Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Dept. of Industrial Economics and Technology Management

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The Impact of ESG Perfomance on the Cost of Capital in Energy and Natural Resources Companies

Master's thesis in Industrial Economics and Technology Management
Supervisor: Anne Neumann
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Preface

This thesis represents the culmination of our master's project in the course TIØ4900 for our Master of Science degree in Industrial Economics and Technology Management at the Norwegian University of Science and Technology (NTNU). The thesis was written during the spring semester of 2023, and it builds upon the work initiated in the fall of 2022 for the Project Thesis in the course TIØ4550 (Kjellevoll and Wilberg, 2022).

We have experienced a remarkable change in sustainability and ESG concerns in recent years, and the concept of ESG investing has gained prevalence. We therefore aim to understand not only how firms are adapting to these changes, but also how these changes influence investor behavior. We find this particularly interesting within the sectors that have the largest impact on global sustainability, both in terms of current operations and the potential impact of changes in a sustainable direction. We therefore want to investigate whether an ESG premium exists in the energy and natural resources sectors.

We want to express our sincere gratitude to our supervisors, Professors Anne Neumann and Franziska Holz, for guiding us over the past year. They have provided invaluable support in terms of academic writing, input on methodology, and valuable discussions drawing on their expertise in empirical finance and energy and resource markets.

Abstract

This thesis explores the presence of an ESG premium for firms operating in the energy and natural resources sectors. Specifically, we examine the influence of ESG performance on firms' cost of capital in both debt and equity markets to assess the total effects on financing costs. We apply a measure of the ex-ante implied cost of equity and the cost of debt to a global sample of over 4,000 firm-year observations from 2010 to 2021, and separately investigate the financial impact of each component comprising the aggregated ESG score. We employ a pooled OLS with robust standard errors, controlling for firm-specific and macroeconomic factors. Furthermore, we employ two feature selection techniques to identify relevant control variables.

Contrary to the prevailing view in recent literature, our results indicate no evidence supporting an ESG premium for energy and natural resources firms. However, we observe a significant and negative relationship between environmental performance and the cost of capital in both markets. Our findings therefore support the presence of a "green premium," which can be attributed to both green investor preferences and sustainable operations reducing regulatory and other environmental risks. Furthermore, the social score exhibits a significant and positive relationship with the cost of debt, suggesting that lenders view investments in social efforts as risk-enhancing or a waste of resources. Therefore, we argue that the aggregated ESG score is too exhaustive, but that individual ESG factors adequately capture investors' risk-return preferences. Firms can benefit from reduced financing costs by improving environmental efforts, although social investments may cause higher borrowing costs.

Sammendrag

Dette studiet tar for seg eksistensen av en ESG-premie for selskaper innen energi- og naturressurssektorene. Mer spesifikt utforsker vi innflytelsen av ESG-faktorer på bedrifters avkastningskrav i både gjelds- og aksjemarkedet, for å vurdere de samlede effektene på finansieringskostnadene. Vi benytter et mål for det implisitte avkastningskravet for egenkapital samt et mål for avkastningskravet for gjeld, basert på over 4000 globale observasjoner i perioden 2010-2021. Vi analyserer også den økonomiske virkningen av hver delkomponent i den samlede ESG-scoren. Vi anvender Pooled OLS med robuste standardfeil, samtidig som vi kontrollerer for selskapsspesifikke og makroøkonomiske faktorer. Videre benytter vi to variabelseleksjonsmetoder for å identifisere relevante kontrollvariabler.

I motsetning til tidligere litteratur, indikerer resultatene våre ingen støtte for eksistensen av en ESG-premie for selskaper innen energi- og naturressurssektorene. Imidlertid observerer vi en betydelig og negativ sammenheng mellom miljøkomponenten og avkastningskravet i både gjelds- og aksjemarkedet. Det støtter tilstedeværelsen av en "grønn premie" som kan forklares både av grønne investorpreferanser samt at bærekraftig drift reduserer regulatorisk risiko og andre miljørelaterte risikofaktorer. Videre viser den sosiale komponenten en signifikant og positiv sammenheng med gjeldsfinansieringskostnader, noe som tyder på at långivere oppfatter sosiale investeringer som risikoforsterkende eller ressurssløsende. Vi argumenterer derfor for at den aggregerte ESG-scoren er for bred i omfang, og at individuelle ESG-faktorer bedre fanger opp investorenes preferanser for risiko og avkastning. Som en konsekvens kan bedrifter dra nytte av reduserte finansieringskostnader ved å forbedre sin miljøinnsats, mens sosiale investeringer kan medføre høyere lånekostnader.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

2SLS	2 Stage Least Squares
BLUE	Best Linear Unbiased Estimator
bps	Basis points
CAPM	Capital Asset Pricing Model
COC	Cost of Capital
COD	Cost of Debt
COE	Cost of Equity
CSP	Corporate Social Performance
CSR	Corporate Social Responsibility
DPS	Dividends Per Share
EPS	Earnings Per Share
ESG	Environmental, Social and Governance
FE	Fixed Effects
I/B/E/S	Institutional Brokers' Estimate System
LASSO	Least Absolute Shrinkage and Selection Operator
LIBOR	London Interbank Offered Rate
OJ	Ohlson and Juettner-Nauroth model (2005)
OLS	Ordinary Least Squares
PEG	Price-Earnings-Growth
USD	US Dollar
US	United States of America
VIF	Variance Inflation Factor
WACC	Weighted average cost of capital

1 Introduction

This thesis explores the impact of Environmental, Social and Governance (ESG) performance on investors' risk-return preferences for companies operating in the energy and natural resources industries. This relationship is examined by regressing both a measure of implied cost of equity, as well as the cost of debt, against ESG performance measures while controlling for both firm-specific variables and macroeconomic risk factors. Furthermore, we incorporate two feature selection techniques: best subset and LASSO regression, the application of which aid in isolating the most impactful variables while mitigating the risk of model overfitting.

The significance of firms' ESG performance has been notably amplified in recent years. As interest in ESG concerns increases, stakeholders from the financial industry, corporations, governments and academic circles seek to understand these changes' possible long-term effects on investors and firms. This process involves reassessing the thinking regarding financing strategies and allocating capital and resources to new investments and projects. The "Environmental" component relates to a firm's efforts to reduce its environmental footprint, such as initiatives aimed at reducing greenhouse gas emissions and promoting sustainable activities. The "Social" aspect gauges the extent of a company's investment in its workforce and local communities. "Governance," on the other hand, examines the decision-making processes and leadership practices within the corporation (MSCI, n.d.). Corporate social responsibility (CSR) and corporate social performance (CSP) are similar measures, which address the social and environmental impact of firms' operations.

The global pivot towards sustainability in finance is expected to boost ESG investing significantly. According to PwC's Asset and Wealth Management Revolution 2022 report, financial asset managers are projected to increase their ESG-oriented Assets under Management (AuM) to \$33.9 trillion by 2026. This is an increase from \$18.4 trillion in 2021 and represents a compounded annual growth rate of 12.9%. While this growth rate far outpaces the rest of the asset management industry, it also signifies a continuation in growth from the extraordinary pace seen in recent history. In just six years, from 2015 to 2021, the value of ESG-focused AuM soared from \$2.2 trillion to \$18.4 trillion, illustrating their robust momentum and increased significance in the financial landscape. Following this trend, ESG-focused assets will comprise over one-fifth of the total assets under management in approximately four years. Furthermore, the report suggests that 81% of US institutional investors and 83.6% of European investors plan to increase their shareholdings in ESG-related assets in the next two years. This growth is both due to new funds being set up and a retrofitting of already existing funds, where 27% of European funds are reported to have been repurposed to focus on ESG investing. Furthermore, the "United Nations-convened Net-Zero Asset Owner Alliance," a member-led initiative of institutional investors managing more than \$2.4 trillion, announced in 2019 their intention of achieving carbon-neutral portfolios by 2050 (United Nations Environment Program, 2019). A similar announcement was made by the Norwegian Sovereign Wealth Fund, NBIM, in their 2022 carbon action plan (Norges Bank, 2022). By adopting these goals, investors drive climate mitigation initiatives by allocating more capital to low-emission firms and compelling companies to improve their sustainability to secure the necessary financing.

The shift in ESG emphasis is driven not only by asset managers themselves but also by a rising consumer demand for such investment products. Three-quarters of investors report being willing to accept higher management fees for ESG-focused funds, and 88% of institutional investors believe asset managers should be more proactive in facilitating more ESG products (PwC, 2022). In recent market studies by Blackrock (2020), Paribas (2021), and

Schroders (2021), a promise of increased financial returns consistently emerges as the most crucial incentive for investors pursuing ESG-focused investment strategies. The prevailing view generally proposes that improving ESG performance leads to improved financial results. This relationship is multi-dimensional, with factors ranging from the impact of information disclosure, the role of idiosyncratic risk, relationships with key stakeholders, efficient resource use and management efficacy. Moreover, the concept and influence of "green investors" has garnered attention in recent years. These institutional and private investors prioritize ESG responsibility and potentially accept lower risk-adjusted returns for firms with superior ESG performance.

In pursuing sustainable energy solutions, a nuanced understanding of the cost of capital becomes crucial, as it significantly influences the affordability of new technologies and their attractiveness to investors. IEA (2021) estimates that approximately 70% of the investments needed in new technologies and clean energy to reach the net-zero objective must originate from private investors. In exchange for expected future financial returns, these private investors help facilitate capital-intensive projects and research into new technologies by providing necessary funds. Facilitating cheap financing solutions will therefore accelerate investments into emerging energy solutions and technologies (IEA, 2021). The International Renewable Energy Agency echoes this view in their 2023 report titled "Finance for the Energy Transition" (IRENA, 2023), which further highlights the importance of mapping and understanding the drivers behind the cost of financing. Given that new projects in energy industries tend to be capital-intensive, while operational costs are low, the cost of capital used to evaluate new projects critically impacts the cost of producing energy. Therefore, having accurate assumptions and a deep understanding of the drivers underlying the cost of capital is critical.

This thesis focuses on three sectors defined by the Thomson Reuters Business Clarification (TRBC) (Refinitiv Eikon, 2023): Energy, Utilities and Basic Materials. These are all sectors essential to the global economy due to the inherent importance of their operations, providing energy, materials and services that sustain everyday life and business operations. Furthermore, their significant impact on ESG issues has become increasingly apparent in recent years. The energy sector, which includes fossil fuels, renewable energy and uranium, powers and provides services for everything from energy-intensive industries to home appliances and residential buildings. However, the sector has also increasingly received attention due to its crucial role in transitioning to a decarbonized world. Whether it is renewable companies seeking to find new ways to provide clean energy or fossil fuel companies such as coal or oil and gas emitting considerable amounts of greenhouse gasses, it is clear that firms operating in this sector are experiencing a drastic shift in terms of investors' and other stakeholders' expectations. Furthermore, social and governance issues such as relationships with local communities, workplace conditions and corruption have long been a topic of conversation in these industries due to the inherent dangers of their operations and importance to governments and local economies. Utilities play a similar role by providing electricity, gas and water and face heavy ESG scrutiny on issues ranging from water supply in underserved communities to power plant emissions. The Basic Materials sector includes all industries exploring, developing, and processing basic materials (Refinitiv Eikon, 2023). This includes manufacturing chemicals and the mining, forestry, and metals industries. Due to the nature of these operations, investors are similarly increasingly wary of these firms' impact on all aspects of ESG.

A growing body of research has explored the concept of ESG premia and their impact on market values and financial returns. However, existing research points to somewhat diverging results across markets and time periods (Gianfrate et al., 2015), indicating a need for further investigation. Unlike most existing research, we analyze the debt and equity markets simultaneously. This dual focus provides a better understanding of the total financing costs faced by companies in the energy and natural resources industries. Additionally, prior studies by Reverte (2012), Gregory et al. (2016), and El Ghoul et al. (2011) highlight the significant impact of industry membership on the relationship between cost of capital and sustainability performance, yet studies on these sectors remain limited. This enables a better understanding of the sector-specific stakeholder pressure of firms operating within these industries. Firm-specific data is collected from publicly traded companies globally, spanning the period 2010 to 2021, yielding 2,076 unique firms and 24,829 firm-year observations.

For equity capital, we draw on the methodology introduced by Ohlson and Juettner-Nauroth (2005) and compute the implied cost of equity using stock prices and analyst forecasts, while other methods for finding the cost of equity are used as a robustness measure for the results' sensitivity to the choice of equity model. The vast majority of research, such as In et al. (2017) and Bolton and Kacperczyk (2021a), employs historical realized returns and asset pricing models to establish the presence of ESG premia. This approach remains popular due to its unambiguous interpretation and application. However, solely relying on realized returns when determining asset prices, as applied in studies such as Sharfman and Fernando (2008) using CAPM and Fama-French factor models, has been subject to criticism. The key element of the critique, as highlighted by Elton (1999), lies in the backward-looking nature of such methodologies and that realized returns at best serve as an unreliable proxy for expected returns. This should in particular hold true in the rapidly evolving landscape centered around ESG investing. Indeed, Pástor et al. (2022) find that excessive returns from investing in sustainable funds essentially disappear when accounting for demand shifts due to an increase in climate concerns. It is therefore argued that traditional asset pricing models relying on realized returns fail to adequately capture the demand shift related to increasing societal ESG concerns.

The function of debt in the ESG-cost of capital relationship has received comparatively less attention than that of equity, despite its relative importance. Existing literature on the subject, such as Attig et al. (2013), Ge and Liu (2015), Hoepner et al. (2016), Menz (2010) and Oikonomou et al. (2014) supports the notion that ESG performance correlates to a reduction in the cost of debt. However, analyses by Gonçalves et al. (2022), Magnanelli and Izzo (2017) and Sharfman and Fernando (2008) find significant and positive relationships between the cost of debt and various measures of ESG performance, indicating a need for further exploration. We use the average interest rate paid over a year as a proxy for the cost of debt.

In order to identify determinants of the ESG premium in equity and debt markets we employ two feature selection algorithms. This data-driven approach allows us to exclude irrelevant variables from a large set of possible cost of capital determinants. Subsequently, we apply a pooled least squares regression with robust standard errors clustered on the firm level with fixed effects on geographical region and industry. Based on the results from the feature selection, we control for different firm-specific variables for equity and debt. In addition, acknowledging the need for macroeconomic considerations, we incorporate macroeconomic variables into our empirical models. This addition not only provides additional insight into the dynamics of the ESG premium, but also fills a gap in existing literature which to a large extent does not take these effects into account. We argue that this is particularly relevant for energy and natural resource firms, given their high exposure to oil and energy prices and broader macroeconomic conditions.

Contrary to the predominant view in recent literature, we find no significant relationship between the aggregated ESG score and the cost of capital for neither equity nor debt. However, when examining the subcomponents of the ESG score, a different picture emerges. In particular, we determine the environmental score to contribute negatively to the cost of capital across all model specifications, with a magnitude of -1.25 basis points (bps) and -1.25 bps for the cost of debt and cost of equity respectively. Given average leverage levels in our data sample, this corresponds to a 1.03 bps reduction in the pre-tax WACC per unit increase in environmental performance. Interestingly, we find the social score to be positively associated with the cost of capital, but only significantly so for the cost of debt. We therefore argue that the aggregated ESG score is too exhaustive, but that individual ESG factors adequately capture investors' risk-return preferences. In particular, we propose that investors on both sides view environmental performance as a considerable source of risk, where breaching regulations can lead to significant economic consequences or cause assets to become stranded. Conversely, poor social performance lacks equivalent financial risks, and might therefore be perceived by investors as an inefficient use of resources.

The remaining chapters of the thesis are structured as follows. Chapter 2 introduces relevant literature on the concept of ESG premia in the equity and debt markets, with a focus on methodologies employed to determine such premia. Chapter 3 presents the data used for the analysis, including descriptive statistics. Chapter 4 discusses the methodology used to compute the implied cost of equity, as well as cost of debt. Subsequently, we introduce two feature selection techniques utilized to identify appropriate control variables. The chapter is concluded by a description of the regression models used to determine the ESG-premium. The results are shown in Chapter 5, which is followed by an in-depth interpretation as well as discussion regarding sensitivity, validity and robustness in Chapter 6. Finally, we conclude the thesis in Chapter 7 and propose areas of interest for future research.

2 Literature review

The subsequent literature review examines three crucial areas within the current body of research on Environmental, Social and Governance (ESG) performance and its financial effects. Section 2.1 explores research on the general relationship between ESG and financial performance broadly. Section 2.2 provides an overview of the existing literature on the core of this thesis' subject - the effects of ESG on firms' cost of capital - with a focus on methodology. Lastly, Section 2.3 presents the gaps we aim to fill in the existing literature.

2.1 The relationship between ESG and financial performance

Several studies and hypotheses have been developed to understand the correlation between firms' ESG performance and financial performance. Although perspectives in the literature vary, the consensus is that strengthening ESG initiatives positively impacts economic outcomes. This section presents literature exploring the economic effects of ESG and similar corporate goodness metrics, such as corporate social responsibility (CSR) and corporate social performance (CSP).

One line of reasoning supporting a positive correlation between firms' financial and ESG performance revolves around information disclosure. Fishman and Hagerty (1989) find that companies with a higher degree of corporate information disclosure experience greater pricing efficiency compared to peers. Price efficiency represents the degree to which prices reflect all available information regarding speed and accuracy. Qiu et al. (2016) corroborate these results and find that investors prefer firms with higher social disclosures due to an anticipation of higher cash flow growth rates by such firms. Increasing the information disclosure reduces asymmetrical market information, i.e., the information gap between a firm's insiders and outsiders, reducing idiosyncratic risk (Berk et al., 2013). A higher disclosure and informational flow level will lower agency costs as management and stakeholders are more aligned (Akerlof, 1970; Grossman and Stiglitz, 1980; Mankiw, 1986). Siew et al. (2016) find a negative relationship between ESG disclosures and market information asymmetry represented by the average ratio of the bid-ask spread and closing price, and Cui et al. (2018) find an inverse relation between CSR engagement and the information asymmetry measured as the dispersion in analyst forecasts.

Another potential reason for the influence of ESG performance on financial performance relates to the concept of idiosyncratic risk. Idiosyncratic risk stands in contrast to the systematic risk from market-wide factors where all companies are affected simultaneously (Berk et al., 2013). Lee and Faff (2009) find that leading CSP firms exhibit significantly lower idiosyncratic risk. This is supported by companies with better ESG performance being more robust to a potential market shift, both in terms of the increase in physical natural disasters and new regulations and laws. Hoepner et al. (2016) build upon these findings and argue that firms reducing emissions and pollution mitigate the risk of becoming a victim of stricter governmental regulations or change in demand from other stakeholders. Being ESG compliant reduces both the immediate risks from known hazards, regulations and reputational damages, as well as risks from future unanticipated contingencies. OECD (2021) suggests that the cost of capital for high-emitting assets, such as those in the oil and gas industry, can increase due to deteriorating asset performance and regulatory changes. In the worst case, these assets can become stranded. This means that they end up as liabilities before their expected economic lifetime end and remain unused (Grantham Research Institute on Climate Change and the Environment, 2022).

Moreover, the stigmatization associated with these industries could lead to reputational risks, potentially impacting their access to low-cost financing.

