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Environmental Violation and Cost of Equity Capital—Evidence From Europe

Md. Borhan Uddin Bhuiyan¹  | Yimei Man² ¹School of Accountancy, Economics and Finance, Massey Business School, Massey University, Auckland, New Zealand | ²Department of Accountancy and Finance, Otago Business School, University of Otago, Dunedin, New Zealand**Correspondence:** Md. Borhan Uddin Bhuiyan (m.b.u.bhuiyan@massey.ac.nz)**Received:** 1 January 2024 | **Revised:** 8 April 2025 | **Accepted:** 15 April 2025**Keywords:** cost of equity capital | environmental violation | Europe | reputation

ABSTRACT

We examine the association between environmental violations and the cost of equity capital. We posit that firms that breach environmental compliance introduce firm-specific risks and, consequently, elevate the costs associated with equity capital. Utilizing a dataset comprising publicly listed firms from the Bloomberg European 500 index spanning the period from 2005 to 2020, we present empirical evidence that environmental violations contribute to an increase in a firm's cost of equity capital. Our findings hold economic significance, revealing that a one standard deviation increase in environmental violations results in a 4.28–5.12 basis point increase in the cost of equity. Furthermore, we establish that the positive relationship between environmental violations and the cost of equity capital is more pronounced in firms lacking corporate social responsibility training and those operating within highly competitive industries. Importantly, our results withstand endogeneity concerns, affirming their robustness. The implications of our study extend to stakeholders, enhancing their understanding of the repercussions of environmental violations on investment decisions.

1 | Introduction

Our study examines the relationship between corporate environmental violations and the cost of equity (COE). In recent decades, corporate social responsibility (CSR) has become a prevalent practice and an integral component of corporate strategy to achieve both pro-social objectives and profit maximization (Windsor 2013). Environmental responsibility, a crucial aspect of CSR, transcends mere regulatory compliance. Incorporating environmental considerations within CSR initiatives signifies an organization's recognition of its environmental impact and commitment to mitigating adverse effects. Although extensive research has focused on the positive effects of CSR compliance on financial outcomes, and some studies have investigated the detrimental effects of environmental violations on corporate reputation (Zou et al. 2015), tax avoidance (Hoi et al. 2013), and shareholder wealth (Ouyang et al. 2023; Price and Sun 2017), the prevailing tendency to overlook the negative aspects of CSR

results in an incomplete understanding of its overall impact, as highlighted by Mishra and Modi (2013). To address this knowledge gap, we specifically explore the repercussions of environmental violations on the COE.

When corporations engage in improper conduct regarding environmental and societal matters affecting their stakeholders, such actions are defined as corporate social irresponsibility. Globally recognized companies have faced severe environmental violations, as illustrated by notable cases. Before the Gulf of Mexico tragedy in 2010, British Petroleum (BP) had a commendable reputation as one of the most ethical corporations worldwide. However, the Deepwater Horizon oil disaster from April to September 2010 resulted in the discharge of 134 million gallons of oil, contaminating 1300 km of shoreline and causing extensive harm to marine life (NOAA 2025). As a consequence, BP's stock price plummeted from \$60 in April to \$28 in June 2010. Similarly, the Volkswagen (VW) clean diesel

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scandal represents another infamous instance of environmental violation. Despite advertising its diesel vehicles as having low emissions, VW vehicles were found to emit nitrogen oxide pollutants up to 40 times the permissible limit under US law. The vehicles were equipped with a 'defeat device' designed to evade emission testing. When the scandal emerged in 2015, VW's stock depreciated by approximately one-third. VW was subsequently fined \$1.45 billion, and its reputation suffered significantly (Hotten 2015).

Environmental violations can raise a firm's COE capital because investors perceive these actions as increasing risk due to potential financial and reputational harm (Lu et al. 2022). This heightened perception stems from the possible repercussions tied to environmental transgressions. Such violations may result in regulatory fines, legal fees, operational disruptions and reputational damage, all of which create uncertainty about future cash flows. Furthermore, companies with a history of such violations may face increased regulatory scrutiny, which further elevates their risk profile for investors (Ma et al. 2022). As a result, firms with environmental violations often find it necessary to offer higher returns to attract investors, leading to an increased COE capital. Further, environmental violations expose weak governance and poor risk management, eroding investor confidence, especially if the firm's CSR efforts are perceived as insincere or misleading. Although the existing literature emphasizes the role of CSR in lowering a firm's COE (Bhuiyan and Nguyen 2020), empirical research also points out the potential risks of tokenism and greenwashing in CSR efforts. Our contribution to this discourse is the evidence demonstrating the negative impact of environmental violations on the COE.

To investigate our research question, we focus on European firms recognized for their commitment to societal well-being and adherence to stringent environmental regulations. European countries have consistently been at the forefront of environmental legislation. The European Union (EU) has led the enactment of various environmental policies and legislation, exemplified by initiatives such as the EU Emissions Trading System, designed to reduce greenhouse gas emissions, and the EU Water Framework Directive, which establishes rigorous water quality requirements. Furthermore, numerous European nations have independently implemented robust national environmental regulations. For instance, France has enacted the Energy Transition for Green Growth Law (Dreyfus and Allemand 2018), Spain has adopted the Renewable Energy Plan (PNIEC) (Duffield 2021), and Germany has established the Renewable Energy Act and Packaging Ordinance (Langniß et al. 2009; Staudt and Schroll 1999). These national-level measures further underscore the commitment of European countries to environmental sustainability and reinforce our selection of European firms as a representative sample for our research.

Multiple theories support the link between environmental violations and the COE. Reputation theory suggests that such violations tarnish the public image of a firm, shareholder trust, customer loyalty, and access to capital (Walker 2010; Wang et al. 2012). Such loss of trust is particularly important, as it creates an environment where shareholders, including investors, question the reliability and long-term viability of the firm. In the context of the signalling theory, environmental violations serve

as negative signals, indicating a potential lack of commitment to ethical practice and social responsibility. These signals undermine stakeholder confidence, so investors may demand higher returns to compensate for increased perceived risk. Stakeholder theory reinforces this view by framing environmental violation as a failure to effectively balance the interests of key stakeholders, such as local communities, environmental groups, employees and customers. Ignoring environmental concerns destabilizes critical relationships, resulting in operational efficiencies and potential legal consequences, which negatively affect financial performance (Freeman and Dmytriiev 2017). Economic and agency theories emphasize heightened perceptions of financial instability and managerial misalignment between the interests of managers and shareholders. Managers may prioritize short-term gain at the expense of long-term sustainability, increasing the risk of future fines, litigation, or even business disruptions due to environmental damage. These concerns exacerbate the perception of financial instability, prompting investors to raise their expectations for returns as compensation for the heightened risk associated with such violations (Friedman 2007; Li et al. 2016). These theories illustrate how environmental violations damage a firm's ethical standards, reputation and financial stability, forcing investors to adjust their risk assessment and demand higher returns for the perceived increase in risk that leads to higher equity costs.

Using data from the Bloomberg European 500 index from 2005 to 2020, our empirical analysis reveals that environmental violations lead to an increased COE when sourcing capital from investors. Our findings are economically significant, indicating that a one standard deviation increase in environmental violations results in a 4.28–5.12 basis point increase in the COE. Furthermore, our investigation demonstrates that the association between environmental violations and COE capital is more pronounced in firms with higher financial constraints and firms operating in highly competitive industries. Further, we conduct a mediation test considering three potential channels that mediate the relationship between environmental violations and COE. The results reveal partial mediation through the CSR training and environmental innovation channels. We reinforce our research findings, which indicate a cost of debt associated with CSR violations, supported by a measurable increase in the cost of debt. Importantly, our results remain robust under scrutiny, addressing potential concerns related to endogeneity.

Our research significantly contributes to the existing body of knowledge and offers important implications for academics and practitioners. Although it is widely assumed that environmental violations negatively influence investment decisions, empirical evidence on this relationship remains limited and fragmented. The literature has predominantly focused on the benefits of environmental engagement, with findings suggesting that such efforts can enhance corporate reputation and investor confidence. However, the impact of environmental violations on investment decisions and financing costs remains relatively underexplored. Some studies have examined the role of environmental disclosure in shaping firms' financing outcomes. For instance, Reverte (2012) finds that higher-quality CSR reporting is associated with a lower COE capital, highlighting the potential financial benefits of transparent sustainability practices. In contrast, Déjean and

Martinez (2009) report inconclusive evidence on whether environmental disclosure directly reduces a firm's COE, suggesting that mere disclosure may not always translate into financial advantages. Although these studies offer valuable insights into how environmental initiatives impact equity financing, research specifically targeting the consequences of environmental violations remains scarce. Notably, El Ghoul et al. (2018) provide evidence that firms with higher levels of environmental responsibility benefit from a lower COE, based on data from the manufacturing sectors of 30 countries between 2002 and 2011. However, their focus remains on environmental responsibility rather than violations. In this context, our study seeks to address a critical gap by shifting the focus to the adverse side—examining how environmental violations impact a firm's COE capital. By concentrating on the European region, our research provides regional specificity and complements existing studies, offering a novel perspective on the financial implications of noncompliance with environmental standards.

Implications of our findings are significant for both policymakers and investors, highlighting the financial risks associated with environmental violations. For policymakers, understanding the link between environmental infractions and the COE is essential for developing effective regulatory frameworks. Our study demonstrates that environmental violations trigger negative market reactions, reinforcing the argument for stricter environmental regulations and compliance mechanisms. Regulatory bodies can leverage these market-based disincentives to promote environmental responsibility, using them as tools to encourage companies to adopt more sustainable practices and reduce noncompliance. Additionally, policymakers could explore integrating environmental risk metrics into corporate reporting standards to enhance transparency for investors and other stakeholders. For investors, our findings emphasize the need to incorporate environmental factors into investment strategies to address the financial risks associated with environmental violations. Negative market reactions to such violations suggest heightened firm-specific risks that could undermine long-term financial performance. Investors are encouraged to reassess their risk models and adjust portfolio allocations by scrutinizing companies' CSR track records, particularly regarding environmental compliance. Proactively aligning investments with environmentally responsible firms mitigates risks and positions investors to benefit from the growing importance of sustainable finance. As global financial markets increasingly reward firms with robust environmental performance, integrating ESG can enhance long-term returns while contributing to sustainable development goals. In summary, our research provides a dual contribution: It offers policymakers insights into how market reactions to environmental violations can be harnessed to strengthen regulatory efforts while equipping investors with actionable knowledge of the financial implications of noncompliance. Ultimately, these insights serve as a foundation for crafting more informed policies and investment strategies, fostering a mutually reinforcing relationship between financial performance and environmental sustainability.

The remainder of the paper proceeds as follows. In Section 2, we review existing literature on CSR and establish the link between environmental violation and COE. Section 3 describes the

research design. Section 4 reports the baseline results. Section 5 reports the robustness tests. Section 6 concludes this paper.

2 | Literature Review

CSR-related research is grounded in various theoretical perspectives, resulting in conflicting predictions about its implications. According to Attribution Theory (Philippe and Durand 2011), which examines how individuals interpret the behaviour of others, people may attribute observed behaviours to specific causes. This judgment can significantly influence their emotions, motivations and future interactions. When a company commits an environmental violation, stakeholders—such as investors, creditors and regulators—seek to understand the reasons behind the violation (Martinko and Mackey 2019). Consequently, judgments of responsibility may lead to costly firm-level consequences, including harm to reputation and performance, reduced consumer purchase intentions and increased recommendations for legal penalties (Munyon et al. 2019).

Reputation theory explores how reputations are built, maintained and changed and their impact on relationships, decision-making and long-term success (Walker 2010). Reputation is shaped by stakeholders' perceptions—customers, employees, investors and the public—based on both direct experiences and indirect information like media coverage and word-of-mouth (Dowling 1993). A strong reputation brings benefits such as customer loyalty (Islam et al. 2021; Selnes 1993), premium pricing (Fernando et al. 2015), easier access to capital (Wang et al. 2012) and crisis resilience (Kim and Woo 2019), whereas a poor reputation can lead to lost business, decreased trust and long-term damage (Keh and Xie 2009).

Signalling theory posits that firms engage in CSR as a strategic mechanism to demonstrate their commitment to social responsibility and performance, using CSR initiatives to signal their ethical stance and enhance their reputation among stakeholders. Conversely, economic theory asserts that a firm's primary objective is profit maximization for shareholders (Price and Sun 2017), aligning with Friedman's (2007) contention that social responsibility is fundamentally an individual concern rather than a corporate obligation. Adding complexity, agency theory argues that CEOs may pursue CSR initiatives primarily to enhance their personal image or reputation, potentially at the expense of shareholders' interests (Li et al. 2016), highlighting a misalignment between managers' and stakeholders' goals. In contrast, stakeholder theory posits that firms engage in CSR not merely for profit maximization but to create value for a broader set of stakeholders, including employees, customers, suppliers and the community at large (Freeman and Dmytriiev 2017). This perspective emphasizes the importance of balancing various stakeholder interests in the decision-making process, suggesting that firms can achieve long-term sustainability and competitive advantage by prioritizing stakeholder welfare alongside financial performance. Ultimately, these competing theories underscore the complex landscape of corporate responsibility, where motivations behind CSR efforts can vary significantly among firms, and understanding these dynamics is crucial for evaluating the authenticity and effectiveness of CSR initiatives. By

integrating insights from the signalling, economic, agency and stakeholder theories, firms can develop more nuanced strategies that enhance their reputation while aligning CSR efforts with broader societal expectations and stakeholder interests.

