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Environmental sectoral classification and ESG signals: Evidence on the cost of debt from the EU Taxonomy

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ABSTRACT

This study examines how sector-level environmental classifications and firm-level ESG performance jointly influence firms' financing conditions. While ESG scores capture the sustainability profile of individual firms, the EU Taxonomy provides a credible framework to classify the environmental sustainability of entire economic sectors. Using a sample of 770 European companies between 2007 and 2022, we document that companies operating in environmentally sustainable sectors according to the EU Taxonomy enjoy lower debt costs regardless of their individual environmental performance, proxied by ESG scores. Conversely, firms in the other sectors experience lower debt cost only when they achieve higher environmental scores. These findings highlight the complementary roles of sectoral classification and firm-level signals in influencing creditors' assessment of environmental risk, and underscore the importance for firms in less sustainable sectors to credibly signal their environmental commitment to improve access to debt finance.

1. Introduction

The integration of environmental risks into financial decision-making has gained substantial momentum over the past two decades, driven by the increasing societal awareness of climate change and supported by empirical findings linking sustainability to firm outcomes. Existing literature demonstrates that sustainability enhances firm value, creditworthiness, and growth prospects (e.g., Bagh et al., 2024b; Bagh et al., 2025; Huang, 2022; Alves and Meneses, 2024). A broad literature shows that sustainability is valued and priced in financial markets at two distinct yet interrelated levels: the firm level, through company-specific signals such as ESG practices, and the sectoral level, through collective assessments of an industry's structural alignment with the low-carbon transition.

At the firm level, higher environmental performance has been consistently associated with lower borrowing costs across multiple jurisdictions, as creditors reward reduced transition risk and lower information asymmetry (Erragragui, 2018; Eliwa et al., 2021; Goss and Roberts, 2011; Apergis et al., 2022; among many others). At the sectoral level, carbon-intensive industries face significantly higher transition risks than sectors inherently compatible with climate goals (Javadi and Masum, 2021; Sautner et al., 2023; Zhang et al., 2024a). However, empirical research rarely examines these two channels jointly. While a few recent studies begin to explore sectoral heterogeneity in the ESG–cost of debt relationship (Zhang et al., 2024b; Li and Adriaens, 2024; Bagh et al., 2025; Shrestha et al., 2025;

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Malik and Kashiramka, 2024), none integrates a regulatory-backed, policy-driven sectoral sustainability classification—such as the EU Taxonomy—to investigate how sector-level and firm-level environmental signals interact in creditors' risk assessments. This represents a critical research gap, especially in Europe, which is widely recognized as the global frontrunner in sustainable finance regulation (Alexander et al., 2025). Understanding whether and how these two types of signals interact is therefore crucial for creditors, who increasingly integrate sustainability considerations into credit risk models, and for policymakers aiming to steer capital flows toward the real-economy investments needed for the net-zero transition.

The EU Taxonomy Regulation (European Commission, 2020), formally introduced in 2020, provides exactly such a classification by identifying economic activities that substantially contribute to climate objectives. Firms' activities in economic sectors in line with these goals are classified as "eligible" and may benefit from improved access to capital due to their contribution to sustainability goals. Although the regulation is recent, its technical screening criteria rest on real characteristics of activities that were already relevant to investors well before 2020. Rather than creating entirely new distinctions, the Taxonomy renders pre-existing differences more visible, comparable, and credible, reinforcing sectoral signals that debt markets likely incorporated earlier. We therefore use it as an ex-post, policy-backed proxy for the sectoral environmental alignment that the market could already perceive before the formal regulation.

At the same time, the private sector has developed alternative approaches to measure corporate sustainability, particularly through ESG (Environmental, Social and Governance) ratings provided by agencies such as MSCI, S&P, and Bloomberg. These ratings evaluate a company's sustainability-related performance and risks based on a structured assessment process. ESG scores are increasingly used for different aims, including the classification of green and brown stocks (e.g. Avramov et al., 2022; Zhou et al., 2022), and have been studied for their relationship with financial market valuation and firm risk.

Prior research has shown that disorderly transition can pose financial risks, especially for firms with activities incompatible with a low-carbon economy (Alessi and Battiston, 2022; Gourdel et al., 2022; Roncoroni et al., 2021). Firms failing to adapt to these transition and regulatory requirements are exposed to a high risk of default, calling for stronger environmental risk management (Dunz et al., 2021). Hence, in this context, environmental performance can serve as a firm-level signal of a company's ability to manage sustainability-linked risks. This can help reduce the company's overall risk profile, allowing it to obtain more favorable financial conditions from creditors and financial institutions. Moreover, previous literature has primarily focused on the relationship between ESG ratings and financial risk at the firm level, leaving industry or sectoral metrics that might be a relevant factor in shaping this link outside the main scope of analysis (e.g., see Erragragui, 2018; Eliwa et al., 2021; Gibson Brandon et al., 2021; Gillan et al., 2021; Kim et al., 2021; Kong, 2023; Shrestha et al., 2025).

While studies have shown that firms with stronger ESG performance enjoy lower borrowing costs in several countries (e.g., Erragragui et al., 2018; Eliwa et al., 2021), empirical evidence examining both firm-level and sectoral influences jointly remains scarce. This represents a significant research gap. Understanding their relative and interacting effects on borrowing costs is therefore relevant for both policymakers and market actors.

Against this background, our study focuses on two interrelated research questions. First, we examine whether firms operating in EU Taxonomy-eligible sectors benefit from a lower cost of debt. Second, we investigate whether firms in non-eligible sectors can achieve similar benefits by signaling their environmental commitment through strong ESG practices. We focus on the environmental pillar of ESG ratings, as it is most closely aligned with the objectives of the EU Taxonomy. Using a panel of 770 listed European firms observed between 2007 and 2022, and employing fixed-effects specifications with an interaction term between Taxonomy eligibility and environmental scores, we provide the first systematic evidence on the joint pricing implications of these two environmental signals in debt markets.

Our results point to two main findings. First, firms in eligible sectors tend to exhibit a lower cost of debt, possibly reflecting lower sustainability-related risk compared to companies in non-eligible sectors. Second, among firms in non-eligible sectors, those with higher environmental ESG scores also benefit from reduced cost of debt, suggesting that ESG performance may act as a compensatory signal for investors in the absence of regulatory classification. Investors especially value environmental commitment when it comes from firms in sectors not primarily associated with sustainable activities. In such contexts, ESG ratings help to reduce information asymmetry between firms and financial institutions, encouraging capital allocation towards firms that are actively improving their practices despite operating in less sustainable industries.

From a theoretical perspective, the study helps to advance signaling theory by showing that the marginal informational value of firm-level environmental performance is context-specific and higher when the sectoral baseline signal is unfavorable. Empirically, it offers the first large-scale test of the EU Taxonomy's relevance for private debt pricing using the regulation as an ex-post identifier of long-standing sectoral differences. From a policy perspective, the results underscore that, while the EU Taxonomy effectively rewards inherently sustainable business models, firm-level ESG ratings remain crucial complementary tools to channel debt capital toward proactive firms in transition-lagging industries. By combining sector-level metrics with company-specific information, policymakers can design more effective policies that speed up the transition process, particularly in industries less associated with sustainable activities, ensuring that capital flows reach firms actively managing their environmental risks.

