

RESEARCH ARTICLE

Environmental innovation in healthcare industry: The moderating role of women on board in cost of debt

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Abstract

Over recent years, a growing body of empirical evidence highlights a positive correlation between ecological innovation and firm value creation. Building on natural resource-based view and upper echelons theory, this study examines the relationship between environmental innovation and the cost of debt, by verifying whether and to what extent there is a moderation effect due to the board gender diversity. Using a sample of 458 European firms belonging to the healthcare industry, we carried out a cross-sectional analysis, given that the sample is based on just the fiscal year 2020. The empirical evidence shows that environmental innovation decreases the cost of debt, by reducing company's perceived risk. In addition, board gender diversity negatively moderates the foregoing relationship. Therefore, our study suggests that public policy makers might underpin environmental innovation policies and specific features on board of directors, since they exert relevant implications on firm's value creation and investors' decisions.

KEYWORDS

cost of debt, environmental innovation, European context, healthcare industry, women on board

1 | INTRODUCTION

Over the last century, the emergency of negative environmental issues, such as climate change, global warming, greenhouse gas emissions, and overall environmental degradation—often ensuing from uncontrolled economic and social progress—makes the necessity to identify suitable deterrents able to hinder these negative impacts (Sahoo et al., 2022). It is significant for companies to earnestly take into account these environmental concerns, especially in front of a broader expansion of environmental policy involving green management practices (i.e., responsible use of resources, innovation, emissions reduction, etc.) (de Abreu et al., 2023). Therefore, to provide fitting solutions, some studies looked into the influence of environmental innovation (Dangelico & Pujari, 2010; Del Río et al., 2016; Díaz-García et al., 2015; Schiederig et al., 2012) on decreasing of negative environmental impacts. Even though implementing eco-innovation is a demanding

process for companies, it is critical to be in step with the times. They should consider the possible positive effects on the cost of debt reduction and go towards sustainable and responsible management.

In light of the foregoing considerations, it is worth deeming the previous literature on the factors able to raise environmental innovation, such as board gender diversity, which has been widely recognized as a driver (Moreno-Ureba et al., 2022; Nadeem et al., 2020). Specifically, environmental innovation and gender equality are inter alia some of the hallmarks in the goals recommended by the United Nations 2030 Agenda for sustainable development and have gained the attention of several international organizations, including the OECD (2009) and the European Commission (2011). Consequently, the examination on how environmental innovation could be affected by female directors is timely and significant, given that board gender diversity is being discussed

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in different international regulatory reforms, to achieve established SDG targets.¹

Our article is unique in the current literature as it considers a specific financial variable, namely the cost of debt financing, rather than focusing on the most investigated firm performance (Doran & Ryan, 2016; Hermundsdottir & Aspelund, 2022; Li, 2014; Vasileiou et al., 2022; Yu et al., 2017). Furthermore, we focus our attention on healthcare industry, a pivotal sector in national economies. Healthcare expenditures represent a substantial share of the gross domestic product (GDP), which has witnessed a consistent rise over the years (Cardinaels & Soderstrom, 2013; Galizzi & Miraldo, 2011), so much significant, due to global pandemic events (Rhyan et al., 2020; World Bank, 2020). The purpose is to unravel the role of environmental innovation on the cutback of the cost of debt and explore the moderating effect exerted by board gender diversity. In this regard, we intend to move the existent body of knowledge forward by answering the following research questions: “What is the influence of environmental innovation on the cost of debt in healthcare industry? Is board gender diversity able to moderate this relationship, and to what extent?”. The interest on healthcare industry stems from several reasons. First, it is one of the largest and fastest growing service sectors in OECD countries and it is a significant contributor to climate change (Weisz et al., 2020). Second, a wide range of negative environmental footprint, including greenhouse gas emissions, air pollution, plastics waste, and pharmaceutical pollution of ecosystems, through excretion and inappropriate disposal, is often caused by the healthcare industry. Indeed, the magnitude of these impacts is increasingly on the rise in high-income countries, where environmental innovations are needed to prevent catastrophic effects (Hensher, 2020). Third, the implementation of sustainable management practices has the potential to improve firm's reputation and foster stakeholder engagement. Finally, the healthcare industry, and especially the pharmaceutical sector, is poorly explored despite the increasing need to reduce carbon emissions and the related global footprint around the world (Belkhir & Elmeligi, 2019).

Albeit there has been a great deal on this topic, the findings are still mixed (Amorelli & García-Sánchez, 2021). Hence, the present study explores environmental innovation and board gender diversity as drivers to underplay firm's environmental issues and, at the same time, reduce financial risks. On the one hand, environmental innovation represents a chance to strongly mitigate global environmental degradation (Farza et al., 2022; Sahoo et al., 2022); on the other hand, board structure might boost to achieve such a goal (Gurol & Lagasio, 2022; Khatri, 2023). Our contribution provides intriguing food for thought to rethinking the business management practices and board of directors (BDs) composition, with the aim to extend gender inclusivity and environmental concern into firm's mindset.