Corporate environmental behaviour literature suggests that firms improve environmental performance to maintain legitimacy (Wang et al. 2018) and respond to intensified regulatory pressure (Clemens and Papadakis 2008). This trend is reinforced by Gray and Deily's (1996) finding that stricter enforcement of environmental regulations increases firms' likelihood of compliance. However, despite regulatory pressure, Habib and Bhuiyan (2017) note persistent environmental violations by firms. Moreover, the research of Shevchenko (2021) reveals that many firms fail to take adequate actions to enhance their environmental performance. Intriguingly, when examining the impact of penalties for environmental violations, the study challenges the conventional wisdom by demonstrating that neither receiving a penalty nor facing a higher penalty translates into improved corporate environmental performance. This raises questions about the efficacy of financial penalties in motivating firms to enhance environmental compliance, adding a nuanced layer to the existing literature on the relationship between regulatory measures and corporate advocates and critics of CSR, followed by evidence of the effect on the COE capital and the mechanism through which environmental violations may affect COE.

2.1 | Perspectives of CSR

The concept of corporate social responsibility traces back to the 1920s when it was initially motivated more by social considerations than economic ones (Bhaduri and Selarka 2016). However, acceptance of CSR has not been universal. Traditionally, CSR activities were seen as philanthropic costs diverting resources away from more profitable avenues, not aligning with the goal of profit maximization (Jamali and Mirshak 2007). A shift in perspective emerged in the 1970s, with resource-based views challenging this conventional stance. These views argued for a more efficient and sustainable use of resources, contending that socially responsible practices could benefit both society and businesses economically (Cochran and Wood 1984; Spicer 1978). Subsequent research has yielded mixed findings on the impact of CSR.

2.1.1 | Proponents' Perspective: 'Doing Good is Good for Business'

Advocates of environmental CSR argue that engaging in socially responsible practices is morally commendable and economically advantageous. The concept of 'doing good is good for business' suggests that CSR engagement signals legitimacy and enhances firm value. Hartzmark and Sussman (2019) highlight that investors collectively value sustainability, perceiving it as a positive attribute. Kang et al. (2016) find that firms benefit financially from CSR engagement, attributing it to good management practices linked to improved financial performance. Flammer (2013) suggests that CSR functions like an insurance policy, with environmentally responsible firms witnessing stock price increases and the converse for environmentally irresponsible ones. Servaes and Tamayo (2013) emphasize the importance of high consumer

awareness and aligning a firm's reputation with its CSR efforts to add value. Additionally, value-enhancing CSR practices may lead to reduced analyst dispersion of earnings forecasts, lower stock return volatility and a decreased cost of capital (Harjoto and Jo 2015).

2.1.2 | Opponents' Perspective: The Agency Dilemma

Critics of environmental CSR, particularly from an agency perspective, argue that CSR engagement can exacerbate agency problems by intensifying the conflict of interest between managers and shareholders. Friedman (2007) asserts that CSR may be driven more by managers' self-interest than the genuine social conscience of the firm. Hemingway and Maclagan (2004) caution that CSR engagement often manifests individual managerial initiatives rather than a truly 'corporate' effort. This view suggests that CSR, far from being beneficial to shareholders, might merely serve as a manifestation of an agency problem.

For instance, CSR initiatives might reflect managers' self-interest and potentially conceal misbehaviour (Bénabou and Tirole 2010; Masulis and Reza 2015). Krüger (2015) reports that investors respond negatively to positive CSR news when it originates from firms with poor stakeholder relations or where agency problems are likely present. Adhikari (2016) employs analyst coverage as a monitoring mechanism, finding evidence to support the notion that better monitoring discourages CSR engagement in cases viewed as an agency problem. Bhandari and Javakhadze (2017) reveal that CSR, while potentially reducing a firm's capital allocation efficiency and overall value, may also deplete resources when employed to pursue managers' self-interest. In summary, the dynamic landscape of CSR reveals a complex interplay of perspectives, ranging from the intrinsic value of social responsibility to its potential pitfalls as a manifestation of agency issues. This intricate balance continues to shape discussions and research on the role and impact of CSR in contemporary business.

2.2 | Environmental Violation, Firm Risk and COE

Corporate environmental behaviour is a crucial component of CSR, and environmental irresponsibility impairs corporate reputation (Lin et al. 2016). Environmental compliance, a subset of CSR, specifically focuses on adhering to regulations and standards to protect the environment, such as reducing emissions, managing waste and conserving natural resources. Existing research on environmental CSR and the cost of capital predominantly emphasizes positive compliance, often neglecting the critical aspect of environmental violations. For example, Sharfman and Fernando (2008) show that improved environmental risk management reduces COE, especially in the face of litigation or compliance costs. Investors globally favour environment-friendly firms due to the perceived signal of legitimacy, resulting in a lower COE (e.g., Creel 2012; Kim et al. 2020; Mahmood and Bashir 2020). This one-sided emphasis on positive environmental compliance neglects the adverse financial implications of environmental violations.

From the signalling theory perspective, environmental violations can be viewed as signals that convey information about

a company's management quality and commitment to responsible practices. When a company engages in environmental violations, it sends a negative signal to investors, suggesting a potential lack of managerial competence, governance deficiencies and a disregard for long-term sustainability. Investors, perceiving environmental lapses as indicative of underlying issues within the organization, may interpret these signals as increased financial risk. In response, they are likely to demand a higher COE as compensation for the perceived uncertainty and the potential negative impact on future cash flows. Signalling theory posits that firms with strong signals of environmental responsibility are more likely to attract positive investor attention and enjoy lower COE. In contrast, those with poor signals face higher financing costs due to the perceived risk associated with environmental violations. Therefore, understanding how environmental violations function as signals becomes crucial in comprehending the impact on investor decisions and the COE.

Environmental violations have significant impacts on firms, both financially and reputationally. Karpoff et al. (2005) find that firms charged with environmental violations experience statistically and economically significant decreases in common share values, indicating the financial market's adverse reaction to such incidents. Similarly, McKendall et al. (1999) identify a positive association between the value of stock owned by corporate officers and directors and the incidence of serious environmental violations, suggesting that insiders' financial interests may be linked to noncompliant behaviour. Furthermore, Zou et al. (2015) and Xu et al. (2016) find that firms with a history of environmental violations are deemed more culpable by the media for subsequent environmental violations, leading to greater reputational damage which affects shareholders' wealth due to stock market reactions. Firms with a favourable environmental record (e.g., awards and honours) experience less reputational harm. Empirical research consistently demonstrates that companies violating environmental compliance experience adverse effects on investor perception. Environmental violation breaks the public trust.

Socially irresponsible firms are perceived as having a higher level of risk (Cho et al. 2015; Robinson et al. 2008; Starks 2009) because they associate with more uncertainties regarding future explicit claims and litigation risk (Waddock and Graves 1997). Kölbel et al. (2017) reveal that media coverage of corporate social irresponsibility provokes stakeholder sanctions, thereby increasing a firm's financial risk. Stakeholders experience moral outrage or anger at irresponsible corporate behaviour (Antonetti and Maklan 2016), which leads to stakeholders' punitive intentions to retaliate against corporations (Antonetti and Maklan 2016). For the same reason, banks regard CSR concerns as risk and respond with less attractive loan contract terms (Goss and Roberts 2011). Also, there is evidence that underperforming firms are usually associated with less CSR yet more CSR violations (Zhong et al. 2021).

Research on environmental violations has been relatively limited, though a few studies have focused on CSR violations. The existing literature suggests that the public tends to react more sensitively to CSR violations than to CSR (e.g., Hawn 2021). CSR violations also tend to have a longer-lasting negative effect than CSR initiatives (Price and Sun 2017). Firms doing little CSR and little corporate social irresponsibility perform better than firms

doing both at high levels (Price and Sun 2017). Oikonomou et al. (2012) report that CSR is only weakly associated with a reduction in systematic firm risk; however, there is a strong relationship between CSR violations and an increase in financial risk. More recently, García-Sánchez et al. (2021) find evidence that the US market punishes the behaviour of CSR decoupling, leading to higher analyst forecast errors, elevated cost of capital and reduced access to finance.

Regarding environmental violations, evidence of emerging markets using a multicountry sample, Garzón-Jiménez and Zorio-Grima (2021) present that firms with higher carbon emissions are penalized with higher COE; the assurance of CSR report reduces COE by promoting legitimacy, decreasing information asymmetry. Using a sample of firms across 34 countries, Bui et al. (2020) report higher carbon emission attracts higher premiums on the cost of capital, whereas extensive disclosure of carbon emissions helps to reduce the premium, indicating both the extent of carbon disclosure and the underlying nature of environmental performance are taken into consideration when investors assess the firm risk. In China, Jin et al. (2020) find that the market reacts negatively to irresponsible environmental events, manifested by a significant negative cumulative abnormal return in a short period.

Despite the common belief that financial penalties deter environmental violations, Shevchenko (2021) argues that such penalties do not incentivize firms with past violations to improve their environmental performance. Additionally, Wang et al. (2022) suggest that state ownership and significant economic contributions can weaken the relationship between air pollution and the cost of debt, as these factors can increase a company's bargaining power in environmental oversight and ease creditors' concerns about potential defaults. Interestingly, environmental violations may sometimes lead to a reduction in the cost of capital through various mechanisms. After a violation, companies may become diligent in complying with regulations, reducing uncertainty and lowering perceived future risks, which reassures investors and lowers the risk premium (Anton et al. 2004). Moreover, companies may adopt more efficient and sustainable practices, enhancing profitability and stability. Improved governance and transparency in response to violations can further boost investor confidence and decrease perceived risks (Li et al. 2023).

The key relationships in this study that we develop into the testable hypotheses are those between environmental violation and COE. Building on the above argument and given the divergent findings in existing literature, our research explores how investors perceive environmental violations. We hypothesize that environmental violations cause adverse effects on the stakeholders. Firms practising irresponsible CSR activities often find themselves in a disadvantageous situation compared to industry competitors. Empirical research illustrates that when a firm is perceived as irresponsible, it can harm customers' purchasing decisions, leading to a decline in customer loyalty and satisfaction (e.g., Herr et al. 1991). Furthermore, an irresponsible image can deteriorate the attractiveness of a corporation as an employer, tarnish organizational commitment, entail negative effects on corporate reputation and reduce the relationships with local communities (e.g., Cheng et al. 2022; Lin-Hi and Blumberg 2018; Lin et al. 2016). Therefore, an environmental violation would send a negative signal to the

market, consequently increasing COE as the negative effect. Moreover, European societies emphasize environmental protection and strong public awareness of sustainability (Mulholland 2019), so investors and consumers are highly attuned to ESG issues. CSR violations signal increased risk and potential noncompliance, leading investors to demand higher returns. We develop the following hypothesis:

Hypothesis 1. *Environmental violations are positively associated with the firm cost of equity (COE) capital.*

3 | Research Methodology

3.1 | Sample Selection

This study focuses on firms listed in EU countries from 2005 to 2020, sourced from the Bloomberg European 500 Index. The dataset initially comprises 3612 firm-year observations; however, a notable proportion of relevant data fields are missing, introducing selection bias into the sample. To address this, all observations of environmental penalties were excluded if they were missing, indicating that Bloomberg either did not cover these entities or, even if covered, lacked environmental penalty information. This omission could stem from firms not being penalized (where 0 should have appeared) or the absence of reported data (where N/A should have appeared), with Bloomberg uniformly recording N/A for all missing data fields. The sample selection process prioritized nonmissing environmental penalty observations for 2005–2020, given Bloomberg's sparse reporting of environmental violations related to disclosure before 2005. Also, we collect country-specific economic variables from Thomson Reuters Eikon, such as market capitalization and foreign direct investment. Consequently, the final dataset encompasses 1379 firm-year observations with both nonmissing and zero environmental penalty amounts, as Table 1A details the sample selection and distribution. Table 1B presents the sample distribution by year and country.

