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Environmental scores and firm cost of debt – A study examining differences across industries and regions of Europe in the context of the EU Taxonomy

Master Thesis

by

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MSc in Finance

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Abstract

The increasing interest in firms' ESG activities among investors has led to different attempts of measuring the environmental dimension, recently through the EU Taxonomy. This thesis investigates the impact of the environmental scores on the firm cost of debt. The sample consists of 3670 European firm-year observations from 2014 to 2020. The results show a statistically significant negative relationship between environmental performance and the cost of debt. Lenders are found to be more sensitive to environmental concerns in carbon-intensive industries, where the cost of debt is 1.32% above the reference group. For firms in carbon-intensive industries, a one standard deviation higher environmental score is equivalent to 50 basis points lower cost of debt. Since investors seemingly reward environmental sustainability, being Taxonomy aligned potentially eases financing constraints.

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1 Introduction

ESG stands for Environmental, Social, and Governance. Investors are increasingly accounting for these non-financial factors in their investment decisions to identify material risks and growth opportunities (Shanaev & Ghimire, 2022; Dimson et al., 2020). An EY study finds that 52% of banks worldwide consider climate change a key emerging risk over the next five years (EY, 2020). The 2021 United Nations Global Compact-Accenture CEO study on sustainability finds that 81% of CEOs are paying attention to developing new sustainable products and services (Accenture, 2021). Although ESG activities are progressively becoming an integral part of mainstream business activities, there is an ongoing debate on whether these activities are value increasing or destroying. One view considers ESG activities to be a form of overinvestment, while the other sees them as risk mitigating (Goss & Roberts, 2011; Lee & Isa, 2020; Jung et al., 2016; Ye & Zhang, 2011).

The EU Taxonomy, which became effective on January 1st, 2022, is a classification system for sustainable economic activities, developed by the European Union. Its objective is to systemise the definition of sustainability and its measurement. The EU Taxonomy contains technical screening criteria to identify economic activities that make a substantive contribution to one of the six EU environmental goals, do no significant harm, and meet minimum safeguards (European Commission, n.d.). By providing a guide to the measurement of sustainable economic activities, the Taxonomy helps reducing measurement divergence and information asymmetries for investors, financial institutions, and issuers.

The novelty of the taxonomy makes direct analyses on the relationship between cost of debt and taxonomy alignment unfeasible for this master thesis. However, a study by Dumrose et al. (2022) finds a significant positive relation between environmental scores from Refinitiv and firm-level taxonomy alignment. Therefore, this thesis will instead examine the relation between environmental scores and firm cost of debt. This leads to the following research question:

"How is the environmental score affecting the cost of debt of European firms?"

Existing literature comes to different conclusions on the impact of ESG performance on the cost of debt. In addition, no studies doing an extensive analysis on the environmental dimension are identified. This thesis contributes to filling the gap in existing literature by (i) doing an extensive analysis of the environmental dimension of ESG, (ii) using a combination of interest paid on bank loans and bond yields as the firm's cost of debt, investigating differences across (iii) industries and (iv) geographical regions and by using (v) environmental performance as an approximation for EU Taxonomy alignment.

Data on ESG, cost of debt, and other firm-specific variables are obtained from Refinitiv and Bloomberg databases. The dataset contains 3670 firm-year observations on publicly listed European firms from 2014 to 2020. A pooled Ordinary Least Squares (OLS) regression model is applied, where the total cost of debt is the dependent variable and ESG scores and control variables are explanatory variables. To investigate differences in the effect of environmental rating across industries and regions in Europe, the analysis is extended by interaction variables between the environmental score and each industry group and region.

The results show a negative statistically significant relationship between overall ESG score and cost of debt. When separating the total ESG score in the three dimensions environmental, social, and governance performance, a negative statistically significant relation between environmental score and cost of debt is found. A firm with the highest environmental score of the sample (99.12) will on average have a 0.73% p.a. lower cost of debt compared to a firm with a score of zero. The relationship holds through several robustness tests. Despite the increasing awareness of environmental matters, the analysis could not identify that the environmental score has a stronger impact on the cost of debt in the years 2018 to 2020, compared to the years 2014 to 2017. Moreover, the findings indicate that firms that have issued a green bond have on average 0.3% lower cost of debt p.a. When assuming that a firm with an environmental score above the sample mean will be classified as green, a similar reduction in the cost of debt is observed. The environmental rating has the largest effect on the cost of debt for firms operating in carbon-intensive industries, where a one standard deviation increase (23.55 out of 100) in the environmental score reduces the cost of debt by 50 basis points. In terms of regions, the group Rest of Europe (which excludes Nordics and the

British Isles) observes the largest effect. There, a one standard deviation increase in the environmental score lowers the cost of debt by 20 basis points.

These results imply that lenders incorporate ESG information when assessing the creditworthiness of the borrower. Hence, they take on the risk mitigation view when assessing ESG activities, rather than the overinvestment perspective. One can imply that ESG scores can reduce information asymmetries by giving a credible signal of the firm's commitment to sustainability. A good environmental score appears to be associated with lower exposure to business, regulatory, physical, and reputational risks and is therefore rewarded with a lower cost of debt. Since banks seem to reward good environmental performance with low cost of debt, being classified as green under the EU Taxonomy potentially eases financing constraints. Firms operating in carbon-intensive industries or in the region Rest of Europe might experience the largest reduction in the cost of debt from being taxonomy aligned.

2 Theory

There are no strict definitions of Corporate Social Responsibility (CSR) and ESG and their contribution to firm value is a subject of debate. The following shows two opposing views on ESG activities. While the risk mitigation view considers them an integral part of risk management, the overinvestment view sees them as a form of misspending (Goss & Roberts, 2011; Lee & Isa, 2020; Jung et al., 2016; Ye & Zhang, 2011).

2.1 Defining CSR and ESG

ESG is an umbrella term for the inclusion of environmental, social, and governance matters in corporate and portfolio management and decisions. The environmental dimension includes aspects like greenhouse gas emissions, waste disposal, and efficient use of natural resources in the production process. The social category covers the firm's relationship with customers, employees, and society. The governance dimension can be considered ambiguous. On the one hand, traditional governance mechanisms are aligning management and shareholder interests. On the other hand, a narrower definition of the governance dimension is focused on diversity and inclusion and therefore the rights of minorities (Liang & Renneboog, 2020).

The term CSR has no clear definition and is often used synonymously with ESG (e.g., Gillan et al., 2021; Bofinger et al., 2022). Some scholars consider CSR to be a voluntary behaviour, that is not dictated by regulations and laws (Vogel, 2005; McWilliams & Siegel, 2001). Benabou and Tirole (2010) even consider it to be a sacrifice of profits for the social interest. However, many studies apply a broader definition of CSR and consider it to be aligned with value-maximisation (e.g., Liang & Renneboog, 2020; Edmans, 2011; Flammer, 2015).

ESG ratings aim to measure corporate sustainability, however, to date a common standard has not been developed. Therefore, different rating agencies provide different ESG performance and/or disclosure scores based on varying methodologies (Kahn, 2022). The EU Taxonomy contributes to the disclosure of environmental matters (European Commission, n.d.).

2.2 The debate on CSR and ESG

An unresolved debate is whether ESG investments create or destroy value. On the one hand, they are considered a form of overinvestment, possible through agency problems, and therefore value destroying (e.g., Goss & Roberts, 2011; Lee & Isa, 2020; Ferrell et al., 2015). On the contrary stands the argument that ESG investments are reducing the risk exposure and are therefore value-increasing for shareholders and debtholders alike (e.g., Jung et al., 2016; Ye & Zhang, 2011; Chava, 2014).

2.2.1 The overinvestment view: CSR and ESG as value-destroying investments

According to the overinvestment view, CSR and ESG investments are a costly and unnecessary use of resources that should be allocated elsewhere (Goss & Roberts, 2011). This view is based on the agency theory, which states that agents carry out ESG investments to benefit themselves at the expense of the principal (Ferrell et al., 2015; Goss & Roberts, 2011). There are two different motivations behind this misspending: managers acting in their own interest and firms acting as delegated philanthropists (Goss & Roberts, 2011).

In the first scenario, CSR investments can arise from agency conflicts between managers and shareholders. If managers are not properly incentivised, they might be inclined to overinvest in ESG for private benefits at the expense of the shareholders, which is value-destroying (Goss & Roberts, 2011; Lee & Isa, 2020). Such benefits can include a good reputation amongst the local community, labour unions or local politicians (Krüger, 2014). Additionally, time-consuming ESG activities will make managers lose focus on their main managerial responsibilities (Ferrell et al., 2015).

In the second scenario, the firm might act as a philanthropic agent on behalf of its shareholders when making ESG investments (Goss & Roberts, 2011). Based on Milton Friedman's shareholder theory, this "delegated philanthropy" is value-destroying. ESG activities are considered costly investments that are inefficient and not in line with the firm's purpose of profit maximisation (Friedman, 1970). Following the shareholder view, it is the responsibility of the government to issue laws and regulations that force firms to internalise externalities such as the environment (Liang & Renneboog, 2020).

To conclude, ESG investing is value-destroying and not in the shareholders' interest, based on the agency theory, which is often considered to be an extension of shareholder theory (Ferrell et al., 2015).

2.2.2 The risk mitigation view: CSR and ESG as value-enhancing investments

The idea of risk mitigation is central to all arguments in favour of ESG investments. Jung et al. (2016) state three categories of risks that summarise carbon risks: regulatory risk, physical risk, and business risk. Physical risk refers to the direct impact of climate change, such as droughts or floods. Therefore, it addresses the environmental category of ESG. However, regulatory and business risks can be found in all ESG categories, which is why Jung et al.'s arguments will be extended in this thesis. Regulatory risk comprises all risks arising due to new regulations and policies that might affect financial performance. Examples are additional compliance costs or trading emission credits. Business risk is prevalent at the corporate level in the short and long term. If a firm acts irresponsibly in any of the ESG categories, the brand image might be damaged, which potentially affects the market position and future cash flows (Jung et al., 2016). Litigation risk is a form of business risk, since misbehaviour in any of the ESG aspects may lead to costly lawsuits (Chava, 2014). Godfrey (2005) adds to the risk mitigation theory by stating that improved performance in terms of CSR can create positive moral capital among communities and other stakeholders. As a result, misconducts will be assessed less negatively, which reduces the firm's business risks.

Based on the risk mitigation theory, a firm investing in ESG activities is expected to be less exposed to physical, regulatory, and business risks. Since a risk-reduction increases firm value, it is aligned with stakeholder theory, which argues that a firm's value depends on the extent to which stakeholder expectations are satisfied (Ye & Zhang, 2011). The risk exposure affects the firm's ability to repay its debt. Thus, lenders will take ESG aspects into account during the risk assessment process, should they recognise those as risk-mitigating (Weber, 2011).

Reputational risk is another reason for an investor to be concerned about ESG activities of the firm. This relates to the risk mitigation of the lender itself (Chava, 2014). To give an example, increasing concerns about the effects of climate change put pressure on banks to undertake socially responsible lending, since they carry a responsibility that goes beyond profit generation (Goss & Roberts, 2011). Goss and Roberts (2011) state that banks have superior information about the firm, which makes them fundamentally different from other stakeholders. This gives debt holders a unique delegated monitoring role since they can use this insider information when negotiating the loan agreement. As a result, banks' lending decisions might be affected by bad publicity and the social attitude of firms (Chava, 2014). Adding to this, Castillo-Merino and Rodríguez-Pérez (2021) find that the legitimacy theory, which deals with the importance of reputation and social acceptance in corporate performance, is especially relevant in the financial industry. This is largely due to the latest global financial crisis, which revealed the sometimes excessive risk-taking by banks. As a response, banks try to improve their reputation through sustainability-based activities.

ESG ratings are a way of disclosing the exposure to such risk and can reduce information asymmetries between lenders and borrowers. If this thesis finds an inverse relationship between ESG and cost of debt, it suggests that ESG ratings successfully reduce information asymmetries and that lenders incorporate ESG information when determining the creditworthiness of the borrower. If the study cannot find an inverse relationship, this can be explained by investors taking the overinvestment view and interpreting high ESG investments as a manifestation of agency problems.

3 Literature Review

Literature on both ESG and CSR is considered since the terms are often treated interchangeably (e.g., Gillan et al., 2021; Bofinger et al., 2022). Previous literature on the relationship between ESG or CSR and cost of debt can be divided into two groups. One focuses on the cost of public debt (here meaning corporate bonds), while the other concentrates on total debt, which includes bank loans. Findings within both groups of research will be discussed in the following.

3.1 ESG and the cost of public debt

Ge and Liu (2015) examine how a firm's CSR performance is related to the cost of bond issues. The study is based on a sample of 4260 new public bond issues in the U.S. market in the period 1992 to 2009. Both credit ratings and yield spreads are used as measures of financial constraints. An OLS regression is applied, where standard errors of the estimated coefficients are corrected for firm-level clustering and heteroskedasticity. Further, industry and year indicator variables are included to control for potential differences across industries and over time. The study finds that superior CSR performance is associated with better credit ratings and lower yield spread. These results are consistent with the stakeholder theory.

In addition, Ge and Liu (2015) perform an analysis looking at the relationship between each of the seven CSR dimensions and yield spreads. They find community, product, employee relations, and governance to be the statistically significant CSR dimensions. Hence, the authors conclude that the social and governmental pillar scores of ESG are driving the association between CSR performance and yield spreads. A similar study is performed by Oikonomou et al. (2014), using data from the U.S. from 1992 to 2008. The results are consistent since the dimensions related to social and governmental performance are affecting corporate yield spreads the most. However, Oikonomou et al. (2014) evaluate CSR strengths and concerns separately and do not analyse the effect of a firm's overall CSR performance.