Along this line of reasoning, we positioned our study in the following theoretical lens: the natural resource-based view (NRBV) (Hart, 1995) and the upper echelons theory (UET) (Hambrick, 2007; Hambrick & Mason, 1984) to explain our conceptual model.

The NRBV stresses firm's relationship with natural environment to achieve a competitive advantage (Porter, 1980). In particular, the most influential drivers of new resources flourishing for firms are the restrictions in the natural environment. Corporate strategy and competitive advantage should be rooted in the capabilities advancing sustainable activities, from the environmental and economic standpoint. There are three interconnected capabilities, such as pollution prevention, product stewardship, and sustainable development, which represent the main conceptual framework of the NRBV. They are characterized by a path dependence, given that there is a sequential logic. In other words, without having first achieved significant improvements in the pollution prevention field, a product-stewardship strategy might be strongly difficult to set.

Drawing upon the UET first framed by Hambrick and Mason in 1984 and then by Hambrick in 2007, the focus of our study is based on some peculiar traits of the top management teams (TMTs) rather than merely on CEO. Such theoretical construct asserts that traits combined with cognitions, and the interactions of the whole TMT influence organizational outcomes and strategic behaviors, leading to superior environmental performance.

In essence, our quantitative analysis takes root in a sample of 458 European firms belonging to healthcare industry. We conducted a cross-sectional analysis, given that the sample is based on just the fiscal year 2020, to test our hypotheses in this research field.

The remainder of the article is structured as follows. Section 2 provides an overview of the literature. Section 3 depicts the quantitative approach adopted in the empirical study, by describing the data, the variables, and the research method. Section 4 shows the findings, while Section 5 discusses the empirical evidence. At last, Section 6 presents the conclusions and limitations of our work.

2 | LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Environmental innovation, or commonly eco-innovation, is typically defined as the production of goods or services using innovative business methodologies and the related results, throughout their life cycle, in a perspective of environmental impact decrease, including pollution and efficient use of natural resources (Kemp & Pearson, 2007). In essence, in our study, we considered the most shared definition, posited by Rennings (2000). Consequently, we deemed environmental innovation as firm's capacity to develop new ideas, behaviors, products, and processes able to reduce environmental burdens or achieve environmental sustainability goals. Given its relevance in different research streams over the last years (Antonlioli et al., 2016; Cai & Li, 2018; Costantini & Mazzanti, 2012; Li, 2014; Liao & Zhang, 2020; Pan et al., 2021; Porter & Van der Linde, 1995; Soltmann et al., 2015), it is becoming crucial within corporate strategy, since it is a means for improving competitive capacity (Chen et al., 2017; Martinez-del-Rio et al., 2015).

Consistently with NRBV, the company might uphold its competitiveness by using resources and capabilities for crafting products,

¹SDG 5 explicitly calls for gender equality.

implementing processes, and adopting technologies from a long-term sustainable development view. Such theoretical construct focuses on the constraints given by the biophysical environment and suggests a new lens to capture firm's relationship with natural context. Notably, NRBV encompasses three kinds of strategies: pollution prevention, product stewardship, and sustainable development. Still, the concept of environmental innovation is consistent with these strategies since it could be intended as a driving force able to minimize emissions, waste, life-cycle cost of production, and the environmental burden of firm's growth.

In more detail, the emphasis is placed on company's capabilities in encouraging green management practices and attaining the competitive advantage correlated to the development of products or services with a lesser environmental impact (Hart, 1995). Therefore, NRBV provides a holistic view of the relationship between firm resources, skills, and performance, which represents the cornerstone of sustainable competitiveness (Alam et al., 2019). The most innovative feature pertains to the inclusion of natural constraints and opportunities arising from the environment and their influence over the accomplishment of a sustainable competitive advantage (Hart, 1995, 2005). Hence, in the case of a significant influence on environment, eco-innovation and eco-design are crucial determinants to reconvert the production process. Although in the academic debate comes light a difference between eco-innovation and eco-design, those concepts are intended to be a joined benefit for the firm. Whereas eco-innovation is oriented on the rethinking of production process and the efficient use of natural resources (Kemp & Pearson, 2007), eco-design is focused on the development of new technologies, products, and services by reducing their impact on environment. In this perspective, innovation in original ecological-economic paths might lead to "win-win" solutions, by enabling firm to stay competitive, reap the consequent benefits, and pursue sustainable goals by technological progress (Hajer, 1995; Lin et al., 2019). Therefore, the efforts made to achieve better "green" performance do not solely raise environmental productivity and encourage competitiveness (Murphy & Gouldson, 2020), but they might also prove to be an optimal solution against environmental concerns (Spaargaren & Mol, 1992).

2.1 | Environmental innovation and cost of debt financing

Several studies paid attention to the relationship between green management practices and financial performance and, in particular, to those factors that might influence corporate risk, cash flow volatility, dividend payments, and firm's attitude to generate revenues and repay debts (Klassen & McLaughlin, 1996; Melnyk et al., 2003; Porter & Van der Linde, 1995; Przychodzen & Przychodzen, 2015; Yu et al., 2017). However, the academic debate remains lively due to controversial and unexplored findings.

