social responsibility (CSR) commitments, companies are urged to integrate ESG considerations into their strategic and operational decisions (Yang et al. 2024). In response, many firms have issued environmental pledges and sustainability reports to signal their commitment and enhance their reputational standing (Quintana-García et al. 2022; Chatterjee et al. 2024). However, the credibility of such communications is increasingly under scrutiny.

A growing body of research has documented the phenomenon of greenwashing, defined as the strategic misrepresentation of ESG performance to mislead stakeholders and gain reputational or financial advantages (Delmas and Burbano 2011; Testa et al. 2018; Galletta et al. 2024), though the research agenda is relatively new and not well defined (Montgomery et al. 2024).

This strategic misrepresentation can generate contradictory signals in the marketplace, eroding stakeholder trust and undermining the effectiveness of sustainability-oriented policies (Walker and Wan 2012; Heenipellage et al. 2022; Nygaard and Silkoset 2023). While greenwashing may yield short-term reputational gains, it exposes firms to long-term risks—including reputational damage, regulatory scrutiny, and financial penalties (Heras-Saizarbitoria et al. 2020; Shuang et al. 2024).

Evidence from RepRisk (2023), a global ESG data provider that monitors environmental, social, and governance controversies across more than 100,000 companies in 165 countries, reveals the growing pervasiveness of these practices: Global greenwashing incidents rose by 35% in 2023, with the oil and gas industry leading in cases, followed closely by financial services and banking, which saw a 70% surge. In parallel, recent research has proposed various frameworks to detect and classify greenwashing. Dorfleitner and Utz (2024) outline five pillars of ESG information to construct firm-level indicators. Machine learning has been applied to identify greenwashing in Colombian firms (Henao-Rodríguez et al. 2024), and Nemes et al. (2022) offer an integrated framework for assessing greenwashing claims across actors. Other studies have explored its reputational consequences, such as impacts on customer satisfaction (Ioannou et al. 2023) and dynamics in the hospitality sector (Majeed and Kim 2022), or its association with environmental penalties (Zhou et al. 2024).

Despite this growing literature, the financial consequences of greenwashing remain underexplored, particularly its impact on firms' cost of debt. Moreover, it is unclear whether this relationship reflects persistent reputational traits across firms or short-term behavioral shifts within firms. This distinction is critical, as it speaks to how financial markets interpret ESG inconsistencies: as structural signals of risk or as temporary deviations. Against this backdrop, our study addresses the following research question: Do firms that engage in greenwashing face a higher cost of debt, and does this relationship reflect persistent reputational traits or short-term deviations?

We assume that lenders incorporate ESG criteria into their lending decisions as a part of the risk assessment process (Weber et al. 2010, 2015; Apergis et al. 2022; Battiston et al. 2023). Consequently, greenwashing activities as part of ESG performance should influence credit risk and, therefore, the cost of debt (see, e.g., Eliwa et al. 2021; Apergis et al. 2022; Horobet et al. 2024; Attig et al. 2025; Boccaletti and Gucciardi 2025).

To investigate this hypothesis, we build on the methodology proposed by Yu et al. (2020) and Birindelli et al. (2024), who developed greenwashing indicators based on the gap between ESG disclosure and ESG performance scores. Adopting and extending their approach, we construct two firm-level indicators, grESG and gr2ESG, based on z-scores and percentile ranks, respectively. These measures allow us to capture both the magnitude and distributional characteristics of ESG misalignment.

Methodologically, we employ Random Effects Within-Between (REWB) models, which enable the decomposition of the estimated coefficients into structural (between-firm) and temporal (within-firm) components (see Mundlak 1978; Allison 2009; Wooldridge 2010). This approach enables us to evaluate whether persistent reputational disparities among firms or annual fluctuations in ESG credibility influence the cost of debt. By unpacking these dimensions, our analysis contributes to understanding how greenwashing affects financing conditions and offers empirical insight into the mechanisms through which the market prices ESG inconsistency. For lenders and investors, the results underscore the relevance of monitoring ESG disclosure-performance gaps as part of credit risk assessment. For firms, they highlight the financial risks associated with greenwashing and the potential benefits of credible and consistent sustainability strategies. For regulators, the evidence supports efforts to strengthen ESG disclosure standards and enhance transparency in sustainability reporting.

The remainder of the paper is structured as follows: Section 2 presents the theoretical background and develops the research hypothesis. Section 3 describes the dataset and variables and outlines the empirical strategy. Section 4 presents the results. Section 5 provides robustness checks. Section 6 discusses the findings. Section 7 outlines the theoretical, managerial, and methodological implications of the study. Finally, Section 8 concludes the paper by summarizing the main insights and suggesting directions for future research.

2 | Theoretical Background

2.1 | Greenwashing and ESG Credibility

Greenwashing has emerged as a critical issue in corporate sustainability and ESG reporting, attracting growing scholarly attention due to its potential to distort market dynamics, erode stakeholder trust, and undermine genuine environmental efforts (Delmas and Burbano 2011; Lyon and Montgomery 2015; Galletta et al. 2024; Zioło et al. 2024; Forliano et al. 2025). It refers to the strategic misrepresentation or exaggeration of environmental and social performance, often aimed at misleading stakeholders and enhancing corporate reputation without substantive ESG improvements (see, e.g., Delmas and Burbano 2011; Lyon and Montgomery 2015; ESMA 2023a, 2023b; Birindelli et al. 2024).

This behavior undermines the credibility of ESG disclosures and distorts stakeholder perceptions, thereby increasing reputational and financial risks. Prior research indicates that greenwashing is a multifaceted phenomenon, arising from selective disclosure, ambiguous claims, the omission of unfavorable information, and inconsistencies between reported and actual ESG performance (Wang et al. 2024; Poiriazi et al. 2025). Such greenwashing practices, operationalized as ESG misalignment, complicate the evaluation of corporate sustainability and hinder the development of reliable detection frameworks. From a theoretical standpoint, greenwashing challenges the signaling function of ESG disclosure. According to signaling theory, firms use ESG communication to convey intangible qualities such as ethical commitment and long-term orientation (Spence 1973). However, when disclosure lacks credibility, it increases information asymmetry and generates reputational risk rather than mitigating it (Mahajan et al. 2023; Galletta et al. 2024).

To address this issue, scholars have developed methods to quantify greenwashing by measuring the gap between ESG disclosure and ESG performance, often using third-party ratings or composite indices (Dorfleitner and Utz 2024). These indicators allow researchers to assess the degree of ESG inconsistency and its impact on financial outcomes, including investor trust, credit ratings, and cost of capital. The financial implications of greenwashing are increasingly evident. Firms involved in ESG controversies or exhibiting low ESG credibility face higher borrowing costs, reduced access to sustainable finance instruments, and increased regulatory scrutiny (ESMA 2023a, 2023b; Schneider-Maunoury and Joubrel 2025). These effects are particularly pronounced in sectors such as energy, finance, and consumer goods, where ESG performance is closely monitored, and greenwashing risks are more visible and penalized.

For instance, the financial sector has shown a high concentration of greenwashing controversies among large European firms (ESMA 2023b). In the technology and consumer goods sectors, environmental controversies have been shown to significantly increase the cost of debt and equity, especially when firms attempt to obscure environmental externalities (Horobet et al. 2024). Moreover, empirical evidence from the U.S. bond market confirms that environmental decoupling, used as a proxy for greenwashing, is positively associated with higher bond spreads, particularly in firms operating in opaque information environments (Wang et al. 2025).

ESG credibility, defined as the perceived alignment between disclosure and actual performance, has become a decisive factor in how stakeholders interpret sustainability communication. Credible ESG reporting fosters trust, enhances corporate reputation, and reduces perceived risk, while deceptive or inconsistent disclosure can lead to skepticism, reputational damage, and financial penalties (Poiriazi et al. 2025; Agbakwuru et al. 2024; Horobet et al. 2024; Wang et al. 2025). These dynamics are particularly relevant in financial decision-making, where ESG credibility influences access to capital and the cost of debt.