The remainder of this paper is organized as follows. Section 2 describes the background and defines the research hypotheses. Section 3 presents the data and the empirical strategy. Section 4 shows the main findings, a battery of robustness tests, and heterogeneity analyses. Section 5 concludes.

2. Background and hypotheses development

In this section, we discuss the relevant academic literature that informs our analysis. We begin by presenting the signaling theory, which forms the theoretical foundation of our study, and we analytically develop how environmental signals are interpreted by debt

investors and translated into financing costs. We then provide a structured review of the empirical literature on ESG practices and firms' financing conditions. Lastly, in a dedicated subsection we present the hypotheses that we are going to test in the empirical application, showing precisely how they derive from the theoretical and empirical arguments developed earlier. Table 1 summarizes the literature review into three main strands and highlights the research gap that our paper aims to address.

Firms' environmental sustainability has become one of the main variables of interest in financial markets (see, e.g., Akomea--Frimpong et al., 2022; Battiston et al., 2021; Guo et al., 2024). Stakeholders, regulators and investors increasingly demand greater corporate accountability on environmental practices (Baah et al., 2021). However, climate change does not affect all industries and companies uniformly (Javadi and Masum, 2021; Sautner et al., 2023). While carbon-intensive sectors such as fossil fuels and heavy manufacturing face significant transition risks (Zhang et al., 2024a; Barnes et al., 2020), other sectors such as renewable energy and electric mobility represent transformative opportunities driven by regulatory incentives and growing consumer demand for green products and services. The transition to a low-carbon economy therefore creates space for innovation and new investment flows (Semieniuk et al., 2021; Polzin and Sanders, 2020). This dual perspective underlines the role of the financial sector in addressing climate change, since investors might allocate their capital based on firms' ability to adapt to or benefit from climate-related changes (van Benthem et al., 2022; Venturini, 2022).

2.1. Theoretical framework: signaling theory and transmission mechanisms

Financial and non-financial communication helps to reduce information asymmetry between companies and their stakeholders by providing credible indicators of a firm's unobservable quality and risk profile (see, e.g., Spence, 1973; Campbell and Kracaw, 1980; Ahlers et al., 2015). In the context of sustainable finance, signaling theory offers the analytical framework to understand how a company's environmental commitment can influence its access to debt financing and the price it pays for it (Huang, 2022; Brooks and Oikonomou, 2018). ESG ratings are intended to shape investor perceptions and thereby influence capital allocation (Langohr and Langohr, 2010).

Firms can emit credible environmental signals through two main channels. On one hand, firm-level ESG ratings – particularly the Environmental pillar – act as a visible and costly signal of managerial commitment to environmental stewardship, risk management, and long-term value preservation (Landi et al., 2022). On the other hand, the structural characteristics of the sector in which the firm operates convey an additional signal to sustainability-oriented investors (Mrkajic et al., 2019). The EU Taxonomy provides a novel, regulatory-based, science-backed sectoral indicator that classifies economic activities according to their potential contribution to climate objectives. Because it is backed by public policy and objective technical screening criteria, Taxonomy eligibility may reduce the risk of greenwashing that can affect firm-level disclosures.

We distinguish three main mechanisms through which ESG-related information is incorporated into debt pricing: a risk-mitigation mechanism, a monitoring-cost mechanism, and an investor-demand mechanism.

- Risk-mitigation mechanism: Strong environmental performance (whether signaled at firm or sector level) may lower expected transition risks, physical climate risks, regulatory penalties, and reputational damage, thereby reducing perceived default probability (Bolton and Kacperczyk, 2023; Sautner et al., 2023; Chen et al., 2025b).

Table 1
Literature review and research gap.

Main literature strands	Selection of relevant papers	Conceptual framework	Identified Research Gaps
ESG practices and firms' cost of debt	Goss and Roberts, (2011); Magnanelli and Izzo, 2017; Erragragui (2018); Raimo et al. (2021); Fandella et al. (2023); Gangi et al. (2021); Apergis et al. (2022); Gerwanski (2020); Gigante and Manglaviti (2022); Gonçalves et al. (2022); Sharfman and Fernando (2008); Boccaletti and Gucciardi (2025); Chen et al. (2025a).	ESG investments may reduce information asymmetries between the firm and stakeholders (information asymmetry theory) and act as a signal of long-term commitment to sustainable practices (signaling theory).	This strand highlights uncertainty in ESG ratings increasing debt costs, but lacks sectoral moderation. Our study fills this gap by examining EU Taxonomy eligibility's role in ESG-cost of debt.
ESG practices and sectoral attributes	Hinkel et al. (2020); Barnes et al. (2020); Giese et al. (2021); Alfalih (2023); Zhang et al. (2024a); Pillai et al. (2025).	Sectoral characteristics and institutional context shape how sustainability risks become financial risks.	The moderating role of sectoral sustainability features in shaping ESG–financing links is still underexplored. Our study addresses this by integrating policy-backed Taxonomy classification.
ESG practices, firms' cost of debt and sectoral attributes	Zhang et al. (2024b); Li and Adriaens (2024); Shrestha et al. (2025)	Signaling of ESG practices could be stronger or weaker depending on some specific sectoral attributes. In sectors in which sustainable practices are subject to more emphasis, firms should be inclined to focus more on sustainability risks, also reducing financial risks.	Previous works do not fully consider the sustainability-specific sectoral attributes. We aim to address the following research gap: **Does the effect of ESG practices on the Cost of Debt differ based on the sector's eligibility / alignment to the EU Taxonomy?**

- Monitoring-cost mechanism: Credible third-party or regulatory signals decrease the due-diligence and monitoring effort required by lenders (Goss and Roberts, 2011).
- Investor-demand mechanism: The rapid growth of sustainable investment mandates creates excess demand (and hence lower yields) for assets exhibiting strong environmental signals (Pastor et al., 2021; Zerbib, 2019).

The coexistence of a firm-level ESG signal and a sector-level regulatory sustainability signal raises questions about whether the two are complementary—reinforcing each other—or substitutive, when one reduces the marginal informational value of the other. In other terms, do sector-level Taxonomy eligibility and firm-level ESG performance act as complementary signals, substitutive signals, or does one dominate the other? The credibility and marginal informational value of a signal depend on the context (Connelly et al., 2011). For instance, in sectors deemed non-eligible by the Taxonomy, the absence of a positive sectoral signal may heighten investor uncertainty about transition-risk management; consequently, lenders may rely more heavily on firm-level E scores as a compensatory mechanism. Conversely, in eligible sectors, the strong, policy-backed sectoral signal may already reassure investors about the sustainability of the firm's core business model, potentially rendering additional firm-level effort less decisive. This contextual variation in signal weighting provides the theoretical foundation for the interaction effect we test empirically.

2.2. Empirical evidence on ESG practices and firms' financing conditions

The implementation of ESG practices by firms requires complex and careful consideration since such practices are costly and heavily influence firms' production processes (Wang et al., 2024), while also potentially boosting innovation and long-term resilience (Gan and Yusupov, 2025). ESG initiatives have also been shown to affect firm value relevance (Cassimon et al., 2016; Buchanan et al., 2018), as well as sustainable growth trajectories (Bagh et al., 2024b). The academic literature has also demonstrated how sustainability risks may represent financial risks, focusing its attention on how the financial sector can foster the transition to a greener economy (De Haas, 2024).