First, many scholars assert that investments focused on environmental initiatives might increase the costs without generating immediate financial returns (Palmer et al., 1995). Vice-versa, the literature

stream on the green perspective claims that a higher rate of investments in eco-innovations refines operational activities, increases demand and productivity, thereby enhances the long-term financial performance (Aragón-Correa et al., 2008; Esty & Porter, 1998; Nishitani et al., 2011; Porter & Van der Linde, 1995; Sambasivan et al., 2013), and reduces environmental costs (Dai & Zhang, 2017). Moreover, investors perceive socially irresponsible firms as having a higher level of risk (Frederick, 1995; Starks, 2009).

Second, the current literature has focused mainly on the interplay between environmental innovation and financial performance (Bossle et al., 2016; Eiadat et al., 2008; Lanoie et al., 2011), however, merely a few studies considered the cost of debt related to environmental implications (El Ghouli et al., 2011; Eliwa et al., 2021; Erragragui, 2018).

Finally, to the best of our knowledge, the examination of the relationship between environmental innovation and the cost of debt financing is in an embryonic stage. Therefore, there is an intriguing literature gap that can be filled by further empirical evidence which allow to shape a successful corporate strategy.

In light of the foregoing considerations, our purpose is to investigate the influence of environmental innovation on the decrease of the cost of debt. As widely known, the cost of debt financing refers to the interest that firm must pay on loans and financial obligations for the borrowed amounts. When a company employs debt capital to finance its operations, such as issuing bonds or obtaining bank loans, it must refund the borrowed capital along with the agreed-upon interest. The cost of debt is a critical element in financial management (Andrade et al., 2014; Hoepner et al., 2016; Jung et al., 2018) as it directly affects company's operating costs and balance sheet. A higher cost of debt could reduce firm's profitability, while a lower cost of debt might provide more favorable conditions. Consequently, firms often strive to maintain a balance between debt and equity in their financial structure.

Given these reasons, it is pivotal to investigate the determinants that may reduce the cost of debt financing, in order to achieve a positive credit risk assessment and avoid overburdening company's financial infrastructure. In this scenario, we focus on a potential driver—namely environmental innovation—which refers to a firm's ability to develop new sustainable products or services. Prior studies (Bauer & Hann, 2010) suggested that proactive environmental practices are associated with a decrease in the cost of debt, while others pointed out that eco-innovative firms exhibit higher returns on assets and equity (Przychodzen & Przychodzen, 2015). As a result, the debate on sustainability innovation management approach is becoming increasingly intense, calling for further empirical studies.

The engagement in environmental management practices may enhance firm's financial position by lowering costs and increasing profitability (Bauer & Hann, 2010). Additionally, designing and implementing ecological process and products not only reduce environmental costs for stakeholders but also create new market opportunities through the adoption of innovative technologies (Lee & Kim, 2011). In accordance with earlier works, a huger environmental performance is



positively associated with higher profitability and firm value (King & Lenox, 2002; Klassen & McLaughlin, 1996; Konar & Cohen, 2001), leading to positive cash flow implications.

Drawing upon the above-mentioned considerations, we assume that a higher innovation in environmental management practices positively affects future cash flows, by reducing firm's perceived risk, due to the positive financial impact of their sustainable practices.

Accordingly, our first hypothesis is posited as follows:

Hypothesis 1. Firms exhibiting a higher environmental innovation incur a lower cost of debt.

2.2 | The moderating role of gender diversity in TMT

Given its relevance and novelty, the role of women in TMTs has been widely investigated in previous (Adams & Ferreira, 2009; Adams & Funk, 2012; Boulouta, 2013; Campbell & Mínguez-Vera, 2008; Frias-Aceituno et al., 2013; Terjesen et al., 2009) and recent (He & Jiang, 2019; Nadeem et al., 2020; Orazalin & Baydauletov, 2020; Xie et al., 2020; Zaid et al., 2020) studies, reflecting a change in the business landscape.

Despite the inclusion of women in top leadership positions has been an ongoing struggle, it is now broadly acknowledged that gender diversity within BD may engender valuable contributions to organizational success. The historical path of women's participation in corporate governance highlights a long-standing journey marked by challenges, milestones, and growing recognition of their vital role in shaping business decisions. To date, women's equality and their participation in decision-making process in political, economic and public life represent key topics of the sustainable development goal no. 5 in the Agenda 2030 issued by the United Nations (UN). In the European context, institutional pressures (i.e., rules, norms, frameworks, etc.) altered board gender diversity, in a relevant manner. In this sense, institutions contribute to promote gender equality and diversity on BDs (DiMaggio & Powell, 1983). European Union (EU) Directive, named "Women on boards", introduced a procedure meant to reach a minimum threshold equal to 40% of women's representation on BDs in the European companies. Along this line of reasoning, the aforementioned 2030 Sustainable Agenda, adopted by the UN, claims that a full and effective presence of women on BDs is able to influence value creation process (Dwyer et al., 2003) and, more specifically, firm sustainability performance (Elmagrhi et al., 2019). Therefore, to this end, companies should place greater attention to environmental issues and the composition of the BDs through a more balanced gender policy.