2.2 | ESG Disclosure, Information Asymmetry, and the Cost of Debt

The cost of debt is a key component of the Weighted Average Cost of Capital (WACC), which reflects the firm's overall risk profile as perceived by creditors and investors. A lower cost of debt reduces the WACC, thereby enhancing the firm's financial flexibility and investment capacity (Damodaran 2012; Brealey et al. 2020). A growing body of literature has examined how ESG disclosure influences debt financing conditions (Raimo et al. 2021; Krueger et al. 2024). One of the primary mechanisms is the reduction of information asymmetry. ESG disclosure provides transparency on non-financial aspects of corporate behavior, enabling creditors to assess long-term viability and risk exposure (Eliwa et al. 2021). In line with stakeholder theory, credible ESG communication fosters trust among stakeholders, including lenders, suppliers, customers, and regulators, thereby lowering perceived credit risk (Boiral 2013; Mahajan et al. 2023).

Moreover, ESG transparency has been shown to discourage earnings management (García-Sánchez and García-Meca 2017), enhance reputational capital (Hsu 2012; Pérez 2015), and improve the quality of financial reporting, all of which contribute to more accurate credit risk assessments (Attig et al. 2013). These attributes are increasingly valued by financial institutions, particularly in bank-based systems and under sustainability-oriented policy frameworks (Alves and Meneses 2024).

Empirical evidence supports these mechanisms across diverse contexts. Xu et al. (2021), analyzing a quasi-natural experiment in China, found that mandatory CSR disclosure led to a reduction in the cost of debt, especially for firms with higher CSR scores and more comprehensive reports. Shad et al. (2020) observed that sustainability disclosure negatively affects debt costs, with stronger effects for environmental and economic dimensions. Similar findings have been reported in Taiwan (Chi et al. 2020), Australia (Bhuiyan and Nguyen 2020), and Europe (Eliwa et al. 2021), as well as in high-pollution industries in China (Fonseka et al. 2019). However, the evidence is not entirely conclusive. Some studies highlight that ESG disclosure can reduce the cost of debt, while others emphasize that inconsistencies or controversies, such as greenwashing, can increase perceived risk and lead to higher borrowing costs (Seele and Gatti 2017; Hamrouni et al. 2019; Galletta et al. 2024; Horobet et al. 2024).

These findings suggest that the financial benefits of ESG disclosure are contingent on its credibility, not merely its presence. In this light, ESG disclosure acts not only as a tool to mitigate information asymmetry but also as a signal of reputational integrity and risk management quality. When disclosure is perceived as credible, it enhances firms' creditworthiness and is rewarded with more favorable financing terms (Delmas and Burbano 2011; Lyon and Montgomery 2015). Conversely, when disclosure is perceived as misleading, the informational and reputational advantages may be nullified or reversed, leading to increased financing costs and regulatory scrutiny (RepRisk 2023; Wang et al. 2025). Therefore, it is not ESG disclosure per se, but rather its perceived credibility, especially in the presence or absence of greenwashing, that becomes the key variable in explaining differences in firms' cost of debt. This insight forms the theoretical foundation for our empirical investigation.

2.3 | Hypothesis Development

The literature on ESG disclosure and corporate finance has consistently emphasized the role of transparency in reducing information asymmetry and enhancing stakeholder trust (see, e.g., Boiral 2013; Romito and Vurro 2021; Mahajan et al. 2023; Zhang et al. 2024). Credible ESG communication enables lenders to assess firms' long-term viability and risk exposure, often resulting in more favorable financing conditions (Eliwa et al. 2021; Raimo et al. 2021). However, as highlighted in recent studies, the financial benefits of ESG disclosure are contingent on its perceived credibility (Hamrouni et al. 2019; Galletta et al. 2024). Our research question asks whether firms that engage in greenwashing face a higher cost of debt, and whether this relationship reflects persistent reputational traits or short-term deviations. Greenwashing, defined as the strategic misrepresentation of ESG performance, undermines disclosure credibility and introduces reputational and regulatory risks that lenders may incorporate into their credit risk assessments (Delmas and Burbano 2011; Lyon and Montgomery 2015; ESMA 2023a). Firms that disclose extensively but perform poorly on ESG metrics may be perceived as opportunistic or deceptive, leading to increased borrowing costs due to heightened risk perception (Poiriazi et al. 2025; Xu et al. 2019)

To capture this dynamic, we build on the conceptual distinction between ESG disclosure and ESG performance, operationalizing greenwashing as ESG misalignment between the two. Following Birindelli et al. (2024) and Dorfleitner and Utz (2024), we construct firm-level indicators (grESG and gr2ESG) that measure this inconsistency. These indicators enable us to examine whether financial markets penalize firms for ESG credibility gaps and whether such penalties are reflected in debt pricing.

Hypothesis 1. *Firms with higher levels of greenwashing (grESG/gr2ESG) face a higher weighted average cost of debt, as lenders incorporate reputational and regulatory risks into credit risk assessment.*

3 | Data, Variables, and Methodology

3.1 | Data Sample

The dataset used for the analysis has an unbalanced panel structure and consists of yearly firm-level observations. Specifically, it includes 411 companies listed on the S&P 500 in 2023, observed over a 10-year period from 2014 to 2023. The sample is based on data availability across the selected time frame, as retrieved from Thomson Reuters' Refinitiv (now LSEG Workspace) and Bloomberg. Nevertheless, to mitigate simultaneity in the estimated methods, all the explanatory variables have been lagged by 1 year, thus dropping the observations of the first year of the series. The total number of observations used for the estimation is equal to 3322. The analysis focuses on the S&P 500, a stock index that includes the largest companies listed in the United States, which could be considered a key indicator of the overall US equity market and economic performance (Carè et al. 2025).

The response variable in the proposed analysis is the after-tax weighted average cost of debt (*WACC Cost of Debt*), measured at the end of each year, representing the effective financing cost of a firm's debt instruments (Maaloul 2018; Caragnano et al. 2020; Raimo et al. 2021). In detail, based on Bloomberg's calculation approach, the cost of debt is defined as "the weighted average cost of debt for the security, calculated using government bond rates, a debt adjustment factor, and the proportions of short and long-term debt to total debt. The debt adjustment factor represents the average yield above government bonds for a given rating class. The lower the rating, the higher the adjustment factor. The debt adjustment factor (AF) is only used when a company does not have a fair market curve (FMC). When a company does not have a credit rating, an assumed rate of 1.38 (the equivalent rate of a BBB + Standard and Poor's long term currency issuer rating) is used" (Bloomberg 2013, 18). In analytical terms (Equation 1),

$$Cost\ of\ debt = \left\{ \left[\left(\frac{SD}{TD} \times \frac{CS}{AF} \right) \right] + \left[\left(\frac{LD}{TD} \times \frac{CL}{AF} \right) \right] \right\} \times [1 - TR] \tag{1}$$

where SD, short-term debt; TD, total debt; CS, pre-tax cost of short-term debt; AF, debt adjustment factor; LD, long-term debt; CL, pre-tax cost of long-term debt; TR, effective tax rate (Raimo et al. 2021)

To operationalize interest, we employed different measures of firms' greenwashing, defined as ESG misalignment between disclosure and performance. First, following Yu et al. (2020), we define greenwashing behavior as the tendency to disseminate a large amount of information on ESG aspects to create a transparent company image, accompanied by poor ESG performance. As a measure of ESG misalignment (greenwashing), we use the definition developed by the above authors and also adopted by Birindelli et al. (2024). Specifically, the authors observed that the Bloomberg ESG disclosure score measures the extent of ESG information publicly disclosed by the firm. At the same time, the LSEG Workspace (ex-Thomson Reuters) ESG Database report provides firm-level ESG performance derived from publicly reported, verifiable data. Following Cerciello et al. (2023) and Taddeo et al. (2024), this hypothesis is further supported by their findings, which highlight that the Bloomberg ESG Disclosure Score reflects only the extent to which a firm reports ESG information, but not necessarily the substance of its ESG practices, and vice versa.

