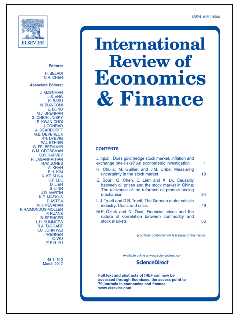
Journal Pre-proof



When is environmental performance most valued? International evidence from the CDS market

Laura Ballester, Ana González-Urteaga, Beatriz Martínez

PII: S1059-0560(25)00220-5

DOI: https://doi.org/10.1016/j.iref.2025.104057

Reference: REVECO 104057

To appear in: *International Review of Economics and Finance*

Received Date: 16 October 2024

Revised Date: 27 February 2025

Accepted Date: 14 March 2025

When is environmental performance most valued? International evidence from the CDS market

Laura Ballester[a,*], **Ana González-Urteaga**[b,c], **Beatriz Martínez**[b]

[a] *University of Valencia, Avda. Los Naranjos s/n, 46022 Valencia, Spain*

[b] Institute for Advanced Research in Business and Economics (INARBE) and *Public University of Navarre, Arrosadia Campus, 31006 Pamplona, Spain*

This version: February 26, 2025

Abstract

Using a sample of 516 firms with CDS data from 37 countries for the period 2010-2022, this study finds that companies with higher environmental performance, particularly in emissions reduction and product innovation, exhibit a reduction in credit risk, supporting the risk mitigation perspective. Our results also highlight the importance of considering both internal and external factors when assessing the financial impact of sustainability initiatives. Firms with initially lower environmental performance, less exposure to the environmental sector, and higher credit ratings experience a more significant reduction in credit risk as they improve their environmental performance. In addition, the CDS market places a higher value on environmental efforts for firms located in countries with lower environmental scores, credit ratings and GDP growth. Conversely, out findings support the overinvestment view for firms in sectors with high environmental risk exposure or in countries with poor climate change performance. Overall, the effect of a firm's environmental performance on credit risk is heterogeneous rather than uniform.

Keywords: environmental performance, CDS spreads, credit risk

JEL classification: G15, G32, Q56

[*] Corresponding author: Laura Ballester Miquel: laura.ballester@uv.es

Acknowledgements. The authors acknowledge financial support from Fundación Ramón Areces and Grant TED2021-131216B-I00 funded by MCIN/AEI/10.13039/501100011033 and by "European Union NextGenerationEU/PRTR". In addition, Ana Gonzalez-Urteaga and Beatríz Martínez acknowledge financial support from the Public University of Navarre (PJUPNA2023–11379).

When is environmental performance most valued? International evidence from the CDS market

Laura Ballester[a,*], **Ana González-Urteaga**[b,c], **Beatriz Martínez**[b]

[a] *University of Valencia, Avda· Los Naranjos s/n, 46022 Valencia, Spain*

[b] *Public University of Navarre, Arrosadia Campus, 31006 Pamplona, Spain*

[c] *Institute for Advanced Research in Business and Economics (INARBE), 31006 Pamplona, Spain*

Abstract

Using a sample of 516 firms with CDS data from 37 countries for the period 2010-2022, this study finds that companies with higher environmental performance, particularly in emissions reduction and product innovation, exhibit a reduction in credit risk, supporting the risk mitigation perspective. Our results also highlight the importance of considering both internal and external factors when assessing the financial impact of sustainability initiatives. Firms with initially lower environmental performance, less exposure to the environmental sector, and higher credit ratings experience a more significant reduction in credit risk as they improve their environmental performance. In addition, the CDS market places a higher value on environmental efforts for firms located in countries with lower environmental scores, credit ratings and GDP growth. Conversely, out findings support the overinvestment view for firms in sectors with high environmental risk exposure or in countries with poor climate change performance. Overall, the effect of a firm's environmental performance on credit risk is heterogeneous rather than uniform.

Keywords: environmental performance, CDS spreads, credit risk

JEL classification: G15, G32, Q56

* Corresponding author: Laura Ballester Miquel: laura.ballester@uv.es

Acknowledgements. The authors acknowledge financial support from Fundación Ramón Areces and Grant TED2021-131216B-I00 funded by MCIN/AEI/10.13039/501100011033 and by "European Union NextGenerationEU/PRTR". Ana Gonzalez-Urteaga and Beatríz Martínez acknowledge financial support from the Public University of Navarre (PJUPNA2023–11379). In addition, Laura Ballester acknowledges financial support PID2023-153128NB-I00 received from MCIU/AEI/10.13039/501100011033/FEDER,UE.

1. Introduction

There are some reasons to believe that environmental, social and governance (ESG) performance is related to corporate credit risk. While some studies argue that ESG criteria are not clearly integrated into the credit risk management process of banks (Zeidan *et al*., 2015), others suggest that sustainability and environmental dimensions are taken into account when assessing the creditworthiness of firms, supporting the assertion that "it pays to be sustainable" (Weber *et al*., 2010). Indeed, credit rating agencies have acknowledged the growing importance of ESG factors in assessing credit risk. As investor interest in ESG issues continues to grow, rating agencies have incorporated ESG analysis into their credit ratings to offer a more comprehensive assessment of an issuer's risk profile.[1] However, it remains unclear whether ESG criteria have a positive or negative impact on credit risk. The existing literature supports two opposing theories regarding the impact of ESG practices on credit risk: the mitigation view and the overinvestment view (Goss and Roberts, 2011).

On the one hand, from a stakeholder theory perspective (Freeman, 2010), companies that pursue ESG goals aim to mitigate credit risk by reducing litigation and reputational risk, resulting in lower credit risk and providing benefit to stakeholders. On the other hand, from an agency theory perspective (Friedman, 1962), ESG companies are thought to increase credit risk through resource consumption or overinvestment by managers, which conflict with shareholder interests. Such activities may also mask corporate misconduct or inaccurate accounting, harming shareholders and reducing firm value.

In summary, although most studies show that credit risk decreases with improved ESG performance (Attig *et al*., 2013; Stellner *et al.*, 2015; Barth *et al.*, 2022, among others), other studies find the opposite association (Magnanelli and Izzo, 2017; Menz, 2010; Kiesel and Lücke, 2019). Consequently, the influence of ESG criteria on credit risk remains uncertain. These results suggest that the three pillars included in this measure may collectively capture highly heterogeneous information when it comes to matching it with credit risk. An interesting finding of the review study by Friede *et al*. (2015) is that

[1] According to the S&P Global Ratings (2019) report, ESG factors resulted in 225 modifications to S&P corporate credit ratings from 2015 to 2017, with ESG issues being cited as analytical considerations in 1,325 rating reports.

among the three ESG dimensions, environmental studies offer the most favourable relationship, followed by governance and finally the social dimension.

At a time when sustainable finance is playing a key role in promoting initiatives to mitigate the devastating effects of the global climate crisis, it would be very positive news for climate change mitigation efforts to be able to confirm that there is a credit risk reduction effect, particularly from environmental activities. This finding would suggest that environmentally responsible firms are perceived as more financially stable, leading to lower credit risk, greater market recognition of environmental factors, and improved long-term business viability. Furthermore, the positive externalities would extend beyond individual firms to broader societal and environmental impacts, driven by growing investor demand for environmentally responsible investment opportunities. Consequently, it is challenging to formulate a priori hypotheses about the expected impact of environmental performance on credit risk. This paper follows this specific line of research.

Specifically, with respect to the environmental dimension, the results mainly favour the risk mitigation perspective (Erragragui, 2018; Eliwa *et al*., 2021; Dorfleitner and Grebler, 2020; Drago *et al*., 2019; Abdul Razak *et al*., 2020), suggesting that it has the most pronounced effect on reducing credit risk among the three ESG dimensions. However, some authors find no significant effect for the environmental score (Hoepner *et al*., 2016; Devalle *et al*., 2017), while others report opposite results in line with the overinvestment view (Sharfman and Fernando, 2008). Again, the results regarding the impact of the environmental dimension on a firm's credit risk are somewhat mixed.

Against this backdrop, the objective of this study is to find an explanation for the contradictory findings in the literature on the effect of environmental performance on credit risk, consistent with both theoretical perspectives: mitigation and overinvestment. To achieve this, we analyse the effect of the environmental score, along with its three environmental categories (resource use, emissions and environmental innovation), on the credit default swap (CDS) market for an international sample of 516 firms in 37 countries covering the period from 2010 to 2022, using the system Generalized Method of Moments (GMM, hereafter) estimator. We hypothesise that the impact of companies' environmental practices on credit risk may be heterogeneous, influenced by various factors, including both internal and external considerations, as well as environmental and financial elements. Notably, there is limited literature addressing this issue when considering CDS spreads as a specific measure of credit risk, which underscores the novelty of this study.

The results show a significant negative relationship between environmental performance and credit risk, as measured by CDS spreads. Higher environmental performance, especially in terms of emissions and product innovation, is correlated with lower credit risk. Internal factors such as a firm's initial level of environmental performance, environmental risk exposure and credit rating influence this relationship. Firms with lower initial environmental performance, lower environmental risk exposure and higher credit ratings experience a greater reduction in credit risk as environmental performance improves. In terms of external factors, environmental performance has a greater impact on credit risk in countries with lower environmental scores, credit ratings and GDP growth. The CDS market values environmental efforts more in these contexts, although the type of environmental score matters, and higher climate change scores lead to lower spreads with improved performance. Finally, our paper has some interesting findings that support the overinvestment view in some situations. Specifically, the results show that in high environmental risk sectors and countries with poor climate performance, efforts to improve environmental scores often lead to higher credit risk or go unrewarded.

In summary, this paper contributes to the literature in several key ways. First, it expands on the analysis of the relationship between overall ESG and credit risk, as proxied by CDS spreads (Barth *et al*., 2022), by focusing specifically on the environmental pillar. Given the heterogeneous effects of ESG, a detailed examination of each dimension of the ESG score is necessary, and the literature on this specific aspect is still scarce, indicating that significant gaps remain. Second, the study examines the relationship between credit risk, measured by CDSs, and environmental performance (Bannier *et al*., 2021). To our knowledge, this is the first study that meticulously analyses both internal and external factors moderating this relationship. Our results support both the overinvestment and mitigation theories, as explained by these potential moderators. At the internal level, existing literature is practically non-existent, focusing primarily on a firm's overall ESG performance (Barth *et al*., 2022) or creditworthiness (Höck *et al*., 2020). Our study contributes by adding potential internal moderators such as a firm's environmental performance, sector-specific environmental risk exposure, and credit rating. Regarding external moderators, while some research has examined geographical differences (Barth *et al*., 2022; Dorfleitner and Grebler, 2020; Dorfleitner *et al*., 2020), legal origin (Eliwa *et al*., 2021,) and national sustainability scores (Abdul Razak *et al*., 2020; Stellner *et al*., 2015; Abdul Razak *et al*., 2023), none have conducted in-depth analyses of both environmental scores and external moderating factors in relation to credit risk. Finally, this study explores the categories of the environmental score, utilising an extensive sample period and international scope, incorporating a wide range of explanatory factors.

The structure of the paper is as follows. Section 2 reviews the relevant literature; Section 3 details the data and the methodology; Section 4 presents the results of the analysis; and Section 5 concludes with key findings.

2. Literature review and hypothesis development

Most studies focus on the effect of the overall ESG score—formerly known conceptually as Corporate Social Responsibility (CSR)—on credit risk, rather than analysing its individual dimensions. As a result, the theoretical understanding of how these practices affect credit risk is largely based on comprehensive ESG performance.[2] In this section, we first introduce two key theories that predict the impact of ESG on credit risk, along with the empirical studies supporting each theory. We then present evidence highlighting the heterogeneous impact of environmental performance on credit risk, leading to the development of our hypotheses.

2.1. Overall ESG performance and credit risk: mitigation versus overinvestment view

From a stakeholder theory perspective (Jones, 1995; Freeman, 2010), known as the mitigation view (Goss and Roberts, 2011), companies pursuing ESG goals are expected to reduce credit risk by mitigating litigation and reputational risk. ESG activities can have a positive impact on many stakeholders, resulting in lower default risk. For example, suppliers to sustainable firms may agree to longer payment terms, and ESG initiatives can serve as a product differentiation strategy, increasing consumer loyalty and enhancing pricing power, which leads to higher profit margins (Albuquerque *et al*., 2019). Moreover, ESG practices can help firms avoid regulatory penalties related to

[2] We use the term "ESG performance" to refer to a company's actual practices related to environmental, social and governance issues, and we use it interchangeably with "Corporate Social Performance" and "Corporate Social Responsibility".

environmental or social violations (Henisz and McGlinch, 2019). By benefiting various societal groups—such as employees, customers, suppliers, regulators, and the community at large—ESG efforts foster intangible relationships and enhance a firm's reputation, which can make it more attractive to investors and lenders due to reduced cash flow volatility. Therefore, one potential benefit of ESG adherence is the reduction of downside risk for firms (Landry *et al*., 2017). This perspective also aligns with "risk management theory" (Godfrey, 2005), which argues that ESG activities generate positive moral capital among stakeholders, creating an "insurance-like" protection for the firm.

In line with these arguments, previous work has supported the mitigation view, suggesting a negative relationship between overall ESG performance and credit risk, as measured by various metrics, including credit ratings (Weber *et al.,* 2010; Attig *et al*., 2013; Jiraporn *et al*., 2014; Ge and Liu, 2015; Stellner *et al*., 2015; Henisz and McGlinch, 2019), cost of private debt (Chava, 2014; Bae *et al*., 2018; La Rosa *et al*., 2018), Altman's (1968) Z-score index (Boubaker *et al*., 2020) and CDS spreads (Barth *et al*., 2022).