Over the last decade, a large body of literature has investigated the link between ESG practices and firms' cost of debt from multiple perspectives (see Table 1 for an overview). Seminal contributions established that higher ESG performance is associated with lower borrowing costs, attributing the effect to reduced information asymmetry and lower perceived risk (Goss and Roberts, 2011; Magnanelli and Izzo, 2017; Eliwa et al., 2021). More recent studies have highlighted additional differences: rating disagreement among agencies increases borrowing costs (Chen et al., 2025b; Christensen et al., 2022), and the relationship between ESG performance and financial outcomes can be non-linear depending on firm size, institutional environment, and performance thresholds (Chen et al., 2025a; Boccaletti and Gucciardi, 2025), with non-linearities being also found in the relationship between ESG and firm's value (de la Fuente et al., 2022; Zhou et al., 2022; Bagh et al., 2024a) and performance (Pu, 2023).

Although many papers examine the ESG-cost of debt relationship within single industries (e.g., energy and renewables: Pinheiro et al., 2024; Hyusein and Cek, 2025), only a few contributions explicitly differentiate or highlight sectoral heterogeneity (Zhang et al., 2024b; Li and Adriaens, 2024; Bagh et al., 2025; Shrestha et al., 2025). Crucially, none of these studies integrates a regulatory-backed, policy-driven sectoral sustainability classification such as the EU Taxonomy when analyzing how sector-level attributes moderate the pricing relevance of firm-level ESG scores in debt markets. This represents a significant gap, especially because the signal sent by ESG practices may be stronger or weaker depending on specific sustainability attributes of the industry in which the firm operates.

In our study, we explore this heterogeneity by examining whether the effect of ESG scores on the cost of debt varies depending on sector-level Taxonomy eligibility. Eligible vs non-eligible sectors act as a contextual moderator, providing an indirect exploration of nonlinearity in a policy-relevant context. Although our empirical strategy relies on a linear panel OLS model with fixed effects, this approach allows us to capture meaningful differences in the ESG–cost of debt relationship across sectors, consistent with broader evidence on context-dependent ESG effects.

2.3. Hypotheses development

Drawing on the mechanisms outlined in Section 2.1 and on the empirical regularities identified in the literature, we develop two testable hypotheses.

First, the EU Taxonomy provides a clear and credible sectoral classification for environmental sustainability. Firms operating in Taxonomy-eligible sectors benefit from a lower perceived risk profile, leading to better financing conditions. Consequently, we expect these firms to enjoy better financing conditions than otherwise similar firms in non-eligible sectors.

H1: *The cost of debt is lower for firms operating in EU Taxonomy-eligible sectors than for firms in non-eligible sectors.*

Second, the effectiveness of the firm-level environmental signal (proxied by the E Score) is contingent on the sectoral context. In non-eligible sectors, where the sectoral signal is weak or negative, investors face greater uncertainty about the firm's ability to manage transition risks. In this context, a high E score becomes a critical compensatory signal that substantially reduces information asymmetry and perceived risk. In eligible sectors, by contrast, the powerful regulatory-backed sectoral signal already reassures lenders about the sustainability of the core business, making additional firm-level performance relatively less informative. We therefore predict a stronger (more negative) effect of E scores on borrowing costs in non-eligible sectors.

H2: *The negative effect of Environmental (E) scores on the cost of debt is stronger for firms operating in non-eligible sectors than for firms in eligible sectors.*

These two hypotheses directly test whether sector-level and firm-level environmental signals function as substitutes or partial complements in the pricing of corporate debt.

3. Data and Empirical strategy

3.1. Dataset description

We use a dataset covering approximately 770 companies operating in Europe from 2007 to 2022, which is the result of a matching of data from different sources: Morgan Stanley Capital Indices (MSCI) ESG, which includes environmental scores at firm-level basis; Orbis, a Bureau van Dijk database, which supplies financial, and accounting information, together with information on the geography and industrial activities at a firm-level basis; the EU Taxonomy regulation (the delegated acts) and the EU Taxonomy Compass to assess sectors' eligibility; Taxonomy Aligned Coefficients (TACs) on a sector basis (NACE 4-digit) are from Alessi and Battiston (2022). Overall, the final dataset is an unbalanced panel of more than 4000 firm-year data points.

We analyze companies' cost of debt by adopting the natural logarithm of the ratio between financial expenditures and the average debt, the latter measured as the average between the amount of debt of the current year and the previous year. To isolate the effect of sector-level eligibility and firm-level environmental performance on the cost of debt, we include a set of control variables capturing key firm characteristics that may affect borrowing conditions. Specifically, we control for firm size (*Total Assets*), as larger firms typically enjoy easier access to credit and lower financing costs; for leverage (*Leverage*), expressed as the ratio of total debt to total assets and reflecting the firm's capital structure and financial risk; for the interest coverage ratio (*Interest Coverage Ratio*), which measures the ability to service debt obligations through operating earnings; for profitability (*ROA*), indicating operational efficiency and financial soundness; and for liquidity (*Current Ratio*), which reflects the availability of liquid resources to meet short-term obligations. Including these variables mitigates potential confounding factors and ensures that the estimated effects of environmental signals on the cost of debt are not driven by underlying differences in firms' financial strength or risk profiles, as suggested in prior studies on signaling and financial characteristics (Campbell and Kracaw, 1980).

We use two different environmental variables. The first is based on the EU Taxonomy of Sustainable Activities. The EU Taxonomy links economic activities to one or more specific industries/sectors (based on the NACE 4-digit classification). Therefore, in our paper we classify companies based on whether they operate in an industry/sector listed in the EU Taxonomy to define their eligibility. However, the taxonomy also allows for a finer definition of firms' alignment with the targets, which requires more careful consideration. We therefore follow the standard approach of Alessi and Battiston (2022), where the Taxonomy Alignment Coefficients (TACs) are constructed using information on the economic structure of the EU so that on average in each sector the TAC is the most plausible guess for the alignment of a firm.

The second environmental-related information is the Environmental Pillar Score from Morgan Stanley Capital Indices (MSCI) ESG, which includes firm level assessments on sustainability-related topics, produced by combining different sources such as companies' disclosures, media sources, and governments and NGOs reports. The *E Score* is a continuous variable ranging from 0 (worst-in-class) and 10 (best-in-class), accounting for companies' environmental performance.

We provide a full description of the variables in Table 2. Summary statistics are reported in Table 3, while Table 4 includes information on pairwise correlations across all sample indicators.

3.2. Empirical strategy

First, we investigate the relationship between the cost of debt and the sector eligibility by estimating the following equation:

$$KD_{it} = \alpha + \beta Eligible_s + \gamma X_{it-1} + \phi_t + \phi_c + \phi_s + \phi_c \times trend + \phi_s \times trend + \epsilon_{it} \quad (1)$$

Where KD_{it} is the cost of debt for firm i in sector s, in year t, measured as the natural log of the ratio between interest expenses and 1-

Table 2
Description of variables.