More precisely, the greenwashing score $grESG_{it}$ (Equation 2) for a firm i at time t is calculated as the difference between the normalized Bloomberg ESG disclosure score (Equation 3) and the normalized LSEG Workspace (ex-Refinitiv) ESG performance score, following the specification employed in Yu et al.'s (2020) and Birindelli et al.'s (2024) works (Equation 4):

$$grESG_{it} = Normalized\ ESG\ Disclosure_{it} - Normalized\ ESG\ Performance_{it} \tag{2}$$

where every normalized score (or z-score), expressed as follows,

$$Normalized\ ESG\ Disclosure_{it} = \frac{BloombergESG\ Disclosure_{it} - \overline{X}_{Bloomberg\ ESG\ Disclosure}}{\sigma_{BloombergESG\ Disclosure}} \tag{3}$$

$$Normalized\ ESG\ Performance_{it} = \frac{LSEG\ ESG\ Performance_{it} - \overline{X}_{LSEG\ ESG\ Performance}}{\sigma_{LSEG\ ESG\ Performance}} \tag{4}$$

measures by how many standard deviations the score for firm i at time t deviates from the average score at the same time. Therefore, it represents the firm's relative position to its peers in the score distribution.

We also propose an alternative measure of greenwashing, $gr2ESG_{it}$, based on the percentile ranks rather than z-scores and defined as follows:

$$gr2ESG_{it} = PCrank\_ESG\_Discl_{it} - PCrank\_ESG\_Perf_{it} \tag{5}$$

In Equation (5), the percentile rank of the score for firm i at time t represents the percentage of firms having a score less than firm i at that time. Compared with the z-score transformation, the percentile rank transformation better focuses on the relative performance of firms. Furthermore, it ensures robustness against non-normal (skewed and multimodal) distributions and the presence of outliers.

Regarding the control variables, the analysis employs several covariates accustomed to the current literature (Usman et al. 2019; Caragnano et al. 2020; Gerwanski 2020; Raimo et al. 2021; Carluccio et al. 2023). The first one is the firm size, measured by the natural logarithm of total assets. Prior studies show that bigger firms have better access to external financing, diminishing information asymmetry, and reducing monitoring costs (Graham et al. 2008; Gerwanski 2020). In addition to that, due to economies of scale and greater resilience to shocks, we expect a negative relationship between firm size and the cost of debt (Petersen and Rajan 1994).

The second covariate is profitability, expressed by the return on assets (ROA). Firms with strong profitability are generally more capable of producing cash flows and covering their debt commitments than those with weaker performance. This financial strength lowers their likelihood of default and, consequently, leads to a reduced cost of debt (Graham et al. 2008).

The third one is the revenue growth, expressed as the percentage change in revenues. Firms that face high levels of revenue growth often require additional financing to support and meet investing opportunities, consequently increasing debt costs (Kim and Sorensen 1986).

The last covariate is the level of indebtedness, captured by the debt to total assets ratio, also known as the financial leverage ratio. A firm's indebtedness is inevitably linked to its default risk, and prior studies show that highly leveraged firms face harder debt burdens and a greater likelihood of default (Zhu 2014). The variables used in the analysis are shown in Table 1.

Table 2 reports the descriptive statistics of the variables. Both measures of greenwashing show a slightly positive mean, which signals that the firms, on average, practice greenwashing. Nevertheless, the medians are slightly below zero; therefore, over half of the observations show no evidence of greenwashing. As expected, the measure based on the percentile ranks (gr2ESG) shows less variability than the z-score measure (grESG).

Given the panel structure of the dataset, before estimating appropriate models for hierarchical structures such as these that exploit the two sources of variability (between units and within units over time), it is worth making a few remarks on the decomposition of variability for the variables under consideration. All the variables differ on average across companies and change over time for every company. For both measures of greenwashing, the two sources of variability are quite well balanced, with the between-component slightly prevailing over the within-component. The response variable (the borrowing costs) fluctuates more within companies over time than across companies. The high within-variability suggests sensitivity to macro and microeconomic environments, policy changes, and external shocks such as the Covid-19 pandemic for the period under study. Among the control variables, profitability (ROA) and revenue growth are performance and risk-sensitive indicators that respond to macroeconomic cycles and shocks. Therefore, like the cost of debt, they exhibit a high within-variability. Conversely, total assets and the leverage ratio differ more between companies, with relatively stable trajectories over time. Indeed, they are more structural indicators, reflecting company-specific persistent characteristics.

As for the overall pairwise correlations (Table 3), all the variables except ROA exhibit a positive and significant correlation

TABLE 1 | Variable description.

Variable	Description	Source
WACC Cost of Debt	Weighted average cost of short- and long-term debt, adjusted for tax effects. Calculated using government bond rates, a debt adjustment factor (AF), debt structure proportions, and the firm's effective tax rate. AF reflects the yield spread over government bonds by rating class and is applied only when no fair market curve is available. If no credit rating exists, a default AF of 1.38 (BBB + equivalent) is used.	Bloomberg
grESG	ESG misalignment (greenwashing) which represents the difference between the ESG disclosure z-score and the ESG performance z-score	Bloomberg and LSEG workspace
gr2ESG	ESG misalignment (greenwashing) which represents the difference between the ESG disclosure percentile rank and the ESG performance percentile rank	Bloomberg and LSEG Workspace
Firm size	Natural log of total assets	LSEG Workspace
ROA	Return on assets	LSEG Workspace
Revenue growth	Revenue growth rate	LSEG Workspace
Leverage ratio	Debt to total assets ratio	LSEG Workspace

TABLE 2 | Descriptive statistics.

Variable	N	Mean	Median	Min	Max		Standard deviation
WACC cost of debt	3322	2.538	2.247	0	7.334	Overall	1.310
						Between	0.464
						Within	1.239
grESG	3322	0.007	−0.020	−2.063	2.286	Overall	0.769
						Between	0.652
						Within	0.416
gr2ESG	3322	0.003	−0.025	−0.640	0.645	Overall	0.224
						Between	0.187
						Within	0.126
Firm size	3322	23.761	23.738	19.768	28.012	Overall	1.264
						Between	1.232
						Within	0.310
ROA	3322	7.857	6.073	−61.821	1676.988	Overall	30.061
						Between	11.342
						Within	27.674
Revenue growth	3322	0.091	0.065	−0.731	1.661	Overall	0.205
						Between	0.097
						Within	0.186
Leverage ratio	3322	0.281	0.268	0	1.070	Overall	0.181
						Between	0.171
						Within	0.065

TABLE 3 | Correlation matrix.

Variable	WACC cost of debt	grESG	gr2ESG	Firm size	ROA	Revenue growth	Leverage ratio
WACC cost of debt	1						
grESG	0.046***	1					
gr2ESG	0.047***	0.953***	1				
Firm size	0.053***	−0.039**	−0.026	1			
ROA	0.091	−0.036**	−0.039**	−0.094***	1		
Revenue growth	0.103***	0.024	0.013	−0.061***	0.049***	1	
Leverage ratio	0.137***	0.074***	0.073***	−0.053***	−0.045***	−0.043**	1

Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

with the response variable. The measures of greenwashing are significantly associated with firm size and profitability (negative correlation) and with indebtedness (positive correlation).