From an agency theory perspective (Friedman, 1962), known as the overinvestment view (Goss and Roberts, 2011), ESG initiatives are expected to increase credit risk. This is because the pursuit of these goals may lead to resource consumption or overinvestment by managers, resulting in conflict with shareholders (Ghoul *et al*., 2017). Furthermore, ESG activities may be used to mask corporate misconduct (Diemont *et al*., 2015) or inaccurate accounting practices (Kim *et al*., 2014), which can harm shareholders and reduce firm value. According to this view, managers use resources to enhance their personal prestige at the expense of shareholder wealth. This aligns with the managerial opportunism theory (Preston and O'Bannon, 1997), which suggests that managers pursue private goals—such as ESG investments—for self-interest rather than to maximize stakeholder value. Managerial entrenchment is exemplified in the mathematical model of Cespa and Cestone (2007), which shows that managers may commit to ESG in order to gain stakeholder support and reduce the likelihood of being replaced through takeovers. This entrenchment strategy leads to overinvestment in ESG, which ultimately increases firm risk. Barnea and Rubin (2010) empirically support this assertion, finding a negative relationship between insider ownership (managers, directors and large shareholders) and ESG ratings. Their results suggest that when managers hold more ownership and are thus more aligned with shareholders, they are less likely to engage in CSR activities, implying that CSR spending reduces firm value.

Several studies support the overinvestment view by showing a positive relationship between ESG and credit risk, as measured by the cost of private debt (Goss and Roberts, 2011; Magnanelli, and Izzo, 2017) or the cost of corporate bond debt (Menz, 2010). Similarly, Kiesel and Lücke (2019) find that greater ESG integration in credit ratings is associated with positive CDS spreads.

The mixed results in the literature on the relationship between overall ESG and credit risk may be attributed to various internal or external corporate factors, or even to the possibility that the individual dimensions—E, S and G—have differing effects. This suggests that a nuanced approach is needed when assessing the impact of ESG on credit risk, taking into account the distinct influences of each ESG component as well as the specific context of the company.

2.2. Environmental performance and credit risk

Many studies that separately analyse the three dimensions of the ESG score and their effect on credit risk fail to reach a consensus on the magnitude and direction of this effect. In the case of the environmental dimension, most findings support the mitigation view (Abdul Razak *et al*., 2020; Bannier *et al*., 2021; Höck *et al.*, 2020; Dorfleitner and Grebler, 2020; Dorfleitner *et al*., 2020; Drago *et al*., 2019; Eliwa *et al*., 2021; Erragragui, 2018; Nandy and Lodh, 2012), suggesting that the environmental dimension has the most significant impact on reducing credit risk. However, some authors report no significant effect for the environmental score (Abdul Razak *et al.*, 2023; Devalle *et al*., 2017; Hoepner *et al*., 2016; Dorfleitner *et al*., 2020), while others find opposite results consistent with the overinvestment view (Bannier *et al*., 2021; Kiesel and Lücke, 2019; Sharman and Fernando, 2008). Furthermore, there is no consensus on which regions are most affected.

Friede *et al*. (2015) conduct a comprehensive analysis of both primary and secondary data from previous academic reviews to examine the impact of companies embracing an ESG agenda on corporate financial performance. They measure this performance using various metrics, including accounting-based, market-based, operational and portfolio performance, as well as various risk measures. One notable finding from this review is that of the three ESG dimensions, environmental has the strongest relationship with financial performance, followed by governance and then social.

In terms of studies that focus on the impact of the environmental dimension on the cost of debt, Nandy and Lodh (2012) narrow their focus to environmental considerations. Using bank loan data for US firms between 1991 and 2006, they conclude that more eco-friendly firms secure more favourable loan contracts, thereby reducing their credit risk through environmental awareness. In contrast, Hoepner *et al*. (2016), who analyse corporate bank loan spreads from 470 agreements across 28 countries signed between 2005 and 2012, find no link between a firm's environmental performance and the cost of debt. Similarly, Sharfman and Fernando (2008) report that US firms with better environmental risk management face higher costs of debt. However, Erragragui (2018), analysing 214 US firms from 2000 to 2011, shows that both the governance and environmental dimensions reduce the cost of debt, with environmental strength having the greatest impact. Eliwa *et al*. (2021), in their study of European non-financial firms from 2005 to 2016, further emphasise that the environmental dimension exerts the strongest negative impact on the cost of debt.

Recent findings also highlight the positive impact of environmental performance on credit ratings. Dorfleitner *et al*. (2020) analyse 724 US and 218 European firms from 2003 to 2017, finding that both environmental and social scores lead to better ratings for US firms, while only the social score shows a positive relationship in Europe. This suggests that geographical area may act as a potential moderator in the relationship between environmental performance and credit risk. To explore this further, Dorfleitner and Grebler (2020) extend their sample to include Asian firms and examine the individual sub-pillars of E and S. They find that all three environmental sub-pillars have a significant positive impact on credit ratings in all regions, with environmental innovation showing the most pronounced effect. In contrast, Devalle *et al*. (2017), using ESG performance data from 56 Italian and Spanish listed companies in 2015, find that credit ratings are positively influenced only by social and governance indicators, with environmental scores showing no significant effect. However, the very small sample size in this study may limit the robustness of the results. As the authors note, further research is needed to confirm these findings.

Other papers use the CDS market as a measure of credit risk, making them particularly relevant to this research. Drago *et al*. (2019) focus on 184 European non-financial firms in 18 countries from 2007 to 2017, using an event study to analyse the relationship between ESG rating announcements and CDS spreads. They report a significant reduction in CDS spreads for the social and environmental pillars, while no significant effect is observed for the corporate governance pillar. Höck *et al.* (2020) examine 149 European non-financial companies from 2006 to 2017 and show that firms with higher environmental sustainability experience lower CDS spreads. Similarly, Abdul Razak *et al*. (2020), using an international sample of 592 non-financial firms between 2013 and 2016, show that ESG criteria reduce CDS spreads in only four of the ten categories analysed, two of which—climate change and natural resource use—are from the environmental dimension. In a follow-up study with a similar sample, Abdul Razak *et al*. (2023) focus on the individual ESG dimensions and find a negative but statistically insignificant effect of the environmental pillar on CDS spreads. Bannier *et al*. (2021) compare the effect of ESG performance on CDS spreads, credit ratings and distance-to-default between Europe and the US from 2003 to 2018. They find that environmental factors only reduce market-based credit risk measures in the US, while the environmental component increases credit risk in Europe. Consistent with this finding, Kiesel and Lücke (2019), using a sample of 605 European and US non-financial firms from 2004 to 2015, find that a higher focus on environmental issues leads to an increase in CDS spreads, supporting the overinvestment view.

2.3. Heterogeneous impact of environmental performance on credit risk: internal and external potential moderators

As highlighted in previous sections, most empirical studies suggest a stronger impact of the environmental dimension compared to the other ESG components, typically aligning with the mitigation perspective. However, there is no complete consensus. We suggest that the impact of companies' environmental practices on credit risk may be heterogeneous. This heterogeneity is consistent with both theoretical perspectives: the mitigation view, which posits that strong environmental performance reduces credit risk, and the overinvestment view, which suggests the opposite. In this section, we identify the factors contributing to this diversity of perspectives, focusing on internal and external environmental and financial considerations.

First, with respect to internal factors, we explore potential variations in the relationship between E and credit risk across the range of E scores. The literature suggests the presence of nonlinear patterns in the relationship between ESG and financial performance (Barth *et al*., 2022; Barnett and Salomon, 2006; Brammer and Millington, 2008; Meier *et al*., 2021;). On the one hand, as Barnett and Salomon (2006) suggest, stakeholders may view firms with low ESG scores as lacking credibility, resulting in limited benefits from ESG engagement (Barnett and Solomon, 2012). Barnett (2007) posits that low ESG firms must first build the capacity to influence stakeholders in order to gain their favour and ultimately benefit from ESG investment. On the other hand, Meier *et al*. (2021) show an inverted U-shaped relationship between employee-focused ESG and a firm's return on assets, suggesting that excessive or inefficient social investments (e.g. in human resources) may fail to yield expected performance outcomes. Extrapolating this finding to the environmental context, it implies that once a firm reaches a certain level of environmental investment, the financial costs may outweigh the benefits. In addition, Brammer and Millington (2008) find that companies with either exceptionally high or exceptionally low ESG performance tend to achieve better financial outcomes than other firms. However, this contrasts with Barth *et al*. (2022) who, in a study of 470 US and European firms from 2007 to 2019, find that the magnitude of the negative relationship between overall ESG and CDS spreads depends on the firm's ESG level, with the effect being more than twice as large for firms with intermediate ESG levels compared to those with very low or very high levels. This is the only literature we have found that considers the potential impact of a company's ESG level on the relationship between overall ESG performance and credit risk. In line with this literature, we analyse whether the level of E plays a moderating role in the relationship between environmental performance and credit risk.

Second, we hypothesise that the sector in which a company operates and its exposure to environmental risk can significantly influence the relationship between its environmental performance and credit risk. Several factors come into play, including the regulatory environment specific to each sector. Industries with a higher environmental risk profile, such as energy or manufacturing, are often subject to more stringent environmental regulations, which can lead to higher compliance costs and increased legal liabilities. This regulatory framework can shape how a firm's environmental performance affects its credit risk within its sector, as non-compliance or environmental incidents can negatively impact its financial health and reputation. Market perception also plays a key role. Sectors with a higher environmental risk profile may face greater scrutiny from investors, lenders and other stakeholders. Poor environmental performance in these sectors can lead to reputational damage, diminished investor confidence and, consequently, higher credit risk. Furthermore, operational risks unique to each sector—such as pollution incidents or regulatory fines—can have a direct impact on a firm's financial and operational performance, contributing to variations in credit risk across industries.

In addition, the transition to a more sustainable economy introduces additional complexities. Sectors undergoing significant environmental transitions, such as the shift to renewable energy or sustainable practices, may face unique credit risks. Companies in sectors that are slow to adapt to these changes may experience credit downgrades or increased financing costs due to concerns about their long-term sustainability and competitiveness. Understanding sector-specific dynamics and environmental risks is essential to accurately assess the overall financial health and sustainability of firms in different industries.

Thus, we argue that environmental factors at the firm level—such as the E level and the environmental risk associated with the sector—can influence how the CDS market responds to a firm's environmental actions, thereby affecting its credit risk. Based on these considerations, we propose the following hypotheses:

Hypothesis H1: The effect of environmental performance on credit risk is moderated by the firm's initial level of environmental performance.

Hypothesis H2: The effect of environmental performance on credit risk is moderated by the environmental risk associated with the industry or sector in which the firm operates.

In addition to environmental factors, a firm's financial position can significantly impact the relationship between its environmental performance and credit risk. The financial health of a company influences how its environmental initiatives are perceived and valued by lenders and creditors. For financially sound companies, the mitigating effect of environmental performance on credit risk may be more pronounced, as these companies are seen as having the resources and capacity to implement effective environmental measures. As a result, they are considered less likely to experience financial difficulties arising from environmental risks. In this case, a strong financial position can amplify the perceived value of a company's commitment to sustainability, leading to a more favourable credit risk assessment.

In contrast, firms with weaker financial standing may struggle to allocate sufficient resources to environmental initiatives, diminishing the positive impact of their environmental performance on credit risk. Investors and lenders may view such firms as more vulnerable to environmental risks, which could jeopardise their financial stability. In this context, Höck *et al*. (2020), for example, analyse a sample of 149 European non-financial firms from 2006 to 2017 and find that only companies with high creditworthiness benefit from high environmental sustainability scores, while firms with low creditworthiness do not suffer any penalty for being sustainable. However, Schneider (2011) finds that the effect of environmental performance on bond pricing disappears for companies with higher bond ratings.[3]

Therefore, the interplay between a firm's financial situation and its environmental performance is crucial in determining how its credit risk is assessed and managed. Based on this reasoning, we propose the following hypothesis:

Hypothesis H3: The effect of environmental performance on credit risk is moderated by the firm's credit rating.

Among the external factors, the institutional setting plays a key role in explaining differences in the impact of environmental performance on the credit risk of the firm. Previous studies have examined differences based on geographical regions, legal origin[4] and national sustainability scores.

Barth *et al*. (2022) analyse 470 US and European firms from 2007 to 2019 and find a stronger risk mitigation effect of overall ESG on CDS spreads in Europe compared to the US. Their finding aligns with theories linking the financial benefits of ESG to regions with higher country-level ESG scores, stronger investor protection and higher transaction

[3] This result suggests that the effect of environmental performance on credit risk is more pronounced for financially weaker firms. The explanation is that financially distressed firms are more vulnerable to environmental risks, are under greater pressure to improve their public image, and can achieve cost savings through stronger environmental practices. As a result, improving environmental performance can reduce risk, enhance reputation, and lead to more favourable credit terms. In contrast, well-capitalised companies with ample resources can absorb significant environmental risks without threatening their financial stability.

[4] Eliwa *et al.* (2021) find that the mitigating effect of the E score is more dominant in European non-financial firms operating in more stakeholder-oriented countries, where community concerns are more prevalent. Boubaker *et al.* (2020), on the other hand, find that the effect of ESG on the Z-score is only evident in companies with strong shareholder rights, suggesting that in such firms, ESG strategies are less likely to be pursued for the extraction of private benefits.

costs.[5] Among the papers focusing on the environmental dimension, Dorfleitner and Grebler (2020) find the same credit risk reduction effect (measured by credit rating) in Europe, the US and Asia. However, Dorfleitner *et al.* (2020) report this mitigating effect only in the US, with no significant effect observed in Europe. Furthermore, Bannier *et al.* (2021) show that while environmental performance reduces CDS spreads in the US, it paradoxically increases them in Europe, though they do not provide an explanation for this result. Despite these seemingly contradictory findings, they underscore the importance of geographical location in shaping the relationship between a firm's environmental performance and its credit risk. This highlights the need for an international sample to observe potential regional differences and to analyse the underlying factors driving these differences.