The effects of ESG on firm-stakeholder relationships also have the potential to influence financial performance. Mutually beneficial long-term relationships bring several comparative advantages. For example, Godfrey (2005) shows that good stakeholder relationships result in better risk management. Most companies rely on investors and their financing, and a good long-term relationship with investors will thus stabilize their financial situation. Clarkson (1995) and Hillman and Keim (2001) find that long-term relationships with investors result in improved profitability. Beyond investors, consumers serve as crucial stakeholders. As the purchasers of products, satisfied consumers are integral to a company's success. Yoon et al. (2006) demonstrate that companies with extensive CSR activities are perceived as more trustworthy by the public, leading to increased consumer demand.

A resource-based view offers another perspective on the relationship between ESG and financial robustness (Bansal, 2005; Barney, 1991). This line of reasoning argues that "greener" companies use their resources more efficiently and are therefore more economically effective. Financial performance improvement can manifest through both earnings increases and lowered costs due to resource efficiency (Bansal and Roth, 2000; Buysse and Verbeke, 2003). Furthermore, Krüger (2015) argues for a possible two-way relationship where financially stable firms exhibit resource-slack, enabling more resources to be aimed towards ESG and sustainability issues. Indeed, Hong et al. (2012) find that financially constrained firms devout fewer resources towards corporate goodness measures.

The ESG premium can also partly be explained by the hypothesis that managements that can incorporate ESG activities and bring a sustainability focus to the firm are more competent and skilled (Hoepner et al., 2016). Waddock and Graves (1997) find evidence supporting the theory that good managements and corporate social performance are positively related. Goss and Roberts (2011) argue that good managers can persuade stakeholders and capitalize on the advantages of ESG investments compared to competing "economic investments".

A positive relationship between ESG and financial returns can also stem from the presence of so called "green investors". Green investors either prefer or limit their investments to only those that are compliant in terms of their own specified green preferences. As this thesis examines investor preferences through the cost of capital, this argument is highly relevant. To show the effects of green investors on the the cost of capital, Heinkel et al. (2001) divide investors into two groups: those that only invest in companies with good environmental performance, i.e. low polluting firms, and those that are indifferent to the degree of environmental performance. They find that the investor base for the non-green companies are smaller than that of the greener companies. A larger investor base may reduce the cost of capital (Merton et al., 1987).

Contrary to the aforementioned literature, there also exists arguments for why ESG performance could negatively affect a company's financial performance. In particular, this might occur when managers over-invest in ESG expenditures to improve their personal reputation as a "good global citizen". This comes at the expense of shareholders and creditors, as investors will bear the costs of over-investments (Magnanelli & Izzo, 2017). Barnea and Rubin (2010) support this hypothesis by finding that insiders' ownership are negatively related to the firm's CSR. This indicates that when managers have lower financial stakes in the company, they are more likely to invest more than optimal amount in CSR. This line of reasoning argues that lenders demand more compensation for bearing the risk of managers over-investing in ESG.

2.2 ESG premium and the cost of capital

Assessing performance based on historical returns and share price performance remains the primary strategy financial practitioners and researchers use. Pástor et al. (2022) describe that a large number of studies measure stock price returns and investigate green premia by contstructing green-minus-brown portfolios (Bolton and Kacperczyk, 2021a; Bolton and Kacperczyk, 2021b; Aswani et al., 2023; In et al., 2017; Görgen et al., 2020; Garvey et al., 2018; Hsu et al., 2023) [1]. Studies by financial institutions, including those by Blackrock (2020) and Paribas (2021), also highlight increased financial returns as a crucial incentive for ESG investments, a potential that asset managers frequently capitalize on in their marketing (Pástor et al., 2022). However, relying on historical performance as a proxy for expected returns is heavily disputed (Elton, 1999). For the ESG premium specifically, Pástor et al. (2022) demonstrate how green assets periodically have exhibited higher realized returns but that the outperformance essentially disappears when accounting for periodic demand shifts due to increased climate concerns. Evaluating investors' risk-return preferences therefore calls for using the cost of capital as a proxy for expected returns. This incorporates current risks and outlooks as perceived by investors, as opposed to historical returns, which by nature are backward-looking and may not consider current market changes.

Furthermore, the cost of capital represents the cost of financing faced by firms and is an important variable when evaluating new projects in the energy and natural resources sectors (IRENA, 2023). For investors, the cost of capital signifies the required return rate on a security. It represents the discount rate that equates a firm's value to the discounted value of future cash flows (Modigliani and Miller, 1958). From the firm's perspective, the cost of capital represents the cost of financing from all sources, including both debt and equity. The cost of equity capital is the theoretical cost incurred by firms when compensating equity investors for the additional risk investors take on when investing in a company's equity capital (Berk et al., 2013). The cost of debt is essentially the effective interest rate that a company pays on its debt, such as bonds and bank loans (Berk et al., 2013).

Figure 1 summarizes the different branches of literature aimed at finding the ESG premium in both equity and debt markets. Reduction in overall cost of capital can be done by either reducing cost of debt or reducing cost of equity.

2.2.1 ESG premium in the equity market

According to Gianfrate et al. (2015), there are two primary research approaches for studying the relationship between ESG-performance and the cost of equity capital. (I) estimating the cost of equity for green and brown portfolios using traditional asset pricing models and (II) regressing the implied cost of equity from ex-ante expectations on a measure of corporate goodness and a set of control variables. These methods are illustrated in figure 1.

The first line of research remains the most common, mainly due to its ease of interpretation

[1] As this thesis focuses on the the cost of capital, literature and methods using realized returns are not further elaborated on.

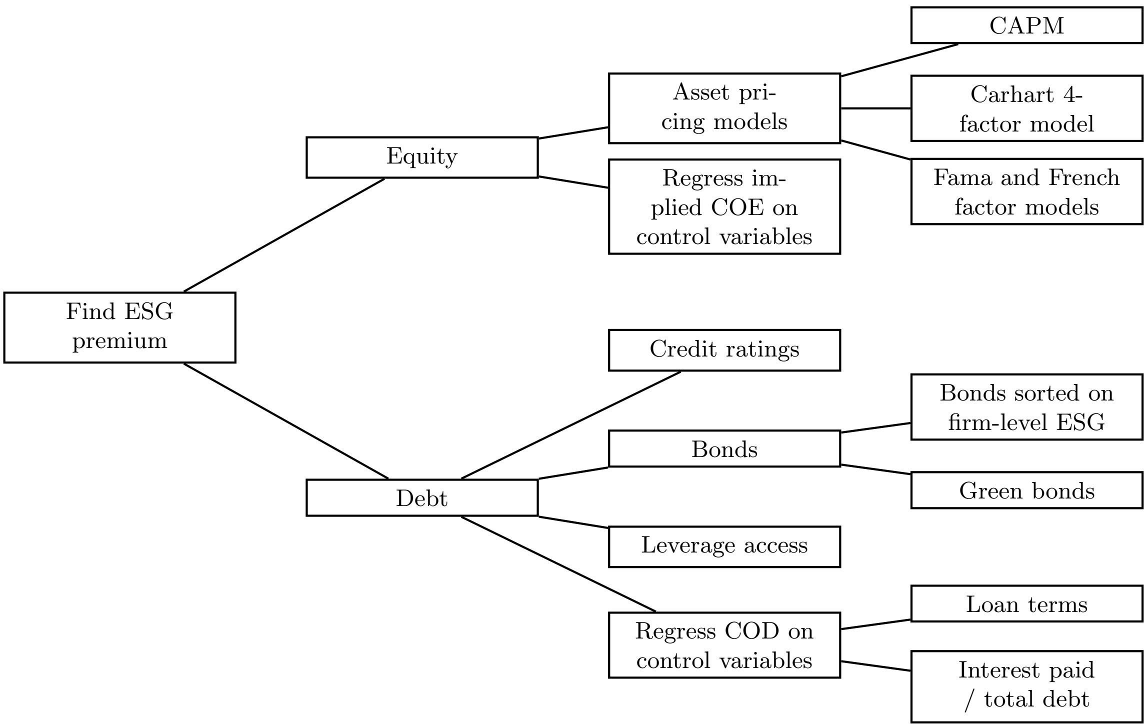

Figure 1: Literature tree giving an overview of the ESG premium landscape. The equity side contains two main branches: Using traditional asset pricing models based on historical returns, and regressing implied cost of equity based on ex-ante data on a set of control variables. For the debt side, the tree contains four main branches: Evaluating bonds, credit ratings, leverage and regressing the cost of debt on a set of control variables.

and the ready availability of data. An early exploration of this subject was conducted by Sharfman and Fernando (2008), analyzing the relationship between sustainability and the cost of capital in 267 firms from the S&P 500. Based on risk mitigation theory, they proposed that enhanced environmental risk management could reduce firms' cost of capital. They infer the cost of equity using the Capital Asset Pricing Model (CAPM), and find that environmental risk management has a negative association to equity financing costs. Koch and Bassen (2013) also use asset pricing models to assess the carbon exposure of a small sample of 20 European utility stocks participating in the European Union Emissions Trading System from 2005-2010. The investigation reveals a considerable risk premium for high-emitting utilities, leading to a higher cost of equity. In contrast, they find no evidence of reduced financing costs for low-emitting utilities. The authors further note that high-emitting firms could benefit through a reduced cost of equity by implementing an investment strategy to reduce carbon emissions.

Gregory and Whittaker (2013) investigate the impact of sustainability on equity values using a Fama-French 3-factor model on a data sample of S&P 500 firms from 1992-2009. While they find that financial markets positively value CSR strengths and that concerns are negatively valued, these effects are primarily caused by the associated growth prospects due to high CSR performance rather than lower cost of equity values. Gregory et al. (2016) utilize the Carhart 4-factor model to demonstrate that CSP has a negligible effect on the cost of equity. Instead, they attribute the premium to higher and more persistent earnings, as well as industry effects.

Using asset pricing models has revealed diverging results in different geographies. Employing both CAPM and multifactor models on a set of firms in the UK market, Humphrey et al. (2012) investigate differences in the cost of equity capital for companies with high and low CSP ratings. Employing both general and industry-specific CSP criteria, the study finds no significant difference in idiosyncratic risks, suggesting that CSP performance does not significantly influence the risk-return tradeoff in the UK market. The authors did however find evidence suggesting that firms with high CSP scores are larger, which could have an effect on expected returns. In contrast, regressing UK firms' systematic risk on a set of previously documented relevant accounting variables, Salama et al. (2011) show that a company's environmental performance is inversely related to its systematic financial risk. The authors investigate whether adding CER (community and environmental responsibility) adds additional information to the models. While finding a significant and negative relationship, they note that the effects remain small where a 1.0 improvement in CER score is associated with only a 0.02 decrease in a firms *beta*. Furthermore, studies from France and China demonstrate that investors demand a risk premium for non-ESG-compliant stocks. Girerd-Potin et al. (2014) apply asset pricing models to the French market and find that investors holding non-socially responsible stocks demanded a risk premium. This indicates a clear preference for ESG-compliant stocks and a willingness to accept lower returns for such investments. Similarly, Li et al. (2017), while examining high-polluting firms the Chinese market, discover that carbon information disclosure (CID) significantly reduces equity financing costs, and that this relationship can be strengthened through media reporting.

For the second line of research, the cost of equity is regressed on a measure of sustainability and a set of control variables. While traditional asset pricing models remain widely used, employing an ex-ante implied cost of capital measure instead of backward looking asset pricing models is gaining favourability among researchers. Asset pricing models, such as the standard single-factor model and the three-factor model (Fama and French, 1993), have been criticized for being unreliable measures of expected return (Fama and French, 1997; Elton, 1999). Wei et al. (2009) and Hail and Leuz (2006) therefore suggest using implied cost of equity as a measure for expected returns, as it can isolate cash flow effects. The cost of capital is by nature forward looking and it is therefore also argued that this approach to a greater extent is able to accurately estimate future expected returns instead of relying on historical share price returns.

El Ghoul et al. (2011) conducted the first study of this kind, examining the association between CSR and implied cost of equity capital for a large sample of US corporations from 1992-2007. Their research shows that firms with higher CSR scores experience a reduction in equity financing costs. In particular, investments in enhancing environmental policies, employee relations and product strategies significantly contribute to a lower cost of equity. Chava (2014) confirms these findings, also employing measures of ex-ante returns, and demonstrates that investors demand much higher expected returns on firms with significant environmental concerns. Gonçalves et al. (2022) follow El Ghoul et al. (2011) and Chava (2014), using an implied cost of equity measure to determine the relationship between ESG performance and cost of capital for a sample of the largest European firms from 2002-2018. In addition to confirming El Ghoul et al. (2011)'s findings in a European context, they also account for industry idiosyncrasies. They find that firms with poor ESG performance relative to industry peers are penalized through a higher cost of equity. As mentioned in the beginning of this section, Pástor et al. (2022) find that green stocks have outperformed brown in the US market, but contribute the performance to increases in climate concerns rather than high expected returns. Instead using a measure of the ex-ante implied cost of equity based on monthly stock prices and analyst forecasts, the authors find evidence for a negative equity premium coefficient. This implies a reduction in the cost of equity capital, and consequently lower expected returns. They argue that the negative relationship between cost of equity and green assets is two-fold: Green assets functions as a hedge from climate risks and investors have green tastes.

Taken together, it is evident that the dynamics of this relationship are complex. Whether through traditional asset pricing models sorting portfolios on ESG-performance, or by regressing the implied cost of equity on a set of control variables, the heterogeneity across industries and regions have been found to have significant impacts on results. In particular, each industry presents unique challenges and opportunities in terms of environmental, social, and governance standards. Consequently, the cost of equity can exhibit considerable variation across different sectors, reflecting the industry-specific risks and opportunities associated with ESG factors.

Research by Reverte (2012) and Gregory et al. (2016) underscore that sustainability disclosure and cost of capital are deeply intertwined with industry membership. This means that the perception of risk and the associated cost of capital can be significantly influenced by the industry a firm operates within. For instance, El Ghoul et al. (2011) discovered that firms operating in ”sin” industries such as tobacco and nuclear energy had a higher cost of equity, thereby highlighting the role of industry reputation in influencing investor expectations. Research by Cajias et al. (2014) further elucidates this point by revealing considerable differences in the correlation between CSR performance and cost of equity capital across sectors in the US market. While the need to understand these dynamics in the energy and natural resource industries are important, the issue remains largely unexplored. Preliminary evidence from OECD (2021) suggests that larger non-renewable energy companies acknowledging stranded assets and implementing transition strategies could experience higher valuations than their more carbon-intensive counterparts. This highlights the potential financial benefits of ESG-focused strategies within high-emitting industries. Yet, the empirical evidence supporting this remain scarce, indicating a need for further research.

2.2.2 ESG premium in the debt market

As explained in Section 2.2, the overall cost of capital depends on both the cost of equity and the cost of debt. While most of the literature on the ESG premium has focused on the equity side (La Rosa et al., 2018), we argue that investigating the effects in the debt market is equally important.

Most firms are financed through both equity and debt. Therefore, grasping implications in both markets is essential to understand the total effects on firms’ financing costs. In particular, Dhaliwal et al. (2011) suggest further research on the effect of CSR performance is needed in the debt market due to the difference in payoff structure for lenders and equity investors. While both equity and debt holders want to minimize the downside, the potential upside differs. Equity investors, who have a claim to residual earnings, are rewarded through both capital appreciation and dividends. Their potential upside is therefore theoretically unlimited. On the other hand, lenders are typically paid through fixed interest payments and the return of the principal at maturity.

Furthermore, Menz (2010), argues that the debt market, and especially the bond market, is dominated by institutional investors such as pension funds and insurance companies. These investors usually act more rationally than private investors. Due to their size and knowledge, they are to a greater extent able to consider the complexity of ESG performance when evaluating potential investments (Menz, 2010). Thus, ESG performance might have a different impact on the debt market compared to the equity market. Furthermore, loans and bonds have a maturity date, meaning that firms must frequently return to the debt market to renew their debt agreements. Therefore, they are constantly up for new scrutiny by investors (Oikonomou et al., 2014).

In figure 1 we show the four main methods used in the literature to find the ESG premium in the debt market. These are bond yield spreads, interest rates, credit spreads and leverage access.

The first branch of research we present finds the ESG premium based on the credit spread of bonds. A bond's credit spread represents the compensation investors require for investing in a bond with default risk compared to a risk-free investment (US Treasury note) (Berk et al., 2013). There are two main methods to evaluate the ESG premium in the bond market: 1) by regressing the credit spread of the bonds to ESG performance and controlling for various variables, or 2) by investigating the difference between the credit spread of green bonds and vanilla (regular) bonds. Green bonds are bonds committed to financing environmental and climate-friendly projects such as renewable energy, sustainable resource use and climate change adaptation.

The bond literature shows mixed results. Menz (2010) conducts a study on 498 European corporate bonds over 38 months between 2004 and 2007, and find no evidence of a CSR premium. Menz (2010) argues this might be because the CSR performance is incorporated in the credit rating, which is used as a control variable. On the other hand, Oikonomou et al. (2014), who use a sample of 3000 bonds from 1991 to 2008, find evidence that bonds from companies with a more socially responsible profile (supporting local communities, have good product safety, high quality and avoiding controversies regarding the firm's workforce) have lower credit spreads. Further, Apergis et al. (2022) find similar results by using ESG ratings for S&P 500 companies from 2010-2019. Considering the second branch of bond literature, Hachenberg and Schiereck (2018) find that green bonds trade tighter, i.e., receive a premium, compared to their non-green peers.

Using bond spreads to find the ESG premium has a few drawbacks. First, comparing the results from bonds directly to the equity side is harder as some companies can have several outstanding bonds used for specific purposes, while others have none. Second, this method leaves out a large portion of the overall debt market as it does not include bank loans or bonds that do not trade in public markets. There are several advantages of including private bank loans in addition to corporate bonds. Houston and James (1996) estimate that only 17% of firms' total debt is public (primarily bonds), where the remaining 83% is mostly private debt (primarily bank loans). In addition to representing a large portion corporate debt, the types of firms issuing public bonds differ from those solely relying on bank debt. Bolton and Freixas (2000) find that riskier firms prefer bank loans while the safer ones tap the bond market. Secondly, banks have more firm-specific information and knowledge than outsiders and the public market, as companies provide this to receive the best possible loan terms (Hoepner et al., 2016). In support of this, Yi and Mullineaux (2006) show that syndicated loan markets have greater informational efficiency than the bond market as they are able to predict defaults earlier. Consequently, loan terms might differ from those in the bond market.

The argumentation above leads to the second branch of literature, which investigates the ESG premium by regressing the ESG performance on the cost of debt. This is either done by 1) considering all debt outstanding, both private bank loans and public bonds, or 2) by only considering bank loans. While the first method finds the cost of capital by dividing the interest paid over a year by its average debt, the second uses loan term agreements.

The results from the first COD method point to inconclusive results. Du et al. (2017) find evidence that corporate environmental performance has a significant negative relationship with interest rates in the Chinese market. La Rosa et al. (2018) analyze European non-financial listed firms from 2005 to 2012 and find a negative relationship between CSR performance and cost of debt. Interestingly, by looking at the Chinese market between 2007 and 2008, Ye and Zhang (2011) find that the cost of debt and CSR performance have a U-shaped relationship. Good CSR performance reduces the cost of debt as long as it is below a certain optimal level, but when the CSR performance exceeds this, firms are penalized with a higher cost of debt. This implies that firms' cost of debt is negatively impacted if their CSR performance is either at extremely high or extremely low levels compared to peers. In contrast, Magnanelli and Izzo (2017), considering a sample of 332 firms between 2005-2009, find a positive relationship between the cost of debt and CSR performance.