Since Ge and Liu (2015) and Oikonomou et al. (2014) regress the different dimensions of CSR, it allows to observe the effect of the environmental dimension. Ge and Liu (2015) find that the environmental dimension is negatively associated with bond yield spreads, but not statistically significant at any of the common significance levels. However, when Ge and Liu (2015) regress the CSR dimension's strength score on yield spread, a negative and statistically significant relation between yield spread and the environmental dimension is found. This finding suggests that bondholders reward issuers that are performing exceptionally well in the environmental dimension. Oikonomou et al. (2014), do not find the same significant relation between environmental strength score and yield spread as Ge and Liu (2015). However, compared to Ge and Liu (2015), Oikonomou et al. (2014) have a more extended analysis of the bond rating where the effect of different CSR dimensions on the bond rating is analysed. They find that the environment strengths score is positively and significantly related to the bond rating. This finding suggests that credit rating agencies incorporate environmental performance in their grade assessment and reward firms that take positive environmental actions.

While the two preceding studies, Ge and Liu (2015) and Oikonomou et al. (2014), are related to the U.S. market, a study by Menz (2010) is using a European dataset. Using a dataset from 2004 to 2007, the author finds a weak positive relation between CSR and bond spreads. Menz (2010) concluding that CSR was not incorporated into the pricing of corporate bonds, is not aligned with Ge and Liu´s (2015) findings in the US market. This might be due to the old dataset of Menz (2010). The author applies a pooled OLS model, with and without industry dummies, and a fixed effects model. Neither of the models are controlling for potential differences between time periods, which differs from Ge and Liu (2015) and Oikonomou et al. (2014). Controlling for potential differences between time periods is beneficial because it captures common shocks in one year, which might be a potential weakness in Menz's (2010) study.

Using bond yields only covers one form of debt. The bond yield will only be similar to the total cost of debt if the firm has a low default risk and thus the riskiness of the debt is modest (Berk & DeMarzo, 2017, p. 450). If there is a significant risk that the firm will not be able to service its debt obligations, the yield to maturity of the firm's debt will overstate investors' expected return (Berk & DeMarzo, 2017, p. 449). Using the total cost of debt gives a broader perspective, which might be a reason why more recent studies are focusing on total debt.

3.2 ESG and the cost of total debt

Banks have access to exclusive private information, which sets them apart from other stakeholders (Goss & Roberts, 2011). This results in great informational efficiency in the loan market, superior to the one in the secondary bond market (Altman et al., 2010, Goss & Roberts, 2011). Goss and Roberts (2011) investigate this topic by hypothesising that banks have a unique monitoring role. They argue that banks can assess the value of a firm's CSR initiatives better and will structure the loan accordingly. The authors examine the link between CSR and bank debt using a sample of 3996 loans to U.S. firms from 1991 to 2006. They find a statistically significant, but economically modest relationship between CSR and bank debt. The weak economic impact of CSR suggests that banks view CSR as a second-order determinant of loan terms. However, when distinguishing between CSR strengths and concerns, the authors suggest that CSR concerns are recognised and priced by banks when setting loan contract terms. This means that CSR concerns are associated with greater risk which is aligned with the risk mitigation view.

A recent study by Li et al. (2021) investigates the effect of CSR on the cost of debt financing, using a sample of publicly listed Chinese firms from 2014 to 2019 in pollution-intensive industries. The ratio of interest expenses to average total debt serves as a measure of the cost of debt. Potential differences between time periods and industries are taken into consideration through year and industry dummies. Li et al. (2021) find that the total CSR score is statistically significant and negatively related to the cost of debt. Hence, they find stronger evidence of CSR affecting the cost of total debt than Goss and Roberts (2011). This can be explained by the market differences between China and the U.S. or by the use of more recent data in Li et al.'s (2021) study. Another interesting aspect is that Li et al. (2021) are only looking at pollution-intensive industries. Hence, their findings can be explained by creditors judging a firm's environmental uncertainty more when being in a pollution-intense industry.

Similar to Ge and Liu (2015) and Oikonomou et al. (2014), Li et al. (2021) also look at the different subcategories of CSR and find that they are all negative and statistically significant. This includes the coefficient for the environment, which takes the third-largest absolute value after employee interests and shareholder rights. Eliwa et al.

(2021) is another study looking at different dimensions. This paper differs from the previous ones because it is using definitions of ESG instead of CSR. The use of ESG scores and data on European firms makes it the most comparable to this master thesis. Eliwa et al.'s (2021) dataset consists of 6,018 firm-year observations covering the period from 2005 to 2016. Consistent with Li et al. (2021) they find that all three dimensions of ESG performance scores are loading negatively on the cost of debt. However, they only find the environmental and social scores to be statistically significant. The total ESG performance is statistically significant and negatively related to the cost of debt at the 1% level. A potential problem with some of the studies is, that they regress the effect of the ESG or CSR dimensions in individual regressions (e.g., Eliwa et al., 2021; Ge & Liu, 2015; Li et al., 2021). Using that approach, the effect of one dimension is measured without controlling for the others, which is problematic if the dimensions are correlated with each other.

A unique and interesting aspect of Eliwa et al.'s (2021) study is the analysis of the ESG disclosure score. The ESG performance score evaluates the ESG activities of the firm, while the disclosure score considers the communication of the ESG performance (Eliwa, 2021). Their findings imply that ESG disclosure has an almost equal impact on the cost of debt as ESG performance. Thus, lending institutions fail to distinguish between ESG performance and disclosure. This reflects that what is disclosed can be equally important to the cost of debt as the actions the firm is taking. However, in Eliwa et al.'s (2021) data set the ESG performance and disclosure have a correlation of 0.61 suggesting that what firms report is somewhat aligned with their actions.

The aforementioned studies find evidence of ESG and CSR reducing the total cost of debt. Hoepner et al. (2016) and Wong et al. (2021) find no conclusive evidence that corporate sustainability can affect the cost of debt. Hoepner et al. (2016) investigate the relationship between corporate and country sustainability on corporate spreads of bank loans in the time period 2005 to 2012 for 28 different countries. Their findings reveal that country sustainability has a negative impact on direct financing but give no conclusive evidence that firm-level sustainability influences the interest rates charged by banks. Wong et al.'s (2021) study differs from previous ones because they perform an event study, treating ESG as a dummy variable that takes the value one for firm-year observations with ESG score and zero otherwise. Moreover, the study is done only on Malaysian firms which is a small, emerging market. Therefore, their findings are not necessarily expected to be similar to those found in this thesis.

To summarise, existing literature draws disparate conclusions on the relationship between ESG and the cost of debt. No studies doing an extensive analysis on the relation between the environmental dimension of ESG and the cost of debt are identified. Hence, this represents a gap in the literature to where this thesis aims to contribute. Existing studies rarely explore differences in the effect of environmental ratings on the cost of debt across industries and regions. More research based on a younger dataset of European firms is of high relevance considering the new EU Taxonomy. The development of the hypotheses is further discussed in chapter 4.

4 Hypotheses

The first group of hypotheses form the base analysis by examining the relationship between the ESG score and its pillars scores on the cost of debt. This is followed by an investigation of the impact of the environmental pillar after 2017, a green bond issuance, and a green classification under the EU Taxonomy. The second and third group of hypotheses are analysing differences across industries and regions.

4.1 Hypotheses 1: Base analysis

Hypotheses 1a:

The majority of previous literature indicates that ESG scores are negatively related to the cost of debt, which is aligned with the risk mitigation theory. For this thesis, similar results are expected. However, some studies cannot confirm that banks incorporate ESG scores in their lending policies. To further investigate this, the following hypotheses are set up.

$H1a_0: The\ firm's\ ESG\ score\ is\ not\ related\ to\ its\ cost\ of\ debt$

$H1a_1: The\ firm's\ ESG\ score\ is\ related\ to\ its\ cost\ of\ debt$

If the null hypothesis is rejected, the conclusion that the ESG score is related to the cost of debt will be made. If the coefficient is negative, a high ESG score will be associated with a lower cost of debt.

Hypotheses 1b:

Next, the relationship between the individual ESG pillars and the cost of debt is investigated. The three pillars, environmental, social, and governance are independent variables of the same regression. Therefore, the impact of the environmental performance is measured, keeping social and governance performance constant. This is rarely done in existing literature, in particular not in the EU market in recent years. The environmental dimension is of special interest since a negative relationship would indicate that firms might benefit from being classified as green under the new EU Taxonomy.

$$H1b_0: The\ environmental\ pillar\ score\ is\ not\ negatively\ related\ to\ the\ firm's\ cost\ of\ debt$$

$$H1b_1: The\ environmental\ pillar\ score\ is\ neagtively\ related\ to\ the\ firm's\ cost\ of\ debt$$

Hypotheses 1c:

In 2017 the green bond issuance increased by nearly 80% compared to the previous year. Reaching USD 155.5bn green bond placement was a new annual record at the time (Climate Bonds Initiative, 2018). The observed decrease in the cost of debt in the data sample from 2018 to 2020 gives rise to hypothesis 1c, which states that the effect of the environmental rating has been higher in the years 2018-2020 compared to 2014-2017. This hypothesis is especially interesting since this thesis' data set consists of more recent data than existing literature and the bond market as well as the environmental awareness has continuously increased.

$$H1c_0: The\ effect\ of\ the\ environmental\ pillar\ score\ on\ the\ firm's\ cost\ of\ debt\ has\ not\ been\ higher\ in\ the\ years\ 2018-2020\ compared\ to\ 2014-2017$$

$$H1c_1: The\ effect\ of\ the\ environmental\ pillar\ score\ on\ the\ firm's\ cost\ of\ debt\ has\ been\ higher\ in\ the\ years\ 2018-2020\ compared\ to\ 2014-2017$$

Hypotheses 1d:

Previous studies find that firms that have issued a bond observe a lower cost of debt (Zhang et al., 2021; Flammer, 2021). Possible explanations for this are lower yields, a reduction in information asymmetry, improved stock liquidity, and a lower perception of the issuer's risk (Tang & Zhang, 2020; Zhang et al., 2021). However, the identified studies are not controlling for ESG aspects when studying the effect of green bonds on the cost of debt. Therefore, it is an interesting analysis to account for the environmental pillar score when investigating the effect of a green bond.

$H1d_0$: *The firm's cost of debt is not affected by the issuance of a green bond*

$H1d_1$: *The firm's cost of debt is affected by the issuance of a green bond*

Hypotheses 1e:

The thesis aims to investigate if firms classified as green under the EU Taxonomy will potentially be able to secure cheaper debt financing. To approximate the effect of a green classification, the following hypotheses are set up. This is done under the assumption that a firm with an environmental score above the mean will be classified as green under the EU Taxonomy. Notably, one cannot test if this approximation is appropriate since the taxonomy became effective only recently.

$H1e_0$: *A firm with an environmental score above the mean does not have a lower cost of debt*

$H1e_1$: *A firm with an environmental score above the mean has a lower cost of debt*

4.2 Hypotheses 2: Differences across industries

In recent years increasing attention has been paid to climate change and its potentially devastating consequences. As a result, many countries decided to implement regulations and policies to mitigate the effects, often in the form of controlling industrial carbon emissions (Jung et al., 2016). Based on their carbon intensity, firms will be affected differently by those regulations. As mentioned previously in chapter 2.2.2, Jung et al. (2016) refer to this as carbon risk, which affects all three risk categories: regulatory, physical, and business risk. The expectation that the cost of debt will differ based on the industry and its environmental concerns is reinforced when looking at previous studies. This analysis will help identify which industries potentially benefit the most from a strong environmental rating. Existing research performed within pollution-intense industries or based on environmental concerns finds a negative relationship between the environmental pillar score and the cost of debt (e.g. Li et al., 2021; Ge & Liu, 2015; Goss & Roberts, 2011).

To investigate if the environmental pillar score has a stronger effect in carbon-intense industries, two hypotheses are set up. Hypothesis 2a examines if the cost of debt differs depending on the carbon intensity of the industry. Hypothesis 2b investigates whether the effect of the environmental score on costs of debt is higher in carbon-intensive industries.

Hypothesis 2a:

$H2a_0$: *The level of cost of debt is not higher in carbon intensive industries*

$H2a_1$: *The level of cost of debt is higher in carbon intensive industries*

Hypothesis 2b:

$H2b_0$: *The effect of the environmental pillar score on cost of debt is not higher in carbon intensive industries*

$H2b_1$: *The effect of the environmental pillar score on cost of debt is higher in carbon intensive industries*

4.3 Hypotheses 3: Differences across geographical areas

The third group of hypotheses is dedicated to investigating differences across regions within Europe, which is another gap in the existing literature. There are various reasons behind expecting differences in the effect of the environmental performance on the cost of debt across Europe. Although all countries in the EU are committed to climate neutrality by 2050 in the Paris Agreement, their regulatory path toward achieving these objectives differs (European Council, 2021). Another factor is the country's legal origin since common law countries tend to be more shareholder-oriented, making firms less willing to engage in ESG activities (Castillo-Merino & Rodríguez-Pérez, 2021). Some areas may also be more prone to natural disasters, increasing the physical risk defined in chapter 2.2, and thus possibly the bank's perception of ESG ratings.

First, hypothesis 3a aims to reveal if the cost of debt in the three regions differs, followed by hypothesis 3b, which investigates if the environmental pillar has a different impact on the cost of debt in the three regions.

Hypothesis 3a:

$H3a_0$: $The\ company's\ cost\ of\ debt\ does\ not\ vary\ in\ different\ regions\ of\ Europe$

$H3a_1$: $The\ company's\ cost\ of\ debt\ varies\ in\ different\ regions\ of\ Europe$

Hypothesis 3b:

$H3b_0$: $The\ effect\ of\ the\ environmental\ pillar\ score\ on\ cost\ of\ debt\ does\ not\ vary\ in\ different\ regions\ of\ Europe$

$H3b_1$: $The\ effect\ of\ the\ environmental\ pillar\ score\ on\ cost\ of\ debt\ varies\ in\ different\ regions\ of\ Europe$

5 Data and Descriptive Statistics

The following chapter is divided into three parts. First, the data collection process and the screening methodology are reported. This is followed by a description and justification of the chosen variables and their measurements. Lastly, summary statistics and correlations are described. Appendix A1 outlines definitions and data sources for all variables.