Variable	Description	Source	Measure
Cost of Debt	Financial Expenditures / Average total debt over two consecutive years.	Orbis (BvD)	Ratio
Cost of Debt (lagged debt basis)	Financial Expenditures / 1-year lagged Total Debt	Orbis (BvD)	Ratio
Eligible Sector	Binary indicator: 1 if sector is considered "eligible" based on the EU Taxonomy, 0 otherwise	EU Taxonomy	Binary
TAC Positive	Binary indicator: 1 if sector has positive Taxonomy Aligned Coefficient based on Alessi and Battiston, (2022)	Alessi and Battiston, (2022)	Binary
Environmental Pillar Score	Environmental assessment (scale: 0–10)	MSCI	Nominal
Total Assets	Balance sheet's assets	Orbis (BvD)	Nominal
Interest Coverage Ratio	EBIT / Financial Expenditures	Orbis (BvD)	Ratio
Debt-to-Capital	Total Debt / Total Assets	Orbis (BvD)	Ratio
ROA	Net Income / Total Assets	Orbis (BvD)	Ratio
Current Ratio	Current Assets / Current Liabilities	Orbis (BvD)	Ratio
CO2 Emissions	Binary indicator: 1 if the firm operates in a country with per capita CO2 emissions above the sample median, and zero otherwise.	WorldBank	Binary

Note: This table includes the name, description, source, and measure of all the variables of the dataset.

Table 3
Summary statistics.

Variable	Obs.	Mean	Std Dev	Median	Min	Max
Cost of Debt (ln)	4627	-0.787	1.650	-0.973	-11.209	12.673
Cost of Debt (1-year lagged debt) (ln)	4627	-0.668	1.711	-0.893	-11.901	5.677
E Score	4267	5.927	1.986	5.800	0.000	10.000
Eligible Sector	4267	0.530	0.499	1.000	0.000	1.000
TAC Positive	4267	0.215	0.411	0.000	0.000	1.000
Tot Assets (ln)	4267	15.964	1.470	15.960	9.686	20.210
Interest Coverage Ratio (ICR)	4267	0.064	0.235	0.035	-1.812	2.168
Debt-to-Capital (ln)	4267	-3.629	1.504	-3.313	-9.769	-0.805
ROA	4267	0.058	0.063	0.057	-0.387	0.320
Current Ratio	4267	1.442	1.223	1.221	0.096	16.319
CO2 Emissions	4627	0.460	0.498	0	0	1

Note: This table provides descriptive statistics (observations, mean, standard deviation, median, minimum and maximum values for all the variables in the dataset).

Table 4
Correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Cost of Debt	1.000										
(2) Cost of Debt (1-year lag debt)	0.898	1.000									
(3) E Score	-0.018	-0.015	1.000								
(4) Eligible Sector	-0.124	-0.129	0.107	1.000							
(5) TAC Positive	-0.084	-0.088	-0.074	0.493	1.000						
(6) Tot Assets	-0.081	-0.093	0.249	0.136	0.147	1.000					
(7) ICR	-0.041	-0.019	-0.030	-0.029	-0.051	-0.039	1.000				
(8) Debt-to-Capital	-0.700	-0.827	0.015	0.095	0.088	0.085	-0.095	1.000			
(9) ROA	-0.043	-0.013	-0.013	-0.003	-0.083	-0.031	0.285	-0.049	1.000		
(10) Current Ratio	0.189	0.224	-0.080	-0.087	-0.086	-0.212	0.007	-0.259	-0.057	1.000	
(11) CO2 Emissions	0.137	0.132	-0.108	-0.068	-0.0136	0.001	0.027	-0.172	0.007	0.087	1.000

Note: This table provides the correlation matrix for all the variables in the dataset.

year lagged debt. *Eligible* is a binary indicator equal to 1 if the sector is eligible according to the EU Taxonomy Regulation, and zero otherwise. X is a vector of control variables at the firm level, which includes *Total Assets*, *Interest Coverage Ratio*, *Leverage*, *Current Ratio*, and *ROA* to consider heterogeneous companies' characteristics such as size, level of indebtedness, and profitability, and ensure the effects of environmental signals on the cost of debt are not driven by firm financial characteristics. All the regressors are 1-year lagged to minimize endogeneity issues in the relationship.

We also include a set of year (ϕ_t), sector (ϕ_s), and country (ϕ_c) fixed effects. Moreover, the full model specification includes country ($\phi_c \times trend$) and sector ($\phi_s \times trend$) time trends to account for any potential temporal pattern independent of the investigated relationship. This panel fixed effects framework is particularly well suited for our setting, as it absorbs unobserved heterogeneity at multiple levels (firm, country, and sector), mitigates concerns of omitted variable bias, and ensures that identification relies on within-firm variation over time rather than on cross-sectional differences. The error term, ϵ_{it}, is clustered at the company level to allow for serial correlation and heteroskedasticity.

The second model estimates the relationship between the Environmental Performance and the Cost of Debt, considering whether the sector in which the company operates is eligible or not. Next, we run the following model, splitting the sample between eligible and non-eligible sectors, and between sectors with positive TAC with respect to sectors with zero TAC:

$$KD_{it} = \alpha + \delta EScore_{i,t-1} + \gamma X_{it-1} + \phi_t + \phi_c + \phi_s + \phi_c \times trend + \phi_s \times trend + \epsilon_{it} \quad (2)$$

As before, the lagged specification of the key regressors reduces simultaneity bias, while the multi-dimensional fixed effects' structure ensures that the estimates are not confounded by unobserved structural differences across countries, sectors, or years. This empirical design therefore provides a robust setting to examine the signaling role of ESG performance and sectoral eligibility on firms' cost of debt.

4. Results

4.1. Main findings

Table 5 reports the main findings of our analysis. Specification 1 shows the estimated coefficients of Eq. (1), which highlights that firms in eligible sectors observe lower cost of debt, confirming our hypothesis (H1). This could be explained by the fact that firms in non-eligible sectors are perceived as riskier by investors who, conversely, do not seem to consider this attribute for companies in eligible sectors. This is in line with previous literature highlighting the important role of industrial characteristics in driving lenders'

perception of borrowers' risks (Amriam et al., 2017). By exploiting this insight, we proceed to estimate model (2) and split the sample based on sector eligibility to study whether higher environmental performance is associated with lower cost of debt across the two sub-samples. We find that companies operating in non-eligible sectors and with superior environmental scores experience lower cost of debt, while for those in eligible sectors we do not find a statistically significant relationship. This is in line with our second research hypothesis (H2). Only in non-eligible sectors is environmental performance associated with a lower cost of debt. In other words, for those sectors, superior environmental performance could signal a lower financial risk to investors, thereby resulting in lower financing costs. We also find the same result when we estimate the model by splitting the sample between non-aligned and aligned sectors (see columns 4 and 5, respectively).

These effects are also economically meaningful. Firms operating in Taxonomy-eligible sectors exhibit cost-of-debt levels on average 19.5 % lower than those of firms in non-eligible sectors. In addition, in non-eligible sectors, a one-standard-deviation improvement in the Environmental Pillar Score (1.99 points) will reduce on average the cost of debt by 12–13 %. This implies that, for a company with a cost of debt equal to 6 %, a one-standard-deviation improvement in the Environmental Score will reduce its cost of debt by 72 basis points. These magnitudes are in line with, or larger than, those documented in recent European studies (e.g., Gigante and Manglaviti, 2022; Eliwa et al., 2021; Alves and Meneses, 2024) and underscore the compensatory role of firm-level environmental performance when the sectoral signal is unfavorable.