Following the second method, which evaluates bank loan agreement terms, Goss and Roberts (2011) use a sample of 3996 US corporate loans between 1991 and 2006 and find that firms with below average ESG scores have a higher cost of debt, where the low-quality borrowers receive the highest spread. This implies that low-quality borrowers should be more incentivized to invest in ESG compared to high-quality borrowers. However, Goss and Roberts (2011) show that firms are not rewarded for being ESG leaders in their respective industries. Nandy and Lodh (2012) show that more environmentally friendly firms receive favorable loan contracts and argue that banks view it as a risk reduction. They use a sample of US firms between 1991 and 2006. In addition, looking at 12,545 syndicated loan term facilities from 19 countries, Kim et al. (2014) show that borrowers' ethical behavior is negatively associated with loan rates. Hoepner et al. (2016) analyze 470 worldwide loan agreements signed between 2005 and 2012. They find a significant negative relationship between a country's sustainable performance and the cost of debt, but there is no significant relationship when looking at firm-specific ESG performance. Further, Hoepner et al. (2016) show that countries' environmental score is the most critical metric, twice as important as the social score.

The third branch of literature considers companies' credit ratings and whether companies with superior ESG performance receive a higher credit rating than peers. A credit rating is a rating on the quality of a borrower, and the higher the credit rating, the better a borrower looks to potential lenders. A higher rating therefore reduces the cost of debt as it leads to improved loan terms. Credit ratings are issued by several institutions such as Moodys', S&P and Fitch. However, not all companies have credit ratings, which limits the sample size of these studies. La Rosa et al. (2018), Attig et al. (2013) and Jiraporn et al. (2014) all find that credit rating agencies tend to award higher ratings to firms with better CSP. They also show that companies performing poorly in terms of CSR are penalized through lower ratings. As an example, the engineering firm ABB went from a credit rating of AA- to B+ when they received heavy litigation claims due to asbestos contamination (Menz, 2010).

The last strand of literature investigates leverage access and whether it is affected by ESG performance. First, firms with lower risk are able to increase leverage as investors assume a lower default risk. Leland (1998) finds that firms' optimal leverage level increases with the level of risk management. Second, higher leverage means that a larger portion of earnings can be shielded from taxation, thus reducing the after-tax cost of capital (Berk et al., 2013). Using this approach, La Rosa et al. (2018) find a significant positive relationship between the leverage access of a company and the CSP score. Sharfman and Fernando (2008) find that firms with better environmental risk management benefit by being able to carry higher levels of debt and Cheng et al. (2014) find that firms with better CSR performance have less capital constraints, meaning easier access to new debt.

2.3 Contribution to the literature

Table 1 presents an overview of past research on the possibility of an ESG premium in both debt and equity markets. As evident, these papers are diverse in scope, encompassing various time periods, sectors, geographies and markets, and employ a variety of methods in order to quantify and identify premia. Furthermore, most of the existing literature primarily focuses on either the debt or equity market, rarely both. By examining both markets, we allow for a more comprehensive understanding of firms' total financing costs and propose that this dual focus is a valuable addition to past literature.

10 out of 14 papers on the equity market find a significant ESG premium, while 14 of 17 papers report evidence of a similar premium in the debt market (Table 1). The literature does not conclusively affirm the presence of an ESG premium, underscoring the need for further exploration. Hence, our research contributes to the financial body of literature by providing additional and new layers of analysis within this emerging field. Given the dynamic and constantly changing focus on sustainability and ESG, our thesis uses current data to understand recent trends in this landscape.

A notable limitation of existing research is the lack of sector specific focus. As evident in Table 1, the majority of papers assessed the impact of sustainability on a firm's cost of capital across all industries collectively rather than concentrating on specific sectors. As companies within different industries are subject to unique operating mechanisms and stakeholder expectations, we argue that a sector-specific analysis is highly valuable. Particularly, there is a need to investigate the potential ESG premium specifically within energy and natural resource firms, as these companies play a crucial role in transitioning to a more sustainable future.

As of our knowledge, there is a notable shortage of research incorporating macroeconomic variables when examining the ESG premium, and for cost of capital analysis in general. The state of the macroeconomic environment has a substantial impact on firms and investors, influencing their spending, financing, and investment behaviors. Our research encompasses a long period of time, during which the macro environment varies significantly, making it essential to account for these macroeconomic effects. To the best of our knowledge, Chava (2014) is the only paper including macroeconomic risk factors in the context of ESG-research. However, they only include term spread[2] and credit spreads between low and high rated bonds and not general macroeconomic conditions. Still, incorporating such variables has been found to significantly affect both asset prices and risk perceptions (Merton, 1974). Due to high exposure to oil and energy prices and general macroeconomic conditions, this consideration is particularly important for energy and natural resource firms.

The majority of previous literature and research examines the potential premium by looking at the overall effects of the combined ESG, CSR and CSP scores. These scores combine several factors, such as climate change mitigation, sustainability, social welfare and human rights. By dividing the ESG score into the three subcomponents, we are able to separate the different effects and get a more comprehensive understanding of what investors value, and what they do not. There are a few papers investigating the environmental impact on the cost of capital (Heinkel et al., 2001; Sharfman and Fernando, 2008; Chava, 2014; Du et

[2]The difference in yields between ten-year and one-year Treasury notes

al., 2017; Nandy and Lodh, 2012), but they do not consider the social and the governance aspects. By examining all ESG pillars, we are also able to get an understanding of the drivers on the overall ESG premium. We therefore argue that an important contribution to the literature is to separate the ESG scores into subcomponents and understand their individual contribution.

Furthermore, there is an opportunity to enhance the robustness of the methodological approach by using alternative tools to decide which independent variables to include in the analysis. As of our knowledge, existing literature on ESG premia primarily relies on theoretical frameworks and various hypotheses to guide the selection of control variables. Thus, the choice of control variables in these analyses varies to a great extent, particularly in the context of debt markets. As the classical approach of selecting control variables relies on multiple distinct theories and hypotheses, in addition to being prone to selection biases, we introduce two feature selection models: best subset and LASSO. This helps to exclude irrelevant variables from the multivariate regression model.

Authors	Published	E / D	Method	Area	Years	Industry	Macro	Sample	ESG prem.
Menz	2010	D	Bond	Europe	2004-2007			498	No
Oikonomou et al.	2014	D	Bond	Global	1991-2008			3000	Yes
Apergis et al.	2022	D	Bond	US	2010-2019			1540	Yes
Hachenberg & Schiereck	2018	D	Bond						Yes
La Rosa et al.	2018	D	RegCOD, CredRat, Lev	Europe	2005-2012			350	Yes
Du et al.	2017	D	RegCOD	China	2009-2011			712	Yes
Hoepner et al.	2016	D	RegCOD	Global	2005-2012			470	No[a]
Goss & Roberts	2011	D	RegCOD	US	1991-2006			3996	Yes
Nandy & Lodh	2012	D	RegCOD	US	1991-2006			3000	Yes
Kim et al.	2014	D	RegCOD	Global	2003-2007			12,545	Yes
Attig et al.	2013	D	CredRat	US	1991-2010			1585	Yes
Jiraporn et al.	2014	D	CredRat	US	1995-2007			2516	Yes
Cheng et al.	2014	D	Lev	Global	2002-2009			2191	Yes
Magnanelli & Izzo	2016	D	RegCOD		2005-2009			332	No
Ye and Zhang	2011	D	RegCOD	China	2007-2008			1446	Yes[b]
Ge and Liu	2012	D	Bond, CredRat		1992-2009			2317	Yes
Sharfman and Fernando	2008	E + D	APM	S&P 500	1999-2001			267	Yes[c]
Koch & Bassen	2013	E	APM	Europe	2005-2010	Utilities		20	Ambiguous[d]
El Ghoul et al.	2011	E	ICC		1992-2007			2809	Yes
Chava et al.	2014	E + D	ICC		1992-2007		Yes[e]	875	Yes
Gonçalves et al.	2022	E + D	ICC	Europe	2002-2018			413	Yes
Salama et al.	2011	E	APM	UK	1994-2006				
Pástor et al.	2022	E + D	ICC	US	2012-2020				Yes
Gregory et al.	2016	E	APM						Ambiguous[f]
Humphrey et al.	2012	E	APM	UK	2002-2010			256	No
Girerd-Potin et al.	2014	E	APM	France	2003-2010			816	Yes
Li et al.	2017	E	APM	China	2009-2014			161	Yes
Reverte et al.	2011	E	ICC	Spain	2003-2008			26	Yes[g]
Cajias et al.	2014	E	ICC	US	2003-2010			2300	Yes

Table 1: Literature overview of previous research on the ESG premium. Year is when the paper was published. E/D refers to which market the paper focuses on. The fourth column refers to the method applied to investigate the ESG premium. The categories are the same as in figure 1 where APM is asset pricing models, ICC is using an implied cost of equity, CredRat is credit ratings, RegCOD is regressing COD on control variables and Lev is leverage access. The subsequent columns refer to the region, years, and the industry of the data sample, and if they include macroeconomic variables. Missing values in the industry and macro column indicates that the paper does not focus on any particular industry or does not include macro variables. The sample size of the data set is either the number of firms, bonds, or loan terms observed. The last column notes whether an ESG premium was found

[a] ESG premium not found based on firms' ESG performance. However, the country ESG performance has an affect on the COC.
[b] ESG premium found, but not for very high, nor very low ESG values.
[c] Find the existence of an ESG premium for equity, not for debt.
[d] Premium attributed to growth and profitability.
[e] Includes two: difference in yield between ten-year and one-year Treasury notes, and credit spread (difference in yields between high and low rated bonds)
[f] Premium attributed to earnings persistence and industry effects.
[g] The effect is more pronounced for environmentally sensitive industries.

3 Data

This chapter presents the data used for the analysis. We extract firm-specific data from the Thomson Reuters Eikon Database, which primarily collects data from the institutional broker estimate system I/B/E/S. We gather macroeconomic data from the FRED database created and maintained by the Research Department at the Federal Reserve Bank of St. Louis, providing data from national, international, public, and private sources. In this section we outline the data sample construction used to generate the final data set. Subsequently, we argue for the inclusion of each of the ESG, firm-specific, and macroeconomic variables.

3.1 Sample construction

We aim to identify the ESG premium for companies operating in the energy and natural resources industries and therefore construct a dataset by selecting all publicly traded companies within the sectors "Utilities," "Energy," and "Basic Materials" globally. We consider data between 2010 and 2021 and extract the data on June 30 every year. Using these criteria yields 2,076 unique firms and 24,829 firm-year observations.

Second, we determine the country of headquarters for the companies retrieved from the database and categorize observations by region. The categorization includes five geographical regions: Europe, North America, South America, Asia, Africa, and Oceania. We categorize the data into different regions to account for the different policies, the difference in risk premium across regions, the attitude towards ESG, and other cultural and institutional characteristics. Previous literature supports the idea of including geographical location in the analysis, as different regions are subject to contingent economic conditions (Magnanelli and Izzo, 2017). Hope (2003) finds that forecast accuracy varies significantly across countries. Both Breuer et al. (2018) and Wei et al. (2009) find that in countries where investor protection is strong, the cost of equity falls when firms invest in CSR. We categorize firms by region instead of individual countries, as most countries are represented by a limited number of firms, which could lead to biased estimates as the country-level effects could dominate the observed variation for those companies.

We then determine the industry each firm operates in - the same as those identified in the initial sample construction - to control for industry effects. Firms' economic state might vary depending on the sector in which they operate due to differences in leverage ratios, risk exposure or sector-specific financial benchmarks. Fama and French (1997) find substantial variation in factor loadings across industries. Sharfman and Fernando (2008) argue that different industries may have different levels of environmental risk management and cost of capital and find the industry effect to be significant in their analysis. Gebhardt et al. (2001) also find a significant relationship for the industry effects in their sector-focused analysis on the cost of equity.

3.1.1 ESG variables

To conduct the analysis, we need a way to measure ESG performance. The Thomson Reuters Eikon database serves this need well as it offers one of the most comprehensive ESG databases, covering over 85% of global market capitalization across more than 630 different ESG metrics (Refinitiv Eikon, 2023). The database provides data-driven, but manually set estimates of ESG performance carried out by over 700 research analysts. They derive these estimates from standardized guidelines to guarantee comparability across the entire range of companies and use publicly reported data, such as annual reports, company websites, CSR reports, and news, to set the score. The ESG database is updated weekly (Refinitiv Eikon, 2023). The *ESG score* is between 0 and 100, where a low score indicates poor ESG performance and insufficient transparency in reporting material. In contrast, a high score indicates good ESG performance and a high degree of transparency (Refinitiv Eikon, 2023).

In addition to the overall *ESG score*, we extract the score for each of the three ESG components: the *environmental score* (*Env*), the *social score* (*Soc*), and the *governance score* (*Gov*). The *environmental score* is based on resource use, environmental innovation, and emissions. The *social score* is based on four factors: workforce, human rights, community, and product responsibility. Lastly, the *governance score* is based on management, shareholders, and CSR strategy. In Appendix A, each sub-category is described in detail according to the definitions of Refinitiv Eikon (2023).

The *ESG score* integrates and accounts for industry materiality and company size biases and is a relative sum of the individual environmental, social, and governance scores. The score is based on a weighted method that varies based on industry for the environmental and social categories, while for governance, the weights remain the same across all industries. For example, for the oil and gas industry, the environmental score accounts for 35% of the total ESG score, the social score accounts for 42%, and the governance accounts for the remaining 23%. In contrast, for the paper and forest industry, these weights are 47%, 30%, and 23% respectively (Refinitiv Eikon, 2023).

3.1.2 Equity control variables

According to the Capital Asset Pricing Model (CAPM), we should be able to find the cost of equity purely by looking at realized returns and the sensitivity to systematic risk (the market beta). However, later research on asset prices has revealed evidence for other factors affecting returns, such as book-to-market values and size. We therefore rely on empirical studies such as Gebhardt et al. (2001) and Hail and Leuz (2006) to find adequate risk factors[3]. We include the *market beta*, *size*, *book-to-market*, and *leverage*. Following El Ghoul et al. (2011) we also include the *long-term growth* and *forecast dispersion* as independent variables and possible risk measures.

We estimate the *market beta* (*Beta*), which measures a stock's sensitivity to market fluctuations, by calculating the covariance of the stock's weekly returns with the weekly returns of the market, divided by the variance of market returns. We do this over a three year period for each *Beta* estimate. As a proxy for the market portfolio, we use the S&P 500 index, as is common in the financial industry and literature. Following CAPM, we should find a positive relationship between *market beta* and the cost of equity capital, as investors expect compensation for taking on systematic, non-diversifiable risk (Lintner, 1975; Mossin, 1966; Sharpe, 1964; Treynor, 1961).

We calculate the *firm size* (*Size*) by taking the natural logarithm of the firm's total assets in USD. Fama and French (1992) find that publicly traded companies with small market capitalizations generate higher returns, implying that larger firms have a lower rate of required return. Thus, we expect a negative relationship with the cost of equity variable.

[3] The variables included are also inspired by the work by Kjellevoll and Wilberg, 2022

Furthermore, a firm's size could function as a proxy for its relationship with the public and the degree of information disclosure. Barth and Hutton (2000) show how size is highly correlated with other measures generally accepted to affect the availability of information and scrutiny by the public, such as bid-ask spreads and institutional ownership. Information disclosure and connectedness to analysts, institutional investors and other stakeholders should be negatively related to risk premia and the cost of equity. The underlying rationale is that reduced information asymmetry between firm management and investors mitigates informational risk. Diamond and Verrecchia (1991) show that information disclosure can lead to higher demand from institutional investors, increased liquidity, and a lower risk premium. This is supported by later findings by Botosan (1997), and Healy et al. (1999) showing that disclosure of information increases liquidity and lowers bid-ask spreads and the risk premium.

We calculate the *book-to-market* (*BtM*) variable by dividing the book value of equity by its market value. Depending on the context, researchers have used this as a control for risk, growth opportunities, and market mispricing (Goss and Roberts, 2011). High *book-to-market* firms, also known as value stocks, are found to have a significant positive association with expected returns (Fama and French, 1992). Furthermore, distressed firms are more likely to have high BtM ratios and are more sensitive to macroeconomic factors, resulting in increased risk (Griffin and Lemmon, 2002). We therefore expect the *book-to-market* coefficient to be positive.

Leverage (*Lev*), calculated as total debt divided by the market value of equity, is expected to have a positive coefficient, as levered firms earn higher subsequent stock returns (Fama and French, 1992). Also, according to Modigliani and Miller (1958), when assuming no taxes or transaction costs, the cost of equity should rise linearly with the increase in leverage.

The *long-term growth* (*LTG*) rate is the expected five-year growth rate, which we extract directly from the Eikon database as the compound average rate of earnings per share (EPS) growth analysts expect over a period of three to five years. Markets generally perceive high-growth companies as riskier, partly because misunderstanding or overstating the growth rate will considerably affect the discounted value of future earnings. We therefore expect to find a positive coefficient for *long-term growth*. Several papers identify a negative coefficient, arguing that markets are overly optimistic on behalf of high-growth firms, resulting in lower risk premia (La Porta, 1996). However, as we employ analyst forecasts in the cost of equity computations and isolate future earnings expectations, we implicitly account for these effects in our models. The excessive optimism will therefore not affect the cost of equity but rather the asset prices themselves.

Forecast dispersion (*Disp*) measures the variation in one-year-ahead earnings forecasts, with high forecast dispersion indicating disagreement among analysts covering the stock and, therefore, a source of risk. Previous studies have found a positive relation between forecast dispersion and risk (and Heitzman et al., 2006; Gode and Mohanram, 2003; El Ghoul et al., 2011).

Table 2 shows a summary of the expected signs of the control variables.

3.1.3 Debt control variables

In addition to variables mentioned above, we use the following firm-specific variables: *return on assets*, *interest coverage*, *adjusted leverage*, *tangibility*, *liquidity*, *performance*, *revenue growth*, *tobinQ*, *asset growth* and *cash flow*.

We calculate *return on assets* (*ROA*) as the income before extraordinary items divided by total assets. More profitable firms should benefit from a lower cost of debt due to their lower default risk, thus leading to an expected negative coefficient.

Interest coverage (*IntCov*) is the sum of income before extraordinary items and interest expenses divided by interest expenses. Interest coverage is a measure of risk where the lower the interest coverage, the higher the risk (Sanchez-Ballesta and Garcia-Meca, 2011; Attig et al., 2013). We therefore expect a negative coefficient.

Adjusted leverage (*AdjLev*) represents total debt divided by total assets less the median ratio in the same industry-year cluster. We subtract the industry-year median because of the difference in leverage levels across industries. Petersen and Rajan (1994) argue that firms with higher leverage tend to pay higher spreads, and Merton (1974) finds that firms are more likely to default when the leverage ratio approaches 1. On the other hand, higher leverage might indicate that lenders have confidence in the firm's ability to repay its debt obligations, and thus see the firm as a less risky investment. The expected sign of the coefficient is thus unclear.

Tangibility (*Tang*) is defined as property, plant and equipment divided by total assets, and controls for asset structure. Pittman and Fortin (2004) argue that the cost of debt increases with increasing tangibility as the banking industry perceives them as riskier borrowers and thus must provide security for their loans. We therefore expect the coefficient to be positive.

We measure *liquidity* (*Liq*) as current assets divided by the current liabilities. Firms with high liquidity can meet their current obligations and thus have lower risk and, thereby, should benefit from a lower cost of debt.

Performance (*Perf*) is calculated as the income before extraordinary items divided by sales. We expect the coefficient to be negative since better performance, represented by higher operating margins, decreases the likelihood of default.