5.1 Sample and Data

The sample consists of non-financial publicly traded firms in the EU that have an ESG performance score from Refinitiv within the period of 2014 to 2020. Firms in the financial industry are excluded since they operate under separate regulations and have different debt financing characteristics than industrial firms (Jiang, 2008). Although Norway, Switzerland, and the United Kingdom are not members of the EU, they have been added to the sample since they are following many EU laws and standards (NOU 2012:2; European Commission, 2016; Pinsent Masons, 2021). The sample has been adjusted by removing the firm-year observations with missing variables, making the panel slightly unbalanced. Refinitiv is the main data source since it is one of the most comprehensive ESG databases, covering over 80% of the global market capitalisation (Refinitiv, 2022). In addition, a study by Dumrose et al. (2022) finds that environmental ratings from Refinitiv are significantly related to the EU Taxonomy. The data on the cost of debt and control variables are also obtained from Refinitiv, except for the Altman's Z-score, which has been extracted from the Bloomberg database. The data on green bonds is extracted from Bloomberg, Refinitiv, and Euronext. The final sample consists of 3670 firm-year observations.

To investigate hypotheses 2, the firm-year observations are sorted into three groups based on the carbon intensity of the industry. An overview of the carbon intensity of each industry is provided in Appendix A2, which is based on an assessment by the environmental data company Trucost. The high carbon intensity group contains the industries with more than 500 TCO2/$ million revenue, the medium intensity contains those with 250-500 TCO2/$ million revenue, and the low carbon-intensive group contains industries with less than 250 TCO2/$ million revenue. The division into high, medium and low carbon intensity is replicated from a study by Rogova and Aprelkova (2020), which also groups the industries based on the ICB sectors. To investigate hypotheses 3, three groups are built depending on the country of exchange. The British Isles form one group since studies indicate that firms in common law countries exhibit significantly lower levels of ESG investments, than firms in civil law countries (Kim et al., 2017). Further, the Nordic countries are placed in one group, since they are considered to have a high standard of sustainability (Potter, 2020; Hametner & Kostetckaia, 2020). The third group is called Rest of Europe and contains the remaining sample. Statistics on firm-year observations per industry and area group are provided in chapter 5.3.

5.2 Variables measurement

The following describes the variable measurements and sources. Appendix A1 provides an overview of all variables.

ESG performance score and ESG pillar scores

The Refinitiv ESG scores are based on information collected from publicly available sources, such as websites, annual reports, and corporate social responsibility reports (Refinitiv, 2022). The information is then audited and standardised by Refinitiv. The ESG Combined Score (ESG) from Refinitiv is based on the environmental (Env), the social (Soc), and the governance (Gov) pillar scores, which are distributed between 0 and 100, where 100 is the best possible score. Table 1 visualises which categories are assessed within each ESG pillar.

Table 1: Categories evaluated within each ESG pillar

Environmental	Social	Governance
• Resource use • Emissions • Innovation	• Workforce • Human rights • Community • Product responsibility	• Management • Shareholders • CSR strategy

(Refinitiv, 2022).

Refinitiv defines the environmental pillar as a score that quantifies a firm's impact on living and non-living natural systems. This includes the air, land, and water, as well as complete ecosystems. It reveals to what extend a firm uses best management practices to steer clear of environmental risks and capitalise on environmental opportunities. The governance pillar score is defined as a measure of a firm's systems and processes that ensure that management and board members act in the shareholder's best interest. It mirrors a firm's capability to control its rights and responsibilities through the creation of incentives that generate long-term shareholder value. The social pillar measures how well a firm creates trust and loyalty with its stakeholders through its use of best management practices. Hence it reflects the firm's reputation. When setting the environmental and social pillar score, Refinitiv uses the industry as a benchmark. Refinitiv justifies this by stating that environmental and social topics are more relevant and material to firms within the same industry. For the governance pillar, the country is used as a benchmark when determining the score since best governance practices are more consistent within countries.

Cost of debt

Cost of debt (CoD) is the dependent variable throughout the analysis. It is extracted directly from Refinitiv, where it is defined as the sum of the weighted cost of short-term debt and weighted cost of long-term debt, based on the 1-year and 10-year points of an appropriate credit curve. Hence, the cost of debt reflects the firm's marginal cost of issuing new debt and is equivalent to the after-tax cost of debt. The cost of debt is represented as a decimal number. Some studies are measuring the cost of debt differently, using the ratio of current interest payments to total debt (e.g., Eliwa et al., 2021; Jung et al., 2016). This might ignore the variability in the debt structure. However, the measure extracted from Refinitiv has the disadvantage that it might disregard heterogeneity across firms. For instance, firms might be subject to different interest rates, even when having similar observable credit ratings, because bank loans may have larger interest rates than the more liquid bonds that Refinitiv uses as benchmarks.

Control variables

Based on prior studies there are three control variables that are consistently used on debt financing. These variables are return on assets (ROA), leverage (Lev), and firm size (Size) (Eliwa et al., 2021; Liu et al., 2019; Ye & Zhang, 2011). In addition, some studies use measures for financial constraints or distress risk. Cash to total assets (cash_ratio) will serve as a financial constraints measure, and the Altman's Z-score (Z_score) will capture the distress risk.

The ROA is extracted directly from Refinitiv, where it is calculated by dividing a firm's net income before financing costs by total assets. The variable is expected to be negatively related to the cost of debt since firms with a high ROA are more profitable and have a lower business risk (Eliwa et al., 2021; Ye & Zhang, 2011). Lev is calculated as the ratio of total debt to total assets in year t, where the total debt includes both short and long-term borrowings and total assets is the book value reported by the firm. It is expected to find a positive association between Lev and CoD since a higher leverage is likely to increase default risk and thereby CoD (Jung et al., 2016; Ye & Zhang, 2011). Size is measured as the natural logarithm of total assets in year t. Prior research suggests that firm size is negatively associated with CoD since larger firms are less likely to be affected by negative economic shocks and have a lower default risk (Jung et al., 2016). Cash_ratio is cash & cash equivalents divided by total assets at time t. This liquidity measure is expected to be negatively related to CoD. The Z_Score measures the firm's probability of default. It is computed using the following formula:

$$1.2\frac{working\ capital}{total\ assets} + 1.4\frac{retained\ earnings}{total\ assets} + 3.3\frac{EBIT}{total\ assets} + 0.6\frac{market\ value\ of\ equity}{total\ liabilities} + 1.0\frac{sales}{total\ assets}$$

A higher Z-Score is correlated to lower default risk. Hence, the Z-Score is expected to be negatively related to CoD (Ge & Liu, 2015; Goss & Roberts, 2011).

Dummy variables

For some of the hypotheses dummy variables are needed. Based on the extraction of green bond data described in section 5.1, a green bond dummy, that takes value one if the firm has issued green bonds and zero otherwise, is created. A dummy EnvAboveMean is generated to investigate hypotheses 1e. It takes the value one if the firm's environmental score is above the sample mean and zero otherwise. Additionally, three dummies that represent each of the carbon groups are created. The dummies HighCO, MedCO, and LowCO take value one if the firm operates in the high, medium, and low carbon-intensive industry respectively, and zero otherwise. The dummies that separate the sample into regions are called Nord, Brit, and Eur and take value one if the firm's country of exchange is in the Nordics, the British Isles, and the Rest of Europe, respectively. Lastly, each regression includes time-dummies, where each of the seven years included in the analysis is represented by a dummy.

Interaction variables

The first interaction variable is created by multiplying the environmental score with a dummy that takes value one if the year is in the time period 2018 to 2020 and zero otherwise. The variable is called envAfter2017 and related to hypothesis 1c. Three more interaction variables are computed by multiplying the environmental pillar score by the three carbon group dummies and called envHighCO, envMedCO, and envLowCO. Their purpose is to analyse the effect of the environmental scores within different industries. In a similar manner the interaction variables envEur, envNord, and envBrit are computed to gauge the effect of environmental ratings within the three regions.

5.3 Descriptive statistics and correlations

Table 2 reports the number of firm-year observations per industry, defined by the Industry Classification Benchmark (ICB), and the corresponding carbon group. All ICB industries are well represented in the sample. The industrials and the consumer discretionary industries are slightly overrepresented with 24.71% and 18.50% of the total sample, respectively. Approximately half of the sample falls into the medium carbon-intensive group, while the rest of the sample is evenly distributed between the high and the low carbon-intensive group. The average environmental score is 64.75

points for the highest carbon-intensive group and 59.76 for the lowest carbon-intensive group.

Table 2: Firm-year observations per carbon group and ICB Industry

Carbon Group	ICB Industry	Firm-year observations	Share of sample	Mean Env score
High intensity	Utilities	208	5.67 %	67.55
	Basic Materials	402	10.95 %	64.95
	Energy	252	6.87 %	62.12
Total high carbon		862	23.49 %	64.75
Medium intensity	Industrials	907	24.71 %	60.68
	Consumer Staples	335	9.13 %	61.74
	Consumer Discretionary	679	18.50 %	59.88
Total medium carbon		1921	52.34 %	60.58
Low intensity	Telecommunications	216	5.89 %	60.81
	Real Estate	242	6.59 %	68.59
	Health Care	278	7.57 %	59.11
	Technology	151	4.11 %	45.31
Total low carbon		887	24.17 %	59.76
Total firm-year observations		3670	100.00 %	61.36

Table 3 provides the number of firm-year observations within each area group and country of exchange. The sample contains a good representation of European countries. Large European economies like the United Kingdom, France, and Germany are well represented with 29.65%, 11.96%, and 11.36% of the total sample respectively. The area group Rest of Europe is the largest, consisting of more than 50% of the sample. The British Isles group makes up 30.41% of the sample, almost exclusively consisting of UK firm observations. The Nordics are representing 17.18% of the sample.

Table 3: Firm-year observations per area group and country of exchange

Area Group	Country of exchange	Firm-year observations	Share of sample	Mean Env score
Nordics	Denmark	124	3.38 %	60.56
	Finland	154	4.20 %	70.28
	Norway	84	2.29 %	57.02
	Sweden	267	7.28 %	66.89
Total Nordics		629	17.14 %	65.15
British Isles	Ireland	28	0.76 %	43.95
	United Kingdom	1088	29.65 %	54.56
Total British Isles		1116	30.41 %	54.3
Rest of Europe	Austria	56	1.53 %	68.73
	Belgium	102	2.78 %	63.27
	Czech Republic	7	0.19 %	64.2
	France	439	11.96 %	75.31
	Germany	417	11.36 %	60.03
	Greece	42	1.14 %	52.33
	Hungary	21	0.57 %	56.83
	Italy	118	3.22 %	72.26
	Luxembourg	7	0.19 %	44.2
	Netherlands	140	3.81 %	65.96
	Poland	105	2.86 %	37.41
	Portugal	35	0.95 %	73.91
	Spain	170	4.63 %	68.61
	Switzerland	266	7.25 %	56.92
Total Rest of Europe		1925	52.45 %	64.22
Total firm-year observations		3670	100.00 %	61.36

Table 4 reports the descriptive statistics for the key and control variables of the sample. The mean (median) decimal value of CoD is 0.018 (0.014). This value falls into a reasonable range compared to other studies (e.g., Eliwa et al., 2021; Erragragui, 2018). It is also aligned with ECB's statistics on bank lending rates on new loans to firms (Falagiarda & Köhler-Ulbrich, 2022). The mean values of the ESG measures are similar to those of Eliwa et al. (2021). The mean ESG score is 59.83, the mean environmental score is 61.36, the mean social score is 66.64, and the mean governance score is 58.83. The mean ROA is 0.055, the mean Z-score is 3.55, mean leverage is 0.27, mean firm size is 22.66, and mean cash to total assets is 0.083. All control variables fall within reasonable bounds observed in literature (e.g., Eliwa et al., 2021; Ge & Liu, 2015; Jung et al., 2016; Ye & Zhang, 2011), except for the firm size, which is slightly larger than most studies. However, Goss and Roberts (2011) also have a mean firm size close to 22 and have extracted data in a similar manner, by only including firms that have a CSR score and deleting missing values. This can contribute to the average firm size being large since larger firms are more likely to have an ESG score.

Table 4: Summary statistics

Variable	N	Mean	Median	Std.dev	Min	Max
CoD	3670	0.0177	0.0136	0.0164	-0.003	0.2585
ROA	3670	0.0551	0.0483	0.0615	-0.3704	0.5341
Z_score	3670	3.5472	2.83	3.2977	-5.31	46.26
Lev	3670	0.2701	0.2551	0.1578	0	1.0969
Size	3670	22.6605	22.5701	1.3533	18.8076	26.9321
cash_ratio	3670	0.08324	0.06579	0.07159	0	0.8202
ESG	3670	59.8291	61.012	16.7535	3.248	94.5897
Env	3670	61.3624	65.2898	23.5535	0	99.1175
Soc	3670	66.6357	70.7165	20.5701	1.8676	98.6277
Gov	3670	58.8345	60.6719	20.882	1.6667	98.6418

The sample consists of 3670 firm-year observations over the period 2014-2020. Appendix A1 outlines definitions and data sources for all variables.

Table 5 presents the Pearson correlation matrix of the key and control variables. An extended correlation matrix that includes all variables, is shown in Appendix A3. It is noted that the cost of debt is significantly negatively correlated with ESG performance, environmental performance, and social performance, while it is not significantly positively correlated with governmental performance. The correlation between the cost of debt and environmental score is moderate at -0.19. Consistent with the predictions and previous findings, the control variables ROA, Z-score, firm size, and cash ratio have significant negative loadings on the cost of debt. The leverage variable is positively correlated with the cost of debt, which was also expected (Ge & Liu, 2021; Goss & Roberts, 2011; Li et al., 2016).