Finally, other studies highlight how the effect of ESG scores on credit risk varies according to a country's sustainability score, although the results remain mixed. On the one hand, Abdul Razak *et al*. (2020) show that improvements in ESG are more effective in reducing credit risk, as measured by CDS spreads, for companies in countries with low sustainability scores. Given that such scores are typically found in emerging markets, this finding seems to align with the results of Friede *et al*. (2015) regarding overall ESG.[6] On the other hand, Stellner *et al*. (2015) analyse a sample of twelve European Monetary Union countries from 2006 to 2012 and find that overall ESG improves firms' CDS ratings only in countries with above-average ESG scores. In a related study, Abdul Razak *et al*. (2023) use a similar dataset to Abdul Razak *et al*. (2020), but focus on the total ESG score and its individual dimensions. Their findings indicate that the effect of total ESG performance on CDS spreads is stronger in countries with higher ESG levels. However, the evidence is mixed as to whether country sustainability acts as a substitute or a complement to ESG performance across the dimensions. In particular, they do not find that country sustainability affects the environmental score. Despite these contradictory

[5] This is consistent with Maignan's (2001) research, which shows differences in consumer behaviour between individualistic countries like the US and collectivist countries such as France and Germany. Maignan's survey-based research suggests that consumers in the latter countries are more likely to support responsible business practices than consumers in the US.

[6] Friede *et al*. (2015), in their review article, find that the proportion of positive effects of ESG on corporate financial performance is significantly lower in developed countries (excluding North America) than in emerging markets. Therefore, the CDS market may respond more positively to the environmental efforts of firms from countries with lower environmental scores.

results, it seems clear that country sustainability plays a significant role in the nexus between corporate sustainability and credit risk.

However, as noted by Bannier *et al*. (2021), there is a lack of comprehensive comparisons between the effects of sustainability issues and firm credit risk across countries, despite the importance of country-specific factors such as regulatory standards, disclosure requirements and cultural attitudes towards environmental issues. We suggest that external factors related to both the environmental and financial aspects of firms, rooted in the institutional context, shape the impact of environmental practices on firm credit risk, as measured by CDS spreads. The reaction of the CDS market to these practices—whether favourable or unfavourable—may hinge on expectations tied to the environmental and financial context in which the company operates. We therefore propose the following hypotheses:

Hypothesis H4: The effect of environmental performance on credit risk is moderated by the country's environmental performance.

Hypothesis H5: The effect of environmental performance on credit risk is moderated by the country's financial performance.

3. Data

3.1. Sample selection

The initial dataset for this study comprises 705 public non-financial firms with ESG scores and CDS spreads sourced from Refinitiv Eikon for the period 2010 to 2022.[7] Accounting and market variables are also provided by this database. After excluding firms with missing data, extreme outliers, or fewer than four consecutive years[8] of observations, the final sample consists of 516 public non-financial firms (5,703 observations) from 37 countries over the period 2010-2022.

Refinitiv Eikon is one of the eight leading ESG rating providers (Huber *et al*., 2017), having acquired Asset4, which was the first agency to offer raw ESG data to investors. It

[7] In line with previous research (Goss and Roberts, 2011; Stellner *et al*., 2015), financial institutions have been omitted from the sample due to the distinct treatment of debt financing compared to non-financial entities.

[8] This is a requirement for calculating the m_2 statistic, which is a specification test that should be included when using the system GMM as an estimation technique.

is considered one of the most thorough and reliable sources for ESG data (Utz, 2018). Unlike other ESG metrics that are based on questionnaires, content analysis of annual reports, or expert evaluations, Refinitiv's data is publicly available to the entire financial community, which enhances its transparency and accessibility (Drago *et al*., 2019). Refinitiv ESG scores evaluate the ESG performance of companies based on publicly reported data across three pillars: environmental, social and governance, with 10 related ESG topics. The ESG framework includes approximately 630 company-level ESG indicators, from which a subset of 186 of the most relevant and comparable data points are selected to inform the overall ESG assessment and scoring process. These indicators are selected based on their materiality, data availability and relevance to the firm's industry.

3.2. Dependent variable

We utilize CDS spreads as a market-based indicator of credit risk because they represent the premium that market participants are willing to pay to assume a firm's default risk (Das *et al*., 2009). This allows us to capture default risk in its purest form (Callen *et al*., 2009), making CDS spreads a superior measure of credit risk compared to other alternative indicators (Longstaff *et al*., 2005; Abinzano *et al*., 2020). As noted by Kölbel *et al*. (2017), CDS spreads provide and accurate and timely reflection of the market's perception of a firm's credit risk, unaffected by broader economic factors such as interest rates or country-specific tax regulations (Focardi and Fabozzi, 2004).

We obtain CDS spread data for each firm from Refinitiv Eikon, which provides daily quotes of the mid-premium (the average of the bid and ask prices) denominated in US dollars. We focus on 5-year maturity CDS spreads as these are the most liquid and accurately priced contracts and represent the largest share of the CDS market (Jorion and Zhang, 2007; Eichengreen *et al.*, 2012; Ballester *et al.*, 2016). Given the annual frequency of ESG score publications, we calculate annual CDS spreads by averaging daily data over the year. Firms without traded CDS contracts are excluded from the sample. For the analysis, we apply a log transformation to the CDS spreads to account for the right-skewed distribution of the variable (Bannier *et al*., 2021; Barth *et al*., 2022).

3.3. Main explanatory variables

For this analysis, we focus on the overall environmental score (E score) and its three subcategories: resources, emissions and environmental innovation. The *resources* category refers to the company's performance in reducing the use of materials, energy or water. The *emissions* category measures the firm's commitment and effectiveness in reducing environmental emissions throughout its production and operational processes. Finally, *innovation* reflects the firm's efforts to develop new environmental technologies, processes or eco-designed products aimed at reducing environmental costs and burdens while creating new market opportunities. All scores are expressed as percentiles, making them relative indicators of performance, with higher values indicating better performance on a particular environmental issue.

3.4. Control variables

Following the previous literature (Abdul Razak *et al*., 2020; Barth *et al*., 2022), two types of control variables have been included in the model: firm-level and country-level. At firm level, we include firm *size*, which is measured by the natural logarithm of market value; *roa*, which is net income divided by total assets; *leverage*, which is measured by the ratio of total debt to total assets; *mtb*, which denotes the market-to-book ratio and is measured by the market value of equity divided by the book value of equity; *liquidity*, which refers to cash and cash equivalents divided by total assets; *sales*, which is scaled to the firm's total assets; *tangibility*, measured by the ratio of property, plant and equipment to total assets; *capex*, which refers to capital expenditures and is measured as interest expenses and cash dividends to total assets; and finally, *coverage*, measured by the ratio of EBIT plus interest expenses to interest expenses. We also control for country-specific effects by including in our model the country's gross domestic product growth (*gdp_growth*), as well as industry and year effects.

3.5. Descriptive analysis

Panel A of Table 1 shows the correlations between the variables included in the model. The variance inflation factor is less than 5, indicating that there are no multicollinearity issues in our model.[9] Panel B of Table 1 presents the main descriptive statistics for these variables. The average environmental pillar score in our sample is 62.75. Among the three

[9] The mean VIF value is 1.98, with a maximum individual value of 2.87 for the gdp_growth variable and a minimum of 1.15 for the tangibility variable.

categories comprising this pillar, the environmental innovation score is the lowest, with an average of 47.01.

[Insert Table 1 about here]

Our sample comprises companies from 37 countries. Table 2, Panel A presents the distribution of the environmental score and each of its categories by country, while Panel B shows the distribution by sector. The largest proportions of companies in our sample are from the US and Japan, followed by the UK, France and Germany. Notably, companies from New Zealand (29.83), the Philippines (37.88) and China (46.75) have significantly lower environmental pillar scores compared to the overall sample average. Conversely, firms from Spain (84.55), Italy (84.00) and Ireland (80.36) have significantly higher average scores. In terms of industry representation, most companies belong to the manufacturing sector, followed by "transportation, communications, electric, gas and sanitary services".

[Insert Table 2 about here]

4. Methodology

4.1. Model and moderators

Equation (1) presents our baseline model, which builds on previous studies that examine the determinants of firms' CDS spreads (Abdul Razak *et al.*, 2020; Atif and Ali, 2021; Bannier *et al.*, 2021; Barth *et al.*, 2022; Drago *et al.*, 2019; Kölbel *et al.*, 2017, among others):

$$L(CDS_{it}) = \beta_0 + \beta_1 L(CDS_{i,t-1}) + \beta_2 Score_{i,t} + \varphi Controls_{i,t} + \eta_{i,t} + \varepsilon_{i,t} \tag{1}$$

where $L(CDS_{it})$ denotes the natural logarithm of the CDS spread and $Score_{i,t}$ refers to each of the environmental scores discussed previously. Firm-level control variables and country-specific, industry and year fixed effects are also included. Finally, the model includes individual heterogeneity (individual effect, $\eta_{i,t}$) to account for firm unobservable fixed effects, and the random disturbance term, $\varepsilon_{i,t}$.

In addition, we analyse different factors (internal and external, environmental and financial) that moderate the relationship between the different scores and the firms' CDS spreads. To capture these moderating effects, we introduce an interaction term into the main model that allows us to study the impact of each score for different groups of firms. The model is shown in Equation (2):

$$L(CDS_{it}) = \beta_0 + \beta_1 L(CDS_{i,t-1}) + \beta_2 Score_{i,t} + \beta_3 Score_{i,t} * Moderator_{i,t} + \varphi Controls_{i,t} + \eta_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $Moderator$ is a dummy variable that equals 1 for companies that meet a specific criterion and 0 otherwise. We define firms for which the moderating variable equals 1 as "Group 1", and firms for which the moderating variable equals 0 as "Group 2". The effect of $Score$ on CDS for Group 1 is the sum of the coefficients β_2 and β_3, while the effect for Group 2 is represented by the coefficient β_2. The $Moderator$ variable is also included as a control in the model.[10]

First, for the internal environmental factors, we include two types of moderators. The first is *High Score*, which takes the value of 1 if a firm's environmental performance score is above the median for that year, and 0 otherwise. The second indicator is *Low environmental risk*, which is assigned the value of 1 if the firm's exposure to environmental risk—based on its sector—falls below the median for the year, and 0 otherwise. This second dummy variable is constructed using data from the S&P Environmental Risk for Sectors.[11]

Second, for the internal financial factors, we use Moody's credit rating to define two different dummy variables. The first, *High_rating,* is equal to 1 if the firm's debt has no speculative characteristics (i.e. with a rating of A3 or higher), and 0 otherwise. In addition, we convert the rating expressed in letters into a numerical rating, where higher values indicate better credit ratings. In this case, *High_rating* takes the value of 1 if the firm's credit rating is above the median for the year, and 0 otherwise.

[10] Except for the variable *High_Score*, as this dummy is calculated based on the Score variable, taking the value of 1 if the score is higher than the annual median, and 0 otherwise.
[11] The S&P Risk Atlas provides environmental risk assessments for sectors, providing a broad assessment of the associated challenges on a scale of 1 to 6, with a score of 1 representing the lowest likely risk. S&P Global Ratings determined the scores by combining its insights with public assessments from sources such as the UN-backed Principles for Responsible Investment, the World Bank, the World Health Organization and Transparency International. https://www.spglobal.com/

Third, for the potential external environmental factors, we include two different indexes. The first is the Environmental Performance Index (EPI), which provides a data-driven assessment of a country's sustainability efforts. Higher EPI scores indicate greater environmental sustainability.[12] We create a dummy variable, *High_EPI*, which takes the value of 1 if the country's EPI score is above the annual median, and 0 otherwise. As a second measure of environmental sustainability at the country level, we include information gathered from the S&P Environmental Map, which includes territorial greenhouse gas (GHG) emissions covering land use, land-use change and forestry. Here, we define *Low_GHG* as a dummy variable that takes the value of 1 if the country's GHG emissions are below the yearly median, and 0 otherwise.

Finally, we incorporate two variables as potential external financial moderators. First, the S&P's country rating, which we convert into a numerical variable where higher values indicate stronger ratings. *High_rating* takes the value of 1 if the country's credit rating exceeds the yearly median, and 0 otherwise. Second, we use a dummy variable, *High_gdp_growth*, which equals 1 if the country's GDP growth is above the median for the year, and 0 otherwise.[13]

4.2. Estimation procedure

The use of the two-step dynamic system GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) is particularly well-suited for our study, as it addresses several econometric challenges commonly encountered in panel data analysis. First, it effectively mitigates endogeneity concerns by using internal instruments—specifically, lagged values of the explanatory variables—which help control for simultaneity bias (Arellano and Bond, 1991). Therefore, it accounts for reverse causality—one source of endogeneity (Wooldridge, 2010, Wintoki *et al*., 2012)—through the use of lags of the instrumented variable. Additionally, this dynamic estimator allows us to include the lag of the dependent variable in the model, as recommended by Oikonomou *et al*. (2014), who note that lags are often included as explanatory variables in studies analysing the relationship between corporate social performance and financial performance. Third, the estimator

[12] The EPI assesses the climate change performance, environmental health and ecosystem vitality of 180 countries using 40 performance indicators across 11 issue categories. These indicators offer a national-level measure of how closely countries align with established environmental policy targets. It is available at https://epi.yale.edu/

[13] Table A.1 in Appendix A shows the definition of each control and moderator variable used in the analysis.

corrects for potential biases arising from omitted variables by incorporating the individual effect, which is a non-observable firm fixed effects.

When applying this estimator, two specification tests are essential. First, is the Hansen statistic, that test the validity of the instruments, ensuring that they are exogenous. The null hypothesis asserts that the instruments are uncorrelated with the error term. Second is the m_2 (second-order serial correlation) test, which checks for the absence of correlation between the residuals in second differences. For a correct interpretation of the results, both tests should fail to reject their respective null hypotheses. Given these methodological advantages, the dynamic system GMM approach provides a rigorous framework for analysing the causal impact of environmental performance on credit risk.