Revenue growth (*RevG*) is the historical one-year growth rate in sales. According to Bliss and Gul (2012), firms that experience sales growth are less likely to default on their loans. This is because the increase in revenue enables them to better serve their debt obligations. The total effects are, however, more complex. Similar to the equity side, a high growth rate could also indicate uncertainty with regards to future expected earnings. Furthermore, if a considerable amount of new debt is needed to fund the revenue expansion, this could raise investor concerns. We therefore do not assume the coefficient sign.

We also include *asset growth* (*AssetG*). Similar to revenue growth, a high growth in assets can function as an indicator of positive earnings outlooks. On the other hand, asset growth often needs to be financed by issuing new debt, which could represent an increase in risk. Similar to revenue growth, the expected sign is uncertain due to several confounding factors.

TobinQ is a measure of the firm's market value divided by the replacement cost of its assets and is a proxy of the relationship between intrinsic and market value. It is calculated by dividing the sum of market capitalization plus long- and short-term debt by the book value of total assets. *TobinQ* is therefore a measure of risk, as lower values reflect greater default risk (Sanchez-Ballesta and Garcia-Meca, 2011). We expect the coefficient to have a negative sign.

We also incorporate a *cash flow* margin, measured as operating cash flow divided by total assets. Cash-generating firms are better positioned to service their debt obligations, and we therefore expect a negative coefficient to the cost of debt (Petersen and Rajan, 1994; Pittman and Fortin, 2004).

We calculate the *market beta*, *size* and the *long-term growth* using the same method as for the equity control variables, and the expected sign of the coefficient remains the same: We expect a positive *market beta* coefficient, negative *size* coefficient and a positive *long-term growth* coefficient.

Table 2 summarizes the expected sign of the control variables.

3.1.4 Macroeconomic control variables

The relationship between macroeconomic factors and capital markets has been thoroughly debated, primarily in the context of stock market returns. Macroeconomic factors have been known to affect both risk perceptions and asset prices (Merton, 1973). Furthermore, these risks are non-diversifiable, and firms affected by such factors should therefore experience a change in the risk premium (Ross, 1976). These macroeconomic factors should affect most firms, although in different ways through both earnings and risk premia, and we argue that including them as independent variables is suitable. We primarily extract macroeconomic data from the US market[4].

The first empirical study on macroeconomic effects was conducted by Chen et al. (1986). Using a multi-factor model, the authors find that changes in macroeconomic variables significantly influence stock returns. While the authors find no such effect from oil prices, they note the importance of differences across industries. In the following years, several papers produced similar results (Fama and French, 1989; Ferson and Harvey, 1991; Schwert, 1990).

To our knowledge, previous literature on ESG premia in the equity and debt markets do not include macroeconomic factors in their models. This is partly explained by year-effects being included and accounted for using dummy variables and fixed-effects regression models, where the year-variable would capture relevant macroeconomic factors. However, we argue that this fails to capture and study the individual effects themselves and therefore leaves out important information. We contribute to the literature by including risk factors related to the macroeconomic environment the firms operate in by adding measures for volatility, energy prices, inflation and term-structure slope. While this is certainly not an exhaustive list of potential macroeconomic factors, we note that controlling for industry and country/region effects will capture many regional and industry-wide differences in policy, economic sentiment and expectations.

The *VIX index* (*VIX*) measures the implied volatility in the market and represents the expected 30-day volatility. It is calculated as the weighted average of out-of-the-money call and put options on the S&P 500 index. A lower *VIX* represents a decrease in risk in the market and the economy, which theoretically should lower the overall market risk premium (Galil et al., 2014; Zhang et al., 2009). DeLisle et al. (2011) find that sensitivity to the VIX is negatively associated with returns as volatility increases. However, we argue that the negative relationship with short-term stock returns is due to an increase in risk premia rather than long-term expected returns. Therefore, we expect a positive relation

[4] The validity of doing this is discussed further in Section 6.3.

between *VIX* and cost of equity.

Inflation (*Infl*) is the percentage of inflation change per year. We use inflation as the increase in the consumer price index (CPI) from the US. Bodie (1976), Fama (1981), Pearce and Roley (1983) and Geske and Roll (1983) document a negative relation between the inflationary rate and equity values. However, Fama (1981) claims that this relationship is merely a proxy for the relationship between expected real economic activity and financial returns. Mundell (1963) and Tobin (1965) show through equilibrium models that high expected inflation raises the opportunity costs of money, and investors therefore shift towards interest-bearing assets. The shift results in a decrease in the cost of capital. Kaul (1987) shows that the negative relation between returns and inflation can be attributed to counter-cyclical money supply effects through the equilibrium process in the monetary sector. We therefore expect a negative inflation coefficient.

The *spot rate* (*Spot*) is the 10-year maturity treasury collected from FRED. Interest rates will directly impact the cost of capital as they affect borrowing costs for companies. Longstaff and Schwartz (1995) argue that a higher spot rate increases a company's internal rate used to value an investment's net present value. A higher rate implies fewer risky projects will be launched; thus, the probability of default decreases. We therefore expect a negative spot rate coefficient.

The *term-structure slope* (*Slope*) is calculated as the differences between the 10-year Treasury Constant Maturity Rate and the two-year Treasury Constant Maturity Rate. Fama and French (1989) argue that an increase in the slope coefficient predicts improved economic growth and activity. On the other hand, Zhang et al. (2009) argue that an increase can forecast a rising inflation rate and a tightening of monetary policy, and Galil et al. (2014) argue that an increase in slope reduces the number of positive net present value projects. Due to the divided literature, it is unclear what sign to expect.

We include the *brent oil price* (*Brent*) as a control variable as we hypothesize that the sectors examined are highly dependent on the price of energy. Energy prices should have material effects on cash flows and, in turn, financial returns. As we can isolate the cash flow effects, both current and expected, using an implied cost of equity method[5], the relation to the discount rate in our analysis is unclear. Sklavos et al. (2013) argue that shocks in the oil price affect energy companies, which then trigger investors to change their shareholdings in these assets. This implies that when energy prices increase, energy firms will experience a demand shock as investor interest increases. Intuitively, a negative relationship between the cost of capital and the oil price is expected. On the other hand, Prodromou and Demirer (2022) find that oil supply shocks have a positive effect on the cost of capital and argue that this is a result of an increase in uncertainty. A supply shock will lower long-term oil prices, and increase uncertainty regarding future profitability. Furthermore, while the negative impacts of oil price shocks on the economy are well documented, there is generally no consensus on the behavior of stock markets regarding changes to the oil price (Reboredo and Rivera-Castro, 2014).

Table 2 shows a summary of the expected sign of the control variables.

[5] We discuss implied cost of equity in Section 4.1.

Control variable	Expected sign	
	Equity	Debt
Beta	+	+
Size	-	-
Lev	+	
BtM	+	
LTG	+	+
Disp	+	
ROA		-
IntCov		-
Tang		+
AdjLev		Unknown
Liq		-
AssetG		Unknown
Perf		-
CashFlow		-
RevG		Unknown
TobinQ		-
Brent	Unknown	Unknown
VIX	+	+
Infl	-	-
Slope	Unknown	Unknown
Spot	-	-

Table 2: Overview of the expected sign of the control variables, both firm-specific and macroeconomic, for both equity and debt. "Unknown" indicates diverging results in existing literature, or confounding effects, and we can therefore not assume the sign of the coefficient.

3.2 Descriptive statistics

This section presents the descriptive statistics of the data sample[6]. Table 3 summarizes the *ESG score* data, each of the three ESG subcomponents and the macroeconomic variables. The mean value of the *ESG score* is 46, with mean *environmental*, *social* and *governance* scores of 44, 44 and 53 respectively. The *brent oil price*, measured in US dollars per barrel, has a mean value of 68 over the period analyzed, reaching a high of 105 and lows under 40. The *inflation rate* was fairly stable throughout the period, ranging between 218 basis points and 272 basis points.

Variable	N	Mean	Std. Dev.	Min	Q1	Q3	Max
ESG	11445	46	21	7.4	29	63	87
Env	11445	44	26	0.88	21	65	92
Soc	11445	44	24	2.6	24	64	93
Gov	11445	53	23	7.2	34	71	94
Brent	10	68	20	39	48	85	105
VIX	10	19	6.8	12	14	18	34
Infl	10	247	15	218	238	258	272
Slope	10	1.2	0.76	0.25	0.5	1.7	2.7
Spot	10	2	0.73	0.66	1.4	2.5	3.2

Table 3: Summary statistics of the ESG scores and the macroeconomic control variables. N represents the number of firm-year observations. Size is the logarithm of totals assets measured in USD. ESG and its subcomponents are scores between 0 and 100. The brent oil price is measured in USD/barrel. Inflation rate is measured in basis points (bps), while the spot rate and slope are percentages

3.2.1 Descriptive statistics on the equity side

Table 4 summarizes the descriptive statistics of the control variables used for the equity analysis, with 4,477 firm-year observations.

Variable	N	Mean	Std. Dev.	Min	Q1	Q3	Max
Beta	4477	0.84	0.46	-0.17	0.5	1.1	2
Size	4477	23	1.3	20	22	24	26
BtM	4477	0.72	0.49	0.079	0.39	0.91	2.8
Lev	4477	0.58	0.59	0.0012	0.19	0.76	3.2
LTG	4477	0.15	0.2	-0.2	0.049	0.2	1.2
Disp	4477	12	28	-133	4	17	147

Table 4: Summary statistics of the control variables used in the equity analysis. N represents the number of firm-year observation, which in this case is limited by the variable with the lowest number of available observations. *Leverage* (Lev) and *book-to-market* (BtM) are ratios as described in Section 3.1.2. *Size* is the logarithm of total assets measured in USD. *long-term growth* (LTG) is the expected 5 year EPS growth rate. *Forecast dispersion* (Disp) is the coefficient of variation for analyst forecastsed earnings.

Table 4 shows a substantial degree of variation existing in the financial characteristics of the companies utilized in the equity analysis. The *market beta* ranges from -0.17 to 2.0 with a mean of 0.84, suggesting that, on average, the companies carry slightly less

[6]We winsorize variables at 1% and 99%.

systematic risk than the overall market portfolio. The variation in logarithm of total assets (*Size*) indicates a broad spectrum of company sizes. The mean *leverage* of 0.58 implies a capital structure composed of approximately 63% debt and 37% equity [7]. The *long-term growth* shows significant variation and the *forecast dispersion* indicates a broad range of potential outcomes and high uncertainty.

The high variation in *forecast dispersion* values could be attributed to differences in analyst forecasts when important news affecting a company is reported. Suppose a company releases news that affects its projected earnings. In that case, it is plausible that not all analysts covering the stock would have updated their analyses by the time we extract the data. This is supported by Ali et al. (1992), which propose that analysts may not fully utilize all available information when forecasting and may react slowly to news. Additionally, the *forecast dispersion* variable is sensitive to mean earnings close to zero. Based on the high variation in the variable, we decide to not include it in our analysis.

Table 5 presents a Pearson's correlation matrix for the independent variables. It shows a strong correlation between the macroeconomic variables. For example, *inflation* correlates with the *slope* (0.7) and with *spot* (0.6), and the *brent oil price* exhibits similar correlation levels to the other macroeconomic variables. This may result from the variables all being closely related to the overall economic market condition. We also note that the *book-to-market* and *leverage* variables correlate with a value of 0.4, and that *Size* correlates with a coefficient of 0.4 to the *ESG score*. The correlation could indicate potential multicollinearity issues, and we thus perform a VIF test. We show the results from the VIF test in Appendix B, which indicates that all the VIF scores are below the critical value five (Brooks et al., 2019). We are therefore confident in including all the control variables above in the regression model

[7] Leverage is calculated as debt divided by market capitalization. We compute debt and equity ratios as $\frac{D}{V} = \frac{0.6}{1+0.6} \approx 0.375$ and $\frac{E}{V} = \frac{1}{1+0.6} \approx 0.625$, where V is total firm value.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) ESG	1	0.049	0.448	0.044	-0.003	-0.048	-0.086	0.041	0.157	-0.102	-0.110
(2) Beta	0.049	1	-0.006	0.081	-0.010	0.125	0.072	0.003	-0.115	0.105	0.060
(3) Size	0.448	-0.006	1	0.169	0.285	-0.129	0.012	0.036	0.003	0.012	-0.006
(4) BtM	0.044	0.081	0.169	1	0.419	0.067	-0.011	-0.020	-0.026	-0.002	-0.055
(5) Lev	-0.003	-0.010	0.285	0.419	1	0.025	-0.057	-0.001	0.055	-0.053	-0.074
(6) LTG	-0.048	0.125	-0.129	0.067	0.025	1	0.007	-0.038	0.015	-0.005	0.048
(7) Brent	-0.086	0.072	0.012	-0.011	-0.057	0.007	1	-0.274	-0.426	0.649	0.571
(8) VIX	0.041	0.003	0.036	-0.020	-0.001	-0.038	-0.274	1	-0.131	0.041	-0.284
(9) Infl	0.157	-0.115	0.003	-0.026	0.055	0.015	-0.426	-0.131	1	-0.708	-0.554
(10) Slope	-0.102	0.105	0.012	-0.002	-0.053	-0.005	0.649	0.041	-0.708	1	0.489
(11) Spot	-0.110	0.060	-0.006	-0.055	-0.074	0.048	0.571	-0.284	-0.554	0.489	1

Table 5: Pearson's correlation matrix for the equity control variables showing the relationship between each of the variables used in the regression analysis. In particular, we note a high correlation between the macroeconomic variables.

3.2.2 Descriptive statistics on the debt side

Table 6 shows the descriptive statistics of the control variables used for finding the ESG premium where we have 4,977 firm-year observations.

Variable	N	Mean	Std. Dev.	Min	Q1	Q3	Max
Beta	4977	0.84	0.47	-0.18	0.5	1.1	2.1
Size	4977	23	1.3	20	22	24	26
Lev	4977	0.61	0.65	0.0019	0.19	0.79	3.7
LTG	4977	0.13	0.21	-0.34	0.038	0.18	1.1
ROA	4977	0.043	0.058	-0.16	0.018	0.067	0.24
IntCov	4977	17	42	-4.1	2.8	12	322
Tang	4977	0.55	0.28	0.013	0.35	0.72	1.6
AdjLev	4977	-76	760	-9828	-0.16	0.051	5.2
Liq	4977	1.6	1	0.35	1	2	6.2
AssetG	4977	0.076	0.2	-0.31	-0.024	0.12	1.2
Perf	4977	0.089	0.16	-0.64	0.03	0.14	0.71
CashFlow	4977	0.097	0.063	-0.051	0.06	0.12	0.34
RevG	4977	0.046	0.23	-0.45	-0.074	0.14	1
TobinQ	4977	1.1	0.63	0.36	0.74	1.3	4

Table 6: Summary statistics of the control variables used in the debt analysis. N represents the number of firm-year observation, which is limited by the control variable with the fewest firm-year observations. *Market beta* (Beta), *Size*, *Leverage* (Lev), and *long-term growth* (LTG) are measured in the same way as on the equity side. *Return on assets* (ROA), *interest coverage ratio* (IntCov), *tangibility* (Tang), *adjusted leverage* (AdjLev), *liquidity* (Liq), *cash flow margin* (CashFlow) and *performance* (Perf) and *TobinQ* are ratios as described in Section 3.1.3. *Revenue growth* (RevG) and *asset growth* (AssetG) are growth rates calculated as decimals.

The *market beta*, *size*, *leverage*, and *long-term growth* variables exhibit similarities to those observed on the equity side. The substantial range in *interest coverage* may arise from the inclusion of firm-year observations with high income levels or low leverage, resulting in low interest expenses. The mean *Liquidity* ratio is 1.6 where a value greater than 1 is optimal. Roughly one-quarter of the firm-year observations have ratios below 1.

As seen from the descriptive table, *adjusted leverage* ranges from -9,828 to 5.2 with a mean value of -76. This variation stems from the calculation of subtracting industry means. Due to the poor data quality of this variable, we decide to use the *leverage* coefficient instead.

In Table 7 we show the Pearsons' correlation matrix for the debt data. As evident, the macroeconomic variables are also here highly correlated to each other. In addition, we see that the *performance* and the *return on assets* has a high correlation of 0.7 and the *cash flow* and *return on assets* has a correlation of 0.6. This is expected, as these variables all relate to company earnings. To test whether the correlation is manageable and the data is without multicorrelation, we perform a VIF test on the debt data. The VIF results are shown in Appendix B. All values are below the critical value five, and we therefore include these control variables in the next step of the analysis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) ESG	1	0.038	0.445	-0.013	-0.038	-0.067	-0.032	-0.085	-0.091	-0.125	-0.070	-0.066	-0.162	-0.113	-0.094	0.039	0.172	-0.111	-0.113
(2) Beta	0.038	1	-0.011	0.027	0.090	-0.131	-0.029	-0.123	0.147	-0.002	-0.193	-0.035	-0.019	-0.100	0.043	0.007	-0.093	0.081	0.047
(3) Size	0.445	-0.011	1	0.260	-0.106	-0.138	-0.132	0.111	-0.304	-0.064	-0.020	-0.166	-0.090	-0.346	0.009	0.029	0.003	0.013	-0.004
(4) Lev	-0.013	0.027	0.260	1	0.004	-0.385	-0.243	0.061	-0.298	-0.099	-0.230	-0.354	-0.105	-0.415	-0.051	0.004	0.032	-0.038	-0.073
(5) LTG	-0.038	0.090	-0.106	0.004	1	-0.163	-0.042	0.007	0.043	0.061	-0.132	-0.085	0.090	0.060	0.017	-0.039	0.004	0.002	0.060
(6) ROA	-0.067	-0.131	-0.138	-0.385	-0.163	1	0.353	-0.001	0.182	0.244	0.727	0.579	0.256	0.484	0.083	0.004	-0.084	0.038	0.076
(7) IntCov	-0.032	-0.029	-0.132	-0.243	-0.042	0.353	1	-0.039	0.286	0.071	0.187	0.345	0.049	0.261	0.030	0.006	-0.036	0.028	0.019
(8) Tang	-0.085	-0.123	0.111	0.061	0.007	-0.001	-0.039	1	-0.179	0.366	0.155	0.218	0.191	-0.020	0.039	0.060	-0.053	0.044	0.044
(9) Liq	-0.091	0.147	-0.304	-0.298	0.043	0.182	0.286	-0.179	1	0.049	0.044	0.173	0.016	0.247	0.015	-0.020	-0.004	0.016	0.009
(10) AssetG	-0.125	-0.002	-0.064	-0.099	0.061	0.244	0.071	0.366	0.049	1	0.253	0.217	0.438	0.173	0.078	0.054	-0.025	0.003	0.071
(11) Perf	-0.070	-0.193	-0.020	-0.230	-0.132	0.727	0.187	0.155	0.044	0.253	1	0.353	0.324	0.272	0.081	0.001	-0.036	0.018	0.049
(12) CashFlow	-0.066	-0.035	-0.166	-0.354	-0.085	0.579	0.345	0.218	0.173	0.217	0.353	1	0.196	0.452	0.038	0.038	-0.071	0.057	0.028
(13) RevG	-0.162	-0.019	-0.090	-0.105	0.090	0.256	0.049	0.191	0.016	0.438	0.324	0.196	1	0.149	0.178	-0.122	-0.043	-0.072	0.122
(14) TobinQ	-0.113	-0.100	-0.346	-0.415	0.060	0.484	0.261	-0.020	0.247	0.173	0.272	0.452	0.149	1	0.022	0.014	0.017	0.025	0.031
(15) Brent	-0.094	0.043	0.009	-0.051	0.017	0.083	0.030	0.039	0.015	0.078	0.081	0.038	0.178	0.022	1	-0.301	-0.426	0.657	0.570
(16) VIX	0.039	0.007	0.029	0.004	-0.039	0.004	0.006	0.060	-0.020	0.054	0.001	0.038	-0.122	0.014	-0.301	1	-0.087	-0.001	-0.330
(17) Infl	0.172	-0.093	0.003	0.032	0.004	-0.084	-0.036	-0.053	-0.004	-0.025	-0.036	-0.071	-0.043	0.017	-0.426	-0.087	1	-0.696	-0.542
(18) Slope	-0.111	0.081	0.013	-0.038	0.002	0.038	0.028	0.044	0.016	0.003	0.018	0.057	-0.072	0.025	0.657	-0.001	-0.696	1	0.478
(19) Spot	-0.113	0.047	-0.004	-0.073	0.060	0.076	0.019	0.044	0.009	0.071	0.049	0.028	0.122	0.031	0.570	-0.330	-0.542	0.478	1

Table 7: Pearsons correlation matrix for the debt control variables showing the relationship between each of the variables used in the regression analysis.