Table 5: Pearson correlation matrix of the key variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CoD (1)	1.00									
ROA (2)	-0.17***	1.00								
Z_score (3)	-0.17***	0.56***	1.00							
Lev (4)	0.19***	-0.18***	-0.33***	1.00						
Size (5)	-0.15***	-0.17***	-0.26***	0.13***	1.00					
cash_ratio (6)	-0.08***	0.04**	0.13***	-0.16***	-0.14***	1.00				
ESG (7)	-0.18***	0.03**	-0.09***	0.07***	0.31***	-0.03	1.00			
Env (8)	-0.19***	-0.07***	-0.21***	0.06***	0.52***	-0.04**	0.72***	1.00		
Soc (9)	-0.21***	0.04**	-0.08***	0.05***	0.46***	-0.02	0.76***	0.68***	1.00	
Gov (10)	0.01	-0.04**	-0.10***	0.10***	0.24***	-0.01	0.53***	0.28***	0.33***	1.00

*The sample consists of 3670 firm-year observations over the period 2014-2020. Appendix A1 outlines definitions and data sources for all variables. ***, **, * denote a significant correlation at the 1%, 5% and 10% levels, respectively*

6 Methodology

The first part of this chapter is dedicated to identifying a suitable model for the data described in chapter 5. This is followed by a discussion on the validity of the chosen model.

6.1 Model Development

The data has both cross-sectional and time-series dimensions and is therefore defined as panel data. Different types of models can be applied to panel data, where the fixed effect model (FE model), the random effect model (RE model), and the pooled OLS are the most common.

6.1.1 Fixed effect model

A Hausman test examines whether fixed or random effects are most notable in the data and thereby which of the models will be more suitable. The null hypothesis of the test is that the RE model is preferred over the alternative FE model. Performing the Hausmann test on the sample data gives a *p*-value of zero, which results in a rejection of the null hypothesis. This indicates that the FE model is more suitable than the RE model (Table 6).

Table 6: Model development tests

Model	Test	*ESG*		*ESG pillars*		Interpretation
		p-value	Conclusion	p-value	Conclusion	
RE/FE	Hausmann	0	Reject H0	0	Reject H0	FE is a better fit than RE
OLS/FE	Poolability	0	Reject H0	0	Reject H0	FE is a better fit than OLS
OLS	Breush-Pagan	0	Reject H0	0	Reject H0	Heteroskedasticity is present
OLS	Box-Pierce	0	Reject H0	0	Reject H0	Panel autocorrelation is present

The benefit of the fixed effect regression is that it controls for omitted variables in panel data when the omitted variables vary across entities. Hence it reduces the endogeneity problem (Stock & Watson, 2020). The endogeneity problem is further discussed in chapter 6.2. The FE model is estimated using the within transformation technique which involves subtracting the time means from each variable to obtain a regression containing only demeaned variables (Brooks, 2019, p. 629).

The model with the demeaned variables is

$$y_{i,t} - \bar{y}_i = \beta\left(x_{i,t} - \bar{x}_i\right) + u_{i,t} - \bar{u}_i$$

This can be rewritten as

$$\ddot{y}_{i,t} = \beta\ddot{x}_{i,t} + \ddot{u}_{i,t}$$

Where the demeaned variables are denoted with the double dots above the variables.

The FE model takes out the firm characteristics which are constant over time and leaves the within-firm variation. Since the cost of debt is expected to vary over time, the FE model must also include time-fixed effects in addition to entity-fixed effects. Combined, the model for the base regression would be:

$$\ddot{CoD}_{i,t} = \beta_1 \ddot{ROA}_{i,t} + \beta_2 \ddot{Zscore}_{i,t} + \beta_3 \ddot{Lev}_{i,t} + \beta_4 \ddot{Size}_{i,t} + \beta_5 \ddot{CashRatio}_{i,t} + \beta_6 \ddot{ESG}_{i,t} + \gamma_1 Year_{i,t} + \ddot{u}_{i,t}$$

Where I = 1, …, 535 and t = 2015, …, 2020, and $Year_{i,t}$ is a vector of time dummies. The double dots above the variables denote the demeaned values

A Chow test for poolability indicates that fixed effects are present in the data and that this model can be considered for the analysis. However, it does not test if any variables are very persistent. Hence, one should also check whether the inclusion of fixed effects changes the coefficient magnitudes in an economically meaningful way, compared to an OLS regression (Roberts & Whited, 2011). For instance, in the FE model, the size and the social pillar score coefficients are positively related to CoD which contradicts economic intuition. A shortcoming of the FE model is that it forces all variables to have a mean of zero. Hence, the data variation that identifies the coefficients is within-firm variation and not the cross-sectional variation. The purpose of the research question is to investigate cross-sectional variation in a variable and the FE model doesn't support this purpose (Roberts & Whited, 2011). Another shortcoming of the FE model is that it treats the variable-specific effects as constant over time and removes the time-invariant error term $u_{i,t}$ (Hill et al., 2018, p. 642). The desired analysis is based on the use of time-invariant dummy variables to analyse differences across industries and regions, that cannot be applied in a FE model. Hence, the FE model is not the obvious choice for this analysis, but due to the results from the Hausman test and the poolability test, it will be applied as a robustness check.

6.1.2 Pooled model with time fixed effects and robust-cluster standard errors

Another way to deal with panel data is to estimate a pooled regression. This involves estimating a single equation on all the data together where all the cross-sectional and time-series data are stacked into one column for the dependent variable. Similarly, the independent variables would be stacked in a single column for each independent variable. Thereafter, this equation would be estimated using OLS (Brooks, 2019, p. 626). For this thesis, the base pooled model is represented by:

$$CoD_{i,t} = \beta_0 + \beta_1 ROA_{i,t} + \beta_2 Zscore_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Size_{i,t} + \beta_5 CashRatio_{i,t} + \beta_6 ESG_{i,t} + \gamma_1 Year_{i,t} + \mu_{i,t}$$

Where I = 1, ..., 535 and t = 2015, ..., 2020, and $Year_{i,t}$ *is a vector of time dummies*

A weakness of pooled regression is that it assumes that the average values of the variables and the relationships between them are constant over time and across all the cross-sectional units (Brooks, 2019, p. 626). The cost of debt is expected to vary over time and the time will be fixed with year dummies, resulting in a pooled regression with time fixed effects. This will also resolve the issue of cross-sectional correlation.

A Breusch-Pagan test for heteroskedasticity and a Box-Pierce test for panel autocorrelation confirm that the standard errors suffer from disturbances due to heteroskedasticity and autocorrelation. The test results are summarised in Table 6.

When using pooled OLS in the presence of heteroskedasticity and autocorrelation the least square estimator is still consistent, but the standard errors are incorrect meaning that hypothesis tests on these standard errors are invalid (Brooks, 2019, p. 262 & p. 276). When the number of entities is relatively larger than the number of time periods, which holds in this data sample, cluster-robust estimation is expected to make the standard errors valid for hypotheses testing (Hill et al., 2018, p. 374).

6.2 Validity

The chosen model is a pooled OLS with time fixed effects and robust-cluster standard errors. This section will focus on how to secure validity for the OLS, by explaining the assumptions that must hold for this model.

$The\ mean\ of\ the\ errors\ is\ zero: E\left(u_{i,t}\right) = 0$

The first necessary assumption is that the error mean is zero. Since a constant term will be included in the regression, the assumption will not be violated for this thesis (Brooks, 2019, p. 256).

$The\ variance\ of\ the\ errors\ is\ constant: Var\left(u_{i,t}\right) = \sigma^2 < \infty$

The assumption of homoscedasticity assumes that the variance of the errors, σ^2, is constant. This assumption was originally violated which leads to invalid standard errors as already described in section 6.1.2. Using cluster-robust standard errors accounts for the heteroscedasticity, as described in section 6.1.2. The effect is an increase in the standard errors of the slope coefficients compared to the regular OLS standard errors. This makes the hypothesis testing more conservative and secures the validity of the results (Brooks, 2019, p. 257).

$The\ covariance\ between\ the\ error\ terms\ is\ zero: Cov\left(u_{i,t}, u_{j,t}\right) = 0\ for\ all\ i \neq j$

The next assumption of the OLS model is that the covariance between the error terms over time and cross-sectionally is zero. A violation of this assumption means that the errors are autocorrelated or serially correlated, leading to potential wrong inferences of hypotheses tests (Brooks, 2019, p. 264). The cluster-robust standard errors will be adjusted for autocorrelation.

$The\ disturbances\ are\ normally\ distributed: u_{i,t} \sim N(0, \sigma^2)$

A violation of the normality assumption doesn't cause biased or inefficient estimators in the model. It can affect the p-values for significance testing, but only when the sample size is small. Hence, this assumption is not a concern in the relatively large data set of this thesis (Brooks, 2019, p. 288).

$Multicollinearity$

This problem occurs when the explanatory variables are highly correlated with each other. Multicollinearity can result in wide confidence intervals for the parameters, which can lead to inappropriate conclusions in significance tests (Brooks, 2019, p. 292). The correlation matrix in Table 5 reveals that none of the explanatory variables are highly correlated except for ESG with the three pillar scores. This is not problematic since the ESG score is never regressed together with the pillar scores.

$The\ regressors\ are\ exogenous: E(u_{i,t}) = 0\ and\ Cov(u_{i,t}, x_{i,t}) = 0$

This assumption states that the random error $u_{i,t}$ and the explanatory variables $x_{i,t}$ must be contemporaneously uncorrelated and the average of the random errors must be zero (Hill et al., 2018, p. 483). If violated, the least square estimator will not be an unbiased and consistent estimator of the population parameters. It is not possible to empirically test if a variable is correlated with the regression error term because the error term is unobservable. Therefore, one cannot statistically ensure that an endogeneity problem has been solved (Roberts & Whited, 2011). There exist advanced techniques to deal with endogeneity, like instrumental variables techniques. However, considering the scope of this thesis, the following section will focus on identifying the causes of endogeneity in the model rather than solving them.

Hill et al. (2018) explain four situations that cause endogeneity, which is the main source of inference problems. Those are measurement errors, simultaneous equation bias, omitted variables, and lagged-dependent variable models with serial correlation. Since this thesis does use a lagged dependent variable, the latter is not relevant and will not be discussed.

Omitted variables

Omitted variables are relevant variables that are left out of the statistical model. This problem is particularly severe in corporate finance research since many corporate decisions are based on both public and private information, making several relevant factors unobservable (Roberts & Whited, 2011). The omitted variables will appear in the error term and if it is correlated with an explanatory variable, the regression error will be correlated with the explanatory variable (Hill et al., 2018, p. 489). Due to the possibility of private information affecting the cost of debt, like the length of loan contracts, it is reasonable to suspect that the chosen OLS model might have omitted variables. However, it is impossible to test if these are correlated with an explanatory variable and cause endogeneity.

Measurement error

If an explanatory variable is measured inaccurately, the measurement error becomes part of the error term (Hill et al., 2018, p. 488). In corporate finance, it is often necessary to use approximations for variables that are unobservable or difficult to quantify. In this thesis, the ESG scores can suffer from measurement errors. There are various providers of ESG scores that use different approaches in constructing ratings. Even if they carefully and thoroughly estimate the scores, the ratings might suffer from measurement errors since they are based on the concept of trying to quantify qualitative data. If the measurement error is correlated with the explanatory variables, the OLS estimates are inconsistent and unobservable (Roberts & Whited, 2011).

Simultaneous equation bias

Simultaneity bias occurs when the dependent variable and one or more of the explanatory variables are determined in equilibrium such that the dependent variable causes the independent one and reverse (Roberts & Whited, 2011). In this research setting, one must consider the possibility of the cost of debt affecting the ESG scores or one of the control variables. One might argue that firms with lower cost of debt have more financial resources to allocate to ESG investments and hence obtain superior ESG ratings.

The last three assumptions cannot be formally tested and might cause endogeneity (Roberts & Whited, 2011). Therefore, endogeneity must always be considered when making inferences from the results. The variables are chosen carefully, aiming to avoid the dominant sources of endogeneity. This includes selecting variables based on similar literature, which mitigates the omitted variable bias and choosing reliable data sources such as Refinitiv to address the measurement error problem.

7 Results

In the following chapter, the results for all hypotheses are analysed. First, the outcomes for testing hypotheses 1 are discussed based on the regression of the combined ESG score and the individual pillar scores. Next, the effect of environmental scores in different industries and regional areas is analysed. Lastly, the results from the robustness tests are presented.

7.1 Base analysis: Effect of ESG and pillar scores on the cost of debt

In this section, the results from testing the first group of hypotheses are described and discussed.

7.1.1 ESG score

To investigate the alternative hypothesis 1a, stating that the firm's ESG score is related to the cost of debt, the following equation is set up. The results of estimating Equation 1 are displayed in Table 7 in column Model 1 (ESG).