3.2 | Methodology

In panel data analysis, researchers typically choose between a fixed effects (FE) model and a random effects (RE) model. Both approaches can be expressed using the same general model specification for unit i:

$$y_{it} = x_{it}\beta + u_i + \varepsilon_{it} \qquad t = 1, 2, \ldots, \tag{6}$$

Here, y_{it} is the time-varying dependent variable, x_{it} the set of time-varying predictors, β the corresponding coefficients, u_i the unit-specific unobserved heterogeneity, and ε_{it} the idiosyncratic error term. The FE model estimates u_i as fixed parameters and relies solely on within-unit variability, while the RE model treats u_i as random variables drawn from a normal distribution and exploits both within- and between-unit variability (Wooldridge 2010).

To address our research questions, we adopt a more flexible model that encompasses both the FE and RE approaches and combines their respective advantages. This specification allows for the distinct estimation of within- and between-unit effects, and is known as the hybrid model—originally proposed by Mundlak (1978) and further developed by Allison (2009). Specifically, we focus on a parameterization referred to in the literature as the random effects within-between (REWB) model (Bell et al. 2019), which takes the following form:

$$y_{it} = \beta_0 + \left(x_{it} - \overline{x}_i\right)\beta_W + \overline{x}_i\beta_B + u_i + \varepsilon_{it}. \qquad t = 1, 2, \ldots, T \quad (7)$$

In this formulation, $\overline{x}_i$ denotes the vector of the time-averaged values for the explanatory variables. The parameters β_W and β_B represent the within-unit and between-unit effects, respectively. This specification offers the advantage of not requiring the choice between FE model and RE model and not delegating that choice to the Hausman test. The REWB model is able to test the equality of internal and external estimates, corresponding to the RE assumption of non-correlation between the u_i term and the regressors, which represents an alternative to the Hausman test. Specifically, for our analysis, the REWB framework allows us to disentangle within-unit and between-unit effects, which is central to our research question. To investigate the impact of greenwashing on debt costs, two models are estimated: the first (Model A1) uses the greenwashing measure constructed with z-scores (grESG), while the second (Model A2) uses the measure based on percentile ranks (gr2ESG). Both models control for firm size, profitability, revenue change, and indebtedness. Furthermore, we included sector and year dummy variables, to control for industry-level and time-related heterogeneity, respectively. We conducted all the statistical analyses using the STATA 18.0 software. Additional diagnostics, including full VIF tables and pairwise correlation matrices for all model specifications, are reported in Appendix A.

4 | Results

Table 4 presents the results of the models' estimation. Following the formulation of Equation (7), each regressor x is split into its within component $x_{it} - \overline{x}_i$ (the deviation from the time mean) and its between component $\overline{x}_i$ (the time mean). In the first case, the coefficients represent the within-unit effects, whereas in the second case, they represent the between-unit effects.

Regarding the impact of greenwashing on debt costs, the primary outcome of Model A1 indicates that the between-coefficient of the greenwashing measure is positive and highly significant. In contrast, the corresponding within-coefficient is not significant. This means that the differences in greenwashing behavior between companies, rather than the variations in greenwashing behavior over time for every company, are what explain the variations in borrowing costs. The result is also valid with the alternative greenwashing measure

TABLE 4 | Random effects within-between (REWB) models.

	Model A1		Model A2	
Within effects				
grESG	−0.039			
	(0.026)			
gr2ESG			−0.077	
			(0.086)	
Firm size	0.142	***	0.144	***
	(0.044)		(0.044)	
ROA	−0.006	***	−0.006	***
	(0.002)		(0.002)	
Revenue growth	0.133	**	0.132	**
	(0.065)		(0.065)	
Leverage ratio	0.673	***	0.674	***
	(0.168)		(0.168)	
Between effects				
grESG	0.091	***		
	(0.027)			
gr2ESG			0.330	***
			(0.093)	
Firm size	−0.050	***	−0.050	***
	(0.014)		(0.014)	
ROA	−0.031	***	−0.032	***
	(0.003)		(0.003)	
Revenue growth	0.309	*	0.333	*
	(0.177)		(0.176)	
Leverage ratio	1.038	***	1.037	***
	(0.103)		(0.103)	
Intercept	3.184	***	3.189	***
	(0.362)		(0.361)	
Sector dummies	Yes		Yes	
Year dummies	Yes		Yes	
R^2 within	0.778		0.778	
R^2 between	0.538		0.539	
R^2 overall	0.745		0.745	
Number of companies	411		411	
Number of observations	3322		3322	

Note: Standard errors in parentheses. The variance-inflation factors (VIF) for the explanatory variables are all less than 1.71; therefore, no multicollinearity issues arise.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

(Model A2). For both models, the equality for within and between estimates should be rejected, which constitutes evidence against the RE assumption. In this case, the REWB model proved helpful because it separated the two effects, showing that only the between effect if the greenwashing measure is significant. In fact, between effects cannot be estimated with FE models, and cannot be estimated separately from within effects in RE models.

The estimated coefficients of the control variables are all significant. With regard to firm size, the two effects (between and within) have opposite signs. All other variables being equal, for a larger company compared to a smaller one, there is a decrease in the average cost of debt (between effect). However, an increase in size over time is associated with an increase in the cost of debt. For the other covariates, the signs of the two effects coincide. An increase in profitability is associated with a reduction in the cost of debt. Conversely, the cost of debt increases on average with both revenue growth and leverage ratio, all other variables being equal. Hypothesis 1 then is confirmed.

As a robustness check, we contrast the REWB model with a FE specification, showed in Table 5.

TABLE 5 | Fixed effects (FE) models.

	Model A1		Model A2	
grESG	−0.039			
	(0.026)			
gr2ESG			−0.074	
			(0.086)	
Firm size	0.137	***	0.138	***
	(0.044)		(0.044)	
ROA	−0.006	***	−0.006	***
	(0.002)		(0.002)	
Revenue growth	0.130	**	0.129	**
	(0.065)		(0.065)	
Leverage ratio	0.666	***	0.666	***
	(0.167)		(0.167)	
Intercept	−1.280		−1.317	
	(1.033)		(1.033)	
Sector dummies	No		No	
Year dummies	Yes		Yes	
R^2 within	0.778		0.778	
R^2 between	0.247		0.251	
R^2 overall	0.703		0.704	
Number of companies	411		411	
Number of observations	3322		3322	

Note: Standard errors in parentheses. The variance-inflation factors (VIF) for the explanatory variables are all less than 1.71; therefore, no multicollinearity issues arise.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

The REWB within coefficient is nearly identical to FE coefficients, which assures that the results are not sensitive to unobserved time-invariant heterogeneity.

5 | Robustness Check Tests

5.1 | Accounting for ESG Controversies in the ESG Performance Evaluation

We derived alternative greenwashing measures by replacing the ESG score with the ESG Combined score, which takes into account any ESG controversies that the company may have encountered.

The ESG Combined score is described by LSEG Data and Analytics (2023) as the "overall company score based on the reported information in the environmental, social and corporate governance pillars (ESG Score) with an ESG Controversies overlay." Specifically, in the event of ESG controversies in a given year, the resulting combined ESG score will be lower than the ESG score.

The estimated models are reported in Table 6. Model B1 includes the measure of greenwashing based on z-scores, whereas model B2 includes the measure based on percentile ranks. As for the estimated models in Table 4, the within coefficient of the greenwashing measure is not significant, while the between coefficient is positive and significant. No differences in estimates are observed compared to those reported in Table 4.