Building on the UET (Hambrick, 2007; Hambrick & Mason, 1984), the focus is on the TMTs' traits to yield a better explanation of organizational outcomes, rather than paying attention solely on CEO. As such, the leadership of a heterogeneous company is the result of capabilities, combined cognitions, and

interactions of the whole TMT participating in strategic behaviors. Executives and directors play a crucial role in making strategic decisions and formulating competitive strategies, thereby influencing the overall firm performance by their knowledge, skills, and expertise (Krishnan & Park, 2005; Orazalin & Baydauletov, 2020). Adopting the perspective of the UET, some scholars (Adams & Ferreira, 2009; Liao et al., 2019; Post et al., 2015) assert that companies with a higher level of female directors display huger environmental performance (García Martín & Herrero, 2020; Orazalin & Baydauletov, 2020), mostly due to the implementation of effective sustainability-related strategies.

Despite several analyses supporting women's positive influence in corporate upper echelons, the academic debate is still lively (Moreno-Gómez et al., 2018). This ongoing discussion opens the doors for further research to better figure out how gender diversity is able to moderate and strengthen the relationship between environmental innovation and the cost of debt financing through different mechanisms.

First, board gender diversity may lead to a broader spectrum of perspectives and cognitive heterogeneity. Women directors could bring unique standpoints and experiences to boardroom discussions, conveying a greater emphasis on environmental issues and sustainability (Hillman et al., 2002; Horbach & Jacob, 2018; Williams, 2003). This might encourage a stronger commitment to adopt and invest in environmental innovation within the company.

Second, the extant literature (Valls Martínez et al., 2019) suggests that gender-diverse boards are associated with higher levels of CSR and ethical decision-making (Campbell & Mínguez-Vera, 2008; Carter et al., 2003, 2010; Erhardt et al., 2003). Women directors often prioritize long-term goals and stakeholder interests, including sustainability concerns (Kassinis et al., 2016), which may improve the integration of environmental innovations with potential long-run benefits for firm's financial performance.

Furthermore, gender diversity could foster more inclusive and participative decision-making processes. A diverse BDs composition may encourage an open dialog and scrutiny of firm's environmental practices (Mahadeo et al., 2012), leading to improved transparency and accountability. Such transparency may positively influence the evaluation of the firm's environmental risk management by investors and financial institutions, resulting in lower perceived financial risk and, consequently, more reduced cost of debt.

Each mechanism that explains the influence of environmental innovation on the cost of debt can be strengthened or weakened on the grounds of the presence of women on BDs. Gender diversity is able to strengthen the communication and dissemination of environmental innovation practices within the organization, leading to a more comprehensive understanding and commitment towards sustainability initiatives (Carvajal et al., 2022). This increased emphasis on sustainability can positively sway firm's reputation and image among investors (Quintana-García et al., 2022), contributing to a cutback of the cost of debt. Conversely, in the absence of

TABLE 1 The Refinitiv® Business Classification (TRBC).

Economic sector	Business sector	Industry group	Industry	Activity	PermID	TRBC Hierarchical ID
Healthcare					4294952853	56
	Pharmaceuticals & medical research				4294952845	5620
		Pharmaceuticals			4294952844	562010
			Pharmaceuticals		4294952724	56201040
				Pharmaceuticals (NEC)	4294951272	5620104010
				Proprietary & advanced pharmaceuticals	4294951271	5620104011
				Biopharmaceuticals	4294951270	5620104012
				In-vivo diagnostic & testing substances	4294951269	5620104013
				Veterinary drugs	4294951268	5620104014
				Generic pharmaceuticals	4294951267	5620104015
				Alternative medicine	4294951266	5620104016
				Recreational pharmaceuticals	1004365423	5620104017
				Pharmaceuticals wholesale	1004365420	5620104018
	Biotechnology & medical research				4294952783	562020
			Biotechnology & medical research		4294952842	56202010
				Biotechnology & medical research (NEC)	4294951265	5620201010
				Bio-therapeutic drugs	4294951264	5620201011
				Bio-diagnostics & testing	4294951263	5620201012
				Bio-medical devices	4294951262	5620201013

Source: Authors' elaboration from refinitiv.com.

gender diversity, there might be little attention to environmental concerns within BDs and a weaker connection between environmental performance and financial outcomes. A lack of diverse perspectives may also hinder the identification and mitigation of environmental risks, which could lead to a higher perception of financial risk and, consequently, an increased cost of debt.