Equation 1:

$$CoD_{i,t} = \beta_0 + \beta_1 ROA_{i,t} + \beta_2 Zscore_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Size_{i,t} + \beta_5 CashRatio_{i,t} + \beta_6 ESG_{i,t} + \gamma_1 Year_{i,t} + \mu_{i,t}$$

Table 7: Regression results on hypotheses 1

VARIABLES	Model 1 (ESG)	Model 2 (Pillars)	Model 3 (Environment after 2017)	Model 4 (Green bond effect)	Model 5 (Environment above mean)
ROA	-0.0339***	-0.0338***	-0.0336***	-0.0340***	-0.0341***
	(-3.29)	(-3.24)	(-3.21)	(-3.27)	(-3.33)
Z_Score	-0.000471***	-0.000495***	-0.000496***	-0.000505***	-0.000459***
	(-3.37)	(-3.31)	(-3.33)	(-3.38)	(-3.19)
Lev	0.0203***	0.0190***	0.0182***	0.0190***	0.0192***
	(6.22)	(6.03)	(6.03)	(6.01)	(6.11)
Size	-0.00217***	-0.00182***	-0.00182***	-0.00177***	-0.00185***
	(-5.72)	(-4.20)	(-4.18)	(-4.10)	(-4.30)
cash_ratio	-0.000945**	-0.00890*	-0.00885*	-0.0104**	-0.00876*
	(-1.79)	(-1.71)	(-1.71)	(-1.99)	(-1.68)
Env		-0.0000736**	-0.0000677**	-0.0000661**	
		(-2.59)	(-2.32)	(-2.33)	
Soc		-0.0000561*	-0.0000568*	-0.0000593*	-0.0000705**
		(-1.72)	(-1.74)	(-1.84)	(-2.37)
Gov		0.0000958***	0.0000955***	0.0000948***	0.000095***
		(4.15)	(4.13)	(4.11)	(4.12)
ESG	-0.0000975***				
	(-3.44)				
envAfter2017			-0.0000149		
			(-0.67)		
GB_d				-0.00339***	
				(-2.62)	
EnvAboveMean					-0.00314***
					(-2.91)
Constant	0.0785***	0.0681***	0.0677***	0.06711***	0.0668***
	(9.24)	(7.68)	(7.50)	(7.62)	(7.42)
Year dummies	YES	YES	YES	YES	YES
R-squared	0.1861	0.2022	0.2023	0.2054	0.2029
Adj. R-squared	0.1834	0.1992	0.1990	0.2021	0.1998
Observations	3,670	3,670	3,670	3,670	3,670

*This table contains pooled OLS regression coefficients with t-statistics in parentheses. The sample consists of 3670 firm-year observations over the period 2014-2020. Appendix A1outlines definitions and data sources for all variables. The standard errors of the estimated coefficients are corrected for firm-level clustering and heteroskedasticity. ***, **, * indicate a statistical significance at the 1%, 5%, and 10% levels, respectively.*

All control variables are significant at the 1% level, except for the cash ratio, which is only significant at 10%. The signs of the coefficients of the control variables are in line with the expectations formulated in chapter 5.2, based on existing literature (e.g., Eliwa et al., 2021; Goss & Roberts, 2011; Erragragui, 2018; Jung et al., 2016). The relationships between the cost of debt and return on assets, Z-score, size, and cash ratio are negative. This indicates that a high value in those variables leads to a reduction in the cost of debt. The leverage coefficient is positive since a high debt level is associated with higher default risk, resulting in a higher cost of debt.

The results show an ESG coefficient of -0.000098, which is statistically significant at the 1% level. The significant negative association between ESG score and cost of debt leads to a rejection of the null hypothesis and indicates that firms with higher ESG scores have a lower cost of debt. A firm with the sample's mean ESG score (59.83) will have on average a 0.58% lower cost of debt compared to a firm with an ESG score of zero. Economically this suggests that lenders are willing to accept lower interest rates from firms with higher ESG scores, meaning that they presumably include information about the ESG performance in their lending decision. The adjusted R-squared is 18.34%, indicating that the regression can capture over one-sixth of the variation in the cost of debt.

While this result is in line with some of the previous literature (e.g., Eliwa et al., 2021; Li et al., 2021; Goss & Roberts, 2011), it contradicts some of the less recent literature that found a positive relationship or no statistically significant evidence, like Hoepner et al. (2016) and Menz (2010). Ye and Zhang (2011) find a U-shaped relationship between CSR and the cost of debt. However, the study defines CSR as charitable donations which is a different interpretation than used in preceding studies and in this thesis.

7.1.2 Pillar scores

To investigate the alternative hypothesis 1b stating that the environmental pillar score is negatively related to the firm's cost of debt, Equation 2 is set up, where the pillar scores replace the combined ESG score. The results are displayed in Table 7 column Model 2 (Pillars).

Equation 2:

$$CoD_{i,t} = \beta_0 + \beta_1 Env_{i,t} + \beta_2 Soc_{i,t} + \beta_3 Gov_{i,t} + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

All control variables keep the same sign as in Model 1 and are significant at the 1% level, except for the cash ratio being significant at the 10% level. Adjusted R-squared is slightly higher at 19.92%. The environmental and social pillar scores are significant at the 10% level, and the governance pillar score is significant at the 1% level. The governance pillar has the strongest effect on the cost of debt, with a coefficient of 0.000096, compared to -0.000074 for the environmental dimension and -0.000056 for the social dimension. To exemplify, a firm with the highest environmental score of the sample (99.12) will on average have a 0.73% lower cost of debt compared to a firm with a score of zero. The inverse relationship between the social and environmental pillars and the cost of debt is consistent with prior studies (e.g., Eliwa et al., 2021; Erragragui, 2018). The positive effect of governance on the cost of debt is offset by the negative effect of the social and environmental dimensions, explaining the overall negative effect of ESG on the cost of debt observed in Model 1.

Previous research comes to different inferences regarding the effect of the governance pillar on the cost of debt. While some studies find a significant negative effect (e.g., Aman & Nguyen, 2013; Bradley & Chen, 2011; Rahaman & Al Zaman, 2013), others cannot confirm a significant relationship (e.g., Eliwa, 2021; Erragragui, 2018). Governance measures cannot only reduce agency conflicts and information asymmetries between shareholders and management but also between shareholders and debtholders. A variety of literature describes how management quality lowers the risk of the firm and matters in the lending process (e.g., Rahaman & Zaman, 2013). This makes the identified positive relationship between the governance score and the cost of debt surprising at first. On the other hand, some studies are arguing that many governance indicators are focused on shareholders' interests since they were initially developed to mitigate principal-agent problems between management and shareholders (El-Chaarani et al., 2022; Liang & Renneboog, 2020). This is not necessarily beneficial for debt holders and explains a positive coefficient. Since the governance coefficient is positive, one can conclude that it is not economically beneficial, in terms of debt financing, for the shareholders to invest extensively in governance measures.

The results from Model 2 lead to a rejection of the null hypothesis H1b, stating that the environmental pillar score is not negatively related to the firm's cost of debt. This is consistent with the risk-mitigation theory introduced in chapter 2.2 and the notion that an environmental score can send a credible signal to lenders and thereby reduce information asymmetries between debtholders and shareholders (Jensen & Smith, 1985). The environmental score seems to help lenders evaluating the regulatory, physical, and business risk associated with the environmental dimension.

7.1.3 Effect of the environmental pillar score after 2017

To test the alternative hypothesis 1c, stating that the environmental pillar score has a higher effect on the cost of debt in the years 2018 to 2020 compared to 2014 to 2017, the interaction variable envAfter2017 is introduced. This gives Equation 3 and the results in Table 7 in column Model 3 (Environment after 2017).

Equation 3:

$$CoD_{i,t} = \beta_0 + \beta_1 Env_{i,t} + \beta_2 Soc_{i,t} + \beta_3 Gov_{i,t} + \beta_4 envAfter2017_{i,t} + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

The interaction variable is not statistically significant, which leads to an acceptance of the null hypothesis. It is concluded that the increase in the cost of debt from 2018 to 2020 cannot be explained by an increased effect of the environmental pillar score.

7.1.4 Effect of green bonds

To test the alternative hypothesis 1d, stating that the cost of debt is affected by the firm issuing green bonds, a green bond dummy variable is introduced. The results of regressing Equation 4 are displayed in Table 7 in column Model 4 (Green bond effect).

Equation 4:

$$CoD_{i,t} = \beta_0 + \beta_1 Env_{i,t} + \beta_2 Soc_{i,t} + \beta_3 Gov_{i,t} + \beta_4 GB\_d_{i,t} + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

The results indicate that on average firms that have issued a green bond can expect a lower cost of debt of 0.34%, keeping all other coefficients constant. Notably, this additional effect is significant at the 1% level, although the regression already controls for the environmental rating of the firm. A negative effect of a green bond issuance on the cost of debt is consistent with existing research (e.g., Zhang et al., 2021; Flammer, 2021).

A lower cost of debt can be found because the green bonds might be priced at a discount or because other debt sources are financed at a lower interest rate if the firm has issued a green bond. One explanation for cheaper debt financing is, that the issuance of a green bond reduces information asymmetries by giving a credible signal of its commitment to environmental sustainability. Since the proceeds of corporate green bonds finance climate-friendly projects, issuers improve their performance post-issuance, e.g., by lowering their carbon emissions (Zhang et al., 2021). One cannot conclude if the reduction in the cost of debt is caused by a pricing discount on green bonds since existing literature on green bond pricing is dispersed. Zerbib (2019), Bachelet et al. (2019), and Baker et al. (2018) find a green bond premium, indicating that investors are willing to sacrifice returns. Other studies cannot confirm this and find no difference in pricing (Larcker & Watts, 2020). Since the green bond market is growing exponentially, future studies in this area might provide more clarity.

7.1.5 Environmental score above the sample mean

To investigate the alternative hypothesis 1e stating that firms with an environmental score above the mean have a lower cost of debt, the environment above mean dummy is introduced. The results of regressing Equation 5 are displayed in Table 7 in column Model 5 (Environment above mean).

Equation 5:

$$CoD_{i,t} = \beta_0 + \beta_1 Soc_{i,t} + \beta_2 Gov_{i,t} + \beta_3 EnvAboveMean_{i,t} + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

The findings indicate that a firm with an environmental score above the mean sample value has on average 0.31% lower cost of debt than a firm with an environmental score below the mean. The result is statistically significant at the 5% level. Hence, one can argue that the taxonomy alignment might be beneficial for the firm in terms of debt financing. Notably, this conclusion is drawn under the assumption that an environmental score above mean is an appropriate approximation for a green classification.

7.2 Differences across industries

This chapter aims to investigate the effect of the environmental pillar score across industries of different carbon intensities. Initially, an analysis of the difference in cost of debt across industries is needed. Equation 6 is used to test alternative hypothesis 2a, stating that the cost of debt is higher in carbon-intensive industries. The results are displayed in Table 8 in column Model 6 (Industries).

Equation 6:

$$CoD_{i,t} = \beta_0 + \beta_1 Env + \beta_2 Soc + \beta_3 Gov + \beta_4 HighCO + \beta_5 LowCO + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

Table 8: Regression results on hypotheses 2

VARIABLES	Model 6 (Industries)	Model 7 (Industries & Environment Interaction)
ROA	-0.0313***	-0.0325***
	(-3.01)	(-3.22)
Z_Score	-0.000389***	-0.000322**
	(-2.88)	(-2.58)
Lev	0.020284***	0.0204***
	(6.21)	(6.30)
Size	-0.00191***	-0.00179***
	(-4.41)	(-4.09)
cash_ratio	-0.00777	-0.00675
	(-1.49)	(-1.31)
Env	-0.0000757***	
	(-2.71)	
Soc	-0.0000533*	-0.0000514*
	(-1.68)	(-1.65)
Gov	0.0000915***	-0.0000834***
	(4.08)	(3.69)
HighCO	0.00433***	0.0132***
	(2.99)	(2.86)
LowCO	-0.00112	-0.00609**
	(-1.09)	(-2.31)
envHighCO		-0.000210***
		(-3.42)
envMedCO		-0.0000735**
		(-2.32)
envLowCO		0.000000994
		(0.28)
Constant	0.0685***	0.0656***
	(7.79)	(7.36)
Year dummies	YES	YES
R-squared	0.2167	0.2282
Adjusted R-squared	0.2133	0.2244
Observations	3,670	3,670

*This table contains pooled OLS regression coefficients with t-statistics in parentheses. The sample consists of 3670 firm-year observations over the period 2014-2020. Appendix A1outlines definitions and data sources for all variables. The standard errors of the estimated coefficients are corrected for firm-level clustering and heteroskedasticity. ***, **, * indicate a statistical significance at the 1%, 5%, and 10% levels, respectively.*

The ESG pillars of environment and governance are statistically significant at the 1% level, while the social pillar is statistically significant at the 10% level. The signs of the pillar coefficients have not changed compared to the previous analysis. The signs of the control variables remain the same and are significant at the 1% level, except for the cash ratio, which is not statistically significant. The adjusted R-squared is 21.33%.

The dummy variables reveal that firms in the high carbon-intensive industry group tend to have a higher cost of debt than firms in the low carbon-intensive industry group. Firms in a carbon-intensive industry have on average 0.43% p.a. higher cost of debt above the reference group of medium carbon-intensive industries. The coefficient for firms in low carbon-intensive industries is 0.0011 and not statistically significant. Therefore, one cannot assume a difference in the cost of debt between low and medium carbon-intensive industries.

To further analyse the impact of the environmental pillar score on industries of different carbon intensity, interaction variables between the industry categories and the environmental pillar score are introduced in Equation 7. This tests alternative hypothesis 2b, stating that the effect of the environmental pillar score on the cost of debt is higher in carbon-intensive industries. The results are shown in Table 8 in column Model 7 (Industries & Environment interaction).

Equation 7:

$$CoD_{i,t} = \beta_0 + \beta_1 Soc + \beta_2 Gov + \beta_3 HighCO + \beta_4 LowCO + \beta_5 envHighCO + \beta_6 envMedCO + \beta_7 envLowCO + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

The regression results show that the effect of environmental ratings is stronger in reducing the cost of debt for high than for low carbon-intensive industries. Based on this regression firms in a carbon-intensive industry have on average 1.32% p.a. higher cost of debt compared to the control group. However, if the firm has a good environmental rating it can reduce its cost of debt. If the firm in the carbon-intensive industry group is one standard deviation (23.55) above the mean (61.36) in terms of its environmental score, its cost of debt will be reduced by 50 basis points. Vice versa if the firm is one standard deviation below the mean, the cost of debt is expected to increase by 50 basis points. Interestingly the coefficient of the interaction variable between the environmental rating and the low carbon intensity group is not statistically significant at any of the common confidence levels. This indicates that the cost of debt of firms operating in low carbon-intensive industries is not affected by their environmental performance.