Moreover, these results confirm previous literature that shows the industry-specificity behind the relationship between ESG and firms' financial performance (Li and Adriaens, 2024; Shrestha et al., 2025). They also advance the explanation of how specific sectoral ESG attribute might influence the impact of ESG practices development on firms' financing conditions. This perspective is important since, while most literature on ESG practices and the cost of debt finds a negative relationship, showing that better ESG practices are associated with better financing conditions (see, for example, Eliwa et al., 2021; Raimo et al., 2021), some studies find mixed or even positive outcomes (see, for example, Sharfman and Fernando, 2008; Gigante and Manglaviti, 2022; Fandella et al., 2023). Our results may contribute to reconciling these perspectives by offering a new approach that incorporates industry-ESG information into both the assessment of companies' ESG commitments and the evaluation of their creditworthiness.

Our results highlight one important feature of the transformation of sustainability-linked risks into financial risks. Firms operating in eligible sectors enjoy a significant reduction in their cost of debt, regardless of their environmental performance. Our analysis suggests that investors seem to be more inclined to lend at lower rates to firms operating in eligible sectors because of lower perceived risks in the transition to a greener economy. Conversely, companies operating in these sectors experience a higher cost of debt and thus are perceived as riskier by the investors. In non-eligible sectors, firms with higher E scores enjoy lower cost of debt. Investors recognize

Table 5
Baseline findings.

Dependent Variable	Cost of Debt				
	(1)	(2)	(3)	(4)	(5)
Eligible Sector	-0.217***				
	(0.072)				
Environmental Pillar Score		-0.067**	-0.023	-0.056***	-0.038
		(0.027)	(0.022)	(0.021)	(0.043)
Total Asset	-0.076***	-0.040	-0.074**	-0.041	-0.084**
	(0.023)	(0.047)	(0.029)	(0.031)	(0.040)
ICR	-0.433***	-0.383**	-0.415*	-0.437***	0.027
	(0.141)	(0.173)	(0.225)	(0.148)	(0.299)
Debt-to-Capital	-0.759***	-0.769***	-0.688***	-0.751***	-0.729***
	(0.028)	(0.039)	(0.035)	(0.030)	(0.055)
ROA	-1.901***	-1.650**	-1.610***	-1.916***	-1.035
	(0.466)	(0.730)	(0.593)	(0.534)	(1.102)
Current Ratio	-0.019	-0.052	0.068	-0.021	0.047
	(0.036)	(0.041)	(0.057)	(0.036)	(0.091)
Constant	-2.045***	-2.267***	-2.016***	-2.329***	-1.931***
	(0.384)	(0.707)	(0.456)	(0.462)	(0.698)
Observations	4627	2171	2450	3631	993
Adj. R-squared	0.560	0.591	0.543	0.571	0.570
Eligible sector	-	No	Yes	-	-
Aligned sector	-	-	-	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector × Trend	Yes	Yes	Yes	Yes	Yes
Country × Trend	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the results of the OLS panel fixed effects estimations of Eq. (1) (col. 1) and Eq. (2) (col. 2 on the sub-sample of non-eligible sectors, col. 3 on eligible sectors, col. 4 on non-aligned sectors, and col. 5 on aligned sectors). *Cost of Debt* is constructed as the natural logarithm of the cost of debt relative to the average total debt over two consecutive years. *Eligible Sector* is a dichotomous indicator equal to 1 if the sector is eligible according to the EU Taxonomy regulation, and zero otherwise. *Environmental Pillar Score* is a continuous indicator ranging from 0 to 10. Control variables include: *Total Assets*, *Interest Coverage Ratio*, *Leverage Ratio*, *Current Ratio*, and *Return on Assets*. All the regressors are 1-year lagged. The estimations include year, sector × trend, and country × trend fixed effects. Errors are clustered at the company level.

and value these efforts positively, suggesting that environmental responsibility can serve as an important risk mitigation signal in these sectors. These results suggest that firms in less environmentally-friendly sectors need to signal themselves as less risky by improving their environmental practices.

In summary, our analysis shows that sector-level sustainability metrics and firm-level sustainability metrics provide complementary insights. When assessing a company's creditworthiness, investors consistently consider both sector-wide indicators and firm-specific data. At each level, sustainability-related information can influence investor decisions. At the sectoral level, EU taxonomy eligibility and alignment has been recognized as a relevant information that guides firms in the journey toward sustainability. This information can serve as sector-level regulatory sustainability signal, since it informs the market that the firm is operating in a sector that is more inclined towards medium-long-term sustainable goals. Instead, firms operating in sectors that are neither aligned nor eligible under the EU taxonomy, may be more exposed to sustainable risks since their business activities could be perceived as less compatible with the transition toward a low-carbon and climate-resilient economy. At the company level, ESG ratings now are widely adopted as measures of performance on the exposure and management of ESG risks. By obtaining higher ESG ratings, firms can signal themselves and separate themselves from "browner" industry peers, signaling to the market that they are effectively addressing and managing sustainability linked risks. Our analysis unveils that the two signals are relevant: the sectoral-level signal "enables" firms to enjoy a significant reduction in their cost of debt, regardless of their environmental performance, since it represents a lower perceived risks in the transition to a greener economy. Within this framework, the company level signal is important for investors, especially in non-eligible sectors, where better Environmental Performance effectively proves the firm's commitment to reducing this type of risk.

4.2. Robustness test

We conduct a battery of robustness tests to corroborate our baseline findings. We first test the definition of our dependent variable, the cost of debt. In the baseline analysis, we define the cost of debt as the (natural log of the) ratio between financial expenses and the average debt, the latter measured as the average between the amount of debt of the current year and the previous year. Averaging the debt over two consecutive years helps smooth overall debt levels and mitigates the impact of large leverage spikes due to significant debt issuances that have relatively minor effects on the year's interest expenses. To check the robustness of our results to this definition, we replicate our baseline analysis by using as dependent variable the natural logarithm of the ratio between interest expenses of a given year and the amount of debt of the previous year. This definition is more in line with the view that current interest expenses are a consequence of debt raised in the past. Table 6 shows the outcome of this test which confirms our previous findings.

The second robustness test is related to the potential endogeneity issue on the environmental performance variable. In particular, although we include a number of company-level control variables as well as a number of fixed effects, we may be missing important variables that potentially affect both ESG performance and the cost of debt (omitted variable bias). Moreover, even though we use lagged value of the environmental performance, decisions on ESG practices may not be entirely unrelated to decisions on capital structure and potential funding costs (reverse causality). To mitigate these issues, and following prior literature (e.g., Anginer et al., 2018; Chiaramonte et al., 2024), we implement a two-stage least squares (2SLS) instrumental variable approach.

We employ a binary indicator for country-level CO_2 emissions, equal to 1 if per capita emissions exceed the sample median, and zero otherwise. This variable is a natural proxy, as firms in high-emission contexts are systematically rated lower on environmental dimensions, while aggregate emissions should not directly determine firm-level financing costs other than through their effect on Environmental scores.[1]

Table 7 presents the results. Panel A reports the first-stage estimations, confirming that the instrument is strongly correlated with the Environmental Pillar Score, with first-stage F-tests always highly significant. Panel B shows the second-stage results. The Cragg–Donald statistics are above the conventional weak instrument thresholds in all specifications (in Column (2) slightly below the most stringent benchmark). Importantly, the results remain consistent with our baseline estimations and confirm the negative association between environmental performance and the cost of debt.

Lastly, to check whether our results are not driven by a single country or sector, we explore whether excluding one country or one sector at a time influences our results. Specifically, we estimate model (1) and (2) (only in the subsample of non-eligible sectors) 27 and 93 times, excluding one country or one sector in each estimation. Figs. 1 and 2 show the output of these analyses, which highlight that the estimated coefficients are always significant at the 10 % level independently of the exclusion of specific countries or sectors.