5.2 | Alternative Robustness Analysis Using Dynamic Panel GMM Estimation

To address possible endogeneity between greenwashing and cost of debt, we estimated a two-step system generalized method of moments (GMM) model in a dynamic setting (Roodman 2009; Wintoki et al. 2012). In the model, we treated the within component of the greenwashing measure as endogenous since the short-term ESG behavior may react to the same shocks that affect the cost of debt, thus generating possible reverse causality. We instrumented this regressor using its own lags in differences, assuming that past changes in greenwashing practices are valid predictors of current changes, but not directly correlated with current debt costs. By contrast, the between component of greenwashing, which reflects the long-term ESG orientation, is modeled as predetermined and instrumented externally, since it accounts for persistent corporate practices less likely to be driven by contemporaneous debt market conditions. As an external instrument, following Benlemlih and Bitar (2018), Atif and Ali (2021), and Kong (2023), we used the industry mean greenwashing measure, computed for the *i* company in a given year as the average score of greenwashing across all the firms of the same sector (with the exclusion of the *i* company) in that year. This instrument has been used in the equation in levels. As diagnostic tests, we relied on first-order, AR(1), and second-order, AR(2), serial correlation tests, the Hansen test of over-identifying restrictions, and Diff-in-Hansen tests for the exogeneity of subsets of instruments.

TABLE 6 | Random effects within-between (REWB) model using alternative greenwashing measure.

	Model B1		Model B2	
Within effects				
grESGComb	−0.033			
	(0.020)			
gr2ESGComb			−0.092	
			(0.068)	
Firm size	0.143	***	0.144	***
	(0.044)		(0.044)	
ROA	−0.006	***	−0.006	***
	(0.002)		(0.002)	
Revenue growth	0.132	**	0.131	**
	(0.065)		(0.065)	
Leverage ratio	0.674	***	0.675	***
	(0.168)		(0.168)	
Between effects				
grESGComb	0.068	***		
	(0.025)			
gr2ESGComb			0.246	***
			(0.087)	
Firm size	−0.069	***	−0.070	***
	(0.016)		(0.016)	
ROA	−0.032	***	−0.033	***
	(0.003)		(0.003)	
Revenue growth	0.304	*	0.316	*
	(0.178)		(0.178)	
Leverage ratio	1.046	***	1.048	***
	(0.104)		(0.104)	
Intercept	3.655	***	3.692	***
	(0.385)		(0.388)	
Sector dummies	Yes		Yes	
Year dummies	Yes		Yes	
R^2 within	0.778		0.778	
R^2 between	0.534		0.535	
R^2 overall	0.744		0.744	
Number of companies	411		411	
Number of observations	3322		3322	

Note: Standard errors in parentheses. The variance-inflation factors (VIF) for the explanatory variables are all less than 1.71; therefore, no multicollinearity issues arise.
Significance level: ***$p<0.01$, **$p<0.05$, *$p<0.1$.

Table 7 reports the results of the GMM model. The AR(1) test indicates significant first-order autocorrelation ($p=0.049$), which confirms the expected structure of residuals in models estimated in differences. The AR(2) test fails to detect second-order autocorrelation ($p=0.724$). This supports the validity of the lagged instruments and confirms that the moment conditions underlying the system-GMM estimator are not violated. The Hansen test is not significant ($p=0.234$), meaning that the chosen instruments are valid. Finally, the Diff-in-Hansen test confirms that the subset of instruments used in the levels equation is exogenous ($p=0.182$).[1] Consistent with the previous findings in Table 4, the coefficient of the between effect of greenwashing is significant and positive, whereas the coefficient of the corresponding within effect is not significant. Therefore, the main findings remain unchanged when the endogeneity problem is controlled. Hypothesis 1 is corroborated by the results displayed.

The results, reported in Table 7, confirm the robustness of our main findings: The long-term ESG orientation (between effect) is positively associated with the cost of debt, while the short-term ESG behavior (within effect) remains non-significant.

5.3 | Further Robustness Analysis Using Propensity Score Matching (PSM)

To further address the potential endogeneity bias linked to selection on observables, we employed the propensity score matching (PSM) procedure (Rosenbaum and Rubin 1983). In the first step, we defined a dummy variable (treatment variable) that takes the value of 1 if both greenwashing measures (the time-averaged value and the deviation from the average) are above their respective medians and 0 otherwise (Zhang and Ge 2024). Firms with both greenwashing measures greater than the sample medians constitute the treatment group, whereas the other firms are included in the control group (Fu et al. 2025). Then we ran a logit regression for the binary treatment as a function of the explanatory variables included in the models in the previous section. The predicted estimates from the logit regression were used as the propensity scores to match each observation in the treatment group to an observation in the control group. To this end, we used three different matching criteria: one-to-one matching without replacement (Model 1), one-to-one matching with replacement (Model 2), and the nearest neighbor with $n=2$ (Model 3). Finally, using the matched samples, we estimated the REWB model (Table 8). All the models confirmed the previous findings: the between-coefficient of the greenwashing measures is positive and significant whereas the within-coefficient of the greenwashing measure is not significant. Therefore, the results confirm its validity across all model specifications, supporting Hypothesis 1.

6 | Discussion of Results

6.1 | Greenwashing and Cost of Debt: Between Versus Within Effects

The estimation results presented in Table 4 reveal a consistent and theoretically meaningful pattern: The between-firm component of greenwashing is positively and significantly

TABLE 7 | Two-step system GMM model.

	GMM model	
Within effects		
grESG	−1.576	
	(1.025)	
Firm size	0.074	
	(0.139)	
ROA	−0.007	*
	(0.004)	
Revenue growth	0.367	**
	(0.161)	
Leverage ratio	0.151	
	(0.650)	
Between effects		
grESG	0.098	**
	(0.045)	
Firm size	−0.037	
	(0.027)	
ROA	−0.016	
	(0.018)	
Revenue growth	−0.052	
	(0.322)	
Leverage ratio	0.511	
	(0.605)	
Intercept	2.438	**
	(1.188)	
WACC cost of debt$_{t-1}$	0.562	
	(0.415)	
WACC cost of debt$_{t-2}$	−0.163	
	(0.277)	
Sector dummies	Yes	
Year dummies	Yes	
AR(1) test p-value	0.049	
AR(2) test p-value	0.724	
Hansen test p-value	0.234	
Diff-in-Hansen test p-value	0.182	
Number of instruments	37	
Number of companies	407	
Number of observations	2909	

Note: Standard errors in parentheses.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

associated with the after-tax cost of corporate debt. In contrast, the within-firm component is not statistically significant. This finding holds across both greenwashing measures, based on z-scores and percentile ranks, and remains robust when ESG performance is adjusted for controversies using the ESG Combined score.

The distinction between within- and between-effects is crucial for interpreting the results. It suggests that what matters for explaining variations in borrowing costs is not how a firm's greenwashing behavior evolves, but rather how its behavior compares to that of its peers. In other words, greenwashing is perceived by financial markets as a structural reputational trait, rather than a temporary or opportunistic deviation. Firms that consistently exhibit a greater discrepancy between ESG disclosure and actual ESG performance relative to their industry peers are penalized with higher debt costs.

From a methodological standpoint, the use of random effects within-between (REWB) models proves particularly insightful. Unlike traditional fixed effects (FE) or random effects (RE) models, REWB explicitly separates intra-firm and inter-firm variability, offering a more granular understanding of how greenwashing influences financial outcomes. As highlighted by Bell and Jones (2015), failing to distinguish between these sources of variation can lead to misleading interpretations, especially in panel data settings where both dimensions are relevant.

The rejection of the equality between within and between coefficients further supports the appropriateness of the REWB specification and casts doubt on the validity of the RE assumption. This reinforces the idea that greenwashing is not merely a time-varying signal, but a persistent firm-level characteristic that investors and creditors incorporate into their risk assessments.