To take into account the time-invariant unobserved heterogeneity, we include in the model industry fixed effects that would better capture persistent unobserved factors that influence both environmental performance and credit risk. Finally, we repeat all the estimations using country fixed effects an also we include firm fixed effects as a robustness measure to mitigate the presence of endogeneity due to the omitted variables issue (Roberts and Whited, 2013).[14]

5. Results

5.1. Environmental performance and credit risk

In the first column of Table 3, we observe the overall effect of the environmental score on CDS spreads. The negative and significant coefficient (-0.0004) suggests that stronger environmental performance reduces a firm’s credit risk. This result aligns with the risk mitigation perspective, where improvements in environmental performance act as an “insurance-like” protection, shielding firms from potential future penalties due to violations of any of the dimensions of this pillar.[15] We also study the effect of each category than constitutes the score of the environmental pillar of ESG. Columns 2 through

[14] The results are available upon request.

[15] In a preliminary analysis, we also examined the effect of the overall ESG score and found a significant and positive coefficient. This result is consistent with Kiesel and Lücke (2019), who also analysed CDS spreads. We also assessed the environmental, social and governance pillars separately, both individually and together in the same models. Across all models, the environmental pillar consistently displayed a negative and significant coefficient, while the social and governance pillars exhibited positive and significant coefficients. These findings underscore our argument that the impact of ESG practices should be analysed separately for each pillar. These results are available from the authors upon request.

4 present these results, revealing negative and highly significant coefficients for the emissions (-0.034) and environmental innovation (-0.057) categories, but not for the resources category. Overall, our results for the environmental dimension are consistent with the risk mitigation view, which is also supported by Höck *et al.* (2020), Abdul Razak *et al.* (2020) and Drago *et al*. (2019).[16]

[Insert Table 3 about here]

Regarding the control variables, our findings align with the financial literature. Firms with lower risk profiles—characterised by larger size and higher return on assets, market-to-book, tangibility and interest coverage, but lower leverage and capital expenditure—tend to have lower CDS spreads on average. In addition, liquidity, sales and GDP growth have a positive impact on CDS spreads.

In summary, our results support the credit risk reduction theory (the mitigation view) for the environmental pillar, although not uniformly across all its categories. This is consistent with the majority of previous studies. However, as previously discussed, a more in-depth analysis is needed to fully understand the internal and external forces that shape this relationship.

5.2. Heterogeneous effect of environmental performance on credit risk

5.2.1. Internal environmental factors

In Table 4, we analyse whether the impact of environmental performance on credit risk varies based on a firm's current level of environmental performance. To this end, we include an interaction term, *Score*High Score,* in the main model. Panel B reveals that both the overall environmental score and the innovation score index reduce a firm's credit risk for companies with high and low levels of score performance, with a stronger effect for firms starting from lower performance levels. A similar pattern emerges in the resource use category, although companies with high performance in this dimension are not rewarded with lower credit spreads when they improve further (the coefficient is zero,

[16] In contrast, the findings of Kiesel and Lücke (2019) show that companies with better environmental performance face higher CDS spreads. The discrepancy between our findings and theirs may stem from various factors, such as differences in sample selection and methodology. For example, we note that Kiesel and Lücke (2019) use latent Dirichlet allocation (LDA) methodology to extract ESG proportions from Moody's rating reports, rather than relying on ESG scores.

see column 2 of Panel B). This finding aligns with the results in column 2 of Table 3, where no effect was observed for the resources category, which, in light of the results in column 2 of Table 4, seems to be related to moderating factors, such as the current level of the firm's resource use performance. Regarding the emissions category, the reduction in credit risk for firms that perform well in this category appears to be independent of their initial emissions performance level, as the coefficient remains negative for both groups.

Overall, we observe that firms with lower initial levels of environmental performance reduce their credit risk to a greater extent when they improve in this area compared to firms that already have a high level of environmental performance. These findings support hypothesis H1, which posits that the relationship between environmental performance and credit risk is moderated by internal factors, such as the firm's starting level of environmental performance. Specifically, the results show that the CDS market reacts more favourably to those companies that improve their environmental performance when they started from a lower level in this dimension.[17]

[Insert Table 4 about here]

In addition, Table 5 analyses another internal environmental factor, the firm's environmental risk exposure based on its industry sector.[18] To capture this, we include an interaction term, *Score*Low environmental risk*, in the main model. Panel B shows that only firms belonging to sectors with low environmental risk reduce their credit risk when they score higher on environmental issues, supporting the mitigation view. However, for firms in high environmental risk sectors, improved environmental performance is associated with increased credit risk (in the E, resource and emissions categories) or no significant reward (in the innovation category), aligning with the overinvestment view. These results suggest that the efforts of companies in high environmental risk sectors (such as gas or oil) may be perceived as insufficient. Furthermore, in those sectors, the

[17] This is in line with the previous findings by Utz (2018) who shows a U-shaped effect of the environmental dimension on idiosyncratic risk.
[18] The oil & gas, metals & mining, and power generation (coal) sectors each had an environmental risk score of 6. Sectors with relatively low environmental risk scores included business and consumer services, media and technology software and services, with a score of 1.

costs of adopting more sustainable practices may be seen as prohibitively high, whereas in lower-risk sectors, these costs are considered more manageable.

Overall, these findings support hypothesis H2, which posits that the effect of environmental performance on credit risk is moderated by the firm's environmental risk exposure. We also find that this moderating effect can reverse the direction and sign of the relationship.

[Insert Table 5 about here]

5.2.2. Internal financial factors

In Table 6, we test hypothesis H3, which states that the effect of environmental performance on credit risk is moderated by the firm's credit rating. To investigate this, we include an interaction term, *Score*High_rating*, in the main model. In Panel A, we run the analysis measuring *High_rating* as a dummy variable equal to 1 for companies with non-speculative debt characteristics. We find that for the innovation and the overall E score, companies' efforts in these areas are rewarded by the CDS market with lower spreads, although this relationship does not seem to depend on the firm's credit rating. However, for the resource and emissions scores, the reductions in CDS spreads are greater for companies with stronger financial positions—those with higher credit ratings. These results suggest that the impact of environmental performance on credit is more pronounced for financially robust companies. This may be because such companies are perceived to have sufficient resources and capacity to implement effective environmental practices. Consequently, investors and lenders are likely to view these companies having a lower risk of financial instability due to environmental factors, leading to a greater appreciation of their sustainability efforts. These findings are partially consistent with those of Höck *et al.* (2020), who observe a reduction only in high-rated companies, with no significant effect in low-rated ones, while we find a reduction in both high- and low-rated firms, with a stronger effect in the former.

In Panel B, we perform the same analysis but define *High_rating* as a dummy variable equal to 1 for companies with a rating above the median, and 0 otherwise. The results are similar, although in this case only the resource and overall E scores exhibit different effects on CDS spreads based on the firm's credit rating. Therefore, we fully support hypothesis H3 for the resource category, and partially support it for the emissions category.

[Insert Table 6 about here]

5.2.3. External environmental factors

Panel A of Table 7 shows the average Environmental Performance Index (EPI) by country and year. On average, the countries in our sample have a score of 69.66. Notable examples include Denmark (83.03) and Switzerland (82.15), which have the highest scores, and India (34.59), South Africa (49.54) and Saudi Arabia (49.89), which have the lowest. Also noteworthy is the steady increase in EPI scores until 2017, followed by a sharp decline in 2022. This drop may be due to changes in the criteria used to construct the index in that year.[19]

In Panel B, we analyse whether the influence of a firm's environmental performance on credit risk depends on the EPI of the country in which the company operates. To test this, we include an interaction term, *Score*High_EPI*, in the main model. *High_EPI* is defined as a dummy variable that equals 1 for firms from countries with an EPI above the median for that year, and 0 otherwise. Panel C shows the overall effect of the environmental pillar and its categories on credit risk, distinguishing between companies from countries with higher and lower EPI scores.

[Insert Table 7 about here]

We find that the reduction in credit risk associated with improved environmental performance occurs only for companies from countries with lower environmental scores (lower EPI), specifically in the resource (-0.049) and innovation (-0.023) categories. However, there are no significant differences based on the EPI for the overall E score and the emissions score, with both groups of firms showing a negative effect (-0.0003 for the E score, -0.069 for the emissions score). Therefore, we support hypothesis H4, which

[19] Until 2020, this index was constructed with two policy objectives: *Ecosystem Vitality* and *Environmental Health*. From 2022 to the present, the *Climate Change* category has become a third policy objective rather than being included under the *Ecosystem Vitality* objective. This new objective includes a new indicator, *Projected GHG emissions in 2050*, which assesses whether countries are on track to reach zero emissions of four greenhouse gases by 2050. The average rate of increase or decrease in emissions over a ten-year period (2010 – 2019) is calculated, and this trend is extrapolated to predict emission levels in 2050. This new indicator has a weight of 36% in the *Climate Change* category, accounting for 13.8% of the total EPI, while the weight of other emission-related indicators has been reduced.

posits that a country's environmental performance influences the impact of environmental performance on credit risk, although not uniformly across all environmental practices. This finding aligns with Abdul Razak *et al*. (2020), who show, also for the CDS market, that ESG categories are more effective in reducing credit risk for companies located in countries with lower sustainability scores. Our finding may be related to market expectations: the market responds more favourably to companies that make significant environmental strides, especially in countries with lower environmental scores, where such efforts are more visible.

In addition, as another measure of a country's environmental sustainability, Table 8 provides information on the total territorial greenhouse gas (GHG) emissions of each country, measured in tonnes. In Panel A, we observe that countries with large populations such as China (12,697), the US (6,509), Russia (1,980) and Brazil (1,433) have the highest emissions. There is also a slight downward trend in emissions over the years. To analyse the moderating effect of a country's GHG emissions, Panel B of Table 8 includes an interaction term, *Score*Low_GHG*, where *Low_GHG* is a dummy variable that equals 1 for companies in countries with a GHG index below the median (by year), and 0 otherwise. Unlike the previous findings using the EPI, Panel C reveals that in the resource and innovation categories, companies from countries with poor GHG performance are penalised by the CDS market for improvements in environmental performance, resulting in increased credit risk. Several factors could explain this result. Investors might perceive these improvements as temporary or insufficient in the context of broader systemic challenges. Furthermore, the overall poor environmental reputation of the country may overshadow specific improvements, which may be deemed inadequate to mitigate the negative impacts of high GHG emissions, causing investors to continue to view these companies as higher risk.

In addition, we observe that the decreasing impact of environmental practices on credit risk only occurs for companies in countries with lower GHG emissions, i.e. countries demonstrating stronger environmental performance in this area.

[Insert Table 8 about here]

One possible explanation for the opposing effects between the EPI and GHG variables may lie in the direct relationship between a country's emissions and its climate change objectives. For example, when considering clear objectives such as those outlined in SDG 13—which seeks to manage the transition to a low-carbon economy and limit global temperature rise—actions taken by companies in countries that are closer to achieving these objectives (i.e. those with lower emissions) tend to be more highly valued. In contrast, when using broader environmental indices such as the EPI, where there is no such defined goal and the climate change category has less weight in the final score, the market seems to place more value on the efforts of companies in countries that face greater challenges or have poorer environmental scores. This may be because actions taken in such countries are perceived as more impactful due to the greater challenges they face.

5.2.4. External financial factors

Tables 9 and 10 show the results used to test hypothesis H5, which posits that the effect of environmental performance on credit risk is moderated by a country's financial performance, as measured by the S&P country rating and GDP growth. To test this, we include interaction terms in the main model: *Score*High_rating* for Panel B of Table 9 and *Score*High_gdp_growth* for Panel B of Table 10. In Panel C of Table 9, we examine the effect of environmental performance on credit risk for companies from countries with higher and lower credit ratings, using these ratings as a proxy for country credit risk.

Panel A of Table 9 presents the distribution of credit ratings by country and year. We observe that the countries with the highest AAA ratings, such as Australia, Canada and several European countries, are developed countries, while those with the lowest ratings include Greece, Brazil, Hungary and Russia. Although the ratings remain relatively stable over time, we observe an overall increase in country credit ratings over the period analysed.

[Insert Table 9 about here]

[Insert Table 10 about here]

The results presented in Panel B of Table 9 show that companies from countries with lower credit ratings are more positively valued by the CDS market when they improve their environmental performance. These activities have a greater impact on reducing CDS spreads compared to companies from countries with higher credit ratings. This finding aligns with the result obtained using the EPI, where efforts to improve environmental sustainability are more highly valued in contexts with more financial difficulties.

In terms of GDP growth, Panel A of Table 10 shows that the countries with the highest GDP growth rates are emerging economies such as China and Thailand, while Greece is the only country with negative GDP growth. Notably, the global pandemic in 2020 caused by COVID-19 resulted in significant negative GDP growth. The results in Panel B of Table 10 are consistent with previous findings: firms from countries with lower economic performance see a greater reduction in credit risk from environmental activities.

These findings highlight the influence of the institutional context, supporting hypothesis H5. Firms from countries with worse financial performance—in particular, those with lower credit ratings and slower GDP growth—experience the greatest benefit from improving their environmental performance.

6. Robustness tests

First, as a robustness check, we repeat all the analyses using on the one hand, country fixed effects and on the other hand, firm fixed effects, and overall, we reach the same conclusions. The results are available upon request. Second, to further explore the findings obtained with the EPI and GHG index, we conduct an additional robustness analysis, which is presented in Table 11. The analysis examines the impact of the environmental pillar on credit risk using two country-level climate change indicators and one environmental indicator that excludes climate change considerations. In particular, we first consider a category from the EPI that focuses on climate change and renewable energy (CCHRE). In the main model, we include an interaction term, *Score*High_CCHRE*, where the second term is a dummy variable that takes the value of 1 if the country has a climate change and renewable energy performance higher than the yearly median, and 0 otherwise. Next, we include two categories from the Environmental, Social & Governance Risk Score (ESG Risk Score), which expands the Sovereign Risk Score by adding risk factors that measure the health of a country's environment, the robustness of its social system and the quality of its governance.[20] This index consists of nine sections, two of which focus on environmental issues: climate change and renewable energy (CCHRE risk) and biodiversity (BIO risk), both of which are used in our analysis.