3.2 | Research Model

We adopt the following multivariate regression model to estimate firms' environmental-related penalties on the COE capital.

$$\begin{aligned}
 COE_{i,t+1} = & \partial_0 + \partial_1 PENALTY_{i,t} + \partial_2 ENVSCORE_{i,t} \\
 & + \partial_3 GOVSCORE_{i,t} + \partial_4 SOCSCORE_{i,t} \\
 & + \partial_5 FOROWNDUM_{i,t} + \partial_6 ANALYST_{i,t} + \partial_7 ROA_{i,t} \\
 & + \partial_8 SALEGR_{i,t} + \partial_9 DISTRESS_{i,t} + \partial_{10} LNSIZE_{i,t} \\
 & + \partial_{11} DACC_{i,t} + \partial_{12} BETA_{i,t} + \partial_{13} LEVERAGE_{i,t} \\
 & + \partial_{14} MTGDP_{i,t} + \partial_{15} FDI_{i,t} + \partial_{16} LNGDP \\
 & + \partial_{17} CORRUPT + INDUSTRY EFFECT \\
 & + YEAR EFFECT + COUNTRY EFFECT + \epsilon_{i,t}
 \end{aligned} \quad (1)$$

3.2.1 | Environmental Violation Measures (PENALTY)

Our primary coefficient of interest is ∂_1 PENALTY, representing the impact of environmental penalties on the COE capital.

TABLE 1A | Sample selection.

	Details	Sample
	Initial sample: Number of nonfinancial firm-years with environmental violation-related information over a period of 2005–2020 from the BLOOMBERG500 index	3612
	Available (calculated) number of nonfinancial firm-year observations for the cost of equity capital measures (for all three)	7910
	Sample after matching samples between environmental violation and cost of equity capital data	1488
Less	Missing variable observation from board characteristics and other missing financial accounting information	109
	Final sample in firm-year observations	1379
	Unique number of firms across all countries	211

We employ three proxies to measure penalties for environmental violations. First, FINEDUM is a dummy variable assigned a value of 1 if the firm faced a penalty in a specific year and 0 otherwise. Second, LNFINEAMT represents the natural logarithm value of the total environmental fines paid by the company in millions over the relevant financial year. Third, LNFINENUM denotes the natural logarithm of the actual number of penalties imposed on the firm. A positive (negative) coefficient on ∂_1 PENALTY indicates an increase (decrease) in the COE capital for firms facing penalties due to environmental regulation violations.

3.2.2 | COE Measures

Our evaluation of the COE capital employs a meticulous and comprehensive approach, utilizing three distinct measures: COE_CT, COE_OJN and COE_EP. COE_CT is calculated following Claus and Thomas (2001), using the variation of the residual income valuation model. COE_OJN, following Ohlson and Juettner-Nauroth (2005), adopts the abnormal earnings growth valuation model. COE_EP, based on Easton (2004), employs the forecasted earnings per share and dividend per share model. These measures are widely acknowledged in current corporate finance literature (He et al. 2013; Hail and Leuz 2006; Dhaliwal et al. 2011).

3.2.3 | Control Variable Measures

Controlling for potential confounding factors, we include firm-level environmental (ENVSCORE), governance (GOVSCORE) and social (SOCSCORE) performance. Superior environmental, governance and social performance may reduce exposure to environmental regulations and penalties, potentially lowering the COE capital. Foreign ownership (FOROWNDUM) is controlled for, as firms with high foreign ownership may experience a

TABLE 1B | Sample (year and country-wise) distribution.

Year	Firm-year observations	%	Country	Country-wise sample	%	Penalty	% ^a
2005	18	1.31	Austria	21	1.52	11	1.75
2006	36	2.61	Belgium	20	1.45	10	1.59
2007	54	3.92	Denmark	12	0.87	11	1.75
2008	64	4.64	Finland	61	4.42	20	3.19
2009	73	5.29	France	175	12.69	92	14.67
2010	87	6.31	Germany	96	6.96	30	4.78
2011	93	6.74	Greece	18	1.31	10	1.59
2012	102	7.40	Ireland	22	1.6	10	1.59
2013	96	6.96	Italy	100	7.25	38	6.06
2014	125	9.06	Netherlands	49	3.55	33	5.26
2015	101	7.32	Norway	42	3.05	16	2.55
2016	107	7.76	Portugal	25	1.81	16	2.55
2017	107	7.76	Spain	142	10.30	67	10.69
2018	114	8.27	Sweden	122	8.85	35	5.58
2019	109	7.90	Switzerland	113	8.19	42	6.70
2020	93	6.74	The United Kingdom	361	26.18	186	29.67
Total	1379	100		1379	100	627	100

^aCountry-wise penalty for environmental violation divided by the total number of penalties within the sample firm-year observations.

lower COE due to expanded access to a larger pool of potential investors. Analyst followings (ANALYST) serve as a control, where a large number of analysts following a firm is associated with increased transparency and lower perceived risk, potentially leading to a lower COE. Profitability (ROA) and sales growth (SALEGR) are included as controls. Higher profitability and sales growth are indicative of efficient and well-managed firms, instilling investor confidence and potentially reducing the COE capital. Distress level (DISTRESS) is considered, with financially distressed firms being perceived as riskier, resulting in higher costs of equity capital. We also incorporate firm size (LNSIZE), financial reporting quality (DACC), beta (BETA) and leverage (LEVERAGE) as controls. Larger firms may be more complex and involved in riskier investments, potentially raising the COE capital. Financial reporting quality, beta and leverage are included because of their expected associations with the COE capital.

Given the international context of our research, we include several country-level measures as a part of our control variables. Country-level control variables capture economic and regulatory variations. We control market capitalization to GDP ratio (MTGDP), which indicates stock market over (under)valuation, potentially influencing investor decisions and impacting the COE. Foreign direct investment (FDI) reflects a country's economic stability, with higher FDI potentially lowering the COE. Country-level economic indicators, such as GDP, signal economic strength and growth, influencing investor perceptions and the COE capital. Lastly, the perceived corruption index (CORRUPT) accounts for the stability of the economic

environment, with higher corruption potentially leading to increased risk and a higher cost of capital. We refer to [Appendix A](#) for the details on variable definitions.

4 | Results

4.1 | Descriptive Statistics

In [Table 2A](#), we present summary statistics for the variables utilized in our study. Approximately 45.5% of the firms experienced at least one environmental penalty during our sample period. On average, firms incurred a penalty (LNFINEAMT) of 0.13. The mean FINENUM value is 0.70, and the annual environmental penalty ranges between 0 and 6 within our sample duration. The average COE capital measures—COE_CT, COE_OJN and COE_EP—are 14.7%, 9.7% and 6.9%, respectively. Firm environmental, governance and social performance exhibit mean scores of 47.50, 61.99 and 52.16, respectively, with comparatively lower environmental performance. Approximately 11% of firm-year observations indicate foreign ownership during the sample period. On average, each firm year has 18 analyst followers, with a maximum value of 41. Moderate average firm profitability (ROA=0.05) and sales growth (SALEGR=0.07) are observed, and 4% of firms are financially distressed, reflecting the diversity of our sample firms. The average size (SIZE=8.27) and leverage (LEVERAGE=0.18) are moderate. Additionally, the average discretionary accruals of sample firms (DACC=0.14) are noted. Overall, the summary statistics for the control variables align with findings from prior studies.

TABLE 2A | Summary statistics.

Variables	Mean	SD	P25	P50	P75	P95
FINEAMT (<i>in million \$</i>)	0.68	5.47	0	0	0.03	1.10
FINENUM (<i>actual number</i>)	10.18	59.63	0	0	1	27
LNFINEAMT	0.13	0.48	0	0	0.03	0.75
LNFINENUM	0.70	1.16	0	0	0.69	3.33
FINEDUM	0.45	0.5	0	0	1	1
COE_CT	0.15	0.09	0.08	0.12	0.19	0.32
COE_OJN	0.10	0.04	0.07	0.09	0.11	0.17
COE_EP	0.07	0.04	0.05	0.06	0.08	0.14
ENVSCORE	47.50	13.05	39.84	48.84	56.59	67.35
GOVSCORE	61.99	8.48	57.14	62.5	67.86	75
SOCSCORE	52.98	13.38	43.86	54.39	62.28	75
FOROWNDUM	0.11	0.31	0	0	0	1
ANALYST	2.82	0.55	2.40	2.83	3.26	3.56
ROA	0.05	0.07	0.02	0.05	0.08	0.16
SALEGR	0.07	0.36	-0.03	0.04	0.11	0.33
DISTRESS	0.04	0.19	0	0	0	0
LNSIZE	8.27	4.18	7.97	9.53	10.89	12.76
DACC	0.14	0.11	0.08	0.14	0.19	0.31
BETA	1.02	3.73	0.05	0.78	1.6	3.69
LEVERAGE	0.18	0.18	0.07	0.17	0.29	0.48
MTGDP	0.49	0.51	0	0.42	0.65	1.56
FDI	0.04	0.06	0.02	0.03	0.03	0.12
LNGDP	10.68	0.24	10.63	10.67	10.75	11.23
CORRUPT	1.32	0.63	1.08	1.08	1.79	2.24

4.2 | Mean Difference Test

In Table 2B, we conduct mean difference tests for our variables by categorizing the sample into two groups: firms subjected to penalties for environmental violations (FINEDUM=1) and firms without any penalties related to environmental violations (FINEDUM=0). Our results reveal that firms experiencing penalties for environmental violations exhibit a higher COE capital compared to nonviolating firms, and these findings are statistically significant at the 5% level. Furthermore, the environmental and social performance scores are lower for firms penalized for environmental violations, indicating a potential impact on their sustainability practices. Notably, penalized firms are characterized by larger size (LNSIZE), higher leverage (LEVERAGE) and elevated beta (BETA) in comparison to firms not facing financial penalties due to environmental violations. All reported findings hold statistical significance at the 1% level, underscoring the robustness of these observed differences and emphasizing the potential financial implications associated with environmental compliance.

4.3 | Correlation Matrix

In Table 2C, we present the correlation matrix among the variables used in our primary regression analysis, which includes three measures of environmental violations and the COE capital. The positive and significant correlations (ranging from 0.03 to 0.58, $p < 0.05$) between environmental violations and measures of COE suggest that firms facing penalties for such violations experience a rise in their COE capital due to increased perceived risk and diminished investor confidence. Furthermore, the strong positive correlations among the COE measures at the 1% significance level suggest that these measures capture similar underlying constructs. Additionally, firms penalized for environmental violations tend to be larger (LNSIZE), have higher leverage (LEVERAGE) and exhibit better environmental (ENVSCORE), governance (GOVSCORE) and social performance scores (SOCSCORE). Notably, we observe a positive and statistically significant correlation between analyst coverage (ANALYST), environmental violations and the measures of the firm's COE capital.

TABLE 2B | Mean difference test.

Variables	FINEDUM = 0 N = 752	FINEDUM = 1 N = 627	Mean difference	t-statistics
COE_CT	0.133	0.163	-0.030	-6.25***
COE_OJN	0.096	0.100	-0.004	-2.12**
COE_EP	0.065	0.075	-0.010	-4.69***
LNFINEAMT	0.000	0.281	-0.281	-11.366***
LNFINENUM	0.000	1.535	-1.534	-32.446***
ENVSCORE	45.596	49.752	-4.156	-5.684***
GOVSCORE	60.137	64.189	-4.052	-8.666***
SOCSCORE	51.380	54.882	-3.502	-4.648***
FOROWNDUM	0.112	0.097	0.150	1.763*
ANALYST	2.776	2.874	-0.098	-3.327***
ROA	0.053	0.052	0.001	0.35
SALEGR	0.063	0.069	-0.006	-0.87
DISTRESS	0.038	0.032	0.006	1.47
LNSIZE	7.974	8.624	-0.650	-3.88***
DACC	0.147	0.142	0.004	0.59
BETA	0.894	1.169	-0.275	-5.36***
LEVERAGE	0.158	0.199	-0.040	-3.889***
MTGDP	0.515	0.460	0.055	2.012**
FDI	0.037	0.043	-0.006	-1.87*
LNGDP	10.702	10.658	0.044	3.331***
CORRUPT	1.296	1.338	-0.042	-1.296

Note: t-statistics are significant at * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

These findings align with our expectations and are consistent with prior research. Although the univariate tests provide indicative relationships between variables, it is crucial to consider multiple factors, including our control variables, to fully understand the association between firm environmental violations and the COE. Therefore, we assess our developed hypothesis in a multivariate context in the subsequent section to validate its robustness.