4 Methodology

This thesis aims to investigate whether an ESG premium exists in the energy and natural resource sectors, both looking at the equity and debt markets. To accomplish this, we use a three-step approach. The initial step involves using models to determine the cost of equity based on ex-ante expectations and a model for the cost of debt. Subsequently, we utilize a feature selection method to determine the appropriate control variables for the analysis. Lastly, we conduct a multivariate regression analysis using panel data with the cost of equity and debt as dependent variables and the selected control variables as independent variables. The following sections provide a detailed explanation of the process and outline these three steps in depth.

4.1 Determining the cost of capital

4.1.1 Implied cost of equity computation

As described in Section 2, using ex-ante returns to measure the implied cost of capital contrasts most literature, where ex-post returns remain most prevalent. Section 2.2.1 addresses the potential limitations of realized returns as proxies for expected returns (Pástor et al., 2022; Elton, 1999; Fama and French, 1992). The general use of realized returns is primarily due to the inherent unobservability of expected returns. However, given the access to and availability of current data, utilizing an implied cost of capital measure derived from forecasted earnings is feasible. In this context, the implied cost of equity capital is the discount rate that equates expected future earnings to the current share price.

More specifically, we employ the abnormal growth model of Ohlson and Juettner-Nauroth (2003, 2005) (OJ), as implemented by Gode and Mohanram (2003). The OJ model is presented in equation 1. It expresses the implied cost of equity capital (COE_{OJ}) as a function of the current share price, earnings forecasts, expected dividend payments and an expected growth rate. The explicit forecast horizon is set to 1 year, after which earnings experience near-term growth before stabilizing at a perpetual growth rate. The near-term rate (g_2) [8] (eq. 3), is determined by averaging a long-term growth forecast (LTG) and the short-term growth (STG) rate (eq. 4). We use a 3% inflationary rate for the perpetual growth rate (eq. 5). While one might argue that the perpetual growth rate should differ across firms, devising a method to accurately model this is infeasible. By setting the same $\gamma - 1$ (eq. 5) for all firms we also note that the choice of perpetual growth rate only affects mean cost of equity, and not the relative differences, which is what we are interested in. The model requires both the 1-year-ahead and 2-year-ahead earnings forecasts to be positive. While previous studies assume constant dividend payments equal to the prior year's actual dividends, we take advantage of available dividend forecasts and instead employ forecasted dividends for year $t + 1$.

$$COE_{OJ} = A + \sqrt{A^2 + \frac{FEPS_{t+1}}{P_t}(g_2 - (\gamma - 1))} \tag{1}$$

[8] The original OJ model uses only the two-year earnings growth and does not use a five year growth forecast. However, following the implementation by Gode and Mohanram (2003) we incorporate long-term growth in the estimation of near-term growth to avoid to leave out important information regarding future expectations.

$$A = \frac{1}{2}\left((\gamma - 1) + \frac{FDPS_{t+1}}{P_t}\right) \tag{2}$$

$$g_2 = \frac{STG + LTG}{2} \tag{3}$$

$$STG = \frac{FEPS_{t+2} - FEPS_{t+1}}{FEPS_{t+1}} \tag{4}$$

$$(\gamma - 1) = r_f - 0.03 \tag{5}$$

where:

- COE_{OJ}: the implied cost of equity computed using the Ohlson and Juettner-Nauroth (2005) model,
- P_t: stock price on June 30 of year t,
- $FEPS_{t+1}$: forecasted earnings per share in year t+1, measured as of June in year t. Similarly, $FEPS_{t+2}$ represents the forecasted earnings per share in year t+2 as of June in year t+1,
- $FDPS_{t+1}$: forecasted dividend per share in year t+1 measured as of June in year t,
- $\gamma - 1$: the perpetual growth rate[9],
- r_f: the risk free interest rate, measured as the yield on a 10-year US treasury note in June of year t,
- LTG: The long-term (5 year) growth forecast.

The OJ model can be seen as a generalization of the Gordon growth model, also known as the dividend discount model, as proposed by Gordon and Shapiro (1956). The model seeks to estimate the intrinsic value of a stock by discounting the sum of future dividend payments to the current present value. To see the relation to the OJ model (Gode and Mohanram, 2003) note three underlying assumptions behind the Gordon growth model: (1) Current price equals the discounted present value of expected dividends; (2) The dividend payout ratio is constant. For simplicity we can assume all earnings are paid out in dividends for now; (3) Earnings grow at a perpetual rate $g_p = \gamma - 1$. The Gordon growth model can then be represented in a simple way:

$$P_t = \frac{\text{EPS}_{t+1}}{r_e - g_p} \tag{6}$$

Where EPS_{t+1} are earnings per share the following year, r_e is the required rate of return on equity and g_p is the constant growth rate of earnings per share in perpetuity.

[9] Analyst forecasts are nominal, so we set this equal to the risk-free rate less a long-term expected economic growth rate of 3%.

By subtracting and adding $\frac{\text{EPS}_{t+1}}{r_e}$ on the right-hand side of eq. 6, this can be rearranged to

$$P_t = \frac{\text{EPS}_{t+1}}{r_e} + \frac{g_p \times \text{EPS}_{t+1}}{r_e \times (r_e - g_p)} \tag{7}$$

As we assume the growth rate g_p to be constant to perpetuity, we can rewrite $g_p\text{EPS}_{t+1}$ as $\text{EPS}_{t+2} - \text{EPS}_{t+1}$. Doing this yields:

$$P_t = \frac{\text{EPS}_{t+1}}{r_e} + \frac{\text{EPS}_{t+2} - \text{EPS}_{t+1}}{r_e \times (r_e - g_p)} \tag{8}$$

To generalize this formulation of the Gordon growth model, the OJ model follows three main steps (Gode and Mohanram, 2003):

1. As before, price equals the discounted value of future dividend payments.
2. It deviates from the assumption of full payout ratios by following Modigliani and Miller (1958)'s dividend irrelevance arguments, where it is argued that whether a company distributes its dividends or retains them, has no material effect on stock prices. Given certain assumptions, such as no taxes and perfect capital markets, shareholders should be indifferent between the capital gains and earnings potential gained through retained earnings and a cash payout. Hence, instead of $(\text{EPS}_{t+2} - \text{EPS}_{t+1})$ we write $(\text{EPS}_{t+2} - \text{EPS}_{t+1} - r_e(\text{EPS}_{t+1} - \text{DPS}_{t+1}))$. Here the abnormal change in earnings is defined as earnings change in excess of the return on net reinvestment. We note that this simply yields the original formula in equation 6 if we assume full dividend payouts.
3. It also deviates from the assumption of a constant perpetual growth rate and introduces a short-term growth rate, which we assume decays asymptotically to the perpetual growth rate g_p. The OJ model sets the near-term growth rate as

$$\frac{\text{EPS}_{t+2} - \text{EPS}_{t+1} - r_e(\text{EPS}_{t+1} - \text{DPS}_{t+1})}{\text{EPS}_{t+1}}$$

We then arrive at the final generalization of the Gordon growth model that is the OJ model (eq. 9)

$$P_t = \frac{\text{EPS}_{t+1}}{r_e} + \frac{\text{EPS}_{t+2} - \text{EPS}_{t+1} - r_e(\text{EPS}_{t+1} - \text{DPS}_{t+1})}{r_e(r_e - g_p)} \tag{9}$$

which, by rearranging, is equivalent to the formulation shown in equation 1.

In addition to the Ohlson and Juettner-Nauroth (2005) model, the literature proposes several alternative models to calculate the implied cost of equity. The Easton (2004) model and the PEG ratio proposed by Easton (2004), the Claus and Thomas (2001) model, and the Gebhardt et al. (2001) model are among the most prevalent. Specifically, the first two methodologies serve as robustness measures in Chapter 6 with computational results shown in Appendix D[10]. The older Claus and Thomas (2001) model and the Gebhardt et al. (2001) were not calculated, as they are less parsimonious without yielding more accurate outcomes (Gonçalves et al., 2022). Moreover, it has been demonstrated that the

[10]Mathematical description of these models are shown in Appendix C.

Claus and Thomas (2001) model exhibits a high correlation (0.945) with the OJ model (Hail and Leuz, 2006).

Following the implied cost of equity computations, we winsorize data at 1% and 99%. We summarize results from the computations in Table 8. Based on 6,976 firm-year observations we derive an average implied cost of equity of 12.36%. This seems to fit well with what is observed using both traditional asset pricing models and general consensus. In fact, the updated financial dataset curated by Aswath Damodaran, a professor of corporate finance and valuation at New York University Stern School of Business, reveals that the global average cost of equity stands at 12.43% (Damodaran, 2023). In Appendix E, we present a breakdown of the cost of equity across industries, years, and regions.

4.1.2 Cost of debt computation

While the implied cost of equity is calculated by more complex models, the debt side is more straightforward as it is based on loan and bond terms, and publicly available financials. The cost of debt is a measure of how much a company needs to pay for its debt financing, and is calculated by dividing interest expenses by average total debt (long-term plus short-term) over the year. This method is similar to that of previous research on ESG premia in the debt market (La Rosa et al., 2018; Du et al., 2017; Ye and Zhang, 2011; Magnanelli and Izzo, 2017).

Many firms have floating rate corporate loans, meaning that the cost of debt is calculated as the benchmark interest rate, also referred to as the reference rate, plus a risk premium margin (IMF, n.d.). The interest rate environment varies over time based on various macroeconomic factors. The reference rate will significantly affect loan terms and the interest firms pay. To mitigate this effect on our results, we subtract a benchmark interest rate from the cost of debt. We follow the literature and use LIBOR to measure the interest rate environment (Goss & Roberts, 2011; Hoepner et al., 2016; Nandy & Lodh, 2012). LIBOR, the London Interbank Offered Rate, is the borrowing costs between banks for short-term loans. It is a benchmark interest rate at which major global banks lend to one another in the international interbank market. We use the US dollar LIBOR rate as the US dollar is the most influential of the world's currencies, and this is, according to IMF (n.d.), the most widely used and cited rate. Although LIBOR has been phased out since 2022, we find it reasonable to use it. Our analysis covers data from 2010 to 2021, and almost $350 trillion in financial contracts are currently tied to this reference rate (IMF, n.d.).

After computing the cost of debt, we winsorize data at 1% and 99%. We show descriptive statistics for the cost of debt in Table 8. We find some cases of negative cost of debt which could result from subtracting the LIBOR from the calculated cost of debt. Our data sample includes a range of firms operating in different economies with different loan structures and terms, and are therefore in reality subject to other interest rates than the LIBOR rate. We calculate a mean cost of debt of 5.68%, which we find to be reasonable.

Variable	N	Mean	Std. Dev.	Min	Q1	Q3	Max
COE	6976	1236	541	357	857	1488	3178
COD	20014	568	700	-161	229	654	5069

Table 8: Summary statistics of the cost of equity computed using the OJ method, and the cost of debt computed as interest expenses divided by total debt. N represents the number of firm-year observations used in the computations. Note that these may differ from the number of firm-year observations in the final regression analysis.

In Section 4.3, we elaborate on the breakdown of cost of debt across regions, years and industries, as presented in Appendix F.

4.2 Feature selection

In order to specify suitable models for determining the ESG premium in equity and debt markets, we initially incorporate a wide selection of control variables. A good set of control variables helps isolate the effects we wish to measure while mitigating omitted variable bias and increasing the efficiency of the coefficient estimates. As discussed in Chapter 3, we identify a range of possible independent variables based on existing literature, including both firm-specific and macroeconomic factors. For the equity market, we consider ten distinct variables, while for the debt market, we include 18 separate variables in the initial analysis. While including all variables has the potential to increase the explanatory power of the model, it is often true that many of the variables used in multiple regression models are not associated with the response. Including these variables will therefore only lead to unnecessary complexity in the model and reduce interpretability (James et al., 2013).

James et al. (2013) propose three classes of methods for using least squares to fit: best subset selection models, shrinkage (regularization) and dimensionality reduction. We specify models for the first two methods. For the first method we rely on the best subset method proposed by Beale et al. (1967) and Hocking and Leslie (1967). We use the LASSO method, a form of shrinkage or regularization, as introduced by Tibshirani (1996) and Donoho et al. (2001) as a robustness and sensitivity check of the best subset results.

4.2.1 Best subset

The best subset selection method omits irrelevant independent variables in order to end up with a subset of predictors p (James et al., 2013). The best subset approach can be described as follows::

1. We let $\mathcal{M}_0$ denote the null model, containing no predictors. Used to predict the sample mean of the observations.
2. For $k = 1, 2, \ldots, p$, we:
   a) fit $\binom{p}{k}$ models containing k predictors,
   b) pick the best among the $\binom{p}{k}$ models and call it $\mathcal{M}_k$. Best is defined as having the smallest RSS or largest R^2.
3. Select the best model among the different models $\mathcal{M}_0, \mathcal{M}_1, \ldots, \mathcal{M}_p$, .

The second step contains two parts, a and b. In part a, we fit a separate least squares regression for each possible combination of the predictors. That is, we fit all p models that contain exactly one predictor, all $\binom{p}{2}$ models with two predictors etc. In part b, we identify the best models among the original 2^p specifications by minimizing the residual sum of squares (RSS). This step hence narrows down the selection from 2^p models to $p+1$ options.

Selecting the single best model from the $p+1$ options in step three is however not trivial. The residual sum of squares and the R^2 have a monotonic relationship with the number of features included; RSS will decrease while R^2 will increase when adding additional variables. Thus, only relying on these values would invariably lead to selecting a model with all variables. In order to measure the best test-error performance, we adjust the training error to the model size by considering the BIC, C_p (AIC), or adjusted R^2 to select among $\mathcal{M}_0, \mathcal{M}_1, \ldots, \mathcal{M}_p$ (James et al., 2013). As the evaluation criteria may vary, i.e. adjusted R^2 will propose a different amount of predictors compared to the C_p or the BIC, we manually make a final evaluation of which subset specifications to include. We describe this process in Section 4.3.

There are several advantages of using the best subset approach. First of all, it gives a model for each number of variables, making results more transparent and easy to interpret. Second, the method uses only the included variables per iteration and therefore utilizes all available data in the feature selection process. Furthermore, Bertsimas et al. (2016) find that the best subset method outperforms both forward stepwise selection and LASSO method in terms of prediction accuracy. The drawback is then that the method is computationally expensive.

We present the results from the feature selection process in Tables 9 and 12 for equity, and in Tables 11 and 12 for debt. For both equity and debt we include one model with the combined ESG score and one where we separate the aggregated score into its subcomponents (environmental, social, governance).

	6	7	8	9	10	11
ESG				x	x	x
Beta	x	x	x	x	x	x
BtM	x	x	x	x	x	x
Lev			x	x	x	x
Size	x	x	x	x	x	x
VIX	x	x	x	x	x	x
Inflation	x	x	x	x	x	x
Slope						x
Spot					x	x
Brent		x	x	x	x	x
LTG	x	x	x	x	x	x
R2	0.49077	0.49349	0.49542	0.4964470	0.49675	0.49683
Adj R2	0.49009	0.49269	0.49452	0.49543	0.49562	0.49559
Cp	55.7053	33.6390	18.5046	11.4612	10.7203	12.0000
BIC	-2957.137	-2972.640	-2981.335	-2981.981	-2976.323	-2968.640

Table 9: Results from the best subset feature selection method on the equity side, considering the overall ESG score as dependent variable. The top row represents the number of independent variables included in the model specification. The presence of an "X" indicates whether the best subset method suggests to include or discard the control variable. Adjusted R^2 is maximized by including 10 variables, which is also when Cp is minimized. The BIC value is minimized by including 9 variables.

	8	9	10	11	12	13
Env			**x**	**x**	**x**	**x**
Soc	**x**	**x**	**x**	**x**	**x**	**x**
Gov				x	x	x
Beta	**x**	**x**	**x**	**x**	x	x
BtM	**x**	**x**	**x**	**x**	x	x
Lev		**x**	x	x	x	x
Size	x	x	x	x	x	x
VIX	x	x	x	x	x	x
Inflation	x	x	x	x	x	x
Slope						x
Spot					x	x
Brent	x	x	x	x	x	x
LTG	x	x	x	x	x	x
R2	0.49598	0.49882	0.49962	0.50011	0.50046	0.50052
Adj R2	0.49507	0.49781	0.49850	0.49887	0.499	0.49907
Cp	44.5394	21.1578	16.0506	13.7166	12.6058	14.0000
BIC	-2986.273	-3003.171	-3001.878	-2997.815	-2992.529	-2984.731

Table 10: Results from the best subset feature selection method on the equity side considering the subcomponents environmental, social and governance score. The top row represents the number of independent variables included in the model specification. The presence of an "X" indicates whether the best subset method suggests to include or discard the control variable. Adjusted R^2 is maximized by including 13 variables, while Cp is minimized by including 12. The BIC value is minimized by including 9 variables.

	14	**15**	**16**	**17**	**18**	**19**
ESG	x	x	x	x	x	x
ROA	x	x	x	x	x	x
LTG					x	x
Size	x	x	x	x	x	x
IntCov	x	x	x	x	x	x
Beta	x	x	x	x	x	x
Tang	x	x	x	x	x	x
Lev		x	x	x	x	x
Liq	x	x	x	x	x	x
AssetG						x
Perf	x	x	x	x	x	x
CashFlow	x			x	x	x
RevG	x	x	x	x	x	x
TobinQ	x	x	x	x	x	x
VIX	x	x	x	x	x	x
Brent	x	x	x	x	x	x
Infl	x	x	x	x	x	x
Slope	x	x	x	x	x	x
Spot	x	x	x	x	x	x
R2	0.18584	0.18642	0.18678	0.18705	0.18729	0.18731
Adj R2	0.18353	0.18395	0.18416	0.18425	0.18434	0.18419
Cp	18.9980	17.4662	17.2323	17.6380	18.1282	20.0000
BIC	-893.758	-888.788	-882.518	-875.608	-868.612	-860.230

Table 11: Results from the best subset feature selection method on the debt side considering the overall ESG score. The top row represents the number of independent variables included in the model specification. The presence of an "X" indicates whether the best subset method decides include or discard the control variable. Adjusted R^2 is maximized by including 18 variables, while Cp is minimized by including 16. The BIC value is minimized by including 14 variables.