The results highlight the importance of environmental awareness for firms in carbon-intense industries since their sustainable activities can have a much stronger impact on the cost of debt. When analysing such firms, lenders seem to pay increased attention to environmental matters and price them accordingly. It can be concluded that since carbon risk affects the three risk dimensions regulatory, physical, and business risk, it increases the uncertainty of future cash flows. Thereby it influences the default risk that lenders assign to the firm during the lending process. Another explanation is, that banks may consider the impact on their reputation when financing firms with damaging environmental activities. Therefore, the findings support the theory that investors adopt the risk mitigation view.

These results are largely consistent with existing research. Jung et al. (2016) find an economically meaningful impact of carbon risk on the cost of debt, where a one standard deviation increase in carbon risk increases the cost of debt by 38 to 62 basis points. Chava (2014) also finds that banks charge significantly higher interest rates to firms with environmental concerns, like toxic emissions. Notably, this result was found in the United States at a time when greenhouse gas emissions were not regulated. The fact that banks still priced those risks in suggests that they are indeed environmentally sensitive.

7.3 Differences across regions of Europe

To test the effect of the environmental pillar score across different regions of Europe, the sample is sorted into subsamples, as explained in chapter 5.1. Initially, the different levels of cost of debt in the three regions Nordics, the British Isles, and the Rest of Europe are analysed. Equation 8 is used to test alternative hypothesis 3a, stating that the cost of debt varies in different regions of Europe. The results are displayed in Table 9 in column Model 8 (Regions).

Equation 8:

$$CoD_{i,t} = \beta_0 + \beta_1 Env + \beta_2 Soc + \beta_3 Gov + \beta_4 Nord + \beta_5 Brit + ctrl\ var$$
$$+\gamma_1 Year_{i,t} + \mu_{i,t}$$

Table 9: Regression results on hypotheses 3

VARIABLES	Model 8 (Regions)	Model 9 (Regions & Environment Interaction)
ROA	-0.0440*** (-4.28)	-0.0437*** (-4.22)
Z_Score	-0.000452*** (-3.35)	-0.000460*** (-3.39)
Lev	0.0181*** (6.14)	0.0184*** (6.18)
Siz	-0.00104** (-2.37)	-0.00102** (-2.32)
cash_ratio	-0.00358 (-0.71)	-0.00353 (-0.70)
Env	-0.0000646** (-2.49)	
Soc	-0.0000434 (-1.40)	-0.0000404 (-1.30)
Gov	0.0000506** (2.35)	0.0000496** (2.30)
Nord	0.00451*** (3.56)	0.000467 (0.11)
Brit	0.00863*** (7.96)	0.00644** (2.26)
envEur		-0.000087*** (-2.79)
envNord		-0.0000243 (-0.44)
envBrit		-0.0000501 (-1.29)
Constant	0.0485*** (5.28)	0.0493*** (5.26)
Year dummies	YES	YES
R-squared	0.2477	0.2487
Adjusted R-squared	0.2444	0.2450
Observations	3,670	3,670

*This table contains pooled OLS regression coefficients with t-statistics in parentheses. The sample consists of 3670 firm-year observations over the period 2014-2020. Appendix A1outlines definitions and data sources for all variables. The standard errors of the estimated coefficients are corrected for firm-level clustering and heteroskedasticity. ***, **, * indicate a statistical significance at the 1%, 5%, and 10% levels, respectively.*

In Model 8 (Regions) the pillar scores for environment and governance are significant at the 5% level, while the social score is not statistically significant. The adjusted *R*-squared is 24.44%, meaning that nearly a quarter of the variation in the cost of debt is captured by the regression. The pillar scores and the control variables keep the same signs as in the previous tests, which is expected and economically reasonable. All control variables are significant at the 1% level, except for the size coefficient, which is significant at the 5% level, and the cash ratio coefficient, which remains insignificant. Controlling for firm location reveals that the British Isles region has the highest cost of debt out of the three regions, on average 0.86% p.a. above the control group Rest of Europe.

To test the alternative hypothesis 3b, stating that the effect of the environmental pillar score on the cost of debt varies in the three regions of Europe, interaction variables between the regions and environmental score are introduced, as explained in chapter 5.1. The results of regressing Equation 9 are displayed in Table 9 in column Model 9 (Region & Environment interaction).

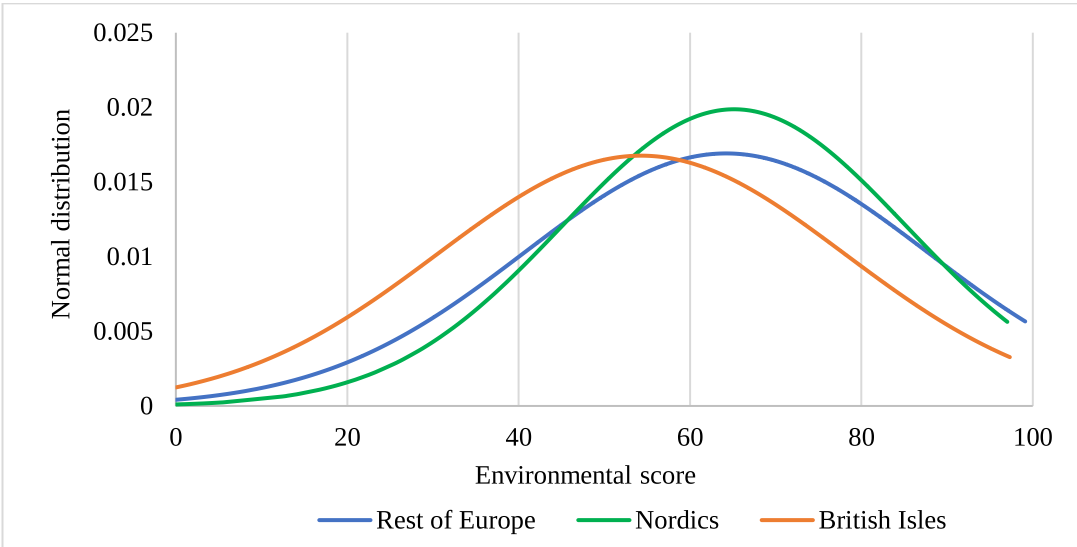
Equation 9:

$$CoD_{i,t} = \beta_0 + \beta_1 Soc + \beta_2 Gov + \beta_3 Nord + \beta_4 Brit + \beta_5 envEur + \beta_6 envNord + \beta_7 envBrit + ctrl\ var + \gamma_1 Year_{i,t} + \mu_{i,t}$$

The results show that all three interaction variables of the environmental rating and the area dummy load negatively on the cost of debt. The interaction variable for Rest of Europe is statistically significant at the 1% level whereas the other variables are not statistically significant at any of the common levels. Therefore, Rest of Europe is the only region where evidence of environmental pillar score reducing the cost of debt can be found. This leads to a rejection of the null hypothesis 3b. If a firm in the region Rest of Europe is one standard deviation (23.55) above the mean (64.22) in terms of its environmental score, its cost of debt will be reduced by 20 basis points.

The Nordic countries are considered to be among the most sustainable countries in the world and as civil law-oriented countries, generally more stakeholder-oriented (Robeco, 2021; Kim et al., 2017). Trends like sustainability-linked corporate loans show that banks in the Nordics care about sustainability in finance (Nordea Bank, 2021). The interaction variable might be statistically insignificant since firms in the Nordics already have a relatively high level of sustainability, therefore an increase in environmental activities may not result in a strong impact on the cost of debt. The high level of sustainability in the Nordics can also be observed in the sample. Graph 1 below visualises that the normal distribution of the environmental pillar score of the Nordic countries is more skewed to the right and has thinner tails than those of the British Isles and the Rest of Europe. The graph also reveals that there is more variation in the scores of the group Rest of Europe, which can explain the significance of the interaction variable for that sample group.

Graph 1: Normal distribution of the environmental pillar score in the three regions



Based on existing literature, the statistically insignificant interaction variable for the British Isles is surprising. Kim et al. (2017) find that firms in common law countries, like the British Isles, traditionally focus more on shareholder value maximization and investor protection, than on the interest of other stakeholders. Therefore, one could expect that firms that are initially focused on shareholder value will get rewarded through lower cost of debt if they take actions that consider stakeholders' interests. Almost the entire sample from the British Isles consists of UK firms and Thompson (1998) found that banks in the UK are increasingly aware of environmental risks and adjust their lending policies accordingly. The author finds evidence that banks are not only doing this in an ad-hoc manner but establishing a systematic and formal process. Additionally, sustainability pressure is exercised by the UK government: The United Kingdom has already cut its emissions by 43% since 1990, which is the fastest among the G7 countries. In 2021 the world's most ambitious carbon target was set, by aiming to reduce emissions by 78% by 2035 compared to 1990 levels (Gov UK, 2021). These ambitious goals increase the risk of laws and regulations affecting the cash flows of the firm and the reputational risk of lenders investing in non-sustainable firms. Hence, the environmental score for the British Isles being statistically insignificant is not aligned with expectations based on previous literature and regulations from the UK government. A potential explanation for this result is that debt investors may not perceive the environmental pillar score as a good evaluation of environmental performance. A reason for this could be that the environmental pillar scores are adjusted for the industry the firm is operating in, consequently resulting in the score not being a good enough representation of environmental risks from the lender's perspective.

7.4 Robustness analysis

This section aims to report whether the findings on the relationship between the environmental score and the cost of debt are robust to an alternative model specification and other adjustments. Model 2 (Pillars) from chapter 7.1.2 will form the base for the robustness analysis.

Fixed effects regression

As the first robustness check, a FE model, described in section 6.1.1, is deployed on Model 2 (Pillars). The FE model is a valuable robustness check since it mitigates the potential omitted variable bias by removing the effect of time-invariant firm characteristics. The results are displayed in Table 10 in column Robustness 1 (FE model) and show a negative association between the environmental score and the cost of debt, which is statistically significant at the 10% level. This is consistent with the findings in the main analysis Model 2 (Pillars), but the relationship is slightly weaker. The social and the governance pillar scores are statistically insignificant in the FE model.

Table 10: Robustness analysis

VARIABLES	Robustness 1 (FE-model)	Robustness 2 (Credit rating dummy)	Robustness 3 (ICR)	Robustness 4 (w/o industrials)	Robustness 5 (Industry dummies)
ROA	-0.0116*** (-2.04)	-0.0337*** (-3.20)	-0.0337*** (-3.22)	-0.0270** (-2.45)	-0.0323** (-3.04)
Z_Score	-0.000421*** (-2.84)	-0.000496*** (-3.31)	-0.000493*** (-3.29)	-0.000534*** (-3.23)	-0.000512*** (-3.53)
Lev	0.0181*** (6.32)	0.0189*** (5.98)	0.0189*** (6.00)	0.0185*** (5.15)	0.0217*** (6.47)
Size	0.00477*** (5.31)	-0.00185*** (-4.38)	-0.00182*** (-4.20)	-0.00192*** (-3.65)	-0.00176*** (-4.17)
cash_ratio	-0.00252 (-0.55)	-0.00929* (-1.78)	-0.00884* (-1.70)	-0.00426 (-0.67)	-0.0106* (-1.88)
Env	-0.0000446* (-1.65)	-0.0000718** (-2.57)	-0.0000738** (-2.59)	-0.0000794** (-2.35)	-0.000063** (-2.18)
Soc	0.0000003 (0.13)	-0.000058* (-1.77)	-0.0000561* (-1.72)	-0.0000382 (-0.94)	-0.0000772** (-2.39)
Gov	0.0000226 (1.29)	0.0000958*** (4.14)	0.0000956*** (4.14)	0.000101*** (3.48)	0.0000872*** (4.02)
Cred. rating dummy		-0.00101 (-0.44)			
ICR			-0.00000003 (-1.35)		
Constant	-0.0834*** (-4.17)	0.0687*** (8.00)	0.0681*** (7.68)	0.0691*** (6.51)	0.0720*** (7.84)
Year dummies	YES	YES	YES	YES	YES
R-squared	0.0243	0.2025	0.2023	0.1867	0.2291
Adjusted R-squared	0.0478	0.1990	0.1990	0.1825	0.2243
Observations	3,670	3,670	3,670	2,763	3,670

*Column 1 in this table contains fixed effects regression coefficients. The other columns contain pooled OLS regression coefficients. T-statistics are in parentheses. The sample consists of 3670 or 2763 firm-year observations over the period 2014-2020. Appendix A1outlines definitions and data sources for all variables. The standard errors of the estimated coefficients are corrected for firm-level clustering and heteroskedasticity. ***, **, * indicate a statistical significance at the 1%, 5%, and 10% levels, respectively.*

Testing other potential control variables

Another way to mitigate the risk of omitted variable bias is to identify potential important control variables that are not included in the main analysis. Whether a firm has a credit rating or not is such a variable, since having an assessment of the creditworthiness of a firm by an external rating agency makes a firm less financially constrained. Sometimes a rating may even be a requirement for a financial instrument, like commercial papers (e.g., Kisgen, 2006; Goebel & Kemper, 2022). Table 10 in column Robustness 2 (Credit rating dummy) displays the results for including a rating dummy that takes the value one if the firm currently has a credit rating and zero otherwise. The variable is not statistically significant. Economically this is surprising but considering the small sample of firms that have a credit rating (40 out of 370), this result was expected. Credit ratings are generally obtained by large publicly listed firms. Hence, it is common to have only a small group of firms with a rating in the sample.

Previous studies analysing the cost of debt sometimes use the Interest Coverage Ratio (ICR) as a control variable (e.g., Eliwa et al., 2021; Oikonomou et al., 2014). This variable is extracted from Refinitiv where it is calculated as the ratio of EBIT divided by interest expenses. The ICR is a measure of a firm's capability to pay its interest obligations, hence it is likely that firms with a higher rate of interest coverage have a lower cost of debt. Table 10 in column Robustness 3 (ICR) displays the results when controlling for the ICR. The variable is negatively related to the cost of debt as expected but not statistically significant. The tests including the credit rating dummy and the ICR further supports the mitigation of the omitted variable bias.