4.4 | Regression Analysis

Table 3 presents the baseline regression results for the hypothesis of the relationship between CSR violation and COE capital. We use three measures of the COE capital (*COE_CT*, *COE_OJN* and *COE_EP*) as the dependent variable. Similarly, we use three measures of environmental violation-related penalty (*LNFINEAMT*, *LNFINENUM* and *FINEDUM*) as an independent variable. We measure the effect of the firm environmental violation on the COE capital using Equation 1. First, in Columns 1–3, we consider all three measures of COE and examine the measures of environmental violation proxies for LNFINEAMT. In Columns 1–3, we find the estimated coefficient of LNFINEAMT is positive and statistically significant

for all three different measures of the COE (coefficient = 0.016, 0.004 and 0.006; $p < 0.01$), suggesting that firms that were penalized for environmental violations are likely to have a higher COE. As far as economic significance is concerned, we find that a one standard deviation increase in environmental violation-related fine (0.48) increases COE by around 0.0512 basis point relative to the mean *COE_CT* (estimated as $(0.016 * 0.48) / 0.15$). The corresponding coefficient in the *COE_OJN* model is 0.004, indicating one standard deviation increase in environmental violation-related fine (1.16) increases COE by around 0.0464 basis point relative to the mean COE (estimated as $(0.004 * 1.16) / 0.10$). Finally, the corresponding coefficient in the *COE_EP* model is 0.006, indicating one standard deviation increase in CSR violation-related fine (0.50) increases COE by around 0.0429 basis point relative to the mean COE (estimated as $(0.006 * 0.50) / 0.07$). In Columns 4–6, we report the results for the second measure of environmental penalty (LNFINENUM). The coefficient of LNFINENUM on the COE capital measures (*COE_CT*, *COE_OJN* and *COE_EP*) is positive (coefficient = 0.007, 0.004 and 0.003; $p < 0.05$) and statistically significant. Finally, we reperform Equation (1) for the measure of FINEDUM, and results are presented in Columns 7–9. We find that the coefficient of environmental violation measures (FINEDUM) is positive (coefficient = 0.018, 0.005 and 0.004; $p < 0.01$) and statistically

TABLE 2C | Correlation analysis.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) LNFINEAMT	1.00											
(2) LNFINENUM	0.26***	1.00										
(3) FINEDUM	0.29***	0.66***	1.00									
(4) COE_CT	0.16***	0.15***	0.17***	1.00								
(5) COE_OJIN	0.08***	0.03**	0.06**	0.52***	1.00							
(6) COE_EP	0.15***	0.08***	0.13***	0.58***	0.49***	1.00						
(7) SALEGR	-0.02	-0.02	0.01	-0.04	-0.01	0.04	1.00					
(8) DISTRESS	0.10***	-0.04	-0.02	0.16***	0.28***	0.09***	-0.11***	1.00				
(9) ROA	-0.06**	-0.05*	-0.01	-0.29***	-0.20***	-0.11***	0.05	-0.26***	1.00			
(10) LNSIZE	0.10***	0.01	0.08***	0.19***	0.11***	0.18***	0.00	0.11***	-0.23***	1.00		
(11) DACC	-0.03	0.05*	-0.02	-0.08***	-0.11***	-0.01	0.03	-0.06*	-0.01	0.17***	1.00	
(12) BETA	0.03	0.00	0.04	0.07**	0.08***	0.04	0.01	0.00	-0.01	-0.01	0.00	1.00
(13) LEVERAGE	0.12***	0.15***	0.11***	0.03	-0.06**	0.00	0.07**	-0.06*	-0.20***	0.02	-0.04	0.00
(14) ENVSCORE	0.11***	0.13***	0.16***	0.09***	-0.04	0.03	-0.12***	-0.03	-0.10***	0.15***	0.03	-0.03
(15) GOVSCORE	0.16***	0.16***	0.24***	0.12***	0.01	0.10***	-0.06*	-0.01	-0.03	0.08***	-0.08***	0.01
(16) SOCScore	0.17***	0.17***	0.13***	0.15***	-0.02	0.02	-0.06*	0.02	-0.21***	0.08***	-0.05*	-0.03
(17) FOWNDUM	-0.02	-0.07**	-0.02	-0.09***	0.03	0.01	0.02	-0.04	0.11***	0.08***	-0.02	-0.01
(18) ANALYST	0.09***	0.05*	0.09***	0.22***	0.05*	0.15***	-0.03	0.00	0.01	0.32***	0.03	0.01
(19) MTGDP	-0.06**	-0.08***	-0.05**	-0.09***	-0.07***	-0.08***	0.06*	-0.07**	0.11***	0.01	0.05	0.04
(20) FDI	-0.02	0.06**	0.05*	0.00	0.05*	0.06**	0.07**	-0.02	0.06**	0.05*	0.04	-0.02
(21) LNGDP	-0.04	-0.10***	-0.09***	-0.16***	-0.03	-0.06**	-0.04	0.01	0.20***	0.00	-0.02	-0.01
(22) CORRUPT	0.01	-0.02	0.03	-0.03	0.07**	0.06**	-0.05	0.03	0.12***	0.00	-0.04	0.02

TABLE 2C | (Continued)

Variables	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	VIF
(1) LNFINEAMT											1.23
(2) LNFINENUM											1.11
(3) FINEDUM											1.26
(4) COE_CT											
(5) COE_OJN											
(6) COE_EP											
(7) SALEGR											
(8) DISTRESS											1.12
(9) ROA											1.16
(10) LNSIZE											1.41
(11) DACC											2.53
(12) BETA											1.31
(13) LEVERAGE	1.00										1.06
(14) ENVSCORE	0.00	1.00									1.41
(15) GOVSCORE	0.07**	0.37***	1.00								1.88
(16) SOCScore	0.15***	0.57***	0.33***	1.00							1.43
(17) FOWNDUM	-0.04	-0.02	0.02	-0.05*	1.00						2.02
(18) ANALYST	-0.09***	0.13***	0.07**	0.11***	-0.04	1.00					1.38
(19) MTGDP	-0.13***	-0.01	-0.10***	-0.07**	-0.18***	0.14***	1.00				1.57
(20) FDI	-0.09***	-0.13***	-0.01	-0.12***	-0.05*	0.10***	0.35***	1.00			1.22
(21) LNGDP	-0.23***	-0.11***	-0.15***	-0.29***	0.22***	0.00	0.35***	0.20***	1.00		1.31
(22) CORRUPT	-0.16***	-0.17***	-0.12***	-0.31***	0.18***	0.14***	0.05*	0.18***	0.50***	1.00	3.60

Note: *t*-statistics are significant at * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

TABLE 3 | Main result.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	COE_CT	COE_OJN	COE_EP	COE_CT	COE_OJN	COE_EP	COE_CT	COE_OJN	COE_EP
Constant	0.193 (1.188)	0.148* (1.874)	0.192*** (2.814)	0.183 (1.121)	0.146* (1.858)	0.191*** (2.789)	0.154 (0.946)	0.144* (1.826)	0.187*** (2.727)
LNFINEAMT	0.016*** (3.105)	0.004** (2.427)	0.006*** (2.678)	—	—	—	—	—	—
LNFINENUM	—	—	—	0.007*** (2.839)	0.004*** (2.814)	0.003** (2.614)	—	—	—
FINEDUM	—	—	—	—	—	—	0.018*** (2.983)	0.005*** (2.951)	0.004*** (2.872)
ENVSCORE	-0.001 (-1.525)	-0.001 (-1.623)	-0.001 (-1.212)	-0.001 (-0.572)	-0.001* (-1.648)	-0.001 (-0.941)	-0.001 (-0.766)	-0.001* (-1.686)	-0.001 (-1.149)
GOVSCORE	0.001 (1.117)	0.001 (0.166)	0.001 (1.09)	0.001 (0.914)	0.001 (0.134)	0.001 (1.168)	0.001 (0.704)	0.001 (0.124)	0.001 (1.071)
SOCSCORE	0.001 (0.401)	0.001 (0.102)	-0.001 (-1.086)	0.001 (0.537)	0.001 (0.212)	-0.001 (-0.814)	0.001 (0.675)	0.001 (0.264)	-0.001 (-0.791)
FOWNDUM	-0.007 (-0.816)	0.012*** (2.992)	0.005 (1.284)	-0.007 (-0.859)	0.012*** (2.958)	0.004 (1.197)	-0.009 (-1.006)	0.012*** (2.922)	0.004 (1.163)
ANALYST	0.001 (0.721)	-0.001 (-0.665)	-0.001 (-0.267)	0.001 (1.013)	-0.001 (-0.564)	-0.001 (-0.143)	0.001 (0.874)	-0.001 (-0.606)	-0.001 (-0.171)
ROA	-0.262*** (-5.739)	-0.102*** (-4.638)	-0.081** (-2.048)	-0.262*** (-5.747)	-0.103*** (-4.659)	-0.097** (-2.137)	-0.264*** (-5.796)	-0.103*** (-4.678)	-0.083** (-2.143)
SALEGR	-0.002 (-0.358)	0.002 (0.738)	0.006* (1.903)	-0.002 (-0.252)	0.003 (0.772)	0.006* (1.929)	-0.003 (-0.364)	0.002 (0.739)	0.006* (1.904)
DISTRESS	0.017 (1.115)	0.034*** (4.806)	0.006 (0.841)	0.023 (1.526)	0.036*** (5.001)	0.008 (1.077)	0.021 (1.401)	0.036*** (4.971)	0.008 (1.062)

(Continues)

TABLE 3 | (Continued)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LNSIZE	0.009*** (3.765)	0.003*** (2.812)	0.006*** (5.58)	0.012*** (4.017)	0.004*** (3.007)	0.006*** (6.013)	0.009*** (3.649)	0.004*** (2.931)	0.006*** (5.796)
DACC	-0.097*** (-3.662)	-0.037*** (-2.894)	-0.017 (-1.542)	-0.101*** (-3.809)	-0.038*** (-2.969)	-0.019* (-1.693)	-0.093*** (-3.475)	-0.037*** (-2.891)	-0.018 (-1.588)
BETA	0.001* (1.773)	-0.001 (-0.127)	0.001*** (2.741)	0.001* (1.842)	-0.001 (-0.079)	0.001*** (2.847)	0.001* (1.694)	-0.001 (-0.099)	0.001*** (2.794)
LEVERAGE	-0.043** (-2.506)	-0.024*** (-2.922)	0.001 (0.026)	-0.048*** (-2.807)	-0.025*** (-3.021)	-0.001 (-0.127)	-0.051*** (-2.901)	-0.0250*** (-3.014)	-0.001 (-0.169)
MTGDP	-0.001 (-0.062)	-0.001 (-0.264)	0.001 (0.189)	-0.001 (-0.017)	-0.001 (-0.263)	0.001 (0.156)	-0.001 (-0.117)	-0.001 (-0.292)	0.001 (0.133)
FDI	0.056 (1.311)	0.056*** (2.703)	0.026 (1.418)	0.036 (0.838)	0.053** (2.531)	0.023 (1.238)	0.047 (1.091)	0.055*** (2.632)	0.023 (1.296)
LNGDP	-0.013 (-0.787)	-0.004 (-0.469)	-0.019*** (-2.786)	-0.012 (-0.759)	-0.0004 (-0.484)	-0.019*** (-2.838)	-0.009 (-0.551)	-0.004 (-0.457)	-0.019*** (-2.755)
CORRUPT	-0.02*** (-2.733)	-0.008** (-2.406)	0.003 (0.841)	-0.018** (-2.535)	-0.008** (-2.309)	0.003 (1.028)	-0.018** (-2.501)	-0.008** (-2.297)	0.003 (1.037)
INDUSTRY	YES	YES	YES	YES	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES	YES	YES	YES	YES
COUNTRY	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1379	1379	1379	1379	1379	1379	1379	1379	1379
R-squared	0.377	0.279	0.367	0.376	0.277	0.362	0.377	0.277	0.362

Note: t-values are in parentheses.
 *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

significant across all the measures on COE. Overall, our findings suggest that firms that were penalized for environmental violations have a higher COE capital.

Regarding the control variables, we find a negative association between firm profitability (*ROA*) and COE capital, suggesting profitable firms avail lower COE capital. In contrast, our findings show a positive association between firm size (*LNSIZE*) and COE capital, indicating that large firms have higher equity costs. Finally, we perform a variance inflation factor test (VIF) for multicollinearity concerns among the independent variables. We find the three largest VIFs are *CORRUPT* (3.60), *LNGDP* (2.63) and *LNSIZE* (2.53). Also, the remaining other independent variables have a VIF score lower than 10. A VIF score above 10 suggests multicollinearity in the multivariate regression model (Thompson et al. 2017). Therefore, we rule out any concern of multicollinearity, which may affect our findings. Overall, our results support the hypothesis that firms penalized for environmental violations have a higher COE capital.

Our findings are consistent with the existing literature, which suggests that the financial repercussions of environmental violations extend beyond immediate penalties and manifest in an increased COE capital. Such findings underscore the broader financial implications and market perceptions associated with corporate environmental irresponsibility. Firms that fall afoul of environmental regulations face direct penalties and a subsequent increase in the cost of capital, a crucial consideration for investors and policymakers alike. This reinforces the argument that stringent environmental regulations and corporate adherence to sustainable practices are integral to financial risk management and market valuation.

4.5 | Endogeneity Concern: 2SLS Regression Model

The endogeneity concern, mainly stemming from selection bias, poses a significant challenge in accurately gauging treatment effects (Tucker 2010). Overlooking detectable differences in crucial factors such as size, growth, complexity and profitability results in 'selection bias owing to observables'. Using a limited set of observations introduces 'selection bias owing to unobservable'. For example, suppose firms with a strong commitment to ethical practices are more vigilant in avoiding CSR violations. In that case, their characteristics may differ from firms that are less concerned about ethical considerations. Failure to account for these unobservable differences could lead to selection bias.