	16	17	18	19	20	21
Env	x	x	x	x	x	x
Soc	x	x	x	x	x	x
Gov	x	x	x	x	x	x
ROA	x	x	x	x	x	x
LTG			x	x	x	x
Size	x	x	x	x	x	x
IntCov	x	x	x	x	x	x
Beta		x	x	x	x	x
Tang		x		x	x	x
Lev					x	x
Liq	x	x	x	x	x	x
AssetG						x
Perf	x	x	x	x	x	x
CashFlow	x		x	x	x	x
RevG	x	x	x	x	x	x
TobinQ	x	x	x	x	x	x
VIX	x	x	x	x	x	x
Brent	x	x	x	x	x	x
Infl	x	x	x	x	x	x
Slope	x	x	x	x	x	x
Spot	x	x	x	x	x	x
R2	0.19344	0.19385	0.19419	0.19446	0.19463	0.19466
Adj R2	0.19083	0.19108	0.19126	0.19137	0.19138	0.19124
Cp	19.4793	18.9241	18.8382	19.1993	20.1393	22.0000
BIC	-923.336	-917.388	-910.971	-904.106	-896.659	-888.289

Table 12: Results from the best subset feature selection method on the debt side considering the subcomponents environmental, social and governance score. The top row represents the number of independent variables included in the model specification. The presence of an "X" indicates whether the best subset method suggests to include or discard the control variable. Adjusted R^2 is maximized by including 20 variables, while Cp is minimized with 18. "3 minimize the BIC value by including 16 variables.

4.2.2 LASSO

An alternative to the best subset selection approach is to fit a model containing all predictors and constrain the coefficient estimates, i.e. shrink these coefficients towards zero. One such approach is the LASSO (Least Absolute Shrinkage and Selection Operator) method, a regularization technique which can be written in the following way (eq. 10):

$$\min_{\boldsymbol{\beta}}\left(\sum_{i=1}^{N}(y_i - \beta_0 - \sum_{j=1}^{p}\beta_j x_{ij})^2 + \lambda\sum_{j=1}^{p}|\beta_j|\right) = \min_{\boldsymbol{\beta}}\left(\text{RSS} + \lambda\sum_{j=1}^{p}|\beta_j|\right) \tag{10}$$

The objective is to minimize the residual sum of squares (RSS), equivalent to the regular OLS, plus a penalty term. The penalty term (L1), given by $\lambda\sum_{j=1}^{p}|B_j|$, is added to the RSS to perform the regularization.

The value of the shrinkage coefficient λ has a significant impact on the number of variables excluded. When λ equals zero, the LASSO regression will operate like a standard linear regression model without any regularization and will not perform a variable selection. As λ increases, the penalty term will increase its influence on the equation, resulting in a higher degree of shrinkage, potentially shrinking some coefficients to be precisely zero. In this way, the LASSO regression can function as a feature selection method promoting sparsity. By changing λ, we can adjust the trade-off between complexity and fit and prevent potential data overfitting while preserving our model's generalization ability. We find the optimal value for λ by performing k-fold cross-validation minimizing the MSE and selecting the one for which the cross-validation error is smallest.

Unlike best subset selection, which considers subsets of predictors, LASSO evaluates all predictors simultaneously. This may cause the LASSO regression to exclude variables (included in the best subset approach) where missing firm-year observations is an issue. It is also unstable when trained on data where multicollinearity is present: one of the variables gets selected arbitrarily, and the other correlated variables are dropped from the model (Grave et al., 2011). We therefore only use the results from the LASSO method as a sensitivity check. The LASSO regression results for both equity and debt are reported in Appendix H.

4.3 Empirical model

We employ a pooled ordinary least square (OLS) model with fixed effects on region and industry with clustered standard errors at the firm-level.

Using fixed effects on region and industry allows the model to exclude the effect of different cost of capital levels across regions and industries. In a fixed effect (FE) model, the intercept can vary freely, i.e., the cost of capital has a distinct mean per region and industry (Brooks et al., 2019). We employ fixed effects on industry because industry-wide events mainly affect companies within the same industry, and region-wide events affect the respective geographical regions. Macroeconomic risk factors are included to account for market-wide shocks that affect the cost of capital over time.

Appendices E and F illustrate the cost of equity and the cost of debt by industry, region, and year, respectively. We observe that the industry average varies between ~1,225, ~1,300, and ~1,010 basis points on the equity side for the basic materials, energy, and utilities sectors, and ~460, ~430, and ~420 basis points on the debt side. Even though the variance is greater for the cost of equity, the relative difference between equity and debt is about the same. Next, we observe that the cost of capital for both equity and debt varies significantly by region. For instance, the greatest difference in average cost of equity is between North America and South America, where it is approximately 750 basis points, and the largest difference in average cost of debt is between Asia and Africa, with approximately 550 basis points. Lastly, we observe that the cost of equity varies over time, with a maximum average value of ~1,400 basis points in 2010 and the lowest average value of ~1,100 basis points in 2019. On the debt side, the relative variation between years is slightly higher, with the highest average value of ~775 basis points in 2011 and the lowest average value of ~250 basis points in 2018. Based on these results, we find it reasonable to have fixed effects on industry and regions. We argue that macroeconomic variables will capture important time-effects.

According to Thompson (2011), the presence of heteroscedasticity in panel data is fairly prevalent. Heteroscedasticity is a change in the distribution of residuals across the range of measured values. Furthermore, Kezdi (2003) argues that FE models typically exhibit serial correlation in the error process, also called autocorrelation. A market-wide shock in year t may affect all firms in the sample in year t but not in year t+1, whereas a firm-specific shock may affect one firm over time, without affecting the remaining firms in the sample. Autocorrelation and homoscedasticity are assumptions of the OLS, and if violated, the model will no longer be BLUE[11].

Kezdi (2003) shows that heteroscedasticity and autocorrelation can be avoided by employing the robust standard error estimator. Therefore, we utilize the robust standard error by White (1980). Robust standard errors include a non-constant variance in the standard error formula. By implementing robust standard errors, the size of the coefficients in the model will remain the same as with normal standard errors; however, the estimated value of standard errors, and thus the resulting "t" and "p-values", will differ and we may trust the inferred significance levels (Brooks et al., 2019). We cluster the robust standard errors at the firm level as we expect the residuals for each individual firm to be correlated.

Following the feature selection methods described previously, we arrive at a set of eight distinct model specifications. Four models are designed to examine the equity side, and four examine the debt side. These are described in Section 4.3.1, and 4.3.2, respectively.

4.3.1 Model specification for the cost of equity

In determining the model specifications for our analysis, we use base equation 11, which incorporates all relevant control variables.

$$
\begin{aligned}
COE_{it} = \alpha_i \\
&+ \beta_1 ESG_{it} \\
&+ \beta_2 Beta_{it} + \beta_3 Size_{it} \\
&+ \beta_4 Lev_{it} + \beta_5 BtM_{it} + \beta_6 LTG_{it} \\
&+ \beta_7 VIX_t + \beta_8 Infl_t + \beta_9 Brent_t + \beta_{10} Spot_t + \beta_{11} Slope_{it} \\
&+ \beta_{12} Region_i + \beta_{13} Industry_i \\
&+ u_{it}
\end{aligned}
\tag{11}
$$

Table 9 presents the results of the best subset approach. The Table shows that the model exhibiting the highest adjusted R^2 value and the lowest Cp index consists of ten control variables, i.e. excluding one: the *slope* control variable. This is further supported by the LASSO regression results outlined in Appendix H. Furthermore, the model with the lowest BIC value suggests removing two control variables: the *slope* and *spot* variables. Based on this, we end up with two model specification: model 1, excluding the *slope* control variable, and model 2, which excludes the *slope* and the *spot* variables.

Table 10 shows the results from the best subset feature selection process when considering the individual subcomponents of ESG: environmental, social, and governance scores. The best subset model, evaluated using adjusted R^2 and Cp values, indicates that the exclusion of one control variable is warranted, and we thus remove the *slope* control variable in model 3. Moreover, the BIC values suggest removing four control variables. However, given that

[11]This implies that the model will remain unbiased, but it will no longer provide the smallest variance among unbiased estimators. This may result in wrong standard errors, and consequently, the results may be incorrectly interpreted (Brooks et al., 2019).

governance and *environmental* scores are the least critical control variables, we exclude only two variables for model 4, namely *slope* and *spot*. In contrast, the LASSO regression results presented in Appendix H suggest retaining all variables. Nonetheless, due to the high correlation of the *slope* variable with the other macro variables, we refrain from relying on the LASSO regression for building our model specifications.

4.3.2 Model specifications for the cost of debt

In our analysis of the debt side, we start with equation 12 as the baseline equation for developing our model specifications.

$$
\begin{aligned}
COD_{it} = \alpha_i \\
&+ \beta_1 ESG_{it} \\
&+ \beta_2 Beta_{it} + \beta_3 ROA_{it} + \beta_4 IntCov_{it} + \beta_5 Lev_{it} \\
&+ \beta_6 Tang_{it} + \beta_7 Liq_{it} + \beta_8 Perf_{it} + \beta_9 RevG_{it} + \beta_{10} Size_{it} \\
&+ \beta_{11} TobinQ_{it} + \beta_{12} AssetG_{it} + \beta_{13} CashFlow_{it} + \beta_{14} LtG_{it} \\
&+ \beta_{15} VIX_t + \beta_{16} Infl_t + \beta_{17} Brent_t + \beta_{18} Spot_t + \beta_{19} Slope_t \\
&+ \beta_{20} Region_i + \beta_{21} Industry_i \\
&+ u_{it}
\end{aligned}
\tag{12}
$$

In examining the debt side and the overall ESG performance, we consider the best subset selection presented in Table 11. The Table reveals that we maximize the adjusted R^2 by eliminating one control variable, minimize Cp by removing three variables, and minimize the BIC by removing eight. The LASSO regression in Appendix H suggests retaining all variables. Based on these findings, we construct two models. model 1 excludes one variable: the *asset growth*, and model 2 excludes three control variables: the *asset growth*, *cash flow* and *long-term growth* variables. Given that the LASSO regression indicates that all variables should be kept, we view it as excessive to remove eight variables based solely on minimizing the BIC value.

Table 12 presents the results when splitting the ESG performance into the three individual scores. The adjusted R^2 indicates that one variable should be removed, while the Cp suggests removing three. We achieve the lowest BIC value by removing eight variables. The LASSO regression in Appendix H suggests keeping all variables. Based on these results, we propose two model specifications. Model 3 removes the *asset growth* control variable, while model 4 removes the four control variables: *asset growth*, *cash flow*, *long-term growth*, and *leverage*.

5 Results

In this section, we detail the results derived from the analysis. An in-depth interpretation and discussion will follow in Chapter 6.

5.1 Cost of equity results

Table 13 shows the results from the four regression model specifications.

	Model 1	Model 2	Model 3	Model 4
ESG	−0.314	−0.309		
	(0.463)	(0.463)		
Env			−0.917*	−0.909*
			(0.457)	(0.456)
Soc			0.821	0.815
			(0.525)	(0.525)
Gov			−0.094	−0.090
			(0.372)	(0.372)
BtM	252.657***	254.193***	254.518***	256.078***
	(31.346)	(31.350)	(31.445)	(31.453)
Beta	149.530***	149.923***	150.352***	150.748***
	(21.089)	(21.103)	(21.105)	(21.118)
Lev	81.890***	82.145***	83.096***	83.349***
	(18.542)	(18.543)	(18.363)	(18.366)
LTG	1305.927***	1302.727***	1306.586***	1303.285***
	(40.013)	(39.795)	(40.117)	(39.896)
Size	−19.371*	−19.558*	−18.781*	−18.983*
	(8.117)	(8.118)	(8.160)	(8.159)
VIX	8.817***	9.253***	8.787***	9.235***
	(0.872)	(0.848)	(0.872)	(0.847)
Infl	−3.583***	−3.217***	−3.702***	−3.324***
	(0.510)	(0.475)	(0.515)	(0.478)
Brent	1.696***	1.526***	1.728***	1.553***
	(0.335)	(0.320)	(0.336)	(0.322)
Slope				
Spot	−16.002+		−16.426+	
	(9.253)		(9.271)	
Industry	yes	yes	yes	yes
Region	yes	yes	yes	yes
Num.Obs.	4469	4469	4469	4469
R2	0.541	0.541	0.542	0.542
R2 Adj.	0.539	0.539	0.540	0.540
Std.Errors	by: Company	by: Company	by: Company	by: Company
Note:	$^{+}$p<0.1; *p<0.05; **p<0.01; ***p<0.001			

Table 13: Results of the regression on the equity side. (1) Includes overall ESG score and excludes the macroeconomic variable slope. (2) Includes overall ESG score and excludes the control variables slope and spot. (3) Includes the subcomponents environmental, social and governance and excludes the control variable slope. (4) Includes the subcomponents environmental, social and governance and excludes the control variables slope and spot. The standard errors are shown in parentheses below the corresponding estimates. Note that the size coefficients are log transformed.

We note from Table 13 a statistically insignificant ESG coefficient in both model 1 and model 2. This implies that an ESG premium may not exist in the equity market for energy and natural resource companies.

Models 3 and 4 replace the *ESG score* with the individual subcomponents: the *environmental performance (Env)*, *social performance (Soc)*, and *governance performance (Gov)*. The only significant ESG factor is the *environmental score*. The coefficient is negative which is in line with expectations, and is significant at the 5% level. The coefficients (-0.917 and -0.909 in model 3 and model 4) imply that a unit increase in the *environmental score* is associated with a reduction of approximately 0.9 basis points in the cost of equity variable, equivalent to less than 0.01 percentage points. While we note that this is a fairly small effect, the significant and negative environmental coefficient lends support to the hypothesis that there exists a "green premium" in the energy and natural resources sectors where firms benefit from investing in sustainable operations.

Among the firm specific control variables *BtM*, *beta*, *leverage* and *long-term growth* are significant at the 0.1% level and *size* is significant at the 5% level. All firm specific control variables align with the expected sign (Table 2). With regards to the macroeconomic variables, *inflation* and *spot rate* have negative signs as expected and are significant at the 0.01% and 10% level respectively. The *VIX* coefficient is significant at 0.01% level and has a positive sign, in line with expectations. Furthermore, *brent oil price* is significant at the 0.01% level and exhibits a positive relationship to the cost of equity.

5.2 Cost of debt results

Table 14 shows the results from the four model specifications (models 1-4) that examine the effect of different variables on cost of debt.

The first two models consider the aggregated *ESG score* which is not statistically significant in either model, suggesting that there is no significant relationship between *ESG score* and cost of debt.

Models 3 and 4 split the *ESG score* into the three subcomponents, *environmental*, *social* and *governance*. In both models, the *environmental* variable is statistically significant at the 10% level and the *social* variable is statistically significant at the 5% level, while the *governance* variable is insignificant. The coefficients for *environmental* and *social score* are -1.251 and 1.307 respectively in model 3, and -1.241 and 1.304 respectively in model 4. This implies that a unit increase in the *environmental score* is associated with a 0.012 percentage point reduction in the cost of debt. This lends support to the idea that lenders provide a "green premium" for sustainable firms in the energy and natural resources sectors. Contrarily, a unit increase in the *social score* is associated with a 0.013 percentage point increase in the cost of debt, indicating that firms are penalized through an increase in borrowing costs by performing well in terms of their social efforts. We note that the *environmental* and *social* coefficients are similar in size, indicating that they have similar, but opposing, effects on the cost of debt.

Among the firm-specific control variables in all model specifications, *interest coverage* and *size* are significant at the 0.1% level, *performance* and *revenue growth* are significant at the 1% level and *beta* is significant at the 5% level, all with the expected sign as defined in Section 3.1.3. Interestingly, both *return on assets* and *liquidity* are significant at the 1% level and exhibit a positive relationship to the cost of debt in all model specifications, while a negative coefficient was expected. The remaining firm specific control variables *tobinQ*, *cash flow*, *long-term growth*, leverage and *tangibility* are not significant in any of the model

	Model 1	Model 2	Model 3	Model 4
ESG	−0.182	−0.175		
	(0.691)	(0.692)		
Env			−1.251+	−1.241+
			(0.651)	(0.655)
Soc			1.307*	1.304*
			(0.628)	(0.624)
Gov			−0.125	−0.107
			(0.403)	(0.404)
ROA	900.716**	893.465**	896.097**	897.097**
	(321.793)	(290.111)	(320.889)	(282.862)
IntCov	−1.052***	−1.044***	−1.050***	−1.038***
	(0.275)	(0.274)	(0.276)	(0.272)
Beta	46.290*	47.930*	47.317*	48.256*
	(22.355)	(22.031)	(22.312)	(21.617)
Tang	−19.872	−14.003	−19.469	−13.992
	(35.314)	(35.795)	(35.288)	(35.678)
Liq	36.167**	36.184**	35.532**	35.877**
	(12.125)	(12.144)	(12.188)	(12.311)
Lev	−3.836	−4.309	−3.435	
	(14.386)	(14.413)	(14.443)	
Perf	−266.800**	−269.263**	−267.859**	−269.608**
	(98.482)	(95.555)	(98.058)	(95.549)
RevG	109.156***	114.596***	108.002***	113.859***
	(32.016)	(32.036)	(31.991)	(32.052)
TobinQ	−33.927	−30.600	−37.266	−33.072
	(25.179)	(23.725)	(24.443)	(21.949)
CashFlow	68.936		70.521	
	(182.676)		(182.721)	
Size	−61.902***	−62.314***	−61.091***	−61.734***
	(9.902)	(9.941)	(9.877)	(10.017)
LTG	41.333		42.896	
	(35.982)		(35.917)	
AssetG				
VIX	7.043***	7.034***	6.951***	6.948***
	(0.895)	(0.894)	(0.897)	(0.895)
Brent	1.006**	0.978**	1.045**	1.015**
	(0.333)	(0.335)	(0.334)	(0.337)
Infl	−2.298***	−2.279***	−2.468***	−2.445***
	(0.584)	(0.583)	(0.587)	(0.587)
Slope	138.395***	138.941***	139.283***	139.979***
	(10.405)	(10.577)	(10.385)	(10.570)
Spot	−80.307***	−79.404***	−81.481***	−80.313***
	(9.716)	(9.647)	(9.823)	(9.794)
Industry	yes	yes	yes	yes
Region	yes	yes	yes	yes
Num.Obs.	4968	4968	4968	4968
R2	0.235	0.234	0.237	0.237
R2 Adj.	0.231	0.231	0.233	0.233
Std.Errors	by: Company	by: Company	by: Company	by: Company

Note: $^{+}p<0.1$; $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

Table 14: Results of the regression on the debt side. (1) Includes overall ESG score and excludes the firm-specific variable asset growth. (2) Includes overall ESG score and excludes the control variables asset growth, cash flow and long-term growth. (3) Includes the subcomponents environmental, social and governance score and excludes the control variable asset growth. (4) Includes the subcomponents environmental, social and governance score and excludes the control variables asset growth, cash flow, long-term growth and leverage. The standard errors are shown in parentheses below the corresponding estimates. Note that the size coefficients are log transformed.

specifications. We note that all the macroeconomic variables included are significant in all model specifications. The *inflation* and *spot* are inversely related to the cost of debt, while the *VIX* coefficient is positive. This aligns with expectations as discussed in Section 3.1.4. The *brent oil price*, which we argued had an unclear relationship to the cost of debt, exhibits a positive coefficient.

6 Discussion and interpretation of results

This section elaborates on the findings presented in Chapter 5. We begin with Section 6.1, where we evaluate the reliability of the results through sensitivity and robustness tests. The purpose is to determine whether the findings are robust to both changes in model specifications and methodologies of estimating the cost of capital. We also check the assumptions of the applied methods, including the OLS. Subsequently, Section 6.2 examines and interprets the results, evaluating the implications for both the equity and debt markets as well as the combined effects. Finally, we address the validity and limitations of the data and methodology in Section 6.3.