At last, gender diversity on BDs may affect the relationship between environmental innovation and the cost of debt through mechanisms related to different perspectives, corporate social responsibility, and decision-making processes. A mixed configuration of BDs can create a context fostering environmental innovation, enhancing corporate sustainability, positively influencing on the perception of firm's risk management by creditors, and, as a result, contributing to a more favorable cost of debt.

Therefore, we posited the following hypothesis:

Hypothesis 2. Board gender diversity negatively moderates the relationship between environmental innovation and the cost of debt.

TABLE 2 Process of sample selection.

Steps	Description	Observations
1	Total European healthcare companies mined by Refinitiv Eikon - Datastream	458
2	Deletion of missing values	360
	Total maximum observations	98
	Sample representativeness	21.40%

Source: Authors' elaboration.

3 | METHODOLOGY AND DATA

3.1 | Depiction of the sample and quantitative analysis

The empirical analysis takes root in a sample of 458 European companies belonging to the healthcare industry. The latter is one of the

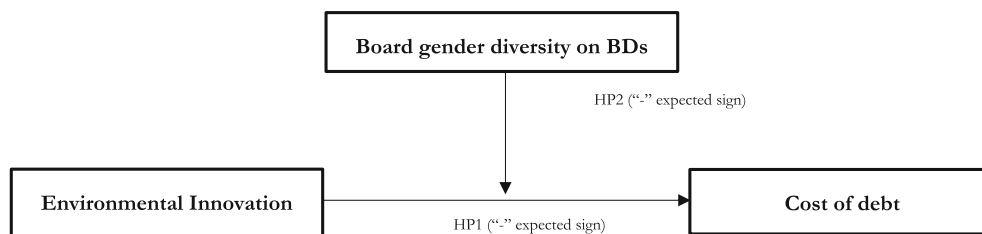


FIGURE 1 Conceptual model: the rationale of the moderating effect.

largest and fastest-growing service sectors in OECD countries and it is a significant contributor to climate change (Weisz et al., 2020). Furthermore, a wide range of negative environmental footprint, including greenhouse gas emissions, air pollution, plastics waste, and pharmaceutical pollution of ecosystems, through excretion and inappropriate disposal, is often caused by the healthcare industry. Indeed, the magnitude of these impacts is increasingly on the rise in high-income countries, where environmental innovations are needed to prevent catastrophic effects (Hensher, 2020).

The sample was mined from the “Refinitiv Eikon” database (Datastream) through a comprehensive search based on all European healthcare companies. Following the Refinitiv® Business Classification (TRBC) (Benz et al., 2021; Govindan et al., 2021; Joslin & Müller, 2016; Kuzey et al., 2021; Uyar et al., 2021), we selected healthcare industry. In particular, we opted for pharmaceuticals and biotechnology industry groups, excluding healthcare providers and medical equipment and services (see Table 1).

Such methodological choice ensues from the purpose to circumscribe the empirical analysis on just pharmaceutical and biotechnology sectors which, despite the urgent need to reduce carbon emissions and the related global footprint worldwide, are still unexplored (Belkhir & Elmeligi, 2019). Table 2 shows that, after the selection process, the sample remains representative (i.e., 21.40%), even though the amount of missing values, due to the recurring unavailability of ESG data.

The data collection was conducted during the second half of the fiscal year 2021, so that 2020 appeared as the most recent year for which comprehensive and reliable figures on environmental innovation, board gender diversity, and the cost of debt within pharmaceutical and biotechnology sectors were available. From the methodological standpoint, we therefore carried out a cross-sectional analysis, since the sample is based on just the fiscal year 2020. In more detail, we ran two ordinary least squares (OLS) regression models, with robust standard errors to better handle possible problems of heteroskedasticity. Still, with the aim to tackle probable endogeneity issues, in the baseline relationship, the key independent variable was tested by both a lag of 1 year and five ones (see Tables 6 and 7). The latter timeframe comes from the common period inherent to long term run in financial accounting research domain (Brickley et al., 1985; Kumar & Sopariwala, 1992). After having verified that the findings were supportive and confirmed a feeble weakness, in terms of reverse causality bias, the second econometric model was focused on the examination of the moderating effect.

At last, we applied Pearson correlations and the VIF tests, in order to safeguard the reliability of the empirical evidence against multicollinearity issues.

TABLE 3 Descriptive statistics.

	N	Min	Max	Mean	SD
<i>longtcdet_perc</i>	98	0	0.6	0.0223	0.00143
<i>eis</i>	98	0	98.82	15.3165	26.6515
<i>bodgenddiv</i>	98	0	60	31.0907	13.9313
<i>boardsize</i>	98	3	20	8.6122	3.1217
<i>roce</i>	98	-1.87	0.97	0.0479	0.4027

Source: Authors' elaboration.

3.2 | Description of the variables

3.2.1 | Dependent variable

Referring to the cost of debt, we selected a specific proxy, namely the “Weighted Average Cost of Debt” (expressed in percentage), as it might be insightful to look into the appreciation of sustainable investments by the financial stakeholder (Escrig-Olmedo et al., 2013; Jeucken, 2010; Ng & Rezaee, 2015; Weber et al., 2008). More precisely, the earlier proxy represents the marginal cost regarding the new long-term debt based on an average period of 10 years. The label is: *longtcdet_perc*.