These results align with prior literature suggesting that ESG-related reputational risks can affect firms' access to capital and cost of financing (Goss and Roberts 2011; Albuquerque et al. 2019). However, this study adds a novel dimension by showing that the misalignment between ESG communication and performance, rather than ESG performance alone, is a key driver of debt pricing. This supports the view that markets are increasingly sensitive not only to ESG metrics, but also to their credibility and consistency. For policymakers, our findings highlight the importance of establishing clear and enforceable ESG disclosure standards. By demonstrating that financial markets penalize firms for inconsistencies between ESG communication and performance, our study provides empirical support for regulatory initiatives aimed at reducing greenwashing. Stronger and more harmonized ESG standards would not only enhance transparency and comparability across firms, but also mitigate reputational risks and improve the efficiency of capital allocation.

The evidence indicates that greenwashing is financially costly, and that this cost is embedded in the structural perception of the firm rather than in its short-term ESG dynamics. This finding has important implications for corporate communication strategies, investor relations, and the design of ESG rating systems,

TABLE 8 | Propensity score matching.

	Model 1 One-to-one matching without replacement		Model 2 One-to-one matching with replacement		Model 3 The nearest neighbor with $n = 2$	
Within effects						
grESG	−0.016		−0.030		−0.007	
	(0.039)		(0.042)		(0.035)	
Firm size	0.177	***	0.184	***	0.172	***
	(0.065)		(0.069)		(0.061)	
ROA	0.001		0.002		−0.001	
	(0.002)		(0.002)		(0.002)	
Revenue growth	−0.117		−0.124		−0.089	
	(0.085)		(0.090)		(0.080)	
Leverage ratio	0.764	***	0.678	***	0.995	***
	(0.235)		(0.255)		(0.221)	
Between effects						
grESG	0.117	***	0.121	***	0.111	***
	(0.031)		(0.032)		(0.031)	
Firm size	−0.024		−0.024		−0.026	
	(0.019)		(0.020)		(0.019)	
ROA	−0.026	***	−0.024	***	−0.025	***
	(0.004)		(0.004)		(0.004)	
Revenue growth	0.655	***	0.540	***	0.506	**
	(0.190)		(0.180)		(0.199)	
Leverage ratio	0.901	***	0.889	***	0.931	***
	(0.132)		(0.142)		(0.134)	
Intercept	2.554	***	2.580	***	2.634	***
	(0.466)		(0.487)		(0.464)	
Sector dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
R^2 within	0.783		0.780		0.786	
R^2 between	0.732		0.734		0.620	
R^2 overall	0.755		0.754		0.749	
Number of companies	397		389		405	
Number of observations	1678		1513		1994	

Note: Standard errors in parentheses.
Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

which should account for the reputational risks associated with disclosure-performance gaps.

Moreover, the results are consistent with established channels through which *creditors*, including bond investors, rating agencies, and lending institutions, internalize ESG misalignment. First, persistent discrepancies between disclosure and performance generate reputational risk, which is incorporated into credit spreads as a structural signal of weaker credibility. Second, ESG misalignment may raise perceived compliance and regulatory risk, particularly in environments where disclosure quality is increasingly monitored by supervisory authorities and auditors. Third, institutional investors with portfolio-level ESG mandates may adjust capital-allocation decisions away from firms exhibiting lower ESG credibility, thereby increasing their external financing costs. These mechanisms explain why the between-firm component, capturing long-term credibility differences across firms, drives debt pricing, whereas short-term fluctuations do not.

Finally, this paper contributes to the ESG effects literature by showing that markets discount firms' ESG credibility, operationalized as disclosure–performance consistency, through higher costs of debt when credibility is persistently lower than peers, thereby distinguishing structural reputational risk from short-term ESG dynamics.

6.2 | Measuring the Unseen: Robustness of Greenwashing Effects Through Alternative Measures and Endogeneity Controls

To ensure the robustness of our findings and the reliability of the greenwashing–cost of debt relationship, we conducted a series of validation tests using alternative operationalizations of the greenwashing construct. Specifically, we replaced the ESG performance score with the ESG Combined score, which incorporates the presence of ESG-related controversies. This adjustment allows us to account for reputational shocks that may not be captured by standard ESG ratings, thereby enhancing the credibility of the performance metric (Chatterji et al. 2016; Liang and Renneboog 2017). These design choices strengthen the relevance of our findings for ESG effects research: by improving measurement credibility and addressing reputational shocks, we reduce the risk that observed financial penalties are artifacts of rating construction and instead isolate a consistent credibility-driven channel in debt pricing.

The results, reported in Table 6, confirm the core findings of our main models. In both specifications, using z-scores (Model B1) and percentile ranks (Model B2), the between-firm component of greenwashing remains positive and statistically significant, whereas the within-firm component remains non-significant. This consistency across models and measures reinforces the conclusion that the financial penalty associated with greenwashing is not driven by short-term fluctuations in ESG behavior, but rather by persistent reputational differences across firms.

Moreover, the use of percentile rank transformations (gr2ESGComb) offers additional methodological advantages. Unlike z-scores, which assume normality and are sensitive to outliers, percentile ranks are more robust to skewed and multimodal distributions, which are common features in ESG datasets (Eccles et al. 2014). The fact that the results hold under both transformations suggests that our findings are not an artifact of the statistical properties of the greenwashing measure but reflect a genuine economic relationship. The consistency across z-score and percentile-rank operationalizations demonstrates that the credibility channel is not sensitive to distributional assumptions typical of ESG data. This methodological robustness supports generalizability across datasets and rating systems, an important condition for cumulative progress in the ESG effects literature.

The stability of the control variables further supports the robustness of the model. Firm size, profitability, revenue change, and indebtedness remain consistent in their signs and significance levels across all specifications, indicating that the model is well-specified and resilient to changes in the definition of the key independent variable.

In addition to these measurement-based robustness checks, we addressed potential endogeneity concerns using dynamic panel GMM estimation (see Section 5.2). This model accounts for reverse causality between greenwashing and cost of debt by instrumenting the endogenous within-firm component using its own lagged differences, and the between-firm component using external instruments such as the industry mean greenwashing score. The results, reported in Table 7, confirm the robustness of our main findings: The long-term ESG orientation remains positively associated with the cost of debt, whereas the short-term ESG behavior remains non-significant. These findings reinforce the structural nature of the reputational penalty associated with greenwashing and suggest that financial markets respond to persistent ESG inconsistencies rather than to temporary fluctuations. Addressing endogeneity clarifies the direction of influence: persistent ESG inconsistencies, rather than short-term shocks, are associated with higher borrowing costs, strengthening causal interpretation and reinforcing the role of credibility in the ESG–finance nexus.

The stability of the control variables across all specifications further supports the robustness of the model. Firm size, profitability, revenue change, and indebtedness maintain consistent signs and significance levels, indicating that the model is well-specified and resilient to both measurement and endogeneity concerns.

Further robustness checks, reported in Table 8, that adopt propensity score procedures with different matching techniques strengthen the reliability of our empirical strategy and validate the paper's central claim: greenwashing is financially costly, and this cost is embedded in the structural perception of the firm's ESG credibility. The results suggest that financial markets can detect inconsistencies between ESG disclosure and performance, pricing these inconsistencies into the cost of debt, regardless of the method used to measure greenwashing.

Finally, results can also be interpreted in light of legitimacy theory, which suggests that persistent inconsistencies between disclosed and actual ESG practices weaken a firm's social and regulatory standing. This mechanism is becoming more salient under emerging regulatory frameworks—such as the CSRD and the EU Green Bond Standard—which place greater emphasis on credible, verifiable sustainability claims. In this context, the reputational and compliance pressures associated with ESG misalignment may further reinforce the credibility channel documented in our findings.

6.3 | Structural Controls and Firm-Level Determinants of Debt Costs

The control variables in the model exhibit consistent, theoretically grounded patterns, reinforcing the robustness of the estimation and offering additional insights into the structural determinants of corporate borrowing costs.