Excluding the industry category "industrials"

Almost 25% of the sample consists of firms in the industry category "industrials" (see Table 2 in chapter 5.3). This can be considered a high representation of one particular group of firms. To ensure robustness, Model 2 is regressed after excluding the industrials industry from the sample. The results are reported in Table 10 in column Robustness 4 (w/o industrials) and are similar to the ones in Model 2 (Pillars). This indicates that the results in the main analysis are not driven just by the industrials industry.

Including industry dummies

One challenge of ESG scores is that they must assign ratings to firms of different industries with different prerequisites. To reward best in class performance, Refinitiv adjusts its scores for industry classes, as described in chapter 5.2. Hence, a relevant robustness check is to ensure the adjustment of the Refinitiv pillar scores has been done successfully. This is tested by adding industry dummies. The results are in Table 10 in column Robustness 5 (Industry dummies) and are almost identical to the main analysis

Model 2. Since this reveals that the best firm within one industry is rewarded with a good score, this test supports the argumentation in chapter 7.3 that examines regional differences.

8 Conclusion and limitations

This thesis contributes to the literature on the relationship between ESG and the costs of debt, in particular by presenting new findings on the effect of the environmental dimension on financing constraints. Examining differences across geographical regions and industries allows for making direct implications on the effect of sustainable investments on the cost of debt. By using environmental rating as an approximation for the EU Taxonomy classification, this thesis contributes directly to the current debate on the effect of the new regulatory environment.

Using a sample of 3670 firm-year observations on listed European companies, this thesis provides evidence of the negative relationship between firms' environmental ratings and their cost of debt. The findings are robust to an alternative model specification and other tests. Having issued a green bond reduces the cost of debt, even when controlling for the environmental rating. Moreover, the analyses have identified that the environmental rating reduces the cost of debt more for firms operating in industries of high carbon intensity. The findings have direct implications for the capital structure choice of firms, especially those in high carbon industries. Under the assumption that the environmental score works as a good approximation for the EU Taxonomy alignment, one can infer that firms classified as green can benefit from cheaper debt financing. Additional inferences can be made for lending decision-making of creditors. The results indicate that lenders take on the risk mitigation view when assessing the ESG investments of the borrower. Therefore, ESG ratings appear to provide valuable insights that reduce information asymmetries.

One must acknowledge that the results might be affected by methodological limitations. As discussed in section 6.2, there is no formal way to test for endogeneity and hence the exogenous assumption might be violated. In particular endogeneity caused by simultaneity bias is a concern in this thesis, since a firm with good prospects can have both a low cost of debt and can afford to invest in improving its environmental performance. Another limitation is that only firms that have an ESG score from

Refinitiv are represented in the dataset. This results in an overrepresentation of large firms since those are more likely to have an ESG rating. Although the regression controls for firm size, the implications made in this thesis may not hold for smaller firms, which have stronger financial constraints.

This thesis also has some limitations that represent avenues for further research. First, many different ESG scores exist and there is an open debate on which of them gives the most accurate assessment. This thesis uses the score from Refinitiv because it is an acknowledged database and measures performance rather than disclosure. Further research could be to investigate the effect of scores from different providers. Secondly, using the environmental score is only an approximation of the EU Taxonomy alignment. Although Dumrose et al. (2022) finds a high correlation between the Refinitiv environmental score and the taxonomy alignment, further research can provide valuable information once the taxonomy has been effective longer. Additional research could also be done regarding environmental strengths and concerns. Findings can tell if good performance is rewarded more than a bad one is punished. This is of high relevance for firms because investments should be allocated accordingly.

Bibliography

Accenture. (2021). *Climate leadership in the eleventh hour*. https://www.slideshare.net/accenture/un-global-compactaccenture-ceo-study-on-sustainability-250543115

Altman, E., Gande, A., & Saunders, A. (2010). Bank Debt versus Bond Debt: Evidence from Secondary Market Prices. *Journal Of Money, Credit And Banking*, *42*(4), 755-767. https://doi.org/10.1111/j.1538-4616.2010.00306.x

Aman, H., & Nguyen, P. (2013). Does good governance matter to debtholders? Evidence from the credit ratings of Japanese firms. *Research in International Business and Finance 29*, 14–34. http://dx.doi.org/10.1016/j.ribaf.2013.02.002

Bachelet, M., Becchetti, L., & Manfredonia, S. (2019). The Green Bonds Premium Puzzle: The Role of Issuer Characteristics and Third-Party Verification. *Sustainability*, *11*(4), 1098. https://doi.org/10.3390/su11041098

Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018). *Financing the response to climate change: the pricing and ownership of U.S. green bonds* (NBER working paper No. 25194).
https://www.nber.org/system/files/working_papers/w25194/w25194.pdf.

Bénabou, R., & Tirole, J. (2010). Individual and Corporate Social Responsibility. *Economica*, *77*(305), 1-19. https://doi.org/10.1111/j.1468-0335.2009.00843.x

Berk, J., & DeMarzo, P. (2017). *Corporate Finance*, Global Edition (4th ed.). Pearson Education, Limited

Bofinger, Y., Heyden, K., & Rock, B. (2022). Corporate social responsibility and market efficiency: Evidence from ESG and misvaluation measures. *Journal Of Banking &Amp; Finance*, *134*, 106322.
https://doi.org/10.1016/j.jbankfin.2021.106322

Bradley, M., & Chen, D. (2011). Corporate governance and the cost of debt: Evidence from director limited liability and indemnification provisions. *Journal Of Corporate Finance*, *17*(1), 83-107. https://doi.org/10.1016/j.jcorpfin.2010.08.001

Brooks, C. (2019). *Introductory econometrics for finance* (4th ed.). Cambridge University Press.

Castillo-Merino, D., & Rodríguez-Pérez, G. (2021). The Effects of Legal Origin and Corporate Governance on Financial Firms' Sustainability Performance. *Sustainability*, *13*(15), 8233. https://doi.org/10.3390/su13158233

Chava, S., (2014). Environmental Externalities and Cost of Capital. *Management Science, 60*(9), 2223-2247. https://doi.org/10.1287/mnsc.2013.1863

Climate Bond Initiative. (2021). *2017 GB Issuance: USD155.5bn: New Record! All the 2017 numbers that count in our Green Bond Highlights report: Plus our Seven Super Trends and 2018 green bonds forecast!* https://www.climatebonds.net/2018/01/2017-gb-issuance-usd1555bn-new-record-all-2017-numbers-count-our-green-bond-highlights

Department for Business, Energy & Industrial Strategy, Prime Minister's Office, 10 Downing Street, The Rt Hon Kwasi Kwarteng MP, The Rt Hon Alok Sharma MP, and The Rt Hon Boris Johnson MP (2021). *UK enshrines new target in law to slash emissions by 78% by 2035.* Gov UK. https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035

Dimson, E., Marsh, P., & Staunton, M. (2020). Divergent ESG Ratings. *The Journal Of Portfolio Management*, *47*(1), 75-87. https://doi.org/10.3905/jpm.2020.1.175

Dumrose, M., Rink, S., & Eckert, J. (2022). Disaggregating confusion? The EU Taxonomy and its relation to ESG rating. *Finance Research Letters*, *48*. https://doi.org/10.1016/j.frl.2022.102928

Edmans, A. (2011). Does the stock market fully value intangibles? Employee satisfaction and equity prices. *Journal Of Financial Economics*, *101*(3), 621-640. https://doi.org/10.1016/j.jfineco.2011.03.021

Eliwa, Y., Aboud, A., & Saleh, A. (2021). ESG practices and the cost of debt: Evidence from EU countries. *Critical Perspectives On Accounting*, *79*. https://doi.org/10.1016/j.cpa.2019.102097

El-Chaarani, H., Abraham, R., & Skaf, Y. (2022). The Impact of Corporate Governance on the Financial Performance of the Banking Sector in the MENA (Middle Eastern and North African) Region: An Immunity Test of Banks for COVID-19. *Journal Of Risk And Financial Management*, *15*(2), 82. https://doi.org/10.3390/jrfm15020082

Erragragui, E. (2018). Do creditors price firms' environmental, social and governance risks?. *Research In International Business And Finance*, *45*, 197-207. https://doi.org/10.1016/j.ribaf.2017.07.151

European Commission. (2016). *EU-Swiss relations.* https://ec.europa.eu/commission/presscorner/detail/en/MEMO_16_3185

European Commission. (n.d.). *EU taxonomy for sustainable activities*. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

European Council. (2021). *5 facts about the EU's goal of climate neutrality.* https://www.consilium.europa.eu/en/5-facts-eu-climate-neutrality/#navigation

EY. (2020). *How banks are defining and internalizing sustainability goals.* https://www.ey.com/en_us/banking-capital-markets/how-banks-are-defining-and-internalizing-sustainability-goals

Falagiarda, M., & Köhler-Ulbrich, P. (2022). *Bank Lending to Euro Area Firms - What Have Been the Main Drivers During the COVID-19 Pandemic? - European Economy*. https://european-economy.eu/2021-1/bank-lending-to-euro-area-firms-what-have-been-the-main-drivers-during-the-covid-19-pandemic/

Ferrell, A., Liang, H., & Renneboog, L. (2015). Socially responsible firms. *Journal of Financial Economics, 122*, 585-606. http://dx.doi.org/10.1016/j.jfineco.2015.12.003

Flammer, C. (2015). Does Corporate Social Responsibility Lead to Superior Financial Performance? A Regression Discontinuity Approach. *Management Science*, *61*(11), 2549-2568. https://doi.org/10.1287/mnsc.2014.2038

Flammer, C. (2021). Corporate green bonds. *Journal Of Financial Economics*, *142*(2), 499-516. https://doi.org/10.1016/j.jfineco.2021.01.010

Friedman, M. (1970, September 13). The Social Responsibility of Business is to Increase Profits. *New York Times Magazine*, pp. 122–126.

Ge, W., & Liu, M. (2015). Corporate social responsibility and the cost of corporate bonds. *Journal Of Accounting And Public Policy*, *34*(6), 597-624. https://doi.org/10.1016/j.jaccpubpol.2015.05.008

Gillan, S., Koch, A., & Starks, L. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal Of Corporate Finance*, *66*, 101889. https://doi.org/10.1016/j.jcorpfin.2021.101889

Godfrey, P. C. (2005). The relationship between corporate philanthropy and shareholder wealth: A risk management perspective. Academy of Management Review, 30(4), 777–798.

Goebel, J., & Kemper, K. (2022). Credit rating changes and debt structure. *The North American Journal Of Economics And Finance*, *59*. https://doi.org/10.1016/j.najef.2021.101558

Goss, A., & Roberts, G. (2011). The impact of corporate social responsibility on the cost of bank loans. *Journal Of Banking & Finance*, *35*(7), 1794-1810. https://doi.org/10.1016/j.jbankfin.2010.12.002

Hametner, M., & Kostetckaia, M. (2020). Frontrunners and laggards: How fast are the EU member states progressing towards the sustainable development goals?. *Ecological Economics*, *177*. https://doi.org/10.1016/j.ecolecon.2020.106775

Hill, R., Griffiths, W., & Lim, G. (2018). *Principles of econometrics* (5th ed.) Wiley.

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 &Amp; Accounting*, *43*(1-2), 158-190. https://doi.org/10.1111/jbfa.12183

Jensen, M. & Smith, C. (1985). Stockholder, manager, and creditor interests: Applications of agency theory. In Jensen, M. (Ed.), *Theory of the Firm: Governance, Residual Claims and Organizational Forms.* Harvard University Press. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=173461

Jiang, J., (2008). Beating Earnings Benchmarks and the Cost of Debt. *The Accounting Review*, 83(2), 377-416

Jung, J., Herbohn, K., & Clarkson, P. (2016). Carbon Risk, Carbon Risk Awareness and the Cost of Debt Financing. *Journal Of Business Ethics*, *150*(4), 1151-1171. https://doi.org/10.1007/s10551-016-3207-6

Khan, M. (2022). ESG disclosure and Firm performance: A bibliometric and meta analysis. *Research In International Business And Finance*, 61. https://doi.org/10.1016/j.ribaf.2022.101668

Kim, H., Park, K., & Ryu, D. (2017). Corporate Environmental Responsibility: A Legal Origins Perspective. *Journal Of Business Ethics*, *140*(3), 381-402. https://doi.org/10.1007/s10551-015-2641-1

Kisgen, D. (2006). Credit Ratings and Capital Structure. *The Journal Of Finance*, *61*(3), 1035-1072. https://doi.org/10.1111/j.1540-6261.2006.00866.x

Krüger, P. (2014). Corporate goodness and shareholder wealth. *Journal of Financial Economics, 115,* 304-329. http://dx.doi.org/10.1016/j.jfineco.2014.09.008

Larcker, D., & Watts, E. (2020). Where's the greenium?. *Journal Of Accounting And Economics*, *69*(2-3). https://doi.org/10.1016/j.jacceco.2020.101312

Lee, S. P., & Isa, M. (2020). Environmental, social and governance (ESG) practices and performance in Shariah firms: Agency or stakeholder theory? *Asian Academy of Management Journal of Accounting and Finance, 16*(1), 1–34. https://doi.org/10.21315/aamjaf2020.16.1.1

Li, Y., Chen, R., & Xiang, E. (2021). Corporate social responsibility, green financial system guidelines, and cost of debt financing: Evidence from pollution-intensive industries in China. *Corporate Social Responsibility And Environmental Management*, *29*(3), 593-608. https://doi.org/10.1002/csr.2222

Liang, H., Renneboog, L. (2020). *Corporate Social Responsibility and Sustainable Finance: A Review of the Literature* (ECGI Working Paper Series in Finance No. 701/2020). https://ecgi.global/sites/default/files/working_papers/documents/liangrenneboogfinal.pdf