We adopt the Heckman two-stage error correction method, a widely accepted strategy to address selection bias in existing studies (Heckman 1979). Our implementation of the Heckman test proceeds as follows: In Equation (2), we use observable firm characteristics, guided by previous research, to model factors influencing firms' experiences with penalties related to environmental violations (Habib and Bhuiyan 2017). The Heckman two-stage regression helps identify the inverse Mills ratio (*MILLRAT*) due to its nonlinear rationale, but this approach requires excluding restrictions. Recognizing that firms within the same industry are likely to adhere to similar CSR practices and face comparable treatment for CSR violations, we introduce the industry-based CSR violation measure, *INDAVGPENAL*

(industry-year median CSR violation-related penalty), as the exclusion variable in Equation (3).

$$\begin{aligned} \text{FINEDUM}_{i,t+1} = & \partial_0 + \partial_1 \text{ENVSCORE}_{i,t} + \partial_2 \text{GOVSCORE}_{i,t} \\ & + \partial_3 \text{SOCSCORE}_{i,t} + \partial_4 \text{FOROWNDUM}_{i,t} \\ & + \partial_5 \text{ANALYST}_{i,t} + \partial_6 \text{ROA}_{i,t} + \partial_7 \text{SALEGR}_{i,t} \\ & + \partial_8 \text{DISTRESS}_{i,t} + \partial_9 \text{LNSIZE}_{i,t} + \partial_{10} \text{DACC}_{i,t} \quad (2) \\ & + \partial_{11} \text{LEVERAGE}_{i,t} + \partial_{12} \text{MTGDP}_{i,t} \\ & + \partial_{13} \text{CORRUPT}_{i,t} + \partial_{14} \text{INDAVGPENAL}_{i,t} \\ & + \text{YEAR EFFECT} + \text{COUNTRY EFFECT} + \varepsilon_{i,t} \end{aligned}$$

$$\begin{aligned} \text{COE}_{i,t+1} = & \partial_0 + \partial_1 \text{PENALTY}_{i,t} + \partial_2 \text{ENVSCORE}_{i,t} \\ & + \partial_3 \text{GOVSCORE}_{i,t} + \partial_4 \text{SOCSCORE}_{i,t} \\ & + \partial_5 \text{FOROWNDUM}_{i,t} + \partial_6 \text{ANALYST}_{i,t} \\ & + \partial_7 \text{ROA}_{i,t} + \partial_8 \text{SALEGR}_{i,t} + \partial_9 \text{DISTRESS}_{i,t} \\ & + \partial_{10} \text{LNSIZE}_{i,t} + \partial_{11} \text{DACC}_{i,t} + \partial_{12} \text{BETA}_{i,t} \quad (3) \\ & + \partial_{13} \text{LEVERAGE}_{i,t} + \partial_{14} \text{MTGDP}_{i,t} + \partial_{15} \text{FDI}_{i,t} \\ & + \partial_{16} \text{LNGDP} + \partial_{17} \text{CORRUPT} + \partial_{18} \text{MILLRAT} \\ & + \text{INDUSTRY EFFECT} + \text{YEAR EFFECT} \\ & + \text{COUNTRY EFFECT} + \varepsilon_{i,t} \end{aligned}$$

Column 1 of Table 4 presents the outcomes of our logistic regression, wherein *FINEDUM* is regressed on potential determinants of an environmental violation-related fine along with the exclusion variable (*INDAVGPENAL*). The logistic regression reveals a noteworthy positive correlation between the incidence of fines (*FINEDUM*) and observable factors impacting environmental violation-related penalties. This correlation remains significant with the inclusion of the relevant exclusion variable (coefficient = 1.086; *t*-statistics = 9.637; *p* < 0.01), affirming the appropriateness of applying the Heckman two-stage method to address potential biases. Moving to the second stage regression model, we compute the inverse-mill ratio (*MILLRAT*) from the initial probit model and incorporate it as a new independent variable. The results, depicted in Columns 2, 3 and 4, reveal that the coefficients on *FINEDUM* are consistently significant and positive (ranging from 0.009 to 0.017; *p* < 0.01) across all measures of the COE capital. This implies that firms subjected to environmental violation-related penalties tend to experience higher costs of equity capital, which supports our initial findings.

4.6 | Propensity Score Matching (PSM)

In our earlier analysis, we observed an increase in a firm's COE when a firm engaged in environmental violation. However, this association might be affected by biases, such as observable heterogeneity and functional misspecification. To mitigate these biases, we employ PSM analysis, a method designed to address these issues by adjusting for differences in covariate distribution between firms with environmental violations (treatment group) and those without (control groups). In the first stage, a logistic regression model is utilized for *FINEDUM*, using the

TABLE 4 | Heckman 2SLS.

Variables	(1)	(2)	(3)	(4)
	FINEDUM	COE_CT	COE_OJN	COE_EP
Constant	2.449 (0.438)	0.164 (0.957)	0.128 (1.588)	0.132* (1.902)
FINEDUM	—	0.017*** (2.724)	0.009*** (3.052)	0.011*** (2.694)
ENVSCORE	0.017* (1.887)	0.001 (1.15)	0.001 (0.368)	0.002** (2.162)
GOVSCORE	0.064*** (5.095)	0.002*** (2.805)	0.001*** (2.791)	0.001*** (3.087)
SOCSCORE	0.011 (1.136)	0.001* (1.711)	−0.001 (−0.002)	−0.001 (−0.617)
FOROWNDUM	0.166 (0.587)	−0.005 (−0.557)	0.004** (2.282)	0.005 (1.378)
ANALYST	−0.007 (−0.527)	0.001 (0.953)	−0.001 (−0.598)	0.001 (0.899)
ROA	−0.804 (−0.565)	−0.301*** (−6.485)	−0.119*** (−5.492)	−0.031* (−1.651)
SALEGR	−0.072 (−0.232)	−0.010 (−1.139)	−0.006 (−1.495)	0.007* (1.915)
DISTRESS	0.245 (0.473)	0.029* (1.862)	0.038*** (5.161)	−0.004 (−0.512)
LNSIZE	0.512*** (6.034)	0.017*** (4.461)	0.004** (1.999)	0.009*** (5.741)
DACC	−3.64*** (−3.451)	−0.179*** (−4.716)	−0.043** (−2.443)	−0.055*** (−3.598)
BETA	0.056* (1.896)	0.003*** (3.079)	0.002*** (3.548)	0.001*** (3.994)
LEVERAGE	1.275** (2.125)	−0.021 (−1.053)	−0.011 (−1.175)	0.016* (1.949)
MTGDP	−0.197 (−0.868)	−0.009 (−1.392)	−0.003 (−0.982)	−0.004 (−1.614)
FDI	1.757 (1.245)	0.104** (2.281)	0.067*** (3.134)	0.044** (2.401)
LNGDP	−1.576*** (−2.846)	−0.026 (−1.379)	−0.004 (−0.419)	−0.019** (−2.477)
CORRUPT	−0.043 (−0.168)	−0.027*** (−3.479)	−0.007* (−1.946)	−0.003 (−1.09)

(Continues)

TABLE 4 | (Continued)

Variables	(1)	(2)	(3)	(4)
INDAVGPENAL	1.086*** (9.637)	—	—	—
MILLRAT	—	0.033 (1.079)	0.004 (1.486)	0.013 (1.196)
INDUSTRY	YES	YES	YES	YES
YEAR	YES	YES	YES	YES
COUNTRY	YES	YES	YES	YES
Observations	1379	1379	1379	1379
Pseudo/R-squared	0.234	0.405	0.392	0.374

Note: *t*-values are in parentheses.
 *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

same control variables as in Equation (1). PSM principles guide us to use identical control variables in both stages to balance treatment and control observations in the matched sample effectively. Specifically, we pair firms penalized for environmental violations ($FINEDUM=1$) with nonpenalized firms ($FINEDUM=0$) and calculate the average difference in the COE capital between these groups. We then apply the estimated score to match each observation with an environmental violation score to an observation with a nonpenalized violation score using a one-to-one matching without replacement approach. Finally, we employ two techniques to investigate environmental violations' impact on the equity capital cost. In the first test, we compare the average COE capital between environmental violation firms ($FINEDUM=1$) and their matched counterparts. The propensity score-matched samples are used in the second analysis, where we rerun the linear models estimated in the primary analysis. The summarized findings are presented in Table 5B.

Table 5A reports the findings of univariate tests. We find significant evidence that firms penalized for environmental violations have higher equity capital costs than firms with nonpenalized environmental violations. The average difference in the COE capital between environmental violation firms and their matched neighbours with nonenvironmental violation scores ranges between 1.2% and 2.4%. Table 5B provides the regression analysis results for the matched sample. In the matched sample, we find a positive and statistically significant coefficient for the *FINEDUM* across all measures of firm COE capital, implying that firms penalized for environmental violations are associated with a higher COE capital.

5 | Additional Tests

5.1 | Moderating Effects: Financial Constraints and Product Market Competition

5.1.1 | Financial Constraints

Financial constraints could amplify the negative impact of environmental violations on a firm's COE by increasing investor perceptions of risk and reducing the firm's ability to manage

TABLE 5A | Descriptive statistics.

Dependent variables	$FINEDUM=0,1$	Difference	<i>t</i> -statistics
COE_CT	Treated = 0.165 Control = 0.141	0.024***	3.781
COE_OJN	Treated = 0.100 Control = 0.088	0.012***	2.732
COE_EP	Treated = 0.109 Control = 0.093	0.016***	2.844

reputational damage. Constrained firms are seen as less capable of covering fines or recovery efforts, leading investors to demand higher returns. This dynamic also fosters short-termism, as these firms prioritize survival over environmental compliance, further eroding investor confidence. Ultimately, the compounded risks from both financial instability and environmental misconduct make it more difficult for constrained firms to access affordable equity financing. To test our conjecture, we examine the relationship between environmental violations and the COE, considering the role of financial constraints. Following Hadlock and Pierce (2010), we measure financial constraints using the SA index based on firm size and age. Firms with higher SA index values are classified as financially constrained. We assign firms in the index distribution's top tercile (bottom tercile) at the end of the year preceding the offering year to the constrained (unconstrained) group. We then re-estimate the primary regression model, with the results presented in Table 6.

Our findings indicate that the coefficient on LNFINEAMT is positive and statistically significant for financially constrained firms compared to nonconstrained firms. Specifically, the coefficients are 0.013, 0.007 and 0.044 ($p < 0.05$), demonstrating that environmental violations have a stronger impact on the COE for constrained firms. These results suggest that environmental violations heighten constrained firms' perceived risk and financial vulnerability, leading investors to demand higher equity premiums. Given their limited resources to address the consequences

TABLE 5B | Propensity score-matched regression analysis.

Variables	(1)	(2)	(3)
	COE_CT	COE_OJN	COE_EP
Constant	0.206 (0.741)	-0.036 (-0.268)	0.188 (0.871)
FINEDUM	0.007*** (2.789)	0.004*** (2.751)	0.003*** (3.391)
ENVSCORE	-0.001** (-2.206)	-0.002 (-1.747)	-0.001 (-1.429)
GOVSCORE	0.001 (1.126)	0.001 (0.402)	0.002 (0.448)
SOCSCORE	0.002*** (3.092)	0.002 (1.604)	0.002 (1.183)
FOROWNDUM	0.048*** (3.419)	0.023*** (3.357)	0.027*** (2.836)
ANALYST	0.002*** (2.604)	-0.002 (-1.136)	-0.002 (-1.888)
ROA	-0.245*** (-3.265)	-0.091** (-2.449)	-0.107** (-2.186)
SALEGR	-0.047* (-1.708)	-0.027** (-2.039)	-0.034* (-1.759)
DISTRESS	0.019* (1.674)	0.016* (1.755)	0.017* (1.817)
LNSIZE	0.008*** (2.722)	0.004*** (2.743)	0.006*** (2.748)
DACC	-0.251*** (-3.75)	-0.103*** (-3.128)	-0.096* (-1.886)
BETA	0.001 (0.008)	0.001 (0.207)	-0.001 (-0.126)
LEVERAGE	-0.041 (-1.295)	-0.001 (-0.029)	-0.004 (-0.171)
MTGDP	0.035** (2.389)	0.004 (1.503)	0.013 (1.306)
FDI	0.077* (1.797)	0.063* (1.842)	0.109* (1.848)
LNGDP	-0.001 (-1.048)	0.019 (1.382)	-0.002 (-1.084)
CORRUPT	-0.039*** (-3.179)	-0.007** (-1.99)	-0.011* (-1.861)
INDUSTRY	YES	YES	YES

(Continues)

TABLE 5B | (Continued)

Variables	(1)	(2)	(3)
	COE_CT	COE_OJN	COE_EP
YEAR	YES	YES	YES
COUNTRY	YES	YES	YES
Observations	297	297	297
R-squared	0.549	0.395	0.413

Note: *t*-values are in parentheses.
****p* < 0.01, ***p* < 0.05 and **p* < 0.10.

of environmental misconduct, financially constrained firms experience a more pronounced increase in their COE relative to nonconstrained firms.