4.3. Heterogeneity analyses

Beyond the baseline results, it is important to explore whether and to what extent the signaling role of ESG performance and sector eligibility depends on the context. Firm-specific factors, such as size, visibility, and access to financial markets, may affect how investors interpret ESG signals and sector eligibility. At the same time, broader conditions of the financial systems, such as differences in

[1] We compute this instrument as country-level averages over the sample period 2007–2022. We acknowledge that country-level factors could in principle correlate with unobserved determinants of financing costs; however, the inclusion of macro variables as controls mitigates this concern. For the sake of robustness, in an unreported test available upon request, we have employed a second empirical approach utilizing the country-average Environmental Pillar Score as an instrumental variable to mitigate potential endogeneity issues. Although the instrumental validity of this approach may be subject to discussion, the obtained results are fully aligned with the main findings reported in Table 7, further strengthening the robustness of our conclusions.

Table 6
Robustness: alternative definition of Cost of Debt.

Dependent Variable	Cost of Debt (lagged debt basis)				
	(1)	(2)	(3)	(4)	(5)
Eligible Sector	-0.186***				
	(0.060)				
Environmental Pillar Score		-0.047**	-0.021	-0.044***	-0.049
		(0.022)	(0.019)	(0.017)	(0.042)
Total Asset	-0.078***	-0.042	-0.086***	-0.049*	-0.104***
	(0.020)	(0.042)	(0.025)	(0.027)	(0.036)
ICR	-0.439***	-0.367**	-0.453**	-0.443***	-0.164
	(0.116)	(0.142)	(0.202)	(0.118)	(0.301)
Debt-to-Capital	-0.956***	-0.970***	-0.931***	-0.958***	-0.974***
	(0.013)	(0.019)	(0.020)	(0.014)	(0.032)
ROA	-1.404***	-1.501**	-1.036**	-1.340***	-1.118
	(0.385)	(0.618)	(0.519)	(0.430)	(0.990)
Current Ratio	-0.011	-0.026	0.013	-0.012	0.007
	(0.016)	(0.017)	(0.041)	(0.015)	(0.069)
Constant	-2.673***	-3.020***	-2.543***	-2.962***	-2.210***
	(0.324)	(0.624)	(0.402)	(0.400)	(0.608)
Observations	4631	2174	2451	3635	993
Adj. R-squared	0.746	0.766	0.722	0.752	0.733
Eligible sector	-	No	Yes	-	-
Aligned sector	-	-	-	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector × Trend	Yes	Yes	Yes	Yes	Yes
Country × Trend	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the results of the OLS panel fixed effects estimations of Eq. (1) (col. 1) and Eq. (2) (col. 2 on the sub-sample of non-eligible sectors, col. 3 on eligible sectors, col. 4 on non-aligned sectors, and col. 5 on aligned sectors). *Cost of Debt (lagged debt basis)* is constructed as the natural logarithm of the cost of debt, calculated as financial expenses relative to the total debt from the previous period *Eligible Sector* is a dichotomous indicator equal to 1 if the sector is eligible according to the EU Taxonomy regulation, and zero otherwise. *Environmental Pillar Score* is a continuous indicator ranging from 0 to 10. Control variables include: *Total Assets*, *Interest Coverage Ratio*, *Leverage Ratio*, *Current Ratio*, and *Return on Assets*. All the regressors are 1-year lagged. The estimations include year, sector × trend, and country × trend fixed effects. Errors are clustered at the company level.

Table 7
Robustness: endogeneity tests – instrumental variable test.

Panel A – First Stage				
Dependent Variable	Environmental Pillar Score			
	(1)	(2)	(3)	(4)
CO2 Emissions	-0.704***	-0.192***	-0.424***	-0.514***
	(0.087)	(0.007)	(0.068)	(0.096)
Observations	2175	2456	3635	996
Control variables	Yes	Yes	Yes	Yes
Eligible sector	No	Yes	-	-
Aligned sector	-	-	No	Yes
First stage F's p-value	0.000	0.012	0.000	0.000
Panel B – Second Stage				
Dependent Variable	Cost of Debt			
	(1)	(2)	(3)	(4)
Environmental Pillar Score (second stage)	-0.190**	0.079	-0.228**	0.157
	(0.086)	(0.218)	(0.103)	(0.131)
Observations	2175	2456	3635	996
Control variables	Yes	Yes	Yes	Yes
Eligible sector	No	Yes	-	-
Aligned sector	-	-	No	Yes
Cragg-Donald F	66.168	6.505	40.022	27.705

Notes: In Panel A, we present the results of the first stage of the IV 2SLS estimation, where we instrument our dependent variable (*Environmental Pillar Score*) with per capita country-level *CO2 Emissions*. Panel B presents the results of the second stage of IV 2SLS and reports where we replace the potentially endogenous variables of interest with the results of the first stage and the F-tests. Panel B also reports the Cragg-Donald F for weak instruments.

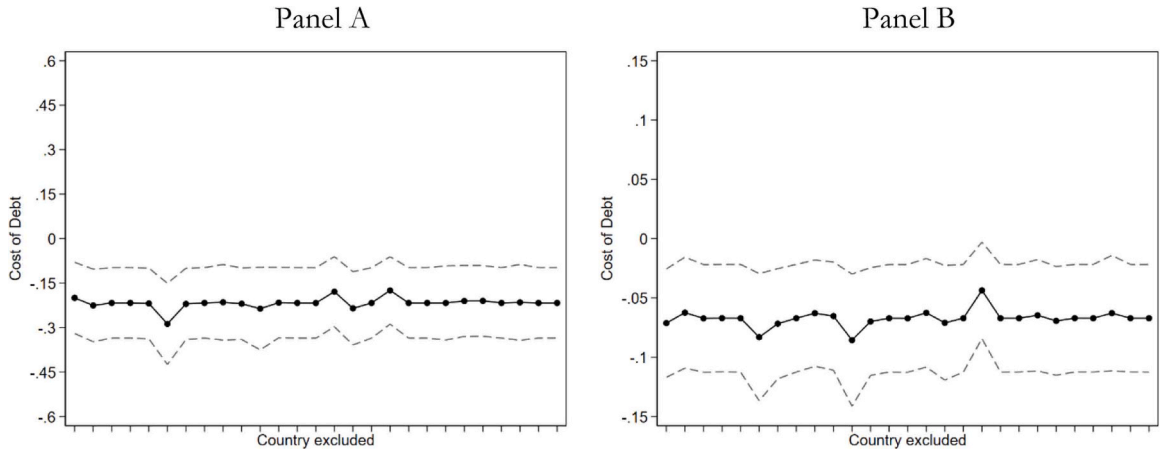

Fig. 1. Country excluded, **Notes**: The figure shows the coefficient estimates and their 10 % confidence intervals from 27 estimations of Eq. (1) (in Panel A) and Eq. (2) on the subsample of firms operating in non-eligible sectors (in Panel B), excluding one country at a time for each estimation. The regressions include all control variables and fixed effects of those included in the baseline estimations presented in Table 5, cols. 1 and 2.