6.1 Sensitivity analysis and robustness tests

Existing literature points to an inherent endogeneity issue in studies seeking to quantify and determine the existence of an ESG premium, both in equity and debt markets (La Rosa et al., 2018; Goss and Roberts, 2011; El Ghoul et al., 2011; Nandy and Lodh, 2012; Ye and Zhang, 2011; Gonçalves et al., 2022). Endogeneity results from the dependent variable correlating with the error term, thus violating a key assumption of the OLS regression. This can potentially lead to biased and inconsistent estimators. Sources of endogeneity are simultaneity, omitted variables and measurement errors (Brooks et al., 2019).

Simultaneity could arise due to a possible two-way relationship between the ESG score and the cost of capital measure. While this thesis aims to understand the causal relationship between ESG performance and the cost of capital, it is also possible that a bidirectional relationship is present where firms with lower cost of capital are better positioned to perform well in terms of ESG. Krüger (2015) argues that a correlation between returns and CSR values is consistent with at least two interpretations: firms perform well because they are socially responsible, or firms are socially responsible because they perform well. In particular, using the slack resource theory (Waddock & Graves, 1997), one can argue that financial stability and performance may facilitate resource slack, where more resources can be allocated towards ESG-improving investments. In support of this view, Hong et al. (2012) find that financial constraints act as important drivers for corporate goodness. Additionally, we note the high correlation between the firm-specific variable $Size$ and ESG. This correlation indicates that larger firms, known to benefit from a lower cost of capital (Fama and French, 1992), invest more heavily in their ESG efforts.

In terms of omitted variable bias, it is possible that variables not considered for our models affect both the ESG score and the dependent variable. On the debt side in particular, we note an R^2 value of 0.23, indicating that we may have omitted one or more important determinants for the cost of debt. Data quality, including possible measurement errors, is discussed further in Section 6.3.

To mitigate the potential effects of endogeneity, we conduct robustness tests using a Two-Stage Least Squares (2SLS) method. This instrumental variable (IV) estimation method aims to capture potential endogeneity issues present in the original estimation due to omitted variable biases or reverse causation issues. We first regress the endogenous variable, in our case the ESG scores, against the exogenous variables, including an instrumental variable (IV). Following El Ghoul et al. (2011) and Attig et al. (2013), we use the initial ESG score at the firm level as the IV as it is predicted to be correlated with the ESG score but not the error term in the regression equation. Second, we use the new predicted ESG values as an explanatory variable in the cost of capital regression.

As described in Section 4.3, the assumptions of heteroscedasticity and autocorrelation are taken into account when employing robust standard errors instead of regular standard errors. We address multicollinearity for equity and debt in Section 3.2, and find no evidence of multicollinearity in our data sets. Appendix G provides an illustration of the residuals' distribution, indicating adherence to the normality assumption. However, Lumley et al. (2002) and Schmidt and Finan (2018) show that when the sample size is sufficiently large, the normality assumption becomes less critical as the central limit theorem comes into play. Hence, even with a slight left skew in the residual tail on the debt side, we have confidence in the results. Finally, the OLS assumption of a mean residual value of zero is satisfied, as both the cost of equity and the cost of debt have a mean of approximately 0.

For the cost of equity, we additionally perform a sensitivity analysis with respect to changes in the implied cost of equity estimation methods found in appendix D. We do this in order to verify that the results are stable across estimation models and not simply a result of the specific cost of equity computation we apply.

6.1.1 Sensitivity and robustness tests on the equity side

As described in Section 4, several models have been suggested to compute a measure for the implied cost of equity. Most popular are the Ohlson and Juettner-Nauroth (2005) model, which is used as the main method in our thesis, the PEG ratio, and the Easton (2004) method. Appendix D shows the results from the implied cost of equity computations, including an average of the three methods. We use model 1 from Section 4.3.1 as a reference model, and present the results from each of the implied cost of equity computations in Table 15.

All estimation methods seem to exhibit similar results with small variations in significance levels and coefficient magnitudes. Contrary to the other models, the ESG coefficient turns significant at a 10% level when employing the PEG-ratio to compute the implied cost of equity. Results seem consistent across models for the remaining independent variables, and all variables behave as expected based on the discussion in Section 3.1.2. The R^2 is highest for the OJ method, and can explain more than 50% of the variance in the cost of equity.

The results from the endogeneity test (2SLS-regression) are shown in Table 16. We perform the test on four model specifications similar to the original multivariate analysis. The weak instruments test in all model specifications shows a p-value below 0.001, indicating that our instruments are not weak. Furthermore, the Wu-Hausmann test reveals a p-value of approximately 0.3 in all models. As this is well above the conventional threshold of 0.05 (or even 0.01), we do not reject the null hypothesis of exogeneity. The original OLS estimation is therefore preferred, which strengthens the results presented in Section 5.1.

	OJ	Easton	PEG	Avg
ESG	−0.314	−0.789	−0.944+	−0.679
	(0.463)	(0.583)	(0.552)	(0.504)
BtM	252.657***	338.068***	296.459***	309.336***
	(31.346)	(31.805)	(24.839)	(28.233)
Beta	149.530***	197.425***	251.519***	199.203***
	(21.089)	(25.202)	(23.484)	(22.107)
Lev	81.890***	98.562***	100.942***	89.016***
	(18.542)	(22.823)	(20.765)	(19.614)
LTG	1305.927***	154.957**	242.106***	570.706***
	(40.013)	(48.847)	(46.402)	(42.021)
Size	−19.371*	−39.451***	−53.770***	−37.409***
	(8.117)	(10.011)	(9.438)	(8.833)
VIX	8.817***	11.401***	9.819***	10.391***
	(0.872)	(1.153)	(1.111)	(1.002)
Infl	−3.583***	−4.661***	−4.732***	−4.170***
	(0.510)	(0.645)	(0.620)	(0.562)
Brent	1.696***	1.318**	0.995*	1.391***
	(0.335)	(0.411)	(0.386)	(0.355)
Spot	−16.002+	−67.254***	−63.662***	−48.477***
	(9.253)	(12.346)	(11.837)	(10.633)
Industry	yes	yes	yes	yes
Region	yes	yes	yes	yes
Num.Obs.	4469	4173	4173	4173
R2	0.541	0.341	0.352	0.417
R2 Adj.	0.539	0.339	0.349	0.415
Std.Errors	by: Company	by: Company	by: Company	by: Company
Note:	$^{+}$p<0.1; *p<0.05; **p<0.01; ***p<0.001			

Table 15: Sensitivity on implied cost of equity calculation method. We use model 1 as a base model where we exclude the slope control variable. The models use the OJ method, the PEG ratio, the Easton method and the average of these three to determine the presence of an ESG premium.

	model 1	model 2	model 3	model 4
ESG	−0.905	−0.905		
	(0.850)	(0.850)		
Env			−2.209*	−2.218*
			(0.901)	(0.901)
Soc			1.683+	1.702+
			(0.999)	(1.000)
Gov			−0.227	−0.238
			(0.673)	(0.673)
Beta	149.881***	150.281***	151.819***	152.257***
	(21.130)	(21.144)	(21.243)	(21.257)
BtM	252.235***	253.784***	256.231***	257.914***
	(31.402)	(31.408)	(31.647)	(31.661)
Lev	80.089***	80.330***	82.253***	82.540***
	(18.792)	(18.793)	(18.411)	(18.408)
Size	−14.523	−14.669	−11.884	−12.048
	(9.807)	(9.809)	(9.920)	(9.919)
LTG	1306.367***	1303.135***	1307.619***	1304.255***
	(39.910)	(39.697)	(40.126)	(39.917)
VIX	8.880***	9.321***	8.830***	9.298***
	(0.873)	(0.850)	(0.874)	(0.849)
Brent	1.687***	1.515***	1.754***	1.572***
	(0.334)	(0.320)	(0.340)	(0.325)
Infl	−3.444***	−3.072***	−3.668***	−3.276***
	(0.520)	(0.487)	(0.539)	(0.501)
Spot	−16.174+		−17.159+	
	(9.262)		(9.353)	
Industry	yes	yes	yes	yes
Region	yes	yes	yes	yes
Wu-Hausman	0.350	0.347	0.290	0.282
Weak instruments	2e-16***	2e-16***	2e-16***	2e-16***
Num.Obs.	4469	4469	4469	4469
R2	0.541	0.541	0.540	0.540
R2 Adj.	0.539	0.539	0.538	0.538
Std.Errors	by: Company	by: Company	by: Company	by: Company

Table 16: 2SLS results testing for endogenity on the equity side. We perform a 2SLS method on each of the four model specifications elaborated on in Section 4. The standard errors are shown in parentheses below the corresponding estimates. We note that the weak instruments are significant and that the Wu-Hausman test is insignificant.

6.1.2 Sensitivity and robustness tests on the debt side

We perform a similar endogeneity test on the debt side using a 2SLS estimation. The results (Table 17) are comparable to the equity side, where we get significant weak instruments indicating that our instruments are not weak. We also fail to reject the Wu-Hausmann test which indicates that all variables are considered sufficiently exogenous, and we treat the original models and results presented in Table 13 as consistent.

	Model 1	Model 2	Model 3	Model 4
ESG	−1.105	−1.086		
	(1.062)	(1.064)		
Env			−1.829+	−1.813+
			(1.094)	(1.091)
Soc			0.873	0.880
			(1.166)	(1.152)
Gov			0.119	0.153
			(0.759)	(0.759)
ROA	906.086**	895.359**	907.938**	905.854**
	(319.865)	(288.177)	(319.615)	(281.362)
IntCov	−1.046***	−1.038***	−1.044***	−1.033***
	(0.275)	(0.273)	(0.276)	(0.273)
Beta	46.344*	48.022*	47.057*	47.590*
	(22.465)	(22.139)	(22.452)	(21.754)
Tang	−23.499	−17.744	−24.832	−20.287
	(35.823)	(36.313)	(35.766)	(36.258)
Lev	−6.285	−6.711	−5.700	
	(14.255)	(14.274)	(14.301)	
Liq	35.964**	35.986**	35.341**	35.870**
	(12.016)	(12.039)	(12.238)	(12.388)
Perf	−269.837**	−272.043**	−268.026**	−268.614**
	(97.458)	(94.564)	(97.034)	(94.611)
CashFlow	65.317		58.014	
	(182.102)		(183.136)	
RevG	103.365**	108.979***	100.673**	106.727**
	(32.611)	(32.641)	(32.481)	(32.512)
TobinQ	−32.644	−29.328	−35.361	−30.962
	(25.157)	(23.703)	(24.257)	(21.882)
Size	−54.209***	−54.727***	−52.566***	−53.499***
	(12.267)	(12.306)	(11.939)	(12.045)
LTG	42.538		43.590	
	(36.037)		(35.997)	
VIX	7.132***	7.122***	7.032***	7.031***
	(0.896)	(0.894)	(0.893)	(0.891)
Brent	1.007**	0.979**	1.038**	1.009**
	(0.333)	(0.335)	(0.336)	(0.339)
Infl	−2.086***	−2.068***	−2.231***	−2.210***
	(0.606)	(0.605)	(0.612)	(0.610)
Slope	138.018***	138.555***	138.886***	139.603***
	(10.422)	(10.594)	(10.456)	(10.642)
Spot	−80.591***	−79.635***	−81.576***	−80.210***
	(9.729)	(9.657)	(9.838)	(9.801)
Industry	yes	yes	yes	yes
Region	yes	yes	yes	yes
Wu-Hausman	0.176	0.182	0.274	0.279
Weak instruments	2e-16***	2e-16***	2e-16***	2e-16***
Num.Obs.	4968	4968	4968	4968
R2	0.234	0.233	0.236	0.235
R2 Adj.	0.230	0.230	0.231	0.231
Std.Errors	by: Company	by: Company	by: Company	by: Company

Table 17: 2SLS results testing for endogenity on the debt side. We perform a 2SLS method on each of the four model specifications elaborated on in Section 4. The standard errors are shown in parentheses below the corresponding estimates. We note that the weak instruments are significant and that the Wu-Hausman test is insignificant.

6.2 Interpretation of results

In the subsequent section, we provide a more comprehensive interpretation of the empirical findings and how they correspond to expectations and previous literature. This includes any economically significant relationship found in the empirical models, which we discuss in the context of the broader literature.

6.2.1 Interpretation of equity results

The results in Table 13 offer multiple intriguing insights, both diverging from and aligning with the literature. We first note the lack of statistical significance in the combined ESG coefficient in both model 1 and model 2. This implies that the effects of the combined ESG score on the cost of equity are not reliably different from zero, given our data sample and chosen independent variables. These results indicate a lack of support for an ESG premium, and we cannot with confidence confirm that firms operating in the energy and natural resource space experience a premium in their cost of equity due to their ESG efforts. This stands in contrast to several of the papers discussed in Section 2.2.1, although these explore market-wide effects in different geographies and periods.

Possible economic explanations can be found in Gregory and Whittaker (2013), where the impact of sustainability on equity values was examined using a Fama-French 3-factor model on a sample of non-industry-specific firms between 1992-2009. In this study, later corroborated in Gregory et al. (2016), the authors find that while markets put a premium on corporate social responsibility, this is primarily attributed to growth and profitability prospects. By applying the OJ model, where both current and future earnings are used as input factors, we implicitly account for these earnings and growth effects. It is therefore possible that investors' ESG premium, while not present in the implied cost of capital, rather affects earnings predictions directly. Indeed, by using the PEG method to calculate the cost of equity instead, we get a negative score significant at the 10% level (Table 15). While the PEG-model also accounts for earnings, it only employs forecasts for the next two years and does not account for growth expectations beyond this. Therefore, a possible interpretation of the difference in significance levels between these models is that the premium disappears when accounting for the long-term earnings persistence effects of strong ESG efforts.

We also note a significant correlation between *ESG* and *size* of 0.448, suggesting that larger firms tend to have higher ESG scores. While the VIF test presented in Appendix B suggests no significant multicollinearity, we cannot rule out that the *size* variable captures the same effects as the *ESG* coefficient. The *size* coefficient is, as expected, negative and significant at the 5% level. The correlation between these variables potentially leads to estimates that are difficult to interpret as the effects are hard to disentangle. Whereas Humphrey et al. (2012) find no significant difference in idiosyncratic risks based on sustainability scores in the UK-market, they also find that firms with high *ESG scores* tend to be large, affecting systematic risks and hence the cost of capital.

An additional reason for the lack of significance in the combined *ESG score* could be the influence of the individual components of the score. As evident in Table 13 in models 3 and 4, these components have different effects and signs that could obscure the aggregated score. The *environmental score* is the only significant ESG variable in both models and has the expected negative sign. In particular, our analysis in models 3 and 4 suggests that a unit increase in the *environmental score* (measured between 0-100) leads to a 0.9

bps decrease in the cost of equity. This supports the hypothesis that good environmental performance leads to a decrease in the cost of capital, which would be a form of ”green premium” in this case. Furthermore, this corroborates previous studies such as those by Chava (2014) which find that investors demand higher expected returns on stocks excluded by environmental screens such as climate change concerns and substantial emissions. As we discuss in Section 2.1, this can both be attributed to the presence of ”green investors” accepting lower returns for the same amount of risk, as well as the view that improving environmental performance reduces regulatory and other environmental risks. Contrasting the *environmental score*, both the *social* and *governance scores* exhibit insignificant coefficients, supporting the idea that investors put more emphasis on firms' environmental efforts than on the other ESG factors.

Examining the independent control variables in our models reveals that our findings, in general, are in line with expectations and existing research. *BtM*, *beta*, *leverage*, *size*, and *long-term growth* all produce significant coefficients with the signs as expected, thus confirming the importance of including these variables when discussing effects driving the cost of equity.

The macroeconomic risk factors generally exhibit signs and significance levels as expected. Both *inflation* and *spot* show a negative and significant relationship to the cost of equity, while the *VIX* index is positively related to our dependent variable. A negative inflationary effect, as predicted by existing research by Fama (1981), Geske and Roll (1983) and Pearce and Roley (1983) provides further evidence that as inflation increases, the real value of future earnings decreases, causing investors to increase their cost of equity. For the same reason, the *spot* coefficient (10-year treasury rate) is also negatively and significantly related to the cost of equity variable. The positive *VIX* coefficient implies that as market volatility increases, investors demand higher returns to compensate for the increased risk, driving up the cost of equity. The *brent oil price*, the effects of which were deemed uncertain based on existing literature, exhibits a positive and significant sign. While one might expect higher energy prices to affect energy firms' underlying systematic and idiosyncratic risk negatively, the positive association confirms that the OJ model sufficiently accounts for the earnings effects. It therefore instead seems to be the case, as described by Prodromou and Demirer (2022), that shocks in energy prices increase macroeconomic instability and risk, thus leading to an increase in the cost of equity.

6.2.2 Interpretation of debt results

Table 14 shows the results for debt capital. Like for the equity side, the aggregated *ESG* coefficient is negative but remains insignificant in models 1 and 2. Furthermore, we find that the *environmental score* is negative and significant at the 10% level in both models 3 and 4 with a coefficient of -1.251 and -1.241 respectively, implying that a unit increase in a firm's environmental performance is associated with a 0.012 percentage point reduction in the cost of debt. We find the *governance score* insignificant across all models, similar to the findings on the cost of equity. Interestingly, the *social score* seems significant at the 5% level with a positive coefficient of approximately 1.3.

Examining the aggregated *ESG score*, we must conclude that the effects on the cost of debt cannot be determined to be reliably different from zero given the chosen methodology and variables. The individual subcomponents offer a more nuanced perspective: like for the cost of equity, the *environmental score* is associated with a negative and significant reduction in debt financing costs. Furthermore, the magnitude of this effect is greater on the cost of debt. This suggests that firms with better environmental practices are rewarded more by lenders through a reduction in borrowing costs than by equity investors. Lenders may view these firms as less likely to be subject to regulatory penalties, litigation risks, or other reputational damages and costs related to environmental issues.

The *social score* has a significant and positive relationship with the cost of debt, indicating that energy and natural resources firms performing well in terms of social efforts face a higher cost of borrowing. This is surprising and contradicts market-wide studies as those described in Section 2.2.2, as it implies that lenders not only interpret investments into social issues such as Health & Safety and workplace discrimination as non-important, but actively penalize such efforts by viewing them as either too costly or leading to an increase in risk. However, previous studies have shown that investors dislike overinvestments in ESG/CSR (Barnea and Rubin, 2010). Similarly, Magnanelli and Izzo (2017) find a significant and positive relationship between a firm's CSP scores and the cost of debt. The authors point to three primary sources of this positive relationship. First, there is a failure to find information regarding CSP reliable, which leads to it not being considered when determining risk. Second, investors may misunderstand the CSP activities themselves and cannot correctly infer the positive effects associated with CSP. Lastly, it takes a significant amount of time to understand these effects adequately.

Additionally, applying risk mitigation theory, Ye and Zhang (2011) find that corporate social responsibility reduces the cost of debt when the CSR scores are below an optimal level. However, the reverse is true when CSR score exceeds this threshold. The authors therefore argue for a U-shaped relationship between the cost of debt and CSR. While this relationship indicates that corporations could lower borrowing costs by reducing spending on CSR issues, managers may be reluctant to reduce investments in these areas for fear of personal reputational loss. Furthermore, managers need to balance the viewpoints of different stakeholders that may have opposing views regarding the optimal level of ESG investment. Divergent views between lenders and other stakeholders regarding the importance of ESG efforts, specifically the social score, can result in managers investing a suboptimal amount in their ESG initiatives. This may lead to a discrepancy between the perceived value of social responsibility as viewed by lenders and actual resource allocation.