[20] Data are available at https://www.countryrisk.io/

In the main model, we first include an interaction term, *Score*Low_CCHRE risk*, where the dummy variable takes the value of 1 if the country has a lower risk than the median (by year) of not meeting climate change and renewable energy targets, and 0 otherwise. Then we include the interaction term *Score*Low_BIO risk*, where the dummy variable takes the value of 1 if the country has lower risk than the median (by year) of not meeting biodiversity targets, and 0 otherwise.

Panels A1, B1 and C1 present the distribution of the three indexes discussed above by country and year. First, the patterns observed for the two climate change and renewable energy indexes (CCHRE from the EPI and CCHRE risk from the ESG Risk Score) closely resemble those observed for the greenhouse gas emissions (GHG) index. Countries with the highest scores for climate change performance, lower risk or lower GHG emissions tend to be Nordic countries such as Norway, Sweden, Finland and Denmark, as well as Switzerland and Austria. Conversely, countries such as Saudi Arabia, Thailand and South Africa exhibit the worst scores for climate change and higher risk, although this pattern is not entirely consistent with the emissions score. It is notable that the US, despite being a developed country, is one of the worst performers in terms of GHG emissions and climate change metrics. Second, the EPI and biodiversity risk scores share a similar pattern. For both indexes, European countries, including Austria, France, Germany and the UK, rank among the best in terms of higher environmental performance and lower biodiversity risk, while Saudi Arabia, China and South Africa score among the worst in both categories. Third, several key trends emerge from the evolution of the three indexes. The CCHRE score, which is part of the EPI, improves over time, with the exception of 2022, when scoring criteria for climate change were revised. This trend aligns with the CCHRE risk score, as risks related to climate change and renewable energy issues have decreased over time. However, while scores related to climate change are improving, this trend is not observed for the biodiversity dimension. In fact, the biodiversity risk score has worsened in recent years compared to the earlier period of analysis. This may indicate that countries have focused more on tackling climate change, potentially sidelining other environmental priorities.

[Insert Table 11 about here]

Regarding the main model results, we expect similar findings to those observed for the GHG index when using the first two indicators (CCHRE and CCHRE risk, Panels A and

B, respectively) and similar to those found for the EPI when using the third indicator (BIO, Panel C). Panel A.3 of Table 11 shows that, in general, environmental performance reduces credit risk, or does so to a greater extent, for companies from countries that are more committed to meeting climate change targets (high CCHRE). The same pattern emerges in Panel B.3, where the country's climate change goal performance is measured using the ESG Risk Score category related to climate change (low CCHRE risk). As expected, these results align with those in Table 8, where the sample is divided into low and high GHG emitting countries. For companies located in countries with strong climate change performance, improvements in environmental performance lead to a reduction in credit risk. However, if a company operates in a country with poor climate change performance, improving its environmental performance worsens its credit risk, as such efforts may be perceived as a waste of resources. Consequently, companies in countries with poor climate change performance have little incentive to improve their environmental performance—at least in terms of credit risk. In contrast, Panel C.3 shows that, consistent with the results for the EPI index, credit risk is reduced to a greater extent for companies from countries with higher biodiversity risk.

In summary, our findings suggest that companies from countries with stronger climate performance or lower GHG emissions see their environmental efforts rewarded with lower CDS spreads. However, when it comes to environmental goals beyond climate change, the CDS market reacts more favourably to companies that make a significant contribution to overall environmental sustainability, particularly in countries with lower sustainability indexes. Market participants may perceive firms operating in countries with lower emissions or ambitious climate change targets as less exposed to long-term environmental risks, leading to greater recognition of their environmental efforts. Conversely, companies operating in countries with weaker environmental performance are likely to be perceived as more vulnerable to environmental risks, making their efforts to mitigate these risks more appreciated by the market.

Furthermore, although there is variability across the environmental categories involved, it is interesting to note that only when companies are divided into two groups based on their country's climate change performance (measured by GHG emissions, CCHRE from the EPI, or CCHRE risk from the ESG Risk Score), do we observe an increasing effect on credit risk for countries with poor climate change performance. This effect does not appear when assessing the country's overall environmental performance, whether using the EPI or the BIO risk from the ESG Risk Score.

Thus, our results support hypothesis H4, which posits that a country's environmental performance significantly influences the relationship between a company's environmental performance and its credit risk. Furthermore, the specific type of environmental score—whether focused on climate change or broader environmental issues—also plays an important role in this dynamic.

7. Conclusions

Our research reveals a significant negative relationship between environmental performance and credit risk, as measured by CDS spreads, across a broad sample of 516 firms from 37 countries for the period 2010-2022. Higher environmental performance, particularly in terms of emissions and product innovation, is associated with lower credit risk, consistent with the risk mitigation view. However, a closer examination of the heterogeneous effects of environmental performance on credit risk—considering both external and internal, as well as environmental and financial factors—also lends support to the overinvestment view.

First, internal environmental factors, such as a firm's initial environmental performance level and its sector's environmental risk exposure, along with financial performance indicators like credit rating, are shown to moderate the relationship between environmental performance and credit risk. Firms with lower initial environmental scores, lower environmental risk exposure and higher credit ratings experience a greater reduction in credit risk when they improve their environmental performance.

Second, environmental performance has a more pronounced impact on credit risk for companies in countries with lower environmental scores, lower credit ratings and slower GDP growth. This suggests that the CDS market places a higher value on the environmental efforts of companies that, due to their institutional context, start from a lower environmental and financial baseline. Interestingly, we find that the type of environmental score used in the analysis matters: firms from countries with higher scores in the climate change category enjoy lower CDS spreads when they improve their environmental performance. Firms from countries that are closer to achieving SDG 13

(Climate Action) are more highly valued by the CDS market for their environmental improvements.

Third, there are instances where the findings align with the overinvestment view. This is particularly true for firms in high environmental risk sectors, such as gas or oil, where improvements in environmental performance may not be seen as sufficient, as they result in higher levels of credit risk or are not rewarded by the market at all. In addition, firms from countries with poor climate change performance may experience an increase in credit risk despite improving their environmental scores. In these cases, the overall poor environmental reputation of the country overshadows the specific environmental improvements of local companies, which may not be sufficient to offset the country's negative indicators, leading investors to still perceive these companies as higher risk.

This study has several practical implications. First, companies operating in countries with lower environmental sustainability scores and higher credit risk should allocate more resources towards environmental practices to mitigate credit risk. Companies should view environmental initiatives not only as ethical imperatives but also as strategic investments that can bolster their long-term financial resilience. Collaborating with local governments, NGOs and other stakeholders can help companies navigate sustainability challenges in countries with weaker environmental and financial infrastructures. These partnerships can provide valuable resources and support the implementation of effective environmental strategies. Second, investors and financial analysts should factor in the institutional context when evaluating companies' environmental initiatives. Firms that demonstrate improved environmental performance despite challenging external conditions may be perceived more favourably by investors.

Finally, these findings underscore the importance for regulators to consider environmental performance as a key factor in assessing credit risk. Regulatory frameworks should incentivise firms to improve their environmental practices, as this can lower borrowing costs and reduce financial vulnerabilities. Moreover, policymakers should tailor regulation to encourage sustainability efforts, particularly in high-risk sectors, while providing support and guidance to firms navigating the transition towards more environmentally sustainable practices. This approach can enhance financial stability and promote long-term economic resilience in the face of environmental challenges.

In conclusion, the study underscores the complex interplay between environmental performance and credit risk, highlighting the importance of considering both external and internal factors when evaluating the financial implications of sustainability initiatives.

References

Abdul Razak, L., Ibrahim, M. H., & Ng, A. (2020). Which sustainability dimensions affect credit risk? Evidence from corporate and country-level measures. *Journal of Risk and Financial Management*, *13*(12), 316.

Abdul Razak, L., Ibrahim, M. H., & Ng, A. (2023). Environment, social and governance (ESG) performance and CDS spreads: the role of country sustainability. *The Journal of Risk Finance*, *24*(5), 585-613.

Abinzano, I., Gonzalez-Urteaga, A., Muga, L., & Sanchez, S. (2020). Performance of default-risk measures: the sample matters. *Journal of Banking and Finance*, 120, num: 105959.

Albuquerque, R., Koskinen, Y., & Zhang, C. (2019). Corporate social responsibility and firm risk: Theory and empirical evidence. *Management Science* 65, 4451–4469.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, 23, 589–609.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, *58*(2), 277-297.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, *68*(1), 29-51.

Atif, M., & Ali, S. (2021). Environmental, social and governance disclosure and default risk. *Business Strategy and the Environment*, 30, 3937-3959.

Attig, N., El Ghoul, S., Guedhami, O., & Suh, J. (2013). Corporate social responsibility and credit ratings. *Journal of business ethics*, *117*, 679-694.

Bae, S. C., Chang, K., & Yi, H. C. (2018). Corporate social responsibility, credit rating, and private debt contracting: new evidence from syndicated loan market. *Review of Quantitative Finance and Accounting*, *50*, 261-299.

Ballester, L., Casu, B., & González-Urteaga, A. (2016). Bank fragility and contagion: Evidence from the bank CDS market. *Journal of Empirical Finance*, *38*, 394-416.

Bannier, C., Bofinger, Y., & Rock, B. (2021). Corporate social responsibility and credit risk. *Finance Research Letters*,102052.

Barnea, A., & Rubin, A. (2010). Corporate social responsibility as a conflict between shareholders. *Journal of Business Ethics*, 97, 71–86.

Barnett, M. L. (2007). Stakeholder influence capacity and the variability of financial returns to corporate social responsibility. *Academy of management review*, *32*(3), 794-816.

Barnett, M. L., & Salomon, R. M. (2006). Beyond dichotomy: The curvilinear relationship between social responsibility and financial performance. *Strategic management journal*, *27*(11), 1101-1122.

Barnett, M. L., & Salomon, R. M. (2012). Does it pay to be really good? Addressing the shape of the relationship between social and financial performance. *Strategic management journal*, *33*(11), 1304-1320.

Barth, F., Hübel, B., & Scholz, H. (2022). ESG and Corporate Credit Spreads. *The Journal of Risk Finance*, 23, 169-190.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, *87*(1), 115-143.

Boubaker, S., Cellier, A., Manita, R., & Saeed, A. (2020). Does corporate social responsibility reduce financial distress risk? *Economic Modelling*, *91*, 835-851.

Brammer, S., & Millington, A. (2008). Does it pay to be different? An analysis of the relationship between corporate social and financial performance. *Strategic management journal*, *29*(12), 1325-1343.

Callen, J. L., Livnat, J., & Segal, D. (2009). The impact of earnings on the pricing of credit default swaps. *The Accounting Review*, *84*(5), 1363-1394.

Cespa, G., & Cestone, G. (2007). Corporate social responsibility and managerial entrenchment. *Journal of Economics and Management Strategy*, 16, 741–771.

Chava, S. (2014). Environmental externalities and cost of capital. *Management Science*, 60, 2223-2247.

Das, S. R., Hanouna, P., & Sarin, A. (2009). Accounting-based versus market-based cross-sectional models of CDS spreads. *Journal of Banking & Finance*, *33*(4), 719-730.

Devalle, A., Fiandrino, S., & Cantino, V. (2017). The linkage between ESG performance and credit ratings: A firm-level perspective analysis. *International Journal of Business and Management*, *12*(9), 53-65.

Diemont, D., Moore, K., & Soppe, A. (2015). The downside of being responsible: Corporate social responsibility and tail risk. *Journal of Business Ethics*, 137, 213–229.

Dorfleitner, G., & Grebler, J. (2020). The social and environmental drivers of corporate credit ratings: international evidence. *Business Research*, *13*(3), 1343-1415.

Dorfleitner, G., Grebler, J., & Utz, S. (2020). The impact of corporate social and environmental performance on credit rating prediction: North America versus Europe. *Journal of Risk*, *22*(6), 1-33.

Drago, D., Carnevale, C., & Gallo, R. (2019). Do corporate social responsibility ratings affect credit default swap spreads? *Corporate Social Responsibility and Environmental Management*, *26*(3), 644-652.

Eichengreen, B., Mody, A., Nedeljkovic, M., & Sarno, L. (2012). How the subprime crisis went global: Evidence from bank credit default swap spreads. J*ournal of International Money and Finance*, 31(5), 1299-1318.

Eliwa, Y., Aboud, A., & Saleh, A. (2021). ESG practices and the cost of debt: Evidence from EU countries. *Critical Perspectives on Accounting*, *79*, 102097.

Erragragui, E. (2018). Do creditors price firms’ environmental, social and governance risks? *Research in International Business and Finance*, *45*, 197-207.

Focardi, S. M., & Fabozzi, F. J. (2004). The mathematics of financial modeling and investment management (Vol. 138). John Wiley & Sons.

Freeman, R. E. (2010). *Strategic management: A stakeholder approach*. Cambridge university press.

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of sustainable finance & investment*, *5*(4), 210-233.

Friedman, M. (1962). Capitalism and Freedom (University Of Chicago Press, Chicago). *Economic Underdevelopment, 143*.

Ge, W., & Liu, M. (2015). Corporate social responsibility and the cost of corporate bonds. *Journal of Accounting and Public Policy*, *34*(6), 597-624.

Ghoul, S. E., Guedhami, O., & Kim, Y. (2017). Country-level institutions, firm value, and the role of corporate social responsibility initiatives. *Journal of International Business Studies*, *48*, 360-385.

Godfrey P.C. (2005). The relationship between corporate philanthropy and shareholder wealth: A risk management perspective. *Academy of Management Review*, 30, 777–798.

Goss, A., & Roberts, G. S. (2011). The impact of corporate social responsibility on the cost of bank loans. *Journal of banking & finance*, *35*(7), 1794-1810.

Henisz, W.J., & McGlinch, J. (2019). ESG, material credit events, and credit risk. *Journal of Applied Corporate Finance*, 31, 105-117.

Höck, A., Klein, C., Landau, A., & Zwergel, B. (2020). The effect of environmental sustainability on credit risk. *Journal of Asset Management*, *21*(2), 85-93.

Hoepner, A., Oikonomou, I., Scholtens, B., & Schröder, M. (2016). The effects of corporate and country sustainability characteristics on the cost of debt: An international investigation. *Journal of Business Finance & Accounting*, *43*(1-2), 158-190.