Liu, X., Wang, E., & Cai, D. (2019). Green credit policy, property rights and debt financing: Quasi-natural experimental evidence from China. *Finance Research Letters*, *29*, 129-135. https://doi.org/10.1016/j.frl.2019.03.014

McWilliams, A., & Siegel, D. (2001). Corporate Social Responsibility: a Theory of the Firm Perspective. *Academy Of Management Review*, *26*(1), 117-127. https://doi.org/10.5465/amr.2001.4011987

Menz, K. (2010). Corporate Social Responsibility: Is it Rewarded by the Corporate Bond Market? A Critical Note. *Journal Of Business Ethics*, *96*(1), 117-134. https://doi.org/10.1007/s10551-010-0452-y

Nordea Bank. (2021). *Nordic corporates embrace sustainability-linked loans.* https://www.nordea.com/en/news/nordic-corporates-embrace-sustainability-linked-loans

NOU 2012: 2. Outside and Inside - Norway's agreements with the European Union. Ministry of Foreign Affairs. https://www.regjeringen.no/contentassets/5d3982d042a2472eb1b20639cd8b2341/en-gb/pdfs/nou201220120002000en_pdfs.pdf

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. https://doi.org/10.1111/fire.12025

Pinsent Masons. (2021). *Retained EU law in the UK after Brexit.* https://www.pinsentmasons.com/out-law/guides/retained-eu-law-uk-after-brexit

Potter, M. (2020). *Are Nordic businesses more sustainability conscious?*. https://journeytozerostories.neste.com/sustainability/are-nordic-businesses-more-sustainability-conscious#40734c01

Rahaman, M., & Zaman, A. (2013). Management quality and the cost of debt: Does management matter to lenders? *Journal of Banking & Finance 37 (2013) 854–874*. http://dx.doi.org/10.1016/j.jbankfin.2012.10.011

Refinitiv. (2022). *Environmental, social, and governance scores from Refinitiv*. Refinitiv. https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf

Robeco. (2021). *Country Sustainability Ranking.* Robeco. https://www.robeco.com/media/3/2/5/325dd63882d778324dd13ad2122d8ecb_202108-country-sustainability-ranking_tcm17-31263.pdf

Roberts, M., & Whited, T. (2011). Endogeneity in Empirical Corporate Finance. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1748604

Rogova, E., & Aprelkova, G. (2020). The Effect of IPCC Reports and Regulatory Announcements on the Stock Market. *Sustainability*, *12*(8), 3142. https://doi.org/10.3390/su12083142

Shanaev, S., & Ghimire, B. (2022). When ESG meets AAA: The effect of ESG rating changes on stock returns. *Finance Research Letters, 46.* https://doi.org/10.1016/j.frl.2021.102302

Stock, J., & Watson, M. (2020). *Introduction to econometrics* (4th ed.). Pearson.

Tang, D., & Zhang, Y. (2020). Do shareholders benefit from green bonds?. *Journal Of Corporate Finance*, *61*. https://doi.org/10.1016/j.jcorpfin.2018.12.001

Thompson, P. (1998). Bank lending and the environment: Policies and opportunities. *International Journal of Bank Market*ing, 16(6), 243–252.

Trucost Plc. (2009). *Carbon Risks and Opportunities in the S&P 500*. Trucost Plc.

Vogel, D. (2005). Is There a Market for Virtue?: The Business Case for Corporate Social Responsibility. *California Management Review*, *47*(4), 19-45. https://doi.org/10.1177/000812560504700401

Weber, O. (2011). Environmental Credit Risk Management in Banks and Financial Service Institutions. *Business Strategy And The Environment*, *21*(4), 248-263. https://doi.org/10.1002/bse.737

Wong, W., Batten, J., Ahmad, A., Mohamed-Arshad, S., Nordin, S., & Adzis, A. (2021). Does ESG certification add firm value?. *Finance Research Letters*, *39*. https://doi.org/10.1016/j.frl.2020.101593

Ye, K., & Zhang, R. (2011). Do Lenders Value Corporate Social Responsibility? Evidence from China. *Journal Of Business Ethics*, *104*(2), 197-206. https://doi.org/10.1007/s10551-011-0898-6

Zerbib, O. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal Of Banking &Amp; Finance*, *98*, 39-60. https://doi.org/10.1016/j.jbankfin.2018.10.012

Zhang, R., Li, Y., & Liu, Y. (2021). Green bond issuance and corporate cost of capital. *Pacific-Basin Finance Journal*, *69*. https://doi.org/10.1016/j.pacfin.2021.101626

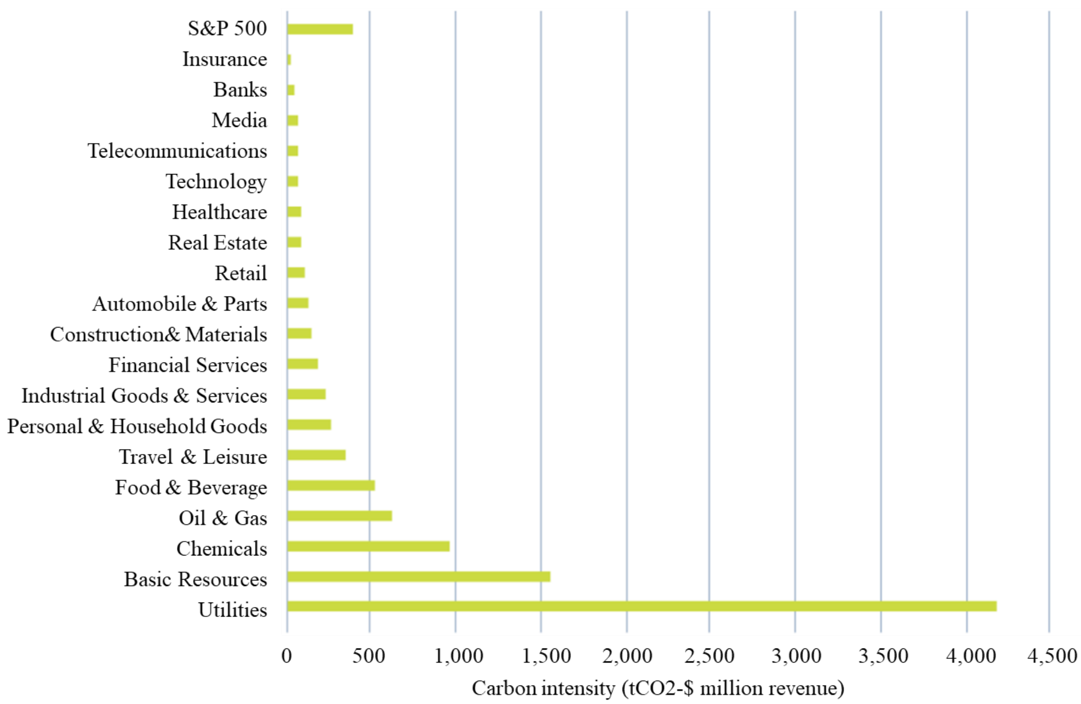
Appendix

Appendix A1: Variable definitions and data source

Variable	Definition	Source
ESG	The ESG combined score from Refinitiv. Measure a company's relative ESG performance, commitment, and effectiveness across three main dimensions: the environmental dimension, the social dimension and governance dimension	Refinitiv
Env	The environmental dimension of the ESG combined score	Refinitiv
Soc	The social dimension of the ESG combined score	Refinitiv
Gov	The governance dimension of the ESG combined score	Refinitiv
CoD	Calculated by Refinitiv by adding the weighted cost of short-term debt and weighted cost of long-term debt based on the 1-year and 10-year points of an appropriate credit curve. Given as a decimal number	Refinitiv
ROA	Return on assets calculated by dividing a company's net income prior to financing costs by total assets	Refinitiv
Z_score	Altman's Z-score is calculated as follows: 1.2 × (working capital/total assets) + 1.4 × (retained earnings/total assets) + 3.3 × (EBIT/total assets) + 0.6 × (market value of equity/total liabilities) + 1.0 × (sales/total assets).	Bloomberg
Lev	Leverage ratio calculated as total debt divided by total assets	Refinitiv
Size	Company size calculated as a natural logarithm of total assets	Refinitiv
cash_ratio	Ratio of a company's cash holdings calculated as cash & cash equivalents divided by total assets	Refinitiv
envAfter2017	An interaction variable created by multiplying the environment pillar score with a dummy that takes value 1 if the year is 2018-2020 and 0 otherwise	Refinitiv
HighCO, MedCO, LowCO	Three dummy variables that take value 1 if the company operates in high, medium, and low carbon-intensive industries respectively, and 0 otherwise	Refinitiv; Rogova & Aprelkova (2020)
envHighCO	The environmental dimension of the ESG combined score multiplied with the HighCO dummy	Refinitiv; Rogova & Aprelkova (2020)
envMedCO	The environmental dimension of the ESG combined score multiplied with the MedCO dummy	Refinitiv; Rogova & Aprelkova (2020)
envLowCO	The environmental dimension of the ESG combined score multiplied with the LowCO dummy	Refinitiv; Rogova & Aprelkova (2020)
Nord, Brit, Eur	Three dummy variables that take value 1 if the company's country of exchange is in the Nordics, the British Isles and rest of Europe respectively, and 0 otherwise	Refinitiv
envNord	The environmental dimension of the ESG combined score multiplied with the Nord dummy	Refinitiv

envBrit	The environmental dimension of the ESG combined score multiplied with the Brit dummy	Refinitiv
envEur	The environmental dimension of the ESG combined score multiplied with the Eur dummy	Refinitiv
GB_d	A dummy that takes value 1 if the company has issued green bonds and 0 otherwise	Bloomberg; Euronext; Refinitiv
EnvAboveMean	A dummy that takes value 1 if the company has an environmental score above the sample mean and 0 otherwise	Refinitiv
Cred.rating dummy	A dummy that takes value 1 if the company currently has a credit rating and 0 otherwise	Refinitiv
ICR	Calculated by Refinitiv as the as the ratio of EBIT divided by interest expenses	Refinitiv

Appendix 2A: Carbon intensity per ICB industry (TCO2 / $million revenue)



(Trucost Plc., 2009)

Appendix 3A: Pearson correlation matrix of all variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CoD (1)	1.00									
ROA (2)	-0.17***	1.00								
Z_score (3)	-0.17***	0.56***	1.00							
Lev (4)	0.19***	-0.18***	-0.33***	1.00						
Size (5)	-0.15***	-0.17***	-0.26***	0.13***	1.00					
cash_ratio (6)	-0.08***	0.04**	0.13***	-0.16***	-0.14***	1.00				
ESG (7)	-0.18***	0.03**	-0.09***	0.07***	0.31***	-0.03	1.00			
Env (8)	-0.19***	-0.07***	-0.21***	0.06***	0.52***	-0.04**	0.72***	1.00		
Soc (9)	-0.21***	0.04**	-0.08***	0.05***	0.46***	-0.02	0.76***	0.68***	1.00	
Gov (10)	0.01	-0.04**	-0.10***	0.10***	0.24***	-0.01	0.53***	0.28***	0.33***	1.00
envAfter2017 (11)	-0.24***	-0.09***	-0.10***	0.12***	0.18***	0.04***	0.31***	0.36***	0.33***	0.25***
GB_d (12)	-0.07***	-0.06***	-0.11***	0.04**	0.17***	-0.13***	0.11***	0.19***	0.09***	0.03*
EnvAboveMean(13)	-0.18***	-0.05***	-0.15***	0.04*	0.44***	-0.02	0.58***	0.83***	0.55***	0.22***
envHighCO (14)	0.06***	-0.16***	-0.21***	0.01	0.21***	-0.09***	0.13***	0.24***	0.14***	0.07***
envMedCO (15)	-0.14***	0.05***	0.05***	-0.08***	0.10***	0.17***	0.24***	0.31***	0.23***	0.09***
envLowCO (16)	-0.05***	0.04**	-0.02	0.12***	0.09***	-0.14***	0.17***	0.20***	0.14***	0.05***
envEUR (17)	-0.26***	-0.17***	-0.18***	0.05***	0.43***	0.06***	0.28***	0.45***	0.33***	0.00
envNord (18)	-0.02	0.09***	0.07***	-0.09***	-0.08***	-0.06***	0.17***	0.18***	0.13***	0.03*
envBrit (19)	0.19***	0.08***	-0.01	0.07***	-0.05***	-0.06***	0.08***	0.08***	0.02	0.20***
Cred. Rating dummy (20)	-0.01	0.02	0.01	-0.03	-0.08***	-0.08***	-0.01	0.01	-0.08***	-0.03*
ICR (21)	-0.04***	0.09***	0.11***	-0.10***	-0.04**	0.05***	-0.03*	-0.04**	-0.02	-0.05***

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
envAfter2017 (11)	1.00										
GB_d (12)	0.05***	1.00									
EnvAboveMean (13)	0.30***	0.17***	1.00								
envHighCO (14)	0.06***	0.13***	0.21***	1.00							
envMedCO (15)	0.13***	-0.10***	0.22***	-0.47***	1.00						
envLowCO (16)	0.08***	0.13***	0.20***	-0.26***	-0.46***	1.00					
envEUR (17)	0.16***	0.10***	0.38***	0.13***	0.13***	0.08***	1.00				
envNord (18)	0.07***	0.12***	0.17***	0.07***	0.01	0.07***	-0.40***	1.00			
envBrit (19)	0.04**	-0.09***	0.05***	-0.04***	0.09***	0.00	-0.54***	-0.25***	1.00		
Cred. Rating dummy (20)	0.00	-0.01	0.02	0.05***	-0.09***	0.07***	0.00	0.16***	-0.14***	1.00	
ICR (21)	-0.02	-0.02	-0.03*	-0.03*	0.00	0.00	-0.01	0.00	-0.03	0.02	1.00

*The sample consists of 3670 firm-year observations over the period 2014-2020. Appendix A1 outlines definitions and data sources for all variables. ***, **, * denote a significant correlation at the 1%, 5% and 10% levels, respectively*