Firm profitability, measured by return on assets (ROA), shows a negative and statistically significant association with the cost of debt in both its within and between components. This result aligns with the expectation that more profitable firms are perceived as less risky by creditors, thereby benefiting from lower borrowing costs. It also confirms prior findings that profitability serves as a key indicator of financial health and creditworthiness (Altman 1968; Fama and French 2002).

The debt-to-assets ratio is positively and significantly associated with the cost of debt, both within and between firms, suggesting that higher leverage is consistently interpreted by the market as a signal of increased financial risk, leading to higher interest rates on corporate debt. The magnitude and stability of this effect across specifications underscore the importance of capital structure in debt pricing decisions (Modigliani and Miller 1958; Myers 2001).

Firm size, proxied by the natural logarithm of total assets, presents an interesting dual pattern: the within-firm effect is positive, while the between-firm effect is negative. This implies that, over time, increases in firm size may be associated with higher debt costs—possibly due to expansion-related risks or changes in debt composition—whereas, in cross-sectional comparisons, larger firms tend to enjoy lower borrowing costs, likely due to economies of scale, better access to capital markets, and stronger reputational standing (Titman and Wessels 1988).

The change in revenues is positively associated with the cost of debt, suggesting that revenue growth may be perceived as a source of volatility or uncertainty, particularly when not accompanied by improvements in profitability. This finding highlights the critical role of performance indicators in shaping creditor perceptions.

These results confirm that the cost of debt is influenced by a combination of structural firm characteristics and performance dynamics, with effects that remain stable across different model specifications. Crucially, they offer a robust empirical basis for isolating the impact of greenwashing behavior, ensuring that the observed relationship is not confounded by omitted firm-level risk factors. The stability of core firm determinants and the separation of within- and between-firm variation enable us to isolate the incremental pricing effect of ESG credibility net of standard risk drivers. This adds to the ESG effects literature by demonstrating that the cost of debt reflects not only profitability, leverage, and size, but also the structural consistency of ESG signaling—an attribute that investors and creditors appear to monitor and price over time.

7 | Implications

7.1 | Theoretical and Managerial Implications

Our findings contribute to a growing body of literature that views greenwashing not merely as an ethical or reputational issue, but as a phenomenon with tangible financial consequences. The evidence that firms exhibiting higher levels of greenwashing face higher borrowing costs suggests that financial markets are increasingly capable of detecting and pricing ESG inconsistencies. From a theoretical standpoint, this supports the notion that ESG-related information asymmetries are not neutral. Rather, they are interpreted by investors and creditors as signals of opacity, risk, and potential misalignment with long-term value creation (Delmas and Burbano 2011; Lyon and Montgomery 2015). The results reinforce the idea that ESG credibility is a form of intangible capital that influences access to financing and cost of capital, aligning with broader theories of signaling and stakeholder trust (Spence 1973; Freeman 1984).

Managerially, the implications are clear: ESG strategies must be coherent and substantive, not merely communicative. Firms that invest in ESG disclosure without corresponding improvements in ESG performance may experience short-term reputational gains, but are likely to be penalized in financial terms. This calls for a shift from symbolic to substantive ESG engagement, where measurable outcomes match transparency. Moreover, the results suggest that financial actors actively monitor ESG ratings and controversies, and that inconsistencies are priced into debt instruments.

For corporate decision-makers, this underscores the importance of integrating ESG into core business strategy, rather than treating it as a peripheral or marketing-driven function. For regulators and standard-setters, the findings highlight the need for greater harmonization and verification of ESG metrics to reduce the scope for greenwashing and enhance market efficiency.

7.2 | Methodological Contribution

Beyond its substantive findings, this study offers a significant methodological contribution through the use of Random Effects Within-Between (REWB) models. This approach allows for the explicit decomposition of panel data into within-firm and between-firm components, providing a more granular understanding of how greenwashing affects the cost of debt.

Traditional panel models—such as fixed effects (FE) and random effects (RE)—often conflate these two sources of variability or fail to estimate them separately. By contrast, the REWB model demonstrates that only the between-firm variation in greenwashing is statistically significant, while the within-firm variation is not. This distinction is critical, as it reveals that the financial penalty associated with greenwashing is rooted in persistent reputational differences across firms, rather than in short-term behavioral shifts.

This methodological insight has broader implications for ESG research and corporate finance. It suggests that future studies should carefully consider the structure of panel data and the nature of the variables under investigation, particularly when dealing with reputational constructs or strategic behaviors that evolve slowly over time. The REWB framework thus enhances the precision and interpretability of empirical models in sustainable finance.

8 | Concluding Remarks

This study provides compelling evidence that greenwashing is not merely a reputational concern but a structural financial liability. By leveraging random effects within-between (REWB) models, we disentangle firm-level reputational traits from temporal fluctuations, revealing that the cost of debt is significantly affected by persistent ESG inconsistencies across firms. This finding holds across multiple operationalizations of greenwashing and remains robust even when ESG performance is adjusted for controversies.

The implications are clear: financial markets are increasingly attuned not only to ESG metrics but to their credibility. Firms that consistently overstate their sustainability commitments relative to actual performance are penalized with higher borrowing costs, reflecting a deeper skepticism among lenders and investors. In this context, ESG credibility emerges as a form of intangible capital, one that influences access to financing and shapes perceptions of long-term viability. A brief clarification is useful in interpreting these findings. While ESG quality reflects the underlying strength of a firm's environmental, social, and governance performance, ESG credibility refers to the perceived consistency between what a firm discloses and what it actually delivers. This distinction matters for lenders because greenwashing operates through an informational channel: when disclosure is not aligned with performance, creditors discount the reliability of reported ESG claims, revise their expectations about firm transparency and risk management, and price this uncertainty into higher debt costs. Our results show that it is this credibility dimension that is systematically reflected in the cost of debt.

Beyond its empirical contribution, this study invites a broader reflection on the evolving role of ESG in corporate finance. As sustainability reporting becomes more standardized and scrutinized, symbolic compliance is no longer sufficient. Firms must move beyond performative sustainability and embrace coherence between what they disclose and what they deliver. This shift requires not only strategic alignment but also cultural and operational integration of ESG principles.

Methodologically, the use of REWB models proves particularly insightful, allowing for a more granular understanding of how reputational signals are embedded in financial outcomes. The distinction between within- and between-firm effects reveals that greenwashing is perceived not as a temporary deviation but as a persistent trait, one that is priced into debt instruments and reflected in credit risk assessments.

Despite the robustness of our findings, several limitations should be acknowledged. First, the analysis focuses exclusively on large U.S. listed firms in the S&P 500, which may limit the generalizability of the results to smaller firms or different institutional contexts. Second, the measures of greenwashing rely on ESG disclosure and performance scores from Bloomberg and LSEG Workspace, which, while widely used, are subject to methodological biases and may not fully capture the complexity of ESG credibility. Finally, although the REWB model allows us to disentangle between-firm and within-firm effects, potential endogeneity and unobserved heterogeneity cannot be entirely ruled out. These limitations suggest caution in generalizing the results and open avenues for future research, including cross-country analyses, alternative measures of greenwashing, and the exploration of sectoral heterogeneity.

Looking ahead, future research could explore how these dynamics evolve under different regulatory regimes, or how investor activism, media scrutiny, and rating agency methodologies interact with debt markets in shaping the cost of greenwashing. Moreover, comparative studies across jurisdictions and high-carbon sectors or firms with intensive disclosure obligations could shed light on the contextual factors that amplify or mitigate the financial consequences of ESG inconsistency. Building on these directions, further research may also investigate sectoral heterogeneity in the financial impact of greenwashing, as industries differ in their exposure to ESG scrutiny and reputational risk. Comparative cross-country analyses under diverse regulatory regimes could clarify how institutional contexts shape the pricing of ESG credibility. Finally, the role of investor activism in reinforcing or challenging ESG credibility deserves closer examination, as activism may act as a disciplining mechanism that reduces greenwashing and enhances transparency in debt markets. Finally, this study reinforces the idea that sustainable finance must be grounded in substance, not symbolism. The credibility of ESG communication is no longer a peripheral concern—it is a core financial variable that deserves close attention from scholars, practitioners, and policymakers alike.