5.1.2 | Product Market Competition

Product market competition moderates the relationship between environmental violations and COE by influencing how investors perceive risk. In highly competitive markets, firms face greater reputational damage and market share loss, leading to higher equity premiums as investors demand compensation for increased volatility. Tighter margins in competitive industries also limit recovery efforts, worsening investor sentiment and further raising the COE. Conversely, firms experience less severe financial consequences in less competitive markets since customers and suppliers have fewer alternatives, reducing the impact on equity costs. Additionally, firms relying on sustainability as a competitive advantage face harsher penalties from investors when environmental violations occur, amplifying the negative effect on equity in competitive industries. Extant corporate governance literature suggests that product market competition is a self-regulating force shaping industries (e.g., Flammer 2015; Tsenduren et al. 2021). Intensified competition prompts firms to invest more in CSR as a strategic move to enhance product competitiveness. Adhering to CSR policies distinguishes firms from their competitors, appeals to new investors and broadens their market presence. CSR activities emerge as a source of competitive advantage by swaying stakeholders in favour of the firm. El Ghoul et al. (2011) prove that firms with superior CSR scores benefit from more affordable equity financing. Consequently, firms facing CSR violations are likely to be viewed unfavourably by stakeholders making investment decisions, potentially signalling higher risk. To explore the relationship between CSR violation and the COE capital within the context of product market competition, we categorize the sample into two groups: firms belonging to highly competitive industries ($HHI = 1$) and those not belonging to competitive industries ($HHI = 0$). The measurement of firm competitiveness utilizes the Herfindahl-Hirschman index (HHI), gauging market concentration. A highly concentrated industry indicates that a few firms control a substantial market share, resembling a near monopoly. Conversely, a low degree of concentration suggests an industry nearing ideal competition, with multiple similarly sized firms sharing the market. We employ a dummy

TABLE 6 | Moderating analysis: Financial constraints.

Variables	(1) COE_CT	(2) COE_CT	(3) COE_OJN	(4) COE_OJN	(5) COE_EP	(6) COE_EP
	FC=1	FC=0	FC=1	FC=0	FC=1	FC=0
Constant	-0.318 (-0.713)	0.396** (2.177)	0.279 (1.411)	0.182** (2.154)	0.186 (1.018)	0.194** (2.432)
LNFINEAMT	0.013** (2.302)	0.006 (0.97)	0.007** (2.271)	0.003 (0.939)	0.044** (2.164)	0.006 (1.177)
ENVSCORE	-0.001** (-2.269)	-0.001 (-0.07)	-0.001 (-0.454)	-0.002* (-1.946)	-0.001 (-0.128)	-0.002 (-0.893)
GOVSCORE	0.001 (0.951)	0.0020 (-0.386)	0.007 (-1.204)	0.001 (-0.589)	0.001 (0.441)	-0.001 (-0.392)
SOCSORE	-0.001 (-0.986)	0.001 (1.443)	0.003 (-1.414)	0.02*** (-0.354)	-0.001** (-2.343)	-0.090 (-0.593)
FOROWNDUM	-0.022 (-1.264)	-0.027** (-2.323)	0.014* (1.789)	0.001 (0.159)	0.002 (0.006)	-0.005 (-1.078)
ANALYST	0.001* (1.79)	0.001** (2.451)	0.001 (1.398)	0.001 (0.303)	0.011 (-0.206)	0.001 (1.379)
ROA	-0.465*** (-3.939)	-0.255*** (-4.394)	-0.044 (-0.833)	-0.112*** (-4.149)	-0.036 (-0.721)	-0.004 (-0.152)
SALEGR	0.023 (0.919)	-0.001 (-0.172)	-0.011 (-0.913)	0.003 (0.717)	0.029*** (2.842)	0.005 (1.408)
DISTRESS	-0.014 (-0.424)	0.026 (1.327)	0.069*** (4.58)	0.028*** (3.116)	0.001 (0.004)	0.014 (1.527)
LNSIZE	0.004 (0.436)	0.012*** (4.022)	0.005 (1.0178)	0.006*** (4.631)	0.003 (0.793)	0.009*** (6.485)
DACC	-0.145** (-2.271)	-0.044 (-1.449)	-0.056* (-1.968)	-0.029** (-2.02)	-0.073*** (-2.82)	0.032** (2.408)
BETA	0.002 (1.108)	0.001 (1.191)	0.007 (0.166)	0.001 (0.358)	0.001** (2.078)	0.001 (0.874)
LEVERAGE	-0.098*** (-3.482)	0.017 (0.734)	-0.051*** (-4.088)	-0.015 (-1.464)	-0.023** (-1.991)	0.015 (1.464)
MTGDP	-0.025* (-1.864)	-0.014* (-1.65)	-0.005 (-0.785)	-0.004 (-1.104)	-0.003 (-0.595)	-0.008** (-2.154)
FDI	-0.013 (-0.217)	0.093 (1.131)	0.028 (1.085)	0.105*** (2.758)	0.025 (1.072)	0.071** (1.982)
LNGDP	0.046 (1.097)	-0.036** (-2.066)	-0.017 (-0.915)	-0.011 (-1.337)	-0.012 (-0.678)	-0.02*** (-2.652)
CORRUPT	0.005 (0.556)	0.002 (-0.044)	0.004 (0.801)	-0.001 (-0.302)	0.006 (1.523)	0.006** (2.172)
INDUSTRY	NO	NO	NO	NO	NO	NO

(Continues)

TABLE 6 | (Continued)

Variables	(1) COE_CT	(2) COE_CT	(3) COE_OJN	(4) COE_OJN	(5) COE_EP	(6) COE_EP
YEAR	Yes	Yes	Yes	Yes	Yes	Yes
COUNTRY	Yes	Yes	Yes	Yes	Yes	Yes
Observations	226	593	226	593	221	586
R-squared	0.228	0.208	0.309	0.167	0.202	0.141

Note: *t*-values are in parentheses.
 ****p* < 0.01, ***p* < 0.05 and **p* < 0.10.

variable, taking a value of 1 for firms in highly concentrated industries ($HHI = 1$) and 0 for those in less concentrated industries ($HHI = 0$). The findings are presented in Table 7.

In Table 7, we observe that the coefficient of LNFINEAMT is positive and exhibits statistical significance (coefficient = 0.014; *t*-statistics = 2.512) when assessing the COE capital (measured as COE_CT) for firms existing in highly competitive industries. Our results indicate that the positive connection between CSR violation and COE capital is more accentuated in environments characterized by elevated product market competition, as opposed to scenarios with lower competitiveness. This pattern persists consistently across alternative measures of the COE capital (COE_OJN and COE_EP). Also, we find that the coefficient on LNFINEAMT and FINEDUM is positive and statistically significant across all the measures of the COE (results are untabulated for the sake of brevity). In essence, our additional tests provide further support for the validity of the formulated conjecture.

5.2 | Environmental Violation and Cost of Debt (COD)

Environmental violations, signalling increased operational and reputational risks, are crucial factors creditors, including banks and bondholders, consider. Their evaluation centres on a company's ability to meet debt obligations, emphasizing credit risk assessment. The financial implications stemming from legal actions and regulatory penalties associated with CSR violations become significant determinants for creditors. In response, creditors may adjust the COD to counterbalance the perceived elevation in default risk. Although existing literature highlights the potential connection between CSR practices and COD, limitations exist in addressing the specific nexus between environmental violation and COD.

Consequently, this examination integrates available evidence, formulating a conjecture grounded in broader insights into CSR and COD. Existing literature presents diverse perspectives on the association between CSR practices and COD. Izzo and Magnanelli (2012) find a positive correlation between CSR performance and COD, suggesting limited risk mitigation by engaging in CSR activities. Conversely, Sharfman and Fernando (2008) observe an inverse relationship between CSR and COD, implying a potential increase in COD despite a reduced COE. We examine the impact of environmental violations on the firm cost of debt.

Table 8 reports the findings. In our analysis, we employ two distinct measures for the cost of debt, denoted as COD1 and COD2. Each independent variable—LNFINEAMT, LNFINEAMT and FINEDUM—is individually included in the model. Our findings reveal a positive association between LNFINEAMT with COD1 and COD2, with coefficients of 0.006 and 0.014 and corresponding *t*-statistics of 1.73 and 2.44, respectively. Our results demonstrate a positive association between LNFINEAMT and COD1 and COD2, featuring coefficients of 0.005 and 0.031 and corresponding *t*-statistics of 1.69 and 2.08, respectively. Moreover, the coefficient of FINEDUM consistently indicates a positive association with COD1 and COD2. This suggests that the cumulative fines incurred due to violations are also positively linked to elevated costs of debt, reinforcing the notion that financial penalties contribute to heightened borrowing costs for firms. Our findings contribute to the broader understanding of the relationship between CSR misconduct and the cost of debt. Importantly, we propose that external creditors consider environmental violations a significant risk factor, leading to an increased cost of debt for firms engaged in such practices. This insight underscores the growing importance of ethical and sustainable business practices, as they directly impact firms' financial standing and borrowing costs.

5.3 | Omitted Variable Test—Industry Sensitivity, CEO Compensation Relating to ESG, Firm Life Cycle and Female Director

To this end, we introduce additional control variables, namely, industry sensitivity (INDSEN), CEO compensation linked to environmental, social and governance performance (CEO_ESG), firm life cycle (LCYCLE) and firm diversity practices (FEMDIR). The variable INDSEN is operationalized as a binary indicator, taking the value of 1 if the firm belongs to the ESG-sensitive sector and 0 otherwise. CEO_ESG is a binary dummy variable, assigned a value of 1 if the CEO's compensation package is linked to environmental, social and governance considerations and 0 otherwise, aligning with prior research conventions. Following the methodology proposed by DeAngelo et al. (2006), LCYCLE is computed as the ratio of retained earnings scaled by total assets, providing insight into the firm's life cycle stage. Lastly, we examine a firm's diversity practices using the variable FEMDIR, which is measured as a binary dummy variable, taking the value of 1 if the firm has established diversity practices and 0 otherwise. By systematically incorporating these control variables into our analysis, we aim to ensure the robustness of our results

TABLE 7 | Moderating analysis: Product market competition (HHI).

Variables	COE_CT		COE_OJN		COE_EP	
	HHI = 0/1		HHI = 0/1		HHI = 0/1	
	0	1	0	1	0	1
Constant	0.066 (0.135)	-0.242 (-1.454)	0.726*** (2.961)	0.004 (0.055)	0.281 (1.482)	0.027 (0.331)
LNFINEAMT	0.015 (1.566)	0.014** (2.512)	0.008 (1.451)	0.001** (2.012)	0.006 (1.367)	0.005** (1.991)
ENVSCORE	0.001 (0.058)	-0.001 (-0.497)	0.001 (0.083)	-0.001* (-1.856)	-0.001 (-1.026)	0.001 (0.851)
GOVSCORE	0.001 (0.806)	0.001 (1.351)	-0.001 (-0.562)	0.001 (0.835)	0.001 (0.359)	0.001 (1.575)
SOCSCORE	-0.001 (-0.936)	0.001* (1.714)	-0.001 (-1.183)	0.001 (0.977)	-0.001 (-0.241)	-0.001 (-0.704)
FOROWNDUM	-0.022* (-1.679)	0.007 (0.571)	0.016** (2.445)	0.009 (1.490)	0.004 (0.708)	0.003 (0.565)
ANALYST	-0.001 (-0.306)	0.001 (0.143)	-0.001 (-0.204)	-0.001 (-0.31)	-0.001 (-0.967)	-0.001 (-0.249)
ROA	-0.181*** (-2.859)	-0.291*** (-4.212)	-0.097*** (-3.053)	-0.105*** (-3.163)	0.004 (0.167)	0.016 (0.478)
SALEGR	0.027* (1.779)	-0.012* (-1.825)	0.016** (2.181)	-0.003 (-0.994)	0.015** (2.407)	0.005 (1.383)
DISTRESS	0.061** (2.212)	0.018 (1.116)	0.065*** (4.73)	0.021** (2.583)	0.015 (1.021)	0.001 (0.131)
LNSIZE	0.008** (2.096)	0.012*** (3.722)	0.004** (2.242)	0.004** (2.198)	0.004*** (2.839)	0.007*** (4.349)
DACC	-0.174*** (-3.472)	-0.093*** (-3.16)	-0.091*** (-3.636)	-0.013 (-0.932)	-0.047** (-2.425)	-0.007 (-0.505)
BETA	0.001 (0.718)	0.002** (2.006)	0.001 (0.627)	0.001 (-0.722)	0.001* (1.877)	0.001** (1.976)
LEVERAGE	-0.029 (-0.977)	-0.062*** (-3.099)	-0.042*** (-2.853)	-0.009 (-0.979)	-0.010 (-0.857)	0.004 (0.399)
MTGDP	0.014 (0.656)	-0.012* (-1.905)	0.002 (0.175)	-0.004 (-1.371)	0.004 (0.467)	-0.002 (-0.737)
FDI	0.058 (0.211)	0.089** (2.297)	0.028 (0.207)	0.056*** (3.004)	0.201* (1.902)	0.038** (2.003)
LNGDP	-0.010 (-0.216)	0.031* (1.871)	-0.058** (-2.461)	0.009 (1.071)	-0.028 (-1.529)	-0.004 (-0.507)
CORRUPT	0.009 (0.679)	-0.048*** (-5.424)	0.001 (0.217)	-0.009** (-2.126)	0.015*** (2.833)	-0.007* (-1.658)

(Continues)

TABLE 7 | (Continued)

	COE_CT		COE_OJN		COE_EP	
INDUSTRY	NO	NO	NO	NO	NO	NO
YEAR	YES	YES	YES	YES	YES	YES
COUNTRY	YES	YES	YES	YES	YES	YES
Observations	681	698	681	698	681	698
R-squared	0.407	0.495	0.329	0.335	0.391	0.434

Note: *t*-values are in parentheses.
 *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

and offer a more comprehensive understanding of the factors influencing our primary findings.