3.2.2 | Independent variable

We considered the environmental innovation score (EIS), as it reflects firm's attitude in reducing the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products. The label is: *eis*.

3.2.3 | Moderating variable

Figure 1 highlights that board gender diversity acts as a moderating variable. In particular, the latter is measured as the percentage of women on BDs (Boulouta, 2013; Nadeem et al., 2020; Pucheta-Martínez & Bel-Oms, 2019). The label is: *bodgenddiv*.

3.2.4 | Control variables

In line with previous studies, we selected either the BDs size or the ratio pertinent to the return on capital employed (Cornett et al., 2008; Rahman & Ali, 2006). The labels are respectively: *boardsize* and *roce*.

**TABLE 4** Pearson correlations matrix.

	1	2	3	4
1. <i>eis</i>	1			
2. <i>bodgendiv</i>	0.1326 (N = 98)	1		
3. <i>boardsize</i>	0.4503*** (N = 98)	0.1957* (N = 98)	1	
4. <i>roce</i>	0.1498 (N = 98)	-0.0527 (N = 98)	0.1067 (N = 98)	1

Note: Significance level: ^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 5 The association between EIS and long-term cost of debt, Model 1.

Variable dependent: <i>longtcdebt_perc</i>	Beta coefficients	Robust standard errors
<i>eis</i>	-0.0001 [^]	0.0001
<i>boardsize</i>	0.0002	0.0004
<i>roce</i>	-0.0079*	0.0038
No. of observations	98	
R ²	0.078	
F-statistic	3.94*	
Mean VIF	1.18	

Note: Significance level: ^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Bold indicates statistically significant results.

TABLE 6 The association between EIS_L1 and long-term cost of debt, Model 1.

Variable dependent: <i>longtcdebt_perc</i>	Beta coefficients	Robust standard errors
<i>eis_L1</i>	-0.0001**	0.0001
<i>boardsize</i>	0.00032	0.0005
<i>roce</i>	0.0039*	0.0039
No. of observations	86	
R ²	0.090	
F-statistic	4.34*	
Mean VIF	1.26	

Note: The independent variable «*eis_L1*» was lagged by 1 years. Significance level: ^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Bold indicates statistically significant results.

4 | ANALYSIS AND FINDINGS

Table 3 shows the findings pertinent to the descriptive statistics. In particular, the EIS ranges between 0 and 98.82 while the mean is equal to 15.32. The value of the standard deviation seems relevant (i.e., 26.65). Vice versa, such value appears less material regarding the dependent variable, given that the mean amounts to 0.0224. Moreover, the weighted average cost of debt (i.e., the “long-term cost of debt”) varies from 0% to 0.06%.

Still, with reference to the control variables, the maximum value of the BDs size is equal to 20 while the best performance, in terms of ROCE, is equal to 0.97.

Table 4 highlights the Pearson correlation coefficients that were computed just between the independent and control variables to

TABLE 7 The association between EIS_L5 and long-term cost of debt, Model 1.

Variable dependent: <i>longtcdebt_perc</i>	Beta coefficients	Robust standard errors
<i>eis_L5</i>	-0.0002***	0.0001
<i>boardsize</i>	0.0001	0.0004
<i>roce</i>	-0.0007*	0.0003
No. of observations	56	
R ²	0.131	
F-statistic	6.66***	
Mean VIF	1.14	

Note: The independent variable «*eis_L5*» was lagged by 5 years. Significance level: ^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Bold indicates statistically significant results.

TABLE 8 The moderating effect of board gender diversity, Model 2.

Variable dependent: <i>longtcdebt_perc</i>	Beta coefficients	Robust standard errors
<i>eis</i>	0.0003*	0.0001
<i>bodgendiv</i>	0.0001	0.0002
<i>eis</i> × <i>bodgendiv</i>	-0.0001**	3.6400
<i>boardsize</i>	0.0003	0.0004
<i>roce</i>	-0.0068 [^]	0.0037
No. of observations	98	
R ²	0.135	
F-statistic	6.11**	
Mean VIF	5.53	

Note: Significance level: ^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Bold indicates statistically significant results.

check some possible multicollinearity problems. In more detail, the results point out a non-relevant statistical significance. To corroborate such values, in the following OLS regression models, we also computed the VIFs tests.

Table 5 depicts the empirical evidence of the association between the independent and dependent variables. In particular, Hypothesis 1 is confirmed, even if the p -value is below the threshold of 0.1. Therefore, it is possible to unveil that environmental innovation negatively influences the cost of debt over an average period of 10 years.