Author Contributions

S. Taddeo: conceptualization, data curation, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, writing – original draft, writing – review and editing. **A. Regoli:** methodology, software, formal analysis, validation, writing – review and editing. **O. Weber:** writing – original draft, writing – review and editing, validation. **R. Carè:** conceptualization, data curation, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, writing – original draft, writing – review and editing.

Endnotes

[1] The instruments used in the GMM estimation are the following: (1) for differences equation: 4-year lagged grESG within; (2) for levels equation: 4-year lagged WACC Cost of Debt t-1 and WACC Cost of Debt t-2; industry mean grESG; all other control variables.

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Appendix A

Table A1. Model A1—variance inflation factors.

	Variable	VIF
Within effects	grESG	1.000
	Firm size	1.710
	ROA	1.160
	Revenue growth	1.240
	Leverage ratio	1.090
Between effects	grESG	1.300
	Firm size	1.380
	ROA	1.430
	Revenue growth	1.220
	Leverage ratio	1.280

Table A2. Model A1—pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) w.e.—grESG	1.000									
(2) w.e.—Firm size	0.005	1.000								
	(0.774)									
(3) w.e.—ROA	−0.002	0.010	1.000							
	(0.890)	(0.560)								
(4) w.e.—Revenue growth	0.014	0.169	0.279	1.000						
	(0.436)	(0.000)	(0.000)							
(5) w.e.—Leverage ratio	0.011	0.019	−0.190	−0.024	1.000					
	(0.520)	(0.268)	(0.000)	(0.173)						
(6) b.e.—grESG	0.000	0.000	0.000	0.000	0.000	1.000				
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)					
(7) b.e.—Firm size	0.000	0.000	0.000	0.000	0.000	−0.047	1.000			
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.007)				
(8) b.e.—ROA	0.000	0.000	0.000	0.000	0.000	−0.123	−0.388	1.000		
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.000)			
(9) b.e.—Revenue growth	0.000	0.000	0.000	0.000	0.000	0.080	−0.256	0.015	1.000	
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.000)	(0.387)		
(10) b.e.—Leverage ratio	0.000	0.000	0.000	0.000	0.000	0.087	−0.046	−0.081	−0.095	1.000
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.008)	(0.000)	(0.000)	

Note: b.e.: between effects; w.e: within effects. *p*-values in parentheses.

Table A3. Model A2—variance inflation factors.

	Variable	VIF
Within effects	gr2ESG	1.000
	Firm size	1.710
	ROA	1.160
	Revenue growth	1.240
	Leverage ratio	1.090
Between effects	gr2ESG	1.280
	Firm size	1.380
	ROA	1.420
	Revenue growth	1.210
	Leverage ratio	1.280

Table A5. Model B1—variance inflation factors.

	Variable	VIF
Within effects	grESGComb	1.020
	Firm size	1.710
	ROA	1.160
	Revenue growth	1.240
	Leverage ratio	1.090
Between effects	grESGComb	1.440
	Firm size	1.600
	ROA	1.420
	Revenue growth	1.230
	Leverage ratio	1.270

Table A4. Model A2—pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) w.e.—gr2ESG	1.000									
(2) w.e.—Firm size	0.026	1.000								
	(0.138)									
(3) w.e.—ROA	0.003	0.010	1.000							
	(0.845)	(0.560)								
(4) w.e.—Revenue growth	0.013	0.169	0.279	1.000						
	(0.469)	(0.000)	(0.000)							
(5) w.e.—Leverage ratio	0.014	0.019	−0.190	−0.024	1.000					
	(0.430)	(0.268)	(0.000)	(0.173)						
(6) b.e.—gr2ESG	0.000	0.000	0.000	0.000	0.000	1.000				
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)					
(7) b.e.—Firm size	0.000	0.000	0.000	0.000	0.000	−0.032	1.000			
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.066)				
(8) b.e.—ROA	0.000	0.000	0.000	0.000	0.000	−0.117	−0.388	1.000		
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.000)			
(9) b.e.—Revenue growth	0.000	0.000	0.000	0.000	0.000	0.038	−0.256	0.015	1.000	
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.027)	(0.000)	(0.387)		
(10) b.e.—Leverage ratio	0.000	0.000	0.000	0.000	0.000	0.085	−0.046	−0.081	−0.095	1.000
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.008)	(0.000)	(0.000)	

Note: b.e.: between effects; w.e: within effects. *p*-values in parentheses.

Table A6. Model B1—pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) w.e.—grESGComb	1.000									
(2) w.e.—Firm size	−0.029	1.000								
	(0.099)									
(3) w.e.—ROA	−0.051	0.010	1.000							
	(0.003)	(0.560)								
(4) w.e.—Revenue growth	−0.021	0.169	0.279	1.000						
	(0.218)	(0.000)	(0.000)							
(5) w.e.—Leverage ratio	0.015	0.019	−0.190	−0.024	1.000					
	(0.399)	(0.268)	(0.000)	(0.173)						
(6) b.e.—grESGComb	0.000	0.000	0.000	0.000	0.000	1.000				
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)					
(7) b.e.—Firm size	0.000	0.000	0.000	0.000	0.000	0.309	1.000			
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)				
(8) b.e.—ROA	0.000	0.000	0.000	0.000	0.000	−0.121	−0.388	1.000		
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.000)			
(9) b.e.—Revenue growth	0.000	0.000	0.000	0.000	0.000	0.025	−0.256	0.015	1.000	
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.151)	(0.000)	(0.387)		
(10) b.e.—Leverage ratio	0.000	0.000	0.000	0.000	0.000	0.051	−0.046	−0.081	−0.095	1.000
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.003)	(0.008)	(0.000)	(0.000)	

Note: b.e.: between effects; w.e: within effects. *p*-values in parentheses.

Table A7. Model B2—variance inflation factors.

	Variable	VIF
Within effects	gr2ESGComb	1.020
	Firm size	1.710
	ROA	1.160
	Revenue growth	1.240
	Leverage ratio	1.090
Between effects	gr2ESGComb	1.440
	Firm size	1.620
	ROA	1.430
	Revenue growth	1.220
	Leverage ratio	1.270

Table A8. Model B2—pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) w.e.—gr2ESGComb	1.000									
(2) w.e.—Firm size	−0.014	1.000								
	(0.423)									
(3) w.e.—ROA	−0.049	0.010	1.000							
	(0.005)	(0.560)								
(4) w.e.—Revenue growth	−0.019	0.169	0.279	1.000						
	(0.266)	(0.000)	(0.000)							
(5) w.e.—Leverage ratio	0.019	0.019	−0.190	−0.024	1.000					
	(0.284)	(0.268)	(0.000)	(0.173)						
(6) b.e.—gr2ESGComb	0.000	0.000	0.000	0.000	0.000	1.000				
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)					
(7) b.e.—Firm size	0.000	0.000	0.000	0.000	0.000	0.327	1.000			
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)				
(8) b.e.—ROA	0.000	0.000	0.000	0.000	0.000	−0.111	−0.388	1.000		
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.000)	(0.000)			
(9) b.e.—Revenue growth	0.000	0.000	0.000	0.000	0.000	−0.007	−0.256	0.015	1.000	
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.683)	(0.000)	(0.387)		
(10) b.e.—Leverage ratio	0.000	0.000	0.000	0.000	0.000	0.048	−0.046	−0.081	−0.095	1.000
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.005)	(0.008)	(0.000)	(0.000)	

Note: b.e.: between effects; w.e: within effects. *p*-values in parentheses.