Table 9 presents the outcomes following the inclusion of the aforementioned omitted variables in our analysis. Our results reveal a negative association with INDSEN, with a coefficient of 0.002 and a *t*-statistic of 2.251. This implies that firms operating in ESG-sensitive industries experience higher equity costs. Additionally, the relationship between CEO_ESG and the firm's COE capital is negative, as indicated by a coefficient of -0.013 and a *t*-statistic of -1.729 . This suggests that firms with CEO compensation packages linked to ESG exhibit lower costs of equity. Furthermore, firms in the maturity stage demonstrate a lower COE, as evidenced by a coefficient of -0.023 and a *t*-statistic of -3.539 , indicating that established firms benefit from reduced costs of equity capital. Finally, the association between FEMDIR and the COE capital is negative, with a coefficient of -0.032 and a *t*-statistic of -4.085 , suggesting that firms practising diversity, particularly in terms of female directorship, experience lower costs of equity. In Columns 1–4, our findings remain consistent, demonstrating that after accounting for potential omitted variables, the measures of CSR violations remain positively and statistically significantly associated at the 1% significance level. In Columns 5–7, where three different measures of the COE capital are considered, alongside the inclusion of all aforementioned omitted variables, our results remain robust and consistent with the initial findings.

5.4 | Mediation Analysis

In the previous sections, we established a statistically significant positive relationship between firms' engagement in environmental violations and COE, indicating that COE rises when firms commit environmental violations. This section explores and tests potential channels through which environmental violations impact COE, aiming to understand better the underlying mechanisms driving this association. We posit that environmental violations affect COE through three potential channels: (i) CSR training, (ii) environmental innovation and (iii) litigation expenses. CSR training aims to enhance employees' awareness and alignment with the firm's environmental and social responsibility goals, signalling a commitment to prevent future violations and restore stakeholder trust, as stakeholder theory suggests (Freeman and Dmytriiev 2017). However, in constrained firms, limited resources may reduce the effectiveness of these initiatives, leading investors to

remain sceptical and demand higher returns. Firms that innovate their environmental practices effectively can achieve competitive advantages and enhance operational efficiency. Such innovations reflect a firm's commitment to sustainability and create new market opportunities, which can result in long-term financial benefits. In instances of environmental violations, the ability to pivot towards innovation can mitigate the negative consequences associated with such misconduct, signalling to investors that the firm is taking proactive steps to address its environmental responsibilities. However, for financially constrained firms, the initial costs of pursuing environmental innovation can be substantial, which may heighten perceived financial risk. This financial strain can lead investors to demand higher equity premiums, complicating the relationship between environmental violations and COE. Lastly, litigation expenses associated with legal actions, fines or settlements highlight governance weaknesses and misalignment between managerial actions and stakeholder interests, as described by agency theory (Jensen and Meckling 1976). High litigation costs strain resources and amplify perceived risk, leading investors to require higher equity premiums.

We collect three potentially relevant variables to capture the effects of CSR training, environmental innovation and litigation expenses on the COE. The variable CSRTRAIN is a dummy variable that assigns a value of 1 if the firm conducts CSR training for its employees and 0 otherwise. ENVINNOV represents the natural logarithm of the environmental innovation category score, reflecting a company's capacity to reduce environmental costs and burdens for its customers while creating new market opportunities through innovative environmental technologies and processes or eco-designed products. Finally, LITEXP is measured as the natural logarithm of the total litigation expenses incurred, as reported by the firm.

Following Baron and Kenny (1986), we use four steps in establishing the mediation effect. First, independent variables in our study (i.e., environmental violation, *PENALTY*) correlate with the dependent variable (i.e., *COE*; Equation 4A; α_1), confirming the possibility of a mediation effect. Second, the independent variable, environmental violation (i.e., *PENALTY*), should be associated with the mediator (i.e., *M*; Equation 4B; β_1). Third, the mediator (i.e., *M*) has a significant effect on the dependent variable (i.e., *COE*; Equation 4C; γ_2). Fourth, the significant relationship between the proxies of *PENALTY* and *COE* (Equation 4A) becomes insignificant after controlling *M* (full mediation, γ_1 becomes insignificant), or the significance

TABLE 8 | Environmental violation and cost of debt.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	COD1	COD2	COD1	COD2	COD1	COD2
Constant	1.018*** (5.13)	0.456 (0.525)	1.01*** (5.115)	0.488 (0.565)	1.051*** (5.392)	0.589 (0.684)
LNFINEAMT	0.006* (1.734)	0.014** (2.44)				
LNFINENUM			0.005* (1.692)	0.031** (2.083)		
FINEDUM					0.035*** (4.84)	0.104*** (3.228)
ENVSCORE	-0.002 (-0.486)	-0.002 (-0.97)	-0.002 (-0.468)	-0.002 (-1.017)	-0.002 (-0.126)	-0.001 (-0.799)
GOVSCORE	-0.001** (-2.417)	0.003 (1.452)	-0.001** (-2.202)	0.004* (1.77)	-0.001 (-1.51)	0.005** (2.107)
SOCSCORE	0.002 (1.12)	0.002 (0.045)	0.001 (1.239)	0.001 (0.397)	0.002 (1.339)	0.002 (0.333)
FOROWNDUM	0.034** (2.207)	0.236*** (3.523)	0.032** (2.093)	0.223*** (3.338)	0.026* (1.688)	0.21*** (3.142)
ANALYST	-0.001* (-1.823)	0.005** (2.547)	-0.001* (-1.821)	0.005*** (2.643)	-0.001* (-1.663)	0.005*** (2.775)
ROA	-0.002*** (-2.995)	0.002 (0.101)	-0.002*** (-3.014)	0.001 (0.146)	-0.002*** (-2.917)	0.001 (0.269)
SALELAG	-0.002 (-1.451)	0.002 (0.18)	-0.005** (-2.129)	0.002 (0.469)	-0.002 (-1.308)	0.002 (1.005)
DISTRESS	-0.025 (-1.284)	0.111 (1.312)	-0.026 (-1.367)	0.111 (1.32)	-0.025 (-1.33)	0.117 (1.396)
LNSIZE	-0.004 (-1.345)	-0.099*** (-7.408)	-0.004 (-1.302)	-0.101*** (-7.638)	-0.005* (-1.674)	-0.104*** (-7.867)
DACC	0.058* (1.818)	0.055 (0.333)	0.06* (1.872)	0.089 (0.537)	0.050 (1.576)	0.063 (0.382)
BETA	-0.002 (-0.107)	-0.004 (-0.792)	-0.002 (-0.122)	-0.004 (-0.782)	-0.002 (-0.021)	-0.003 (-0.69)
LEVERAGE	-0.021 (-0.979)	0.316*** (3.324)	-0.017 (-0.796)	0.344*** (3.603)	-0.006 (-0.292)	0.365*** (3.822)
MTGDP	0.026*** (3.354)	-0.064* (-1.888)	0.025*** (3.29)	-0.068** (-2.018)	0.025*** (3.294)	-0.069** (-2.042)
FDI	0.138*** (2.629)	-0.47* (-1.772)	0.15*** (2.835)	-0.379 (-1.416)	0.158*** (3.04)	-0.376 (-1.422)

(Continues)

TABLE 8 | (Continued)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
LNGDP	-0.055*** (-2.772)	0.09 (1.033)	-0.055*** (-2.782)	0.082 (0.943)	-0.061*** (-3.091)	0.077 (0.809)
CORRUPT	0.018*** (3.779)	-0.044** (-2.073)	0.018*** (3.802)	-0.042** (-2.004)	0.019*** (4.09)	-0.04* (-1.911)
INDUSTRY	NO	NO	NO	NO	NO	NO
YEAR	YES	YES	YES	YES	YES	YES
COUNTRY	YES	YES	YES	YES	YES	YES
Observations	737	718	737	718	737	718
R-squared	0.123	0.138	0.126	0.143	0.15	0.15

Note: *t*-values are in parentheses.
 ****p* < 0.01, ***p* < 0.05 and **p* < 0.10.

TABLE 9 | Omitted variable test.

Variables	(1) COE_CT	(2) COE_CT	(3) COE_CT	(4) COE_CT	(5) COE_CT	(6) COE_OJN	(7) COE_EP
Constant	-0.022 (-0.132)	-0.065 (-0.394)	0.009 (0.056)	0.002 (0.012)	0.009 (0.054)	0.096 (1.258)	0.118 (1.609)
LNFINEAMT	0.019*** (3.194)	0.019*** (3.132)	0.019*** (3.251)	0.018*** (3.057)	0.018*** (3.06)	0.005** (2.538)	0.007*** (2.739)
INDSEN	0.002** (2.251)				0.003** (2.34)	0.004** (1.998)	0.013*** (3.271)
CEO_ESG		-0.013* (-1.729)			-0.008 (-1.118)	-0.003 (-1.388)	-0.001 (-1.445)
LCYCLE			-0.023*** (-3.539)		-0.023*** (-3.637)	-0.013*** (-2.936)	-0.008*** (-2.905)
FEMDUM				-0.032*** (-4.085)	-0.031*** (-3.991)	-0.012*** (-3.254)	-0.012*** (-3.525)
ENVSCORE	-0.001 (-0.759)	-0.001 (-0.745)	-0.001 (-0.675)	-0.001 (-0.427)	-0.001 (-0.489)	0.002* (-1.94)	0.003** (-2.098)
GOVSCORE	-0.001 (0.556)	-0.001 (0.791)	-0.001 (0.523)	-0.001 (0.338)	-0.001 (0.328)	-0.001 (-0.484)	-0.001 (-0.693)
SOCSCORE	-0.001 (-0.711)	-0.001 (-0.563)	-0.001 (-1.066)	-0.001 (-0.484)	-0.001 (-0.895)	-0.003** (-2.101)	-0.003*** (-3.629)
FOWNDUM	-0.015* (-1.656)	-0.015* (-1.656)	-0.014 (-1.513)	-0.016* (-1.787)	-0.014 (-1.594)	0.009** (2.207)	-0.001 (-0.155)
ANALYST	0.001*** (2.989)	0.001*** (2.975)	0.001*** (3.693)	0.001** (2.54)	0.001*** (3.253)	-0.001 (-0.126)	0.002* (1.673)

(Continues)

TABLE 9 | (Continued)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	COE_CT	COE_CT	COE_CT	COE_CT	COE_CT	COE_OJN	COE_EP
ROA	-0.003*** (-6.981)	-0.003*** (-7.043)	-0.003*** (-6.91)	-0.003*** (-6.642)	-0.003*** (-6.59)	-0.001*** (-5.986)	0.001 (0.094)
SALELAG	-0.001 (-0.024)	0.001 (0.054)	-0.001 (-0.15)	0.001 (0.325)	0.001 (0.229)	0.001 (-0.117)	0.001 (0.116)
DISTRESS	0.022 (1.402)	0.024 (1.492)	0.019 (1.193)	0.025 (1.551)	0.021 (1.36)	0.036*** (4.975)	0.011 (1.326)
LNSIZE	0.009*** (3.984)	0.009*** (3.872)	0.009*** (3.787)	0.009*** (3.931)	0.008*** (3.674)	0.005*** (4.476)	0.007*** (6.415)
DACC	-0.082*** (-3.139)	-0.083*** (-3.171)	-0.084*** (-3.249)	-0.083*** (-3.221)	-0.086*** (-3.364)	-0.038*** (-3.185)	0.007 (0.593)
BETA	0.002* (1.869)	0.002* (1.848)	0.002* (1.912)	0.002* (1.897)	0.002* (1.908)	-0.001 (-0.492)	0.001** (2.099)
LEVERAGE	-0.026 (-1.533)	-0.028* (-1.658)	-0.025 (-1.511)	-0.026 (-1.536)	-0.026 (-1.548)	-0.032*** (-4.176)	0.003 (0.363)
MTGDP	-0.016*** (-2.605)	-0.018*** (-2.811)	-0.015** (-2.362)	-0.015** (-2.452)	-0.015** (-2.369)	-0.005* (-1.727)	-0.007** (-2.447)
FDI	0.093** (2.074)	0.089** (2.005)	0.095** (2.141)	0.087** (1.967)	0.09** (2.038)	0.072*** (3.485)	0.063*** (3.199)
LNGDP	0.024 (1.463)	0.029* (1.726)	0.023 (1.371)	0.019 (1.129)	0.021 (1.227)	0.003 (0.448)	-0.007 (-0.896)
CORRUPT	-0.02*** (-5.104)	-0.02*** (-5.155)	-0.02*** (-5.248)	-0.019*** (-4.828)	-0.019*** (-5.002)	-0.006*** (-3.247)	-0.002 (-1.373)
INDUSTRY	NO	NO	NO	NO	NO	NO	NO
YEAR	YES	YES	YES	YES	YES	YES	YES
COUNTRY	YES	YES	YES	YES	YES	YES	YES
Observations	843	843	843	843	843	843	831
R-squared	0.257	0.26	0.268	0.272	0.285	0.225	0.171