Huber, B. M., Comstock, M., Polk, D., & Wardwell, L. L. P. (2017). ESG reports and ratings: What they are, why they matter. *The Corporate Governance Advisor*, *25*(5), 1-12.

Jiraporn, P., Jiraporn, N., Boeprasert, A., & Chang, K. (2014). Does corporate social responsibility (CSR) improve credit ratings? Evidence from geographic identification. *Financial management*, *43*(3), 505-531.

Jones, T.M. (1995). Instrumental stakeholder theory: A synthesis of ethics and economics. *Academy of Management Review*, 20, 404-437.

Jorion, P., & Zhang, G. (2007). Good and bad credit contagion: Evidence from credit default swaps. *Journal of Financial Economics*, 84(3), 860-883.

Kiesel, F., & Lücke, F. (2019). ESG in credit ratings and the impact on financial markets. *Financial Markets, Institutions & Instruments*, *28*(3), 263-290.

Kim, Y., Li, H., & Li, S. (2014). Corporate social responsibility and stock price crash risk. *Journal of Banking & Finance*, 43, 1–13.

Kölbel, J. F., Busch, T., & Jancso, L. M. (2017). How media coverage of corporate social irresponsibility increases financial risk. *Strategic Management Journal*, *38*(11), 2266-2284.

La Rosa, F., Liberatore, G., Mazzi, F., & Terzani, S. (2018). The impact of corporate social performance on the cost of debt and access to debt financing for listed European non-financial firms. *European Management Journal*, *36*(4), 519-529.

Landry, E., Castillo-Lazaro, M., & Lee, A. (2017). Connecting esg and corporate bond performance. MIT Sloan Management School & Breckinridge Capital Advisors Report, (2017).

Longstaff, F. A., Mithal, S., & Neis, E. (2005). Corporate yield spreads: Default risk or liquidity? New evidence from the credit default swap market. *The journal of finance*, *60*(5), 2213-2253.

Magnanelli, B. S., & Izzo, M. F. (2017). Corporate social performance and cost of debt: The relationship. *Social Responsibility Journal*, *13*(2), 250-265.

Maignan, I. (2001). Consumers' perceptions of corporate social responsibilities: A cross-cultural comparison. *Journal of Business Ethics*, 30, 57–72.

Meier, O., Naccache, P., & Schier, G. (2021). Exploring the curvature of the relationship between HRM–CSR and corporate financial performance. *Journal of Business Ethics*, *170*, 857-873.

Menz, K. M. (2010). Corporate social responsibility: Is it rewarded by the corporate bond market? A critical note. *Journal of business ethics*, *96*(1), 117-134.

Nandy, M., & Lodh, S. (2012). Do banks value the eco-friendliness of firms in their corporate lending decision? Some empirical evidence. *International Review of Financial Analysis*, *25*, 83-93.

Oikonomou, I., Brooks, C., & Pavelin, S. (2014). The effects of corporate social performance on the cost of corporate debt and credit ratings. *Financial Review*, *49*(1), 49-75.

Preston, L.E., & O'Bannon, D.P. (1997). The corporate social-financial performance relationship. Business & Society, 36, 419–429.

Roberts, M. R., & Whited, T. M. (2013). Endogeneity in empirical corporate finance1. In *Handbook of the Economics of Finance* (Vol. 2, pp. 493-572). Elsevier.

S&P (2019), "The ESG Advantage: Exploring Links To Corporate Financial Performance", available at: https://www.spglobal.com/ratings/en/research/pdf-articles/190408-the-esg-advantage-exploring-links-to-corporate-financial-performance

Schneider, T. E. (2011). Is environmental performance a determinant of bond pricing? Evidence from the US pulp and paper and chemical industries. *Contemporary Accounting Research*, *28*(5), 1537-1561.

Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. *Strategic management journal*, *29*(6), 569-592.

Stellner, C., Klein, C., & Zwergel, B. (2015). Corporate social responsibility and Eurozone corporate bonds: The moderating role of country sustainability. *Journal of Banking & Finance*, 59, 538-549.

Utz, S. (2018). Over-investment or risk mitigation? Corporate social responsibility in Asia-Pacific, Europe, Japan, and the United States. *Review of Financial Economics*, 36, 167–193.

Weber, O., Scholz, R. W., & Michalik, G. (2010). Incorporating sustainability criteria into credit risk management. *Business strategy and the environment*, *19*(1), 39-50.

Wintoki, M. B., Linck, J. S., & Netter, J. M. (2012). Endogeneity and the dynamics of internal corporate governance. *Journal of financial economics*, *105*(3), 581-606.

Wooldridge, J.M. (2010). *Econometric analysis of cross section and panel data*, 2nd edition. MIT Press, Cambridge, MA.

Zeidan, R., Boechat, C., & Fleury, A. (2015). Developing a sustainability credit score system. *Journal of Business Ethics*, *127*, 283-296.

Table 1. Correlation Matrix and Summary Statistics of the Main Dependent, Explanatory and Control Variables

Panel A: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. CDS spread														
2. E score	-0.13^{***}													
3. Resource	-0.09^{***}	0.84^{***}												
4. Emissions	-0.11^{***}	0.86^{***}	0.73^{***}											
5. Env. Innov.	-0.16^{***}	0.64^{***}	0.34^{***}	0.34^{***}										
6. Size	-0.30^{***}	0.39^{***}	0.40^{***}	0.36^{***}	0.17^{***}									
7. ROA	-0.15^{***}	0.02^{**}	0.03^{***}	0.01	-0.00	0.22^{***}								
8. Leverage	0.14^{***}	-0.10^{***}	-0.10^{***}	-0.11^{***}	-0.06^{***}	-0.15^{***}	-0.21^{***}							
9. MTB	-0.10^{***}	0.02^{**}	0.07^{***}	0.00	-0.04^{***}	0.28^{***}	0.24^{***}	0.06^{***}						
10. Liquidity	0.03^{***}	-0.01	-0.01	-0.03^{**}	0.04^{***}	-0.09^{***}	0.07^{***}	-0.22^{***}	0.13^{***}					
11. Sales	0.04^{***}	-0.06^{***}	-0.06^{***}	-0.09^{***}	-0.01	-0.13^{***}	0.09^{**}	-0.27^{***}	0.13^{***}	0.23^{***}				
12. Tangibility	-0.02^{*}	-0.01^{*}	-0.06^{***}	0.02^{*}	-0.01	-0.18^{***}	-0.12^{***}	0.20^{***}	-0.18^{***}	-0.16^{***}	-0.12^{***}			
13. Capex	-0.03^{***}	0.09^{***}	0.15^{***}	0.08^{***}	-0.08^{***}	0.23^{***}	0.31^{***}	0.10^{***}	0.38^{***}	-0.08^{***}	0.00	-0.04^{***}		
14. Coverage	-0.14^{***}	0.10^{***}	0.06^{***}	0.11^{***}	0.08^{***}	0.19^{***}	0.28^{***}	-0.39^{***}	0.06^{***}	0.22^{***}	0.12^{***}	-0.09^{***}	0.00	
15. GDP growth	0.01	-0.08^{***}	-0.05^{***}	-0.08^{***}	-0.07^{***}	0.03^{***}	0.12^{***}	-0.03^{***}	0.06^{***}	-0.04^{***}	0.04^{***}	-0.03^{**}	0.09^{***}	-0.02

Panel B: Summary Statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mean	111.30	62.75	67.71	67.52	47.01	9.62	0.04	0.30	2.89	0.06	0.79	0.74	0.03	15.44	1.78
SD	147.89	23.90	27.69	27.76	33.24	1.30	0.06	0.13	3.33	0.06	0.55	0.49	0.02	21.02	2.42
Min.	8.63	0.00	0.00	0.00	0.00	3.36	-0.43	0.00	-12.90	0.00	0.03	0.00	0.00	-5.23	-11.32
Max.	2,965	99.17	99.90	99.90	99.79	14.74	2.40	0.85	33.38	0.58	5.38	6.59	0.58	188.16	24.37

This table displays the mean, standard deviation and correlations of the variables. Coefficients marked with ***, ** and * indicate statistical significant at the 1%, 5% and 10% levels, respectively.

Table 2. Environmental Scores Distribution by Country and Sector

Panel A: Distribution by Country

Country	Nº Obs	E	Res.	Emis.	Innov.	Country	Nº Obs	E	Res.	Emis.	Innov.
Australia	149	62.54	70.84	68.58	27.26	Malaysia	36	52.71	47.52	68.34	27.77
Austria	18	71.74	71.86	61.05	85.20	Mexico	38	49.08	57.45	60.14	26.42
Belgium	30	71.92	78.55	66.29	74.42	Netherlands	89	73.17	86.68	76.68	54.20
Brazil	42	58.38	63.63	65.74	25.36	N. Zealand	15	29.83	26.43	38.99	23.24
Canada	90	69.67	76.83	76.22	44.28	Norway	30	75.30	68.24	85.14	64.70
China	34	46.75	54.75	44.84	37.62	Philippines	26	37.88	29.68	65.25	15.97
Denmark	14	66.03	92.28	69.45	27.70	Portugal	20	77.93	76.15	91.74	63.42
Finland	58	77.43	78.10	83.94	71.59	Russia	61	56.71	76.76	69.17	11.32
France	268	76.59	83.78	85.40	56.65	Saudi Arabia	11	73.36	80.91	48.69	89.11
Germany	263	78.19	83.61	79.21	66.75	S. Africa	10	74.37	89.23	74.40	0.00
Greece	20	63.62	69.41	88.04	27.83	S. Korea	145	69.91	66.64	77.57	60.78
Hong Kong	113	60.32	66.40	62.67	45.21	Spain	53	84.55	88.91	94.02	68.40
Hungary	8	72.44	88.08	93.66	29.14	Sweden	117	65.22	73.28	66.77	58.22
India	39	66.66	80.34	69.30	42.56	Switzerland	93	78.09	86.49	89.89	41.72
Ireland	13	80.36	73.18	95.96	69.68	Taiwan	38	54.51	77.98	59.53	25.57
Israel	9	56.98	77.86	52.77	0.00	Thailand	4	72.53	69.17	96.08	51.56
Italy	38	84.00	90.10	90.17	69.38	UK	336	70.51	77.62	77.25	46.50
Japan	1,153	63.00	62.10	69.24	56.14	US	2,197	55.57	62.06	58.09	39.66
Luxemburg	25	56.87	53.34	55.36	50.42	**ALL**	**5,703**	**62.75**	**67.71**	**67.52**	**47.01**

Panel B: Distribution by Sector

Sector	Nº Obs.	E	Res.	Emis.	Innov.
Agriculture, forestry, and fishing	66	69.78	69.45	73.21	66.44
Mining	626	64.99	70.67	74.67	31.71
Construction	205	67.59	66.89	75.63	58.33
Manufacturing	1,950	66.96	71.43	68.20	56.45
Transportation, communications, electric, gas, and sanitary services	1,434	57.01	62.09	64.53	41.37
Wholesale trade	464	66.23	69.12	67.63	64.22
Retail trade	351	61.94	66.47	65.61	44.25
Real state	96	60.72	63.99	61.54	54.33
Services	511	55.00	65.97	62.87	23.34

Panel A displays the mean values of the Environmental Scores by country. Panel B displays the mean values of the Environmental Scores by sector.

Table 3. Environmental Scores and Credit Default Swaps

Dep. var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.881***	0.891***	0.881***	0.882***
	(0.001)	(0.003)	(0.001)	(0.001)
Score	**-0.0004*****	**0.010**	**-0.034*****	**-0.057*****
	(0.0000)	**(0.011)**	**(0.005)**	**(0.003)**
Size	-0.020***	-0.020***	-0.021***	-0.020***
	(0.001)	(0.002)	(0.001)	(0.001)
ROA	-0.930***	-0.898***	-0.911***	-0.886***
	(0.012)	(0.029)	(0.011)	(0.014)
Leverage	0.174***	0.202***	0.183***	0.197***
	(0.009)	(0.021)	(0.007)	(0.007)
MTB	-0.003***	-0.004***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity	0.095***	0.174***	0.080***	0.063***
	(0.015)	(0.034)	(0.017)	(0.017)
Sales	0.011***	0.017***	0.019***	0.022**
	(0.002)	(0.005)	(0.002)	(0.002)
Tangibility	-0.058***	-0.058***	-0.061***	-0.050***
	(0.001)	(0.003)	(0.001)	(0.001)
Capex	1.191***	1.294***	1.190***	1.120***
	(0.020)	(0.057)	(0.022)	(0.018)
Coverage	-0.000	-0.000**	-0.000	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
GDP_growth	0.009***	0.010***	0.010***	0.009***
	(0.000)	(0.000)	(0.000)	(0.000)
Const.	0.863***	0.760***	0.857***	0.829***
	(0.018)	(0.038)	(0.019)	(0.020)
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
m_2 (p-value)	(0.699)	(0.252)	(0.651)	(0.581)
Hansen (p-value)	(0.370)	(0.164)	(0.340)	(0.403)

This table presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test assesses over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 4. Internal Environmental Factors: Firm's Score Performance Level

Panel A. Estimation Results				
Dep. Var.:	1	2	3	4
$L(CDS\_spread_{i,t})$	E	Resource	Emissions	Innovation
$L(CDS\_spread_{i,t-1})$	0.888***	0.893***	0.894***	0.894***
	(0.003)	(0.003)	(0.003)	(0.003)
Score	**-0.0011*****	**-0.073*****	**-0.076*****	**-0.082*****
	(0.0001)	**(0.015)**	**(0.015)**	**(0.014)**
Score* High_Score	**0.0003*****	**0.063*****	**0.008**	**0.030*****
	(0.0000)	**(0.006)**	**(0.007)**	**(0.010)**
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)	(0.00)	(0.36)		(0.00)
w_2 (p-value)	(0.00)	(0.00)		(0.00)
m_2 (p-value)	(0.604)	(0.370)	(0.243)	(0.297)
Hansen (p-value)	(0.123)	(0.152)	(0.127)	(0.182)
Panel B. Effect of Score variable on CDS spreads for different groups of companies (Panel A)				
	1	2	3	4
	E	Resource	Emissions	Innovation
High Score	-0.0008***	0	-0.076***	-0.052***
Low Score	-0.0011***	-0.073***	-0.076***	-0.082***