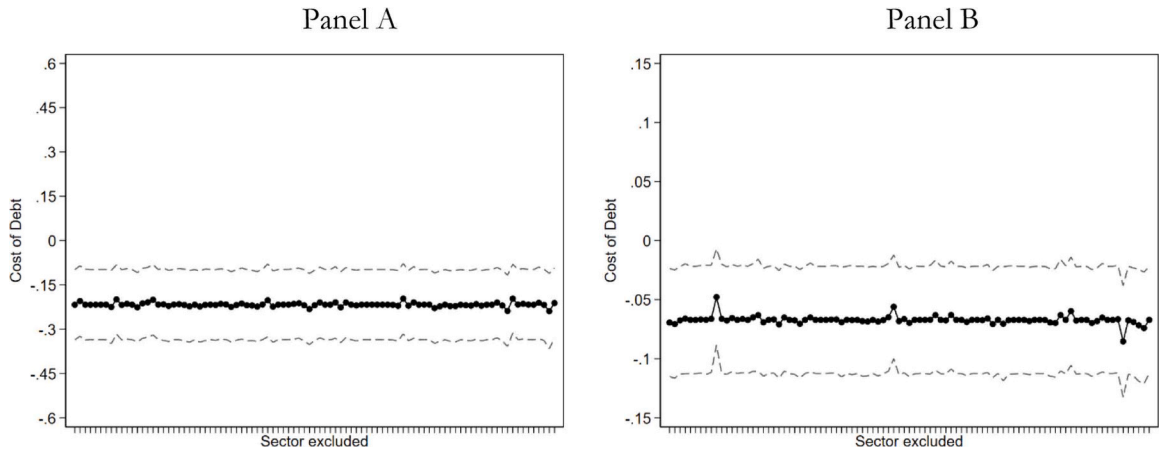

Fig. 2. Sector excluded, **Notes**: The figure shows the coefficient estimates and their 10 % confidence intervals from 93 estimations of Eq. (1) (in Panel A) and Eq. (2) on the subsample of firms operating in non-eligible sectors (in Panel B), excluding one sector (NACE 4-digit) at a time for each estimation. The regressions include all control variables and fixed effects of those included in the baseline estimations presented in Table 5, cols. 1 and 2.

markets, regulatory frameworks, and investor scrutiny across countries, may also influence the effectiveness of ESG and eligibility signaling. To capture these two dimensions, we use firm size and European macro-regions as proxies, and we examine whether the main relationships between ESG performance, sector eligibility, and cost of debt vary along these lines.

We initially focus on firm-specific conditions by examining heterogeneity across company size. Larger firms are typically more visible to investors, subject to greater scrutiny, and may have easier access to financial markets compared to smaller firms, which could in principle strengthen or attenuate the relationship between environmental performance and financing conditions. To test for such heterogeneity, we construct a binary indicator (*High Size*) equal to one for firms with total assets above the sample median, and zero otherwise. We augment the Eqs. (1) and (2) with the interaction terms *Eligible Sector* × *High Size* and *Environmental Pillar Score* × *High Size*, respectively, including all fixed effects and control variables except for *Total Assets* to capture non-linearities in the role of size without introducing redundancy with the continuous asset variable used in the baseline model.

Table 8 reports the results. Column (1) shows that the negative association between sector eligibility and the cost of debt is somewhat stronger for larger firms, as indicated by the negative and significant coefficient of the interaction term. Columns (2) to (5) confirm that the negative relationship between environmental scores and the cost of debt is present only in non-eligible and non-aligned sectors. Since the interaction between environmental scores and firm size is never significant, the cost-of-debt implications of firms' ESG ratings do not differ statistically between smaller and larger firms. Overall, these findings indicate that firm size does not systematically moderate the relationship between environmental performance and financing costs, although sector-level eligibility may serve as a somewhat stronger signal for larger firms.

Next, we investigate how broader financial and market conditions may influence the signaling role of ESG by examining regional

Table 8
Heterogeneity analysis: firm's size.

Dependent Variable	Cost of Debt				
	(1)	(2)	(3)	(4)	(5)
Eligible Sector	-0.141*				
	(0.085)				
Environmental Pillar Score		-0.086***	-0.037	-0.060***	-0.017
		(0.031)	(0.026)	(0.022)	(0.047)
High Size	0.023	0.033	-0.236	0.096	0.231
	(0.083)	(0.224)	(0.194)	(0.163)	(0.350)
Eligible Sector × *High Size*	-0.204**				
	(0.104)				
Environmental Pillar Score × *High Size*		0.008	0.018	-0.017	-0.065
		(0.038)	(0.030)	(0.025)	(0.060)
ICR	-0.435***	-0.382**	-0.431*	-0.437***	0.046
	(0.142)	(0.174)	(0.224)	(0.149)	(0.293)
Debt-to-Capital	-0.759***	-0.769***	-0.688***	-0.750***	-0.729***
	(0.028)	(0.039)	(0.035)	(0.030)	(0.054)
ROA	-1.827***	-1.570**	-1.505**	-1.875***	-0.903
	(0.472)	(0.739)	(0.594)	(0.538)	(1.118)
Current Ratio	-0.007	-0.043	0.079	-0.014	0.054
	(0.035)	(0.041)	(0.054)	(0.036)	(0.089)
Constant	-3.275***	-2.935***	-3.085***	-2.959***	-3.346***
	(0.108)	(0.228)	(0.200)	(0.175)	(0.326)
Observations	4627	2171	2450	3631	993
Adj. R-squared	0.558	0.590	0.541	0.570	0.567
Eligible sector	-	No	Yes	-	-
Aligned sector	-	-	-	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector × Trend	Yes	Yes	Yes	Yes	Yes
Country × Trend	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the results of the OLS panel fixed effects estimations of Eq. (1) (col. 1) and Eq. (2) (col. 2 on the sub-sample of non-eligible sectors, col. 3 on eligible sectors, col. 4 on non-aligned sectors, and col. 5 on aligned sectors). *Cost of Debt* is constructed as the natural logarithm of the cost of debt relative to the average total debt over two consecutive years. *Eligible Sector* is a dichotomous indicator equal to 1 if the sector is eligible according to the EU Taxonomy regulation, and zero otherwise. *Environmental Pillar Score* is a continuous indicator ranging from 0 to 10. *High Size* is a binary indicator being equal to 1 for firms with total assets above the sample median, and zero otherwise. Since this variable is constructed directly from total assets, *Total Assets*, the continuous variable included in the baseline model, is excluded from the list of control variables to avoid redundancy. All the regressors are 1-year lagged. The estimations include year, sector × trend, and country × trend fixed effects. Errors are clustered at the company level.

heterogeneity across European macro-regions. We define a categorical variable with four groups based on the OECD regional classification: Eastern Europe (Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia), Northern Europe (Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Sweden), Southern Europe (Croatia, Greece, Italy, Malta, Portugal, Slovenia, Spain), and Western Europe (Austria, Belgium, France, Germany, Luxembourg, Netherlands). We include interaction terms between *Eligible Sector* and *Environmental Pillar Score* with these regional categories in Eqs. (1) and (2), using Western Europe as the baseline category; the main effects of the other regions are absorbed by the fixed effects.