In addition, with reference to the goodness of fit regarding the OLS regression model, F -statistic is equal to 3.94 (p -value < 0.05),

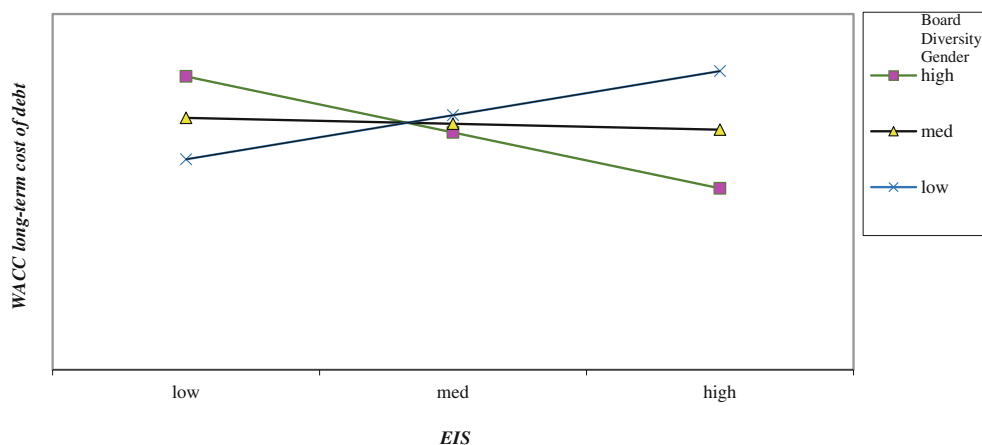


FIGURE 2 The rationale of the moderating effect.

whilst R^2 amounts to 0.078. The mean VIF is furthermore very far from the critical threshold of 10 (Hair et al., 2010). In other words, the multicollinearity does not represent a material weakness with respect to the reliability of the findings (Tables 6 and 7).

Table 8 exhibits the results of the moderating effect exerted by board gender diversity on the relationship between environmental innovation and the cost of debt over an average period of 10 years. In detail, Hypothesis 2 is fully substantiated by the statistical significance (p -value < 0.01) and the negative value of the Beta coefficient (-0.0001).

From a merely quantitative point of view, the F-statistic amounts to 6.11 (p -value < 0.01), and R^2 is equal to 0.135. Despite the mean VIF is below the critical threshold of 10, it should be noted that this result is heavily affected by the variable concerning the moderating effect (i.e., $eis \times bodgenddiv$).

At last, Figure 2 plots that a higher percentage of women on BDs, alongside with a huge environmental innovation, helps to reduce the cost of debt over an average period of 10 years. Conversely, building on our empirical evidence, despite a higher environmental innovation, the earlier cost of debt might increase whether board gender diversity is low.

5 | DISCUSSION AND CONCLUSIVE REMARKS

Over recent years, the influence of environmental innovation on firm's value has significantly increased, making environmental issues a relevant research topic in management studies (Alzakri, 2023; Berrone et al., 2013; Bossle et al., 2016; De Marchi, 2012; Guo et al., 2023). Our study, rooted in the tenets of the NRBV and UET, emphasizes the intricate interplay between environmental innovation and the cost of debt and takes into account the moderating effect exerted by the presence of board gender diversity within the pharmaceutical and biotechnology sectors, in range of the overall healthcare industry.

The findings validate our research hypotheses, namely environmental innovation negatively influences the cost of debt, and this

effect increases when considering board gender diversity. Specifically, the present analysis sheds light on the financial benefits stemming from the implementation of environmental innovation practices. The negative effect upon the cost of debt implies that environmental innovation could convey substantial savings for firms, especially in capital-intensive industries, such as the healthcare sector. Such an outcome highlights that sustainability is not solely an issue of CSR but may also serve as a strategic financial decision.

This analysis provides valuable insights in the current academic debate, given that the bulk of the previous studies was focused on the relationship between green management practices and financial performance (Klassen & McLaughlin, 1996; Melnyk et al., 2003; Porter & Van der Linde, 1995; Przychodzen & Przychodzen, 2015; Yu et al., 2017). Even though the results on such association are often controversial (Palmer et al., 1995), our research is consistent with those studies suggesting that green management practices bring benefits to businesses in both financial returns and long-term reputation (Aragón-Correa et al., 2008; Nishitani et al., 2011; Porter & Van der Linde, 1995; Sambasivan et al., 2013). Interestingly, past research has often overlooked the cost of debt as a relevant outcome variable. Indeed, only a few studies explored its correlation with ESG practices (Eliwa et al., 2021), CSR (El Ghoul et al., 2011), and risks associated with ESG factors (Erragragui, 2018). However, to the best of our knowledge, the examination of the relationship between environmental innovation and the cost of debt financing is still underexplored. This research gap stimulated the foundation of our analysis and offers a compelling opportunity to scholars who intend to advance this field with further empirical studies meant to provide more valuable insights.

5.1 | Theoretical implications

Our empirical evidence might feed the ongoing academic debate given that, in the European context, both environmental innovation and board gender diversity play a crucial role in the value creation process, by decreasing firm's riskiness. Along this line of reasoning, our study can contribute to the current "state of the art" on the NRBV and UET.