Panel A presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_Score* is equal to zero. The w_2 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_Score* is equal to the coefficient of *Score*. ***,** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 5. Internal Environmental Factors: S&P Environmental Risk for Sectors

Panel A. Estimation Results				
Dep. Var.: L($CDS\_spread_{i,t}$)	1	2	3	4
	E	Resource	Emissions	Innovation
L($CDS\_spread_{i,t-1}$)	0.892***	0.890***	0.891***	0.895***
	(.003)	(0.003)	(0.003)	(0.003)
Score	**0.002*** **	**0.275*** **	**0.199*** **	**0.020**
	(0.000)	**(0.020)**	**(0.023)**	**(0.013)**
Score* Low environmental risk	**-0.003*** **	**-0.320*** **	**-0.284*** **	**-0.071*** **
	(0.000)	**(0.019)**	**(0.025)**	**(0.014)**
Low environmental risk	0.163***	0.171***	0.137***	-0.010
	(0.017)	(0.014)	(0.017)	(0.008)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)	(0.00)	(0.00)	(0.00)	
m_2 (p-value)	(0.654)	(0.711)	(0.630)	(0.257)
Hansen (p-value)	(0.182)	(0.183)	(0.173)	(0.277)

Panel B. Effect of Score variable on CDS spreads for different groups of companies (Panel A)				
	1	2	3	4
	E	Resource	Emissions	Innovation
Low environmental risk	-0.001***	-0.045***	-0.085***	-0.071***
High environmental risk	0.002***	0.275 ***	0.199***	0

Panel A presents the coefficients and standard deviations of the variables of the models, estimated using system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low environmental risk* is equal to zero. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 6. Internal Financial Factors: Moody's Company Rating

Panel A.1. Dummy=1 if rating≥ A3 (non-speculative)				
Dep. Var.:	1	2	3	4
L(CDS_spread$_{i,t}$)	E	Resources	Emissions	Innovation
L(CDS_spread$_{i,t-1}$)	0.853***	0.855***	0.859***	0.859***
	(0.004)	(0.006)	(0.003)	(0.004)
Score	**-0.0015*** **	**-0.048** **	**-0.056*** **	**-0.054*** **
	(0.0001)	**(0.019)**	**(0.012)**	**(0.010)**
Score * High_rating	**-0.0000)**	**-0.055* **	**-0.060** **	**0.008**
	(0.0003)	**(0.033)**	**(0.024)**	**(0.017)**
High_rating	-0.037	-0.004	-0.018	-0.065***
	(0.024)	(0.027)	(0.020)	(0.011)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)		(0.09)	(0.01)	
m_2 (p-value)	(0.474)	(0.515)	(0.913)	(0.848)
Hansen (p-value)	(0.191)	(0.102)	(0.213)	(0.206)
Panel A.2. Effect of Score variable on CDS spreads for different groups of companies (Panel A.1)				
	1	2	3	4
	E	Resource	Emissions	Innovation
High rating	-0.0015***	-0.103*	-0.116**	-0.054***
Low rating	-0.0015***	-0.048**	-0.056***	-0.054***
Panel B.1. Dummy=1 if rating≥ median by year				
Dep. Var.:	1	2	3	4
CDS_spread$_{i,t}$	E	Resources	Emissions	Innovation
L(CDS_spread$_{i,t-1}$)	0.841***	0.848***	0.869***	0.847***
	(0.003)	(0.003)	(0.005)	(0.007)
Score	**-0.0012*** **	**-0.043*** **	**-0.071*** **	**-0.140*** **
	(0.0001)	**(0.011)**	**(0.018)**	**(0.027)**
Score * High_rating	**-0.0010*** **	**-0.060*** **	**-0.018**	**0.012**
	(0.0001)	**(0.013)**	**(0.019)**	**(0.026)**
High_rating	0.006	0.002	0.016	-0.065***
	(0.011)	(0.009)	(0.015)	(0.016)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)	(0.00)	(0.00)		
m_2 (p-value)	(0.199)	(0.425)	(0.754)	(0.268)
Hansen (p-value)	(0.360)	(0.395)	(0.194)	(0.190)
Panel B.2. Effect of Score variable on CDS spreads for different groups of companies (Panel B.1)				
	1	2	3	4
	E	Resource	Emissions	Innovation
High rating	-0.0022***	-0.103***	-0.071***	-0.140***
Low rating	-0.0012***	-0.043***	-0.071***	-0.140***

Panels A and C present the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_rating* is equal to the coefficient of *Score*. Panels B and D present the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 7. External Environmental Factors: Country's Environmental Performance Index (EPI)

Panel A. Country's Environmental Performance Index by country and year

EPI by country						EPI by year	
Australia	72.20	India	34.59	Russia	57.44	2010	60.08
Austria	77.11	Ireland	70.60	Saudi Arabia	49.89	2011	60.07
Belgium	71.36	Israel	68.62	S. Africa	49.54	2012	60.30
Brazil	59.28	Italy	75.13	S. Korea	62.04	2013	60.84
Canada	69.17	Japan	71.59	Spain	73.55	2014	70.42
China	46.21	Luxemburg	78.16	Sweden	77.83	2015	70.36
Denmark	83.03	Malaysia	57.05	Switzerland	82.15	2016	83.27
Finland	77.69	Mexico	55.84	Taiwan	63.76	2017	83.28
France	76.63	Netherlands	66.73	Thailand	59.99	2018	73.35
Germany	76.42	N. Zealand	67.29	UK	77.87	2019	73.36
Greece	71.26	Norway	76.46	US	67.23	2020	70.42
Hong Kong	64.22	Philippines	57.44	**ALL**	**69.66**	2021	70.36
Hungary	69.00	Portugal	69.65			2022	55.89

Panel B. Estimation results: Country's Environmental Performance Index

Dep. Var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.890***	0.897***	0.896***	0.884***
	(0.003)	(0.003)	(0.003)	(0.003)
Score	**-0.0003****	**-0.049*****	**-0.069*****	**-0.023*****
	(0.0001)	**(0.014)**	**(0.015)**	**(0.007)**
Score * High_EPI	**-0.0000**	**0.030****	**0.004**	**0.019****
	(0.0001)	**(0.014)**	**(0.015)**	**(0.007)**
High_EPI	-0.009	-0.030***	-0.010	-0.022***
	(0.008)	(0.010)	(0.010)	(0.003)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)		(0.25)		(0.58)
w_2 (p-value)		(0.03)		(0.01)
m_2 (p-value)	(0.367)	(0.329)	(0.247)	(0.622)
Hansen (p-value)	(0.135)	(0.080)	(0.071)	(0.319)

Panel C. Effect of Score variable on CDS spreads for different groups of companies (Panel B)

	1 E	2 Resource	3 Emissions	4 Innovation
High EPI	-0.0003**	0	-0.069***	0
Low EPI	-0.0003**	-0.049***	-0.069***	-0.023***

Panel A present the mean values of the Environmental Performance Index (EPI) by country and year. Panel B presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_EPI* is equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_EPI* is equal to the coefficient of *Score*. Panel B presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 8. External Environmental Factors: Country's Greenhouse Gas Emissions (GHG)

Panel A. Greenhouse Gas Emissions by country and year

GHG by country						GHG by year	
Australia	488	India	3,068	Russia	1,980	2010	3,516
Austria	74	Ireland	60	Saudi Arabia	650	2011	3,589
Belgium	114	Israel	83	S. Africa	512	2012	3,319
Brazil	1,433	Italy	391	S. Korea	661	2013	3,086
Canada	809	Japan	1,286	Spain	296	2014	3,017
China	12,697	Luxemburg	10	Sweden	50	2015	3,015
Denmark	47	Malaysia	187	Switzerland	46	2016	3,005
Finland	62	Mexico	705	Taiwan	295	2017	2,963
France	386	Netherlands	185	Thailand	432	2018	3,077
Germany	819	N. Zealand	64	UK	486	2019	3,000
Greece	94	Norway	31	US	6,509	2020	2,727
Hong Kong	45	Philippines	166	**ALL**	**3,048**	2021	2,824
Hungary	68	Portugal	65			2022	2,788

Panel B. Estimation results: Country's Greenhouse Gas Emissions

Dep. Var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.875***	0.878***	0.877***	0.872***
	(0.003)	(0.003)	(0.003)	(0.003)
Score	**0.000**	**0.065*****	**-0.021**	**0.062*****
	(0.000)	**(0.013)**	**(0.014)**	**(0.012)**
Score * Low_GHG	**-0.001*****	**-0.104*****	**-0.059*****	**-0.209*****
	(0.000)	**(0.020)**	**(0.019)**	**(0.018)**
Low_GHG	0.041**	0.041***	0.020	0.068***
	(0.017)	(0.013)	(0.012)	(0.008)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)		(0.00)		(0.00)
w_2 (p-value)		(0.00)		(0.00)
m_2 (p-value)	(0.807)	(0.902)	(0.911)	(0.229)
Hansen (p-value)	(0.230)	(0.184)	(0.203)	(0.208)

Panel C. Effect of Score variable on CDS spreads for different groups of companies (Panel B)

	1 E	2 Resource	3 Emissions	4 Innovation
Low GHG	-0.001***	-0.039***	-0.059***	-0.147***
High GHG	0	0.065***	0	0.062***

Panel A present the mean values of the greenhouse gas emissions (GHG), measured in tonnes, by country and year. Panel B presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low_GHG is* equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low_GHG is* equal to the coefficient of *Score*. Panel C presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 9. External Financial Factors: S&P Country Rating

Panel A. S&P Country Rating Score by country and year

S&P rating by country						S&P rating by year	
Australia	18	India	9	Russia	8.93	2010	17.05
Austria	17.05	Ireland	13.46	Saudi Arabia	13	2011	16.36
Belgium	16.03	Israel	14.55	S. Africa	7.6	2012	16.24
Brazil	7.23	Italy	9.73	S. Korea	14.98	2013	16.06
Canada	18	Japan	14.37	Spain	11.77	2014	16.07
China	14.5	Luxemburg	18	Sweden	18	2015	15.85
Denmark	18	Malaysia	12	Switzerland	18	2016	15.76
Finland	17.17	Mexico	10.55	Taiwan	15.15	2017	15.76
France	16.22	Netherlands	17.86	Thailand	11	2018	15.80
Germany	18	N. Zealand	16.2	UK	16.86	2019	15.83
Greece	3.95	Norway	18	US	17.06	2020	15.81
Hong Kong	17.50	Philippines	9.61	**ALL**	**15.98**	2021	15.83
Hungary	9.37	Portugal	9.10			2022	15.87

Panel B. S&P Country Rating

Dep. Var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.880^{***}	0.887^{***}	0.887^{***}	0.881^{***}
	(0.003)	(0.003)	(0.003)	(0.003)
Score	**-0.0016^{***}**	**-0.061^{***}**	**-0.172^{***}**	**-0.152^{***}**
	(0.0002)	**(0.017)**	**(0.019)**	**(0.015)**
Score * High_rating	**0.0012^{***}**	**0.070^{***}**	**0.132^{***}**	**0.127^{***}**
	(0.0003)	**(0.021)**	**(0.025)**	**(0.018)**
High_rating	-0.070^{***}	-0.028^{*}	-0.086^{***}	-0.041^{***}
	(0.021)	(0.015)	(0.018)	(0.009)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)	(0.01)	(0.46)	(0.01)	(0.01)
w_2 (p-value)	(0.00)	(0.00)	(0.00)	(0.00)
m_2 (p-value)	(0.592)	(0.635)	(0.926)	(0.927)
Hansen (p-value)	(0.141)	(0.135)	(0.099)	(0.193)

Panel C. Effect of Score variable on CDS spreads for different groups of companies (Panel B)

	1 E	2 Resource	3 Emissions	4 Innovation
High country rating	-0.0004^{***}	0	-0.040^{***}	-0.025^{***}
Low country rating	-0.0016^{***}	-0.061^{***}	-0.172^{***}	-0.152^{***}

Panel A presents the mean value of the S&P country rating by country and year. The S&P country rating ranges from 1 to 18, where 1 if rating=="CC", 2 if rating=="CCC+", 3 if rating=="B-", 4 if rating=="B", 5 if rating=="B+", 6 if rating=="BB-", 7 if rating=="BB", 8 if rating=="BB+", 9 if rating=="BBB-", 10 if rating=="BBB", 11 if rating=="BBB+", 12 if rating=="A-", 13 if rating=="A", 14 if rating=="A+", 15 if rating=="AA-", 16 if rating=="AA", 17 if rating=="AA+", and 18 if rating=="AAA". Panel B presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_rating* is equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_rating* is equal to the coefficient of *Score*. Panel B presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 10. External Financial Factors: GDP Growth

Panel A. GDP growth by country and year

GDP growth by country						GDP growth by year	
Australia	2.42	India	5.89	Russia	1.53	2010	3.39
Austria	1.29	Ireland	7.18	Saudi Arabia	2.83	2011	1.72
Belgium	1.55	Israel	4.07	S. Africa	0.94	2012	1.80
Brazil	0.65	Italy	0.18	S. Korea	2.99	2013	1.81
Canada	1.91	Japan	0.76	Spain	0.85	2014	1.90
China	6.75	Luxemburg	2.26	Sweden	2.31	2015	2.23
Denmark	1.98	Malaysia	4.42	Switzerland	1.73	2016	1.67
Finland	1.14	Mexico	1.95	Taiwan	3.55	2017	2.33
France	1.15	Netherlands	1.62	Thailand	4.57	2018	2.20
Germany	1.37	N. Zealand	2.85	UK	1.58	2019	1.51
Greece	-0.75	Norway	1.69	US	2.11	2020	-4.01
Hong Kong	1.69	Philippines	5.21	**ALL**	**1.78**	2021	4.94
Hungary	3.45	Portugal	1.37			2022	2.30

Panel B. GDP Growth

Dep. Var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.883***	0.892***	0.881***	0.877***
	(0.003)	(0.004)	(0.003)	(0.003)
Score	**-0.0010*****	**-0.105*****	**-0.087*****	**-0.090*****
	(0.0002)	**(0.024)**	**(0.019)**	**(0.009)**
Score * High_gdp_growth	**0.0005*****	**0.103*****	**0.043****	**0.082*****
	(0.0002)	**(0.026)**	**(0.019)**	**(0.010)**
High_gdp_growth	-0.014	-0.052***	-0.008	-0.009***
	(0.014)	(0.019)	(0.014)	(0.005)
Control variables	YES	YES	YES	YES
Year effects	YES	YES	YES	YES
Industry effects	YES	YES	YES	YES
w_1 (p-value)	(0.00)	(0.92)	(0.00)	(0.36)
w_2 (p-value)	(0.00)	(0.00)	(0.02)	(0.00)
m_2 (p-value)	(0.832)	(0.813)	(0.702)	(0.775)
Hansen (p-value)	(0.137)	(0.091)	(0.118)	(0.185)

Panel C. Effect of Score variable on CDS spreads for different groups of companies (Panel B)

	1 E	2 Resource	3 Emissions	4 Innovation
High gdp growth	-0.0005***	0	-0.044***	0
Low gdp growth	-0.0010***	-0.105***	-0.087***	-0.090***

Panel A presents the mean value of the GDP growth by country and year. Panel B1 presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_gdp_growth* is equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_gdp_growth* is equal to the coefficient of *Score*. Panel B2 presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively.