Table 9 reports the results. In Column (1), which examines sector eligibility, there are no significant interaction effects, indicating that the negative association between eligibility and the cost of debt does not differ across European macro-regions. Columns (2) and (3) show the effects of the Environmental Pillar Score in non-eligible and eligible sectors, respectively. In both cases, the results are consistent with the baseline, and no significant differences emerge across regions. Column (4) focuses on non-aligned sectors and confirms that the negative relationship between environmental performance and financing costs is broadly homogeneous across regions. Last, Column (5) focuses on aligned sectors. The main effect, referenced to Western Europe, is negative and significant, in contrast with the baseline findings, whereas the interaction terms for Northern and Southern Europe are positive and significant, indicating that these regions are more in line with the baseline patterns. Overall, while some regional heterogeneity appears in aligned sectors, the ESG signaling effect is largely consistent across European macro-regions, confirming the baseline patterns.

5. Conclusions

This paper contributes to the ongoing debate about the transition towards a more environmentally friendly and sustainable economy, highlighting the financial sector's role in channeling resources into sustainable activities. We leverage the EU Taxonomy to examine how firm-level ESG performance, financial characteristics, and sectoral attributes interact. Specifically, we investigate whether superior environmental performance (as captured by environmental scores) affects the cost of debt differently based on sectoral environmental classification, according to the EU Taxonomy Regulation.

Table 9
Heterogeneity analysis: European regions.

Dependent Variable	Cost of Debt				
	(1)	(2)	(3)	(4)	(5)
Eligible Sector	-0.248***				
	(0.085)				
Eligible Sector × *Northern Europe*	0.016				
	(0.126)				
Eligible Sector × *Southern Europe*	0.173				
	(0.134)				
Eligible Sector × *Eastern Europe*	-0.125				
	(0.274)				
Environmental Pillar Score		-0.082**	-0.039	-0.071***	-0.121**
		(0.033)	(0.026)	(0.024)	(0.053)
Environmental Pillar Score × *Northern Europe*		0.029	0.028	0.022	0.267**
		(0.051)	(0.033)	(0.029)	(0.110)
Environmental Pillar Score × *Southern Europe*		0.044	0.038	0.045	0.132**
		(0.053)	(0.038)	(0.033)	(0.066)
Environmental Pillar Score × *Eastern Europe*		0.064	-0.025	0.114	-0.123
		(0.108)	(0.198)	(0.068)	(0.225)
Total Asset	-0.076***	-0.042	-0.075**	-0.043	-0.098**
	(0.023)	(0.048)	(0.029)	(0.031)	(0.039)
ICR	-0.433***	-0.385**	-0.417*	-0.438***	0.049
	(0.142)	(0.173)	(0.225)	(0.148)	(0.282)
Debt-to-Capital	-0.759***	-0.769***	-0.687***	-0.751***	-0.731***
	(0.028)	(0.039)	(0.035)	(0.030)	(0.052)
ROA	-1.886***	-1.681**	-1.640***	-1.923***	-1.282
	(0.466)	(0.725)	(0.594)	(0.532)	(1.091)
Current Ratio	-0.019	-0.051	0.069	-0.020	0.056
	(0.036)	(0.041)	(0.057)	(0.037)	(0.094)
Constant	-2.052***	-2.226***	-1.989***	-2.307***	-1.685**
	(0.383	(0.713)	(0.457)	(0.464)	(0.679)
Observations	4627	2171	2450	3631	993
Adj. R-squared	0.560	0.590	0.543	0.571	0.576
Eligible sector	-	No	Yes	-	-
Aligned sector	-	-	-	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector × Trend	Yes	Yes	Yes	Yes	Yes
Country × Trend	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the results of the OLS panel fixed effects estimations of Eq. (1) (col. 1) and Eq. (2) (col. 2 on the sub-sample of non-eligible sectors, col. 3 on eligible sectors, col. 4 on non-aligned sectors, and col. 5 on aligned sectors). *Cost of Debt* is constructed as the natural logarithm of the cost of debt relative to the average total debt over two consecutive years. *Eligible Sector* is a dichotomous indicator equal to 1 if the sector is eligible according to the EU Taxonomy regulation, and zero otherwise. *Environmental Pillar Score* is a continuous indicator ranging from 0 to 10. Regions are defined as a categorical variable with four groups: *Eastern Europe* (Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia), *Northern Europe* (Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Sweden), *Southern Europe* (Croatia, Greece, Italy, Malta, Portugal, Slovenia, Spain), and *Western Europe* (Austria, Belgium, France, Germany, Luxembourg, Netherlands). *Western Europe serves as the baseline category, while the main effects of Eastern, Southern, and Northern Europe are absorbed by the fixed effects.* All the regressors are 1-year lagged. The estimations include year, sector × trend, and country × trend fixed effects. Errors are clustered at the company level.

Our findings show that higher environmental scores, reflecting a firm's ability to manage environmental risks, are associated with lower cost of debt primarily for firms operating in non-eligible or non-aligned sectors. In sectors already classified as environmentally aligned, individual ESG performance has a less pronounced effect on the cost of debt. This suggests that while sectoral classification provides a baseline assessment of environmental alignment, firm-level environmental performance remains a relevant signal for firms operating in sectors not recognized as "green". Overall, our paper highlights that environmental ratings and sectoral attributes should be considered as complementary in assessing corporate sustainability, as they both help to bridge the information asymmetry between borrowers and investors.

These results carry significant implications from several perspectives. From a managerial point of view, our results offer a clear strategic insight: improving environmental performance is a particularly valuable strategy for reducing financing costs for companies in non-green sectors. Within these sectors, environmental performance is a strong signal about the company performance in the mitigation of sustainability-linked risks. In greener sectors environmental performance is less differentiating, as companies already operate in activities aligned with long-term sustainability objectives. In these contexts, sectoral metrics themselves are able to provide a strong baseline signal to investors. Our work also sheds light on how investors interpret sustainability related information on different layers (sectoral and corporate), therefore helping to understand how this information is priced in terms of cost of debt. Investors need to leverage both sectoral and individual environmental performance attributes to limit the potential adverse selection in lending, since sustainability-related risk can become financial risks. This is of the utmost importance in non-green sectors, which face

the most significant challenges in advancing the transition to a sustainable economy.

From a regulatory perspective, our analysis proves the important role of policies aimed at improving transparency on sustainable practices. The EU taxonomy fulfills this role by defining criteria for (any) economic activity to be aligned with a net zero trajectory by 2050. This clear classification system enables the definition of metrics at the sectoral level that can be used to analyze sustainable investing. Our analysis unveils that sectoral level sustainable metrics work in principle as a signaling mechanism in relation to the cost of funding. Therefore, we highlight the importance of exploiting the EU Taxonomy as the main tool of the European Green Deal and for analyzing investors and companies' behavior in the engagement in sustainable activities and projects.

This study is not without limitations. The analysis is focused on European companies, and the findings may not be directly generalizable to other geographical contexts with different regulatory environments. Furthermore, our measure of sectoral greenness is based on the EU Taxonomy, which, while being a robust policy benchmark, represents only one specific definition of sustainability. Future research could explore the impact of these signaling mechanisms in different regulatory settings or extend the analysis to the role of the social (S) and governance (G) pillars within the broader ESG context.

Disclaimer: Data Availability Statement

The authors received the data on ESG ratings and scores from Morgan Stanley Capital Indices (MSCI) for research purposes under a non-disclosure agreement.

CRediT authorship contribution statement

Simone Boccaletti: Conceptualization, Methodology, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing. **Gianluca Gucciardi:** Conceptualization, Methodology, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing. **Massimo Ruberti:** Conceptualization, Methodology, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data availability

The authors do not have permission to share data.

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