Note: *t*-values are in parentheses.
 ****p* < 0.01, ***p* < 0.05 and **p* < 0.10.

level reduces after controlling *M* (partial mediation, γ_1 reduces). The following equations are developed to conduct the mediation test:

$$COE_{i,t+1} = \alpha_0 + \alpha_1 PENALTY_{i,t} + \text{Control variables} + FE + \varepsilon_{i,t}, \quad (4A)$$

$$M_{i,t+1} = \beta_0 + \beta_1 PENALTY_{i,t} + \text{Control variables} + FE + \varepsilon_{i,t}, \quad (4B)$$

$$COE_{i,t+1} = \gamma_0 + \gamma_1 PENALTY_{i,t} + \gamma_2 M_{i,t} + \text{Control variables} + FE + \varepsilon_{i,t}. \quad (4C)$$

We report the findings in Table 10A. The total effect of *PENALTY* on *COE* (i.e., α_1 from Equation 4A) can be decomposed into direct and indirect effects (i.e., through the mediator). The direct effect is γ_1 from Equation (4C), whereas the indirect effect is $\beta_1 * \gamma_2$ for a proposed mediator. The core of the mediation effect is testing the null hypothesis that $\beta_1 * \gamma_2 = 0$. We first use the OLS regression using CSRTRAIN as a mediator to perform the causal step regression following Baron and Kenny (1986) for the above estimation. For the analysis of the first mediation channel, CSRTRAIN, following the mediation framework described above, we estimate Equation (4A) to examine the relationship between environmental violations

TABLE 10A | Mediation analysis.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	CSRTRAIN	ENVINNO	LITEXP	COE_CT	COE_OJN	COE_EP	COE_CT	COE_OJN	COE_EP	COE_CT	COE_OJN	COE_EP
Constant	1.328*** (3.91)	0.213*** (3.19)	0.751*** (4.621)	0.218*** (3.051)	0.391*** (2.97)	0.195*** (2.76)	0.607** (2.171)	0.211* (1.76)	0.294** (2.45)	0.907*** (3.011)	0.310** (2.301)	0.408*** (3.114)
LNFINEAMT	0.006** (2.23)	-0.093** (-2.38)	0.241 (1.327)	0.003** (2.27)	0.015*** (2.80)	0.007*** (2.81)	0.020* (1.72)	0.002** (2.33)	0.009* (1.691)	0.019 (1.57)	0.003 (0.987)	0.009* (1.69)
CSRTRAIN				-0.003* (-1.71)	-0.006* (-1.67)	-0.003* (-1.92)						
ENVINNO							-0.010*** (-2.72)	-0.003** (-2.03)	-0.005*** (-2.83)			
LITEXP										0.001 (0.745)	0.001* (1.76)	0.001 (1.421)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
INDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	No	No	No	No	No	No	No	No	No	No	No	No
Observations	841	759	684	841	841	841	759	759	759	684	684	684
RIT				0.006	0.002	0.004	0.047	0.158	0.046	0.011	0.094	0.004
RID				0.006	0.002	0.004	0.045	0.136	0.044	0.010	0.086	0.004

Note: RIT refers to the ratio of indirect effect to total effect. RID is the ratio of indirect effect to direct effect. *t*-values are in parentheses.
 ****p* < 0.01, ***p* < 0.05 and **p* < 0.10.

TABLE 10B | Alternative measures of the cost of equity capital.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	COE_GEB	COE_AVG	COE_GEB	COE_AVG	COE_GEB	COE_AVG
Constant	-3.127** (-2.433)	0.24*** (3.437)	-2.757** (-2.143)	0.247*** (3.435)	-2.793** (-2.223)	0.235*** (3.342)
LNFINEAMT	0.017** (2.394)	0.013*** (3.59)				
LNFINENUM			0.046* (1.796)	0.011** (2.279)		
FINEDUM					0.108*** (2.898)	0.003* (1.878)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1379	1041	1379	1041	1379	1041
R-squared	0.553	0.318	0.562	0.316	0.575	0.317

Note: *t*-values are in parentheses.
 *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

and COE. Our results (untabulated for brevity) show that the coefficient of LNFINEAMT is statistically significant. Next, we estimate Equation (4B) to explore the association between the mediator ($M = \text{CSRTRAIN}$) and environmental violations (LNFINEAMT). In Column 1, the coefficient for LNFINEAMT is positive and statistically significant at the 5% level. In Columns 4–6, both LNFINEAMT and CSRTRAIN remain statistically significant, suggesting the presence of partial mediation. Turning to the second potential mediation channel, ENVINNO, we find a negative association between ENVINNO and LNFINEAMT (coefficient = -0.093^{**} ; $p < 0.05$), indicating that firms with environmental violations tend to be less innovative. Furthermore, Columns 7–9 show that both LNFINEAMT and ENVINNO are statistically significant at the 10% level, again suggesting partial mediation. For the final mediation channel, LITEXP, we do not find any statistically significant relationship between LNFINEAMT and the mediator. Similarly, Columns 10–12 show no consistent statistical significance, indicating no mediation in this third channel. It is noteworthy to report that our findings are qualitatively similar using the alternative proxies of environmental violations, LNFINENUM and FINEDUM.

5.5 | Alternative Measures of Cost of Equity Capital

In our primary analysis, we consider three different measures of COE capital. To enhance our findings' robustness, we have included two additional measures: *COE_GEB* and *COE_AVG*. *COE_GEB* is derived from the implied COE based on the model proposed by Gebhardt et al. (2001), whereas *COE_AVG* represents the average COE calculated from the measures used in our primary OLS regression analysis. Our results, presented in Table 10B,

reveal a positive association between environmental violations and the COE capital. Additionally, we consistently find evidence supporting the relationship between environmental violations and COE across different measures.

6 | Conclusion and Implications

As the focus on corporate environmental responsibilities intensifies, numerous studies have explored market responses to corporate environmental violations. Yet, a noticeable lack of attention has been directed towards noncompliance with environmental provisions. This study adopts a focused approach to delve into the consequences of such violations, providing crucial insights that contribute to the broader literature on environmental responsibility. Within the context of CSR and environmental irresponsibility, our research aims to shed light on the nuanced relationship between environmental violations and their impact on the COE. By addressing this gap, our study adds depth to understanding how environmental lapses can influence a company's financial standing in the equity market, offering valuable implications for academic research and practical corporate decision-making.

Leveraging data from 1379 firm-year observations spanning the period from 2005 to 2020 and drawn from listed companies in the Bloomberg European 500 index, our study unveils a significant positive correlation between environmental violations and COE. As anticipated, the market negatively responds to environmental violations, which is evident in heightened charges during equity offerings. Furthermore, our investigation reveals that the magnitude of the association between environmental violations and COE capital is more pronounced in firms with higher financial constraints and those operating within fiercely competitive industries.

To mitigate concerns related to endogeneity, we conduct a 2SLS regression analysis to address selection bias concerns. Additionally, we perform a PSM analysis comparing firms engaged in environmental violations with nonviolating firms, wherein we find that the findings remain robust, providing evidence that firms with environmental violations experience higher costs of equity capital. Further, we conduct a mediation test considering three potential channels mediating the relationship between environmental violations and COE. The results indicate partial mediation for the CSR training and environmental innovation channels. Finally, our findings demonstrate that the cost of debt for a firm rises when the company is involved in environmental violations, suggesting a tangible financial consequence associated with such breaches of environmental standards.

This study contributes to the literature on CSR and corporate finance by emphasizing the role of agency theory and stakeholder theory in understanding the financial impact of environmental violations. Agency theory suggests that environmental violations reflect agency problems, increasing firms' risk and financial costs, including COE. Stakeholder theory, in turn, highlights the need for firms to align with the expectations of investors, regulators and other stakeholders to mitigate risk. Our findings extend this theoretical discourse by demonstrating how noncompliance with environmental standards signals increased firm risk, prompting investors to demand higher returns. The mediation results further suggest that CSR training and environmental innovation can mitigate some of these risks, supporting the notion that proactive CSR initiatives can restore stakeholder trust and reduce financial costs.

Our findings carry important policy implications. Regulators and policymakers can leverage these insights to design incentives for firms to adopt sustainable practices, such as environmental training programs or green innovation policies, which may help reduce their COE. Regions can encourage more responsible corporate behaviour by creating frameworks that reward firms for compliance and penalize environmental violations. These policies can also align with global efforts to integrate environmental, social and governance principles into investment strategies, which are increasingly critical in today's financial markets. This study offers practical insights into how environmental responsibility impacts financial performance for executives and corporate managers. Firms that address environmental violations proactively can lower their COE, signalling to investors a commitment to sustainable practices and responsible corporate governance. Beyond the immediate financial benefits, integrating environmental practices into business strategies can strengthen investor confidence, foster long-term relationships and enhance corporate reputation. In a market where sustainability is becoming a key driver of value, firms that differentiate themselves through environmental responsibility can gain a competitive edge.

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Appendix

Variable Definitions

Variables	Definition
COE_CT	Implied equity risk premium estimated using the Claus and Thomas (2001) model for each 'fiscal year end month plus 6 months' minus the yield on a 10-year Treasury bond
COE_OJN	Implied cost of equity, estimated by the modified Ohlson and Juettner-Nauroth (2005) model (modified by Gode and Mohanram 2003)
COE_EP	Implied cost of equity estimated using the Easton (2004) model for each 'fiscal year end month plus 6 months' minus the rate on a 10-year Treasury bond
LNFINAMT	Natural logarithm of the total amount of penalty plus 1
LNFINNUM	Natural logarithm of the total number of environmental penalties in a given financial year plus 1
FINEDUM	A dummy variable equals 1 if the firm experiences a penalty due to environmental violation and 0 otherwise.
ENVSORE	Environmental score extracted from Bloomberg
GOVSCORE	Corporate governance score extracted from Bloomberg
SOCSCORE	Social score extracted from Bloomberg
FOWNDUM	A dummy variable equals 1 if the firm has foreign ownership and 0 otherwise. Collected from Thomson Reuters Eikon

Variables	Definition
ANALYST	Natural logarithm of the total number of analysts following plus one. Collected from Thomson Reuters Eikon
ROA	Earnings before extraordinary items are divided by the total assets.
SALEGR	Change of firm total sales between year t and year $t - 1$
DISTRESS	A dummy variable equals 1 if a firm has negative profit and negative working capital (Current assets – Current liabilities) in a current year and 0 otherwise.
LNSIZE	Natural log of total assets of the firm at the end of the fiscal year
DACC	DACC is the unsigned value of discretionary accruals. DACC is calculated using the performance-matched modified Jones model (Kothari et al. 2005).
BETA	A measure of systematic risk extracted from DataStream. DataStream uses 5 years and regresses the share price against the respective DataStream total market index using log changes of the closing price on the first day of each month.
LEVERAGE	The ratio of total liability to total assets
MTGDP	Market capitalization to total GDP. Collected from Thomson Reuters Eikon
FDI	Natural logarithm of foreign direct investment. Collected from Thomson Reuters Eikon
LNGDP	Natural logarithm of gross domestic production per capita. Collected from Thomson Reuters Eikon
CORRUPT	Control of corruption index from Kaufmann et al. (2011). This index measures the perception of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture of the state by elites and private interest'. The index is expressed in standard normal units ranging from around -2.5 – 2.5 .
COD1	Cost of debt measure. The ratio of interest expenses for the year scaled by total debt
COD2	Cost of debt measure. The ratio of interest expenses for the year scaled by total operating revenue
INDSEN	A dummy variable equals 1 if the firm belongs to the environmentally sensitive industry and 0 otherwise.
CEO_ESG	A dummy variable equals 1 if the firm CEO compensation is linked to ESG compliance or performance and 0 otherwise.

Variables	Definition
LCYCLE	Firm life cycle measure. Retained earnings scaled by total assets
FEMDUM	A dummy variable equals 1 if the firm has at least one female director on the board and 0 otherwise.
HHI	Product market competition. PMC is measured by the Herfindahl–Hirschman index. The natural logarithm of the Herfindahl–Hirschman index of sales revenue. That is the natural logarithm of the sum of the squares of a percentage of sales revenue generated by each firm in an industry (for each year).
CSRTRAIN	A dummy variable equals 1 if the firm has an in-house CSR training program and 0 otherwise.
INDAVGPENAL	Industry average environmental violation measure using an industry-year median environmental violation-related penalty
MILLRAT	Inverse Mills ratio, calculated based on Equation (2)