Table 11. Robustness. External Environmental Factors: Country's Climate Change *vs.* Biodiversity

Panel A1. Country's Climate Change and renewable energy performance by country and year

CCHRE by country						CCHRE by year	
Australia	43.18	India	47.20	Russia	53.33	2010	26.17
Austria	61.93	Ireland	57.64	Saudi Arabia	34.90	2011	26.27
Belgium	61.35	Israel	57.32	S. Africa	47.82	2012	26.83
Brazil	50.22	Italy	66.10	S. Korea	42.31	2013	27.80
Canada	49.50	Japan	47.33	Spain	63.40	2014	53.84
China	54.06	Luxemburg	54.25	Sweden	75.87	2015	53.98
Denmark	81.19	Malaysia	42.54	Switzerland	75.33	2016	74.63
Finland	67.04	Mexico	48.92	Taiwan	54.05	2017	74.78
France	62.38	Netherlands	52.64	Thailand	39.19	2018	51.98
Germany	58.19	N. Zealand	56.93	UK	63.47	2019	52.14
Greece	51.02	Norway	65.07	US	48.89	2020	71.24
Hong Kong	58.99	Philippines	54.13	**ALL**	**52.36**	2021	71.19
Hungary	70.38	Portugal	62.67			2022	44.80

Panel A2. Country's Climate Change and renewable energy performance (CCHRE) from EPI index

Dep. Var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.891***	0.878***	0.876***	0.878***
	(0.003)	(0.001)	(0.001)	(0.002)
Score	**-0.0001**	**0.089*****	**0.033*****	**-0.024*****
	(0.0001)	**(0.008)**	**(0.008)**	**(0.006)**
Score * High_CCHRE	**-0.0003****	**-0.107*****	**-0.164*****	**-0.015*****
	(0.0001)	**(0.008)**	**(0.009)**	**(0.005)**
High_CCHRE	0.052***	0.112***	0.150***	0.043***
	(0.010)	(0.005)	(0.006)	(0.003)
w_1 (p-value)		(0.018)	(0.00)	
w_2 (p-value)				(0.00)
m_2 (p-value)	(0.331)	(0.592)	(0.816)	(0.522)
Hansen (p-value)	(0.149)	(0.357)	(0.348)	(0.293)

Panel A3. Effect of Score variable on CDS spreads for different groups of companies (Panel A2)

	1 E	2 Resource	3 Emissions	4 Innovation
High CCHRE	-0.0003***	-0.031**	-0.131***	-0.039***
Low CCHRE	0	0.089***	0.033***	-0.024***

Panel A1 presents the mean values by country and year of the climate change and renewable energy score from the EPI. Panel A2 presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_CCHRE* is equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *High_CCHRE* is equal to the coefficient of *Score*. Panel A3 presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively. Control variables, year and industry effects are included.

Table 11. (*continued*)

Panel B1. Country's Climate Change and Renewable Energy Risk by country and year

CCHRE risk by country						CCHRE risk by year	
Australia	48.42	India	67.73	Russia	56.16	2010	45.97
Austria	14.12	Ireland	34.34	Saudi Arabia	68.57	2011	44.29
Belgium	37.40	Israel	40.71	S. Africa	65.42	2012	43.23
Brazil	16.63	Italy	28.15	S. Korea	55.46	2013	42.12
Canada	32.86	Japan	43.83	Spain	29.28	2014	41.40
China	57.56	Luxemburg	40.25	Sweden	4.58	2015	39.89
Denmark	12.45	Malaysia	57.14	Switzerland	13.43	2016	41.10
Finland	17.56	Mexico	49.18	Taiwan	-	2017	40.27
France	29.53	Netherlands	43.40	Thailand	60.00	2018	40.44
Germany	32.05	N. Zealand	15.19	UK	31.46	2019	40.17
Greece	40.25	Norway	7.42	US	46.01	2020	38.59
Hong Kong	-	Philippines	53.51	**ALL**	**40.87**	2021	38.40
Hungary	39.28	Portugal	20.42			2022	38.04

Panel B2. Country's Climate Change and Renewable Energy Risk (CCHRE risk) from ESG risk score

Dep. Var.: $L(CDS\_spread_{i,t})$	1 E	2 Resources	3 Emissions	4 Innovation
$L(CDS\_spread_{i,t-1})$	0.864***	0.876***	0.866***	0.867***
	(0.002)	(0.002)	(0.003)	(0.003)
Score	**0.0006*****	**0.096*****	**0.013**	**0.014**
	(0.0000)	**(0.009)**	**(0.010)**	**(0.010)**
Score * Low_CCHRE risk	**-0.0010*****	**-0.087*****	**-0.041*****	**-0.061*****
	(0.0000)	**(0.010)**	**(0.009)**	**(0.010)**
Low_CCHRE risk	-0.001	-0.007	-0.036***	-0.030***
	(0.005)	(0.007)	(0.006)	(0.005)
w_1 (p-value)	(0.00)	(0.31)		
m_2 (p-value)	(0.516)	(0.903)	(0.676)	(0.614)
Hansen (p-value)	(0.331)	(0.245)	(0.111)	(0.156)

Panel B3. Effect of Score variable on CDSs' spread for different groups of companies (Panel B2)

	1 E	2 Resource	3 Emissions	4 Innovation
Low CCHRE risk	-0.0004***	0	-0.041***	-0.061***
High CCHRE risk	0.0006***	0.096***	0	0

Panel B1 presents the mean values by country and year of the climate change and renewable energy risk score from the ESG risk score. Panel B2 presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null of no correlation between the instruments and the error term. The w_1 statistic is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low_CCHRE* is equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low_CCHRE is* equal to the coefficient of *Score*. Panel B3 presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively. Control variables, year and industry effects are included.

Table 11. (*continued*)

Panel C1. Country's Biodiversity Risk (from ESG risk score) by country and year

BIO risk by country						BIO risk by year	
Australia	19.97	India	77.53	Russia	42.62	2010	21.79
Austria	15.00	Ireland	39.23	Saudi Arabia	81.45	2011	22.43
Belgium	19.60	Israel	52.44	S. Africa	50.00	2012	22.45
Brazil	35.52	Italy	30.52	S. Korea	59.24	2013	21.77
Canada	48.75	Japan	36.10	Spain	19.62	2014	21.79
China	52.64	Luxemburg	14.40	Sweden	39.36	2015	23.96
Denmark	27.85	Malaysia	42.66	Switzerland	35.05	2016	33.62
Finland	38.27	Mexico	44.10	Taiwan	-	2017	31.51
France	6.59	Netherlands	25.41	Thailand	30.00	2018	29.04
Germany	15.07	N. Zealand	20.26	UK	14.23	2019	28.95
Greece	30.7	Norway	42.40	US	21.08	2020	28.77
Hong Kong	-	Philippines	49.69	**ALL**	**26.92**	2021	30.54
Hungary	23.75	Portugal	31.50			2022	29.46

Panel C2. Country's Biodiversity Risk (BIO risk) from ESG risk score

Dep. Var.: L(CDS_spread$_{i,t}$)	1 E	2 Resources	3 Emissions	4 Innovation
L(CDS_spread$_{i,t-1}$)	0.891***	0.888***	0.888***	0.883***
	(0.003)	(0.004)	(0.004)	(0.003)
Score	**-0.0013*****	**-0.065*****	**-0.160*****	**-0.065*****
	(0.0002)	**(0.020)**	**(0.024)**	**(0.009)**
Score * Low_BIO risk	**0.0007*****	**0.042***	**0.098*****	**0.047*****
	(0.0002)	**(0.021)**	**(0.026)**	**(0.012)**
Low_BIO risk	-0.040**	-0.018	-0.066***	-0.013***
	(0.016)	(0.016)	(0.019)	(0.006)
w₁ (p-value)	(0.00)	(0.15)	(0.00)	(0.06)
w₂ (p-value)	(0.00)		(0.00)	(0.00)
m₂ (p-value)	(0.804)	(0.585)	(0.592)	(0.845)
Hansen (p-value)	(0.170)	(0.115)	(0.107)	(0.217)

Panel C3. Effect of Score variable on the CDS spread for different groups of companies (Panel C2)

	1 E	2 Resource	3 Emissions	4 Innovation
Low BIO risk	-0.0006***	0	-0.062***	-0.018*
High BIO risk	-0.0013***	-0.065***	-0.160***	-0.065***

Panel C1 presents the mean values by country and year of the biodiversity risk score from the ESG risk score. Panel C2 presents the coefficients and standard deviations of the variables of the models, estimated using the system GMM. The dependent variable is the log of the CDS spread. Robust standard errors are in parenthesis. The m_2 statistic tests for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The Hansen test evaluates over-identifying restrictions, asymptotically distributed as χ^2 under the null of no correlation between the instruments and the error term. w_1 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low_BIO* is equal to zero. w_2 is a Wald lineal restriction test, where the null hypothesis states that the sum of the coefficients of *Score* and its interaction with *Low_BIO* is equal to the coefficient of *Score*. Panel C3 presents the effect of each Score variable on the firm's credit risk based on the group of firms. ***, ** and * denote coefficients that are significant at the 1%, 5% and 10% levels, respectively. Control variables, year and industry effects are included.

Appendix A

Table A1. Variable Definitions

Panel A. Dependent variable	
CDS_spread	Average CDS (5 year) spread within one year
Panel B. Explanatory variables	
Environmental score	Refinitiv's Environment Pillar score is the weighted average relative rating of a company based on the reported environmental information and the resulting three environmental category scores.
Resource score	The Resource Use category score reflects a company's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management.
Emissions score	The Emission category score measures a company's commitment and effectiveness in reducing environmental emissions from production and operational processes.
Environmental innovation score	The Environmental Innovation category score reflects a company's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.
Panel C. Control variables	
Size	Natural logarithm of market value
ROA	Net income divided by total assets
Leverage	Total debt divided by total assets
MTB	Market value of equity divided by book value of equity
Liquidity	Cash and cash equivalents divided by total assets
Sales	Sales divided by total assets
Tangibility	Property, plant and equipment divided by total assets
Capex	Interest expenses and cash dividends divided by total assets
Coverage	EBIT plus interest expenses divided by interest expenses
gdp_growth	Growth of the gross domestic product by country
Panel D. Moderators	
Panel D.1. Internal environmental moderators	
High Score	1 if the firm has an environmental performance score above the median (by year), and 0 otherwise
Low environmental risk	1 if the firm has a low exposure to environmental issues due to its sectoral affiliation (lower than the median by year), and 0 otherwise.
Panel D.2. Internal financial moderators	
High_rating	Option A: 1 if the firm's debt has no speculative characteristic (rating higher than or equal to A3), and 0 otherwise. Option B: 1 if the firm's credit rating is higher than the median (by year), and 0 otherwise.
Panel D.3. External environmental moderators	
High_EPI	1 if the country has an EPI score above the median (by year), and 0 otherwise.
Low_GHG	1 if the country has greenhouse gas emissions below the median (by year), and 0 otherwise
High_CCHRE	1 if the country's climate change and renewable energy performance is above the median (by year), and 0 otherwise.
Low_CCHRE risk	1 if the country is at lower risk than the median (by year) of not meeting climate change and renewable energy targets, and 0 otherwise.
Low_BIO risk	1 if the country is at lower risk than the median (by year) of not meeting biodiversity targets, and 0 otherwise.
Panel D.4. External financial moderators	
High_rating	1 if the country has a credit rating higher than the median (by year), and 0 otherwise.
High_gdp_growth	1 if the country has GDP growth above the median (by year), and 0 otherwise.

Highlights

- Companies with better environmental performance reduce credit risk and support mitigation.
- Using a sample of 516 firms with CDS from 37 countries during 2010-2022.
- Consider internal and external factors for sustainability's financial impact.
- The CDS market values environmental efforts in countries with lower scores.
- Our findings support overinvestment for firms in high environmental risk sectors.
- The effect of environmental performance on credit risk is heterogeneous.

Laura Ballester: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data Curation, Writing-Original Draft, Writing-Review & Editing, Visualization, Supervision. **Ana González-Urteaga:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing-Original Draft, Writing-Review & Editing, Visualization, Supervision, Project administration, Funding acquisition. **Beatriz Martínez**. Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Writing-Original Draft, Writing-Review & Editing, Visualization, Supervision.