In detail, given that NRBV emphasizes the influence of environmental principles over firm's financial benefits, our results reveal the presence of an association between environmental innovation and the cutback of the cost of debt (such as Hypothesis 1). Besides, we propose that environmental innovation is more and more significant in corporate value creation, since a company can maintain sustainable competitiveness by using its resources and capabilities for products, processes, and technologies from a long-term sustainable development perspective (Hart, 1995). In this perspective, sustainability represents a relevant source of competitive edge. Finally, the focus on specific industries—namely pharmaceutical and biotechnology sectors—brings fruitful nuances to the NRBV. Considering the significant carbon footprint of the overall healthcare sector (Belkhir & Elmeligi, 2019), our findings underscore the need and advantages of embracing NRBV principles in environmental sensitive industries.

Placing the attention on the second theoretical construct, UET postulates that business outcomes reflect TMT's values (Hambrick, 2007; Hambrick & Mason, 1984). To this end, our study suggests that board gender diversity negatively moderates the basic relationship, named Hypothesis 1. Specifically, the presence of women in BD composition fosters the decrease of the cost of debt. This feeds interesting cues upon the influence of gender dynamics in firm's decision-making process concerning environmental initiatives. Therefore, heterogeneity in BD composition promotes innovation and environmental initiatives (Nishii, 2013), enabling the setting of a corporate strategy inspired by the core tenets of sustainable development. Moreover, it may stimulate innovative ideas that instill a well-functioning organizational culture, ensure the availability of different resources, skills, and expertise, reduce perceived risk, generate lower transaction costs, and improve firm value (Williamson, 1979). A more balanced board composition can improve sustainability practices and reduce firm riskiness and therefore the cost of debt. In other words, a greater participation of women in the decision-making process represents a leading driver in corporate strategy and might stimulate a stronger orientation of BDs on environmental innovation (Moreno-Ureba et al., 2022; Nadeem et al., 2020; Triana et al., 2014).

At last, building on a joint adoption of two pivotal theories in CSR research stream, such as NRBV and UET, our study provides a comprehensive outlook to delve into the influence of sustainable practices and TMT's dynamics on financial outcomes.

5.2 | Practical implications

The empirical evidence provides significant implications for practitioners working in healthcare industry and, more broadly, in other kinds of sectors environmental sensitive. First, given the negative relationship between environmental innovation and the cost of debt, companies should recognize investments in green practices not just as ethical commitments but also as strategic financial decisions. Therefore, the adoption of environmental innovation practices allows companies not merely to reinforce their reputation but

also to conceivably enhance their financial position through lower borrowing costs. Second, our research sheds light on the moderating effect of board gender diversity and its relevance in BDs configuration not just for satisfying normative requirements but mostly for the potential financial benefits. Third, the setting of environmental innovation initiatives and the incentives on board gender diversity may support firms in handling and decreasing different corporate risks, especially nowadays, since environmental concerns are paramount and stakeholders (including investors, competitors, customers, employees, etc.) are increasingly more attentive towards sustainability. Such practices might mitigate reputational risks, regulatory risks, and even certain operational risks. In this sense, companies might improve their stakeholder engagement and increase the likelihood of gaining their trust and support. Moreover, our study confirms the relevance of long-term financial implications upon firm's life. The implementation of sustainable practices and the focus on board gender diversity might enable firms to attain enduring financial performance and develop their resilience against market volatility.

From a policy perspective, our findings suggest that policy-makers might encourage incentives meant to implement environmental innovation practices. In other words, regulatory bodies should develop more focused and effective policies that simultaneously advance CSR and stimulate economic growth. In sum, our results provide a roadmap for practitioners and policymakers, driving them towards sustainable practices that yield both environmental and financial returns.

5.3 | Limitations and future research directions

Despite our study might offer stimulating insights, some limitations need to be highlighted. The first shortcoming pertains to the focus on just one fiscal year (i.e., 2020), on a single industry (i.e., healthcare), and the exclusive attention on the European context. Accordingly, this may not capture the nuances of healthcare industries across different geographical regions or over various timeframes. The second limitation refers to some methodological choices, regarding the limited amount of control variables, due to the sample size. Considering the first point, our analysis stems from an initial sample of 458 European firms (see Table 2) belonging to pharmaceutical and biotechnology sectors, in range of healthcare industry. Although, the sample is representative, the dynamics of the broader industry or firms' characteristics working outside of Europe are not entirely captured. Thus, a larger and more diversified sample might yield deeper insights. Referring to the second aspect, the amount of the control variables was strongly conditioned by the sample size much to select, on the basis of prior studies, only some metrics tightly linked to the research question rather than those more recurring in quantitative analyses, such as firm size and age. Therefore, the increase of the observations, also in a longitudinal perspective, might allow to include other control variables, and thereon offer a more holistic perspective and account for additional factors influencing the cost of debt.



Finally, such shortcomings might reveal stimulating future research routes, with the aim to further move our research question forward along the following three main conceptual pillars: environmental innovation, firm's corporate governance path and cost of debt.

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