Consistent with the expectations described in Section 3.1.3 the variables *size*, *performance* (net income margin), and *interest coverage* contribute negatively to borrowing cost, while a positive and significant relationship is found for *beta* and *revenue* growth. Interestingly, and in contrast to our expectations, both *return on assets* and *liquidity* exhibit a positive relationship with the cost of debt. While this may seem counterintuitive, a possible explanation is that firms with higher *return on assets* and *liquidity* may employ a riskier debt structure to fuel growth and returns, leading to an increase in perceived riskiness by lenders. We further note the high correlation (0.7) between *return on assets* and *performance*, meaning that the performance variable potentially captures some of the positive earnings effects expected from the *return on assets* variable. La Rosa et al. (2018) also find the liquidity ratio to be significantly positively related to firms' cost of debt.

6.2.3 Comparison and total effects

From Sections 6.2.1 and 6.2.2 it is clear that the aggregated ESG score fails to exhibit a statistically significant effect on either the cost of equity or cost of debt. Nevertheless, inspection of the individual subcomponents offers valuable insights. We therefore argue that the aggregated score represents an oversimplification of the relationship between cost of capital and ESG, where investors on both sides may direct their attention to specific dimensions of firms' ESG efforts while putting little emphasis on others.

In particular, we note that the *environmental score* remains significant and negatively associated with both the cost of equity and debt. This supports the existence of a "green premium" for both lenders and equity investors, where investors on both sides accept lower expected returns for firms aligning with their sustainability preferences. While there is evidence for a premium in both markets, the size of the premium is more pronounced in the debt market than in the equity market. Our findings suggest that a unit increase in *environmental score* results in a 0.9 bps decrease in the cost of equity with a standard deviation of 0.45. Although significant, this is a reasonably modest decrease compared to a mean cost of equity value of approximately 12.4%. A similar increase in environmental score is associated with a 1.25 bps decrease in the cost of debt. Considering a mean cost of debt value of 5.68%, the impact is considerably larger than on the equity side.

We propose that the different magnitudes can be explained through the difference in payoff structures, as elaborated in Section 2.1. Due to lenders' fixed income nature which centers on the downside risk, emphasis is put on companies' ability to repay their debt obligations rather than maximizing growth and earnings. Debt investors, or lenders, might be more incentivized to protect against potential environmental regulations risks and penalties that can hurt financial stability. While equity investors also value sustainability performance, their exposure to residual earnings means that growth, profitability and dividend payouts are prioritized over investments in environmental-friendly behavior.

While the *social score* exhibits a positive sign for both the cost of equity and the cost of debt, it is only statistically significant on the debt side. This suggests that investments into firms' social efforts are penalized by investors through an increase in financing costs, and that lenders view it as more risk-enhancing compared to equity investors. Similar to the difference in environmental performance, lenders' focus on preserving the ability to repay debt obligations may lead to investments in social programs being viewed as a distraction diverting resources away from core business areas. While improving efforts in environmental areas can reduce the risks of being affected by economically harmful regulations and penalties, negative impacts from low social performances are mostly limited to reputational damages and more minor fines.

We apply the estimated coefficients on the pre-tax Weighted Average Cost of Capital (WACC) to quantify the total effects on firms' financing costs. This measures the cost of capital from all sources, weighted by their proportions in the capital structure. The pre-tax WACC is calculated as $WACC = \frac{E}{V} \times R_e + \frac{D}{V} \times R_d$, where R_e is the cost of equity, R_d is the cost of debt, E represents market value of equity capital, D debt capital and V is total firm value. The firms in our data sample exhibit a ratio of debt to market value of equity of approximately 0.6 (Section 3.2). We can thus compute debt and equity ratios as $\frac{D}{V} = \frac{0.6}{1+0.6} \approx 0.375$ and $\frac{E}{V} = \frac{1}{1+0.6} \approx 0.625$, implying that firms are financed with 37.5% debt and 62.5% equity. We first focus our calculations on the *environmental score* given its consistent significant relationship with both debt and equity capital. The estimated coefficients from Table 13 and Table 14 show a decrease of approximately 0.91 and 1.25 basis points for a unit increase in the *environmental score* on cost of equity and cost of debt respectively. A unit increase in the *environmental score* then yields a reduction of $0.375 \times (-1.25\text{bps}) + 0.625 \times (-0.9\text{bps}) = -1.03\text{bps}$ in the pre-tax WACC. We apply the same methodology to examine the total effects from a unit increase in the social score. Assuming a zero-effect from cost of equity due to lack of significance, we get a $0.375 \times (1.09\text{bps}) + 0.625 \times (0\text{bps}) = 0.485\text{bps}$ increase in the pre-tax WACC.

6.3 Validity and limitations

As outlined in Chapter 3, we exclude 20,388 firm-year observations from the equity side and 19,888 observations from the debt side, corresponding to a loss of 82% and 80% of the total data respectively, when constructing the data sample. Missing values can originate from various sources, including both the dependent variable (cost of capital) and the independent variables (ESG variables and control variables). In this thesis, we adopt the Ohlson and Juettner-Nauroth (2005) model to derive the cost of equity. This model assumes positive earnings and near-term growth, leading to the exclusion of firm-year observations with negative earnings and growth. Consequently, the results may present a more optimistic outlook than the underlying reality. We rely on analysts' forecasts to calculate several of the control variables. In particular, small firms are less likely to have analyst forecasted values, which could result in the data sample disproportionately consisting of larger firms, potentially deviating from the true distribution. Moreover, these listed companies may have less resources and investor interest, resulting in less extensive reporting. Lastly, firms with lower ESG performance may be less likely to engage in sustainability reporting, causing the data set to skew towards a higher average ESG-score than what is observed in reality. The presence of this missing data introduces the potential for bias, and can potentially affect the results. Although we need to be aware of the potential effect this missing data might have, our approach aligns with previous literature, increasing our confidence in the data sample constructed.

We extract ESG data from the Thomson Reuter Eikon database. The database is one of the world's largest providers of financial markets data and infrastructure and is used by more than 400,000 end users (Refinitiv Eikon, 2023). Although we acknowledge the assumed reliability of the database, there are still causes of concern with regard to the ESG variables. Given the qualitative nature of the social and governance scores, there is a possibility of calculation issues and subjectivity affecting results. In particular, firms smaller in size are covered by few analysts and have less extensive reporting. Consequently, these firms may be subject to greater uncertainty and potential inaccuracies.

The analysis uses the same set of macroeconomic variables on all observations, disregarding geographical location. The macroeconomic variables used are based on the US market, with the *VIX index*, *inflation*, *spot*, and the *slope* predominantly measured on US data. Companies listed in countries and regions outside of the United States may experience varying degrees of sensitivity to this macroeconomic environment. Consequently, utilizing a uniform set of macroeconomic variables may limit the ability to accurately capture the nuances in macroeconomic conditions faced by non-US companies. However, as many of the firms in the data sample operate in multiple regions, and with headquarters possibly not representing their true geographical presence, using country-specific macroeconomic variables would introduce new and possibly more severe sources of error. Another crucial consideration regarding the reliability of macroeconomic variables is the extraction date. Extracting macroeconomic variables on one specific date can lead to the loss of data concerning the macroeconomic environment in the given period. If the data on the extraction date deviates from the average data in the given period, essential macroeconomic data might be overlooked. Further, it is also important to note that the macroeconomic variables could capture otherwise unobserved effects and economic dynamics as they are deeply intertwined with numerous other economic factors in the broader economy and markets. As an example, the brent oil price could be a proxy for geopolitical conflicts and global dynamics of supply-demand. Similarly, the inflationary and treasury rates may not simply represent monetary policy but also economic stability.

We extract all of our data in June for each year, both in-time values and forecast predictions. The extraction date might affect results, both because the data on that specific date could deviate from normalized figures, but also because it might be affected by the lag of analysts covering the company. Ali et al. (1992) find that analysts react slowly to news, and if by any chance a company publishes new figures around the extraction date, but the forecasts are not updated momentarily, the data used might not be as trustworthy as assumed. As data is extracted at the end of June, one month prior to most companies publishing their semi-annual report, we believe this effect to be small for our data set.

As described, the Ohlson and Juettner-Nauroth (2005) method is used to derive the ex-ante implied cost of equity. The method uses long-term growth as a variable in determining the cost of equity (eq. 1), and by doing so, the long-term growth will necessarily be correlated to the cost of equity. The best subset selection model identifies the long-term growth as the most important variable, and it is significant at %1 level across all specifications. Using another method for calculating the cost of equity could therefore affect the best subset selection results. Despite this, we note from the sensitivity analysis (Table 15) that the long-term growth is significant in all models, and we are therefore confident in the inclusion of the variable in our analysis. We also note the similarity in results for all independent variables across the cost of equity computation methods, further strengthening confidence in the results as presented from the OJ model.

To compute the cost of debt, which serves as the dependent variable on the debt side, we divide the annual interest paid by the average total debt over the corresponding year. Although this method is commonly utilized in previous literature (La Rosa et al., 2018; Magnanelli and Izzo, 2017; Ye and Zhang, 2011; Du et al., 2017), we recognize that this method may yield inaccurate results. By considering average total debt, we might include non-interest-bearing debt, resulting in underestimating the cost of debt. Furthermore, the interest paid can be influenced by delays in loan repayments or penalties for late payment, introducing additional complexities that may impact the accuracy of the cost of debt calculations.

We employ the feature selection methods best subset and LASSO to decide which control variables to include in the analysis. Although these methods assist in eliminating some variables, the outcomes indicate that only a few variables should be removed, implying a relatively limited effect of the selection methods. This limited impact may be attributed to our inspiration from previous literature as a reference for determining which control variables to include. It is possible that prior research has already undergone an elimination process in selecting relevant control variables, thereby restricting further exclusions from the feature selection methods. As an example, we note from the best subset results on the equity side (Table 9 and 10) that the initial control variables to exclude are the macroeconomic variables, which are the only variables on the equity side we include that are not found in previous literature.

7 Conclusion

In recent years, there has been a noticeable increase in the focus on Environmental, Social, and Governance (ESG) factors in business, academic and investment communities, which is only expected to increase in the coming years (PwC, 2022). This heightened attention can be attributed to various factors, including a growing awareness of climate change, social inequality and corporate misconduct. ESG considerations have become more important in investment decisions as stakeholders increasingly value sustainable practices and responsible business operations.

The cost of capital represents the cost borne by a business to finance its operations and investments. For the investor, however, it represents the required rate of return for taking on risk by providing necessary capital. The cost of capital, representing investors' risk-return preferences, holds a critical role in enabling sustainable operations due to its direct influence on the affordability of innovative technologies and appeal to private investors, who are instrumental in driving capital-intensive initiatives. By analyzing the relationship between the cost of capital and ESG performance, we determine whether companies with superior ESG practices are rewarded with reduced financing costs, i.e., receive an ESG premium. This helps cast light on the financial implications and potential benefits of integrating ESG policies in business operations, in addition to facilitating efficient capital flows.

Firms operating in the energy and natural resources sectors are essential to the global economy. Not only do they provide essential products and services for everyday life, as well as industry, but their impact on sustainability and other facets of ESG has become increasingly apparent in recent years. Our investigation provides valuable perspectives on the relationship between ESG and investor behavior and preferences in these sectors. We also shed light on whether any of the components - environmental, social, or governance, are more important than others in influencing investors' risk-return preferences. We apply a pooled OLS regression with robust standard errors clustered on the firm-level, with fixed effects on region and industry. In order to identify appropriate determinants of the cost of capital, we employ the best subset feature selection technique. While the specific control variables differ between the cost of equity and cost of debt models, they both include a set of firm-specific variables and macroeconomic risk factors. The inclusion of macroeconomic variables is a novel contribution in this context, further enhancing our understanding of factors influencing the cost of capital.

Our findings diverge from the prevailing consensus in current literature examining cross-industry effects (El Ghoul et al., 2011; Goss and Roberts, 2011; Du et al., 2017; Nandy and Lodh, 2012; Attig et al., 2013; La Rosa et al., 2018; Ye and Zhang, 2011) as we find no significant relationship between the aggregated ESG score and the cost of capital, whether in equity or debt markets. This suggests that ESG does not significantly influence investors' risk-return preferences in the energy and natural resources industries. However, when examining the individual components of the ESG score: environmental, social and governance - a more nuanced perspective arises. Notably, we find a negative and significant relationship between the cost of capital and environmental performance in both equity and debt markets. Specifically, for each unit increase in environmental performance, we find a reduction of approximately -1.25 basis points in the cost of debt and -0.91 basis points for the cost of equity. This suggests that investors attach value to higher environmental performance, providing firms with a green premium. We find that environmental performance has a higher coefficient on the debt side. We therefore argue that lenders' payoff structure makes them more incentivized to be mindful of potential environmental risks. New environmental regulations can lead to economically harmful penalties or stranded assets that will affect the ability to service debt obligations over the long term. Surprisingly, we find the social score to be significant and positively related to the cost of debt, implying that lenders view social investments as a potential source of risk and an inefficient allocation of resources.

To gain a deeper understanding of the relationship between ESG factors and financial performance, future research could explore multiple avenues. As the significance of ESG continues to grow, we believe it is important to repeat this analysis in the future to determine whether any changes have occurred. Secondly, future research could explore the relationship and the sensitivity of the results using different ESG databases. As our findings diverge from existing literature, comparing the analysis using alternative ESG scores would help determine if the observed variations stem from variations in data sources or methodologies. Furthermore, incorporating the measure of leverage (debt access) into the analysis would provide a more comprehensive understanding of the potential ESG premium. Leverage plays a significant role in a company's financial structure and risk profile, and it would be valuable to investigate how ESG practices influence a firm's ability to access debt financing. By incorporating these directions in future research, we could get a more comprehensive and nuanced perspective on the relationship between ESG factors and financial performance, providing investors and businesses with valuable insights for their decision-making.

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Appendix

A ESG categories

Score	Definition
Refinitiv ESG resource use score	The resource use score reflects a company's performance and capacity to reduce the use of materials, energy, or water, and to find more eco-efficient solutions by improving supply chain management.
Refinitiv ESG emissions reduction score	The emission reduction score measures a company's commitment and effectiveness towards reducing environmental emissions in its production and operational processes.
Refinitiv ESG innovation score	The innovation score reflects a company's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes, or eco-designed products.
Refinitiv ESG workforce score	The workforce score measures a company's effectiveness in terms of providing job satisfaction, a healthy and safe workplace, maintaining diversity and equal opportunities, and development opportunities for its workforce.
Refinitiv ESG human rights score	The human rights score measures a company's effectiveness in terms of respecting fundamental human rights conventions.
Refinitiv ESG community score	The community score measures the company's commitment to being a good citizen, protecting public health, and respecting business ethics.
Refinitiv ESG product responsibility score	The product responsibility score reflects a company's capacity to produce quality goods and services, integrating the customer's health and safety, integrity, and data privacy.
Refinitiv ESG management score	The management score measures a company's commitment and effectiveness towards following best practice corporate governance principles.
Refinitiv ESG shareholders score	The shareholders score measures a company's effectiveness towards equal treatment of shareholders and the use of anti-takeover devices.
Refinitiv ESG CSR strategy score	The CSR strategy score reflects a company's practices to communicate that it integrates economic (financial), social, and environmental dimensions into its day-to-day decision-making processes.

Table A: Overview of determinants of the combined and indivdual ESG scores. Resource use, emissions reduction and innovation affect the environmental component. Workforce, human rights, community and product responsibility constitute the social score. The management, shareholders and CSR strategy scores affect governance.

B VIF tests

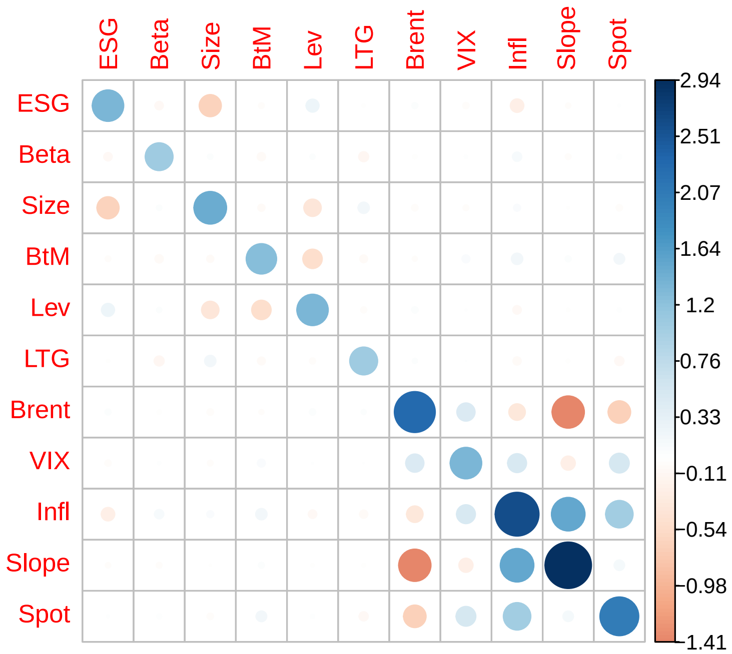

Figure A: VIF test on equity control variables

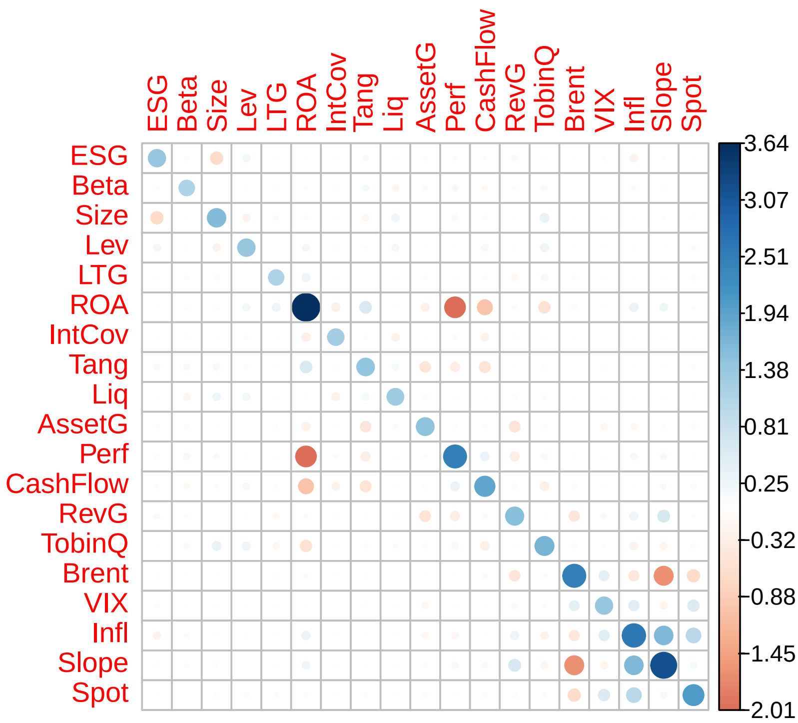

Figure B: Figure A and B show results from Variance Inflation Factor (VIF) tests on equity and debt control variables. Values above 5 indicate a high level of multicolinearity. Values between 1 and 5 show a modest level of multicolinearity that are not significant enough to be considered a cause of concern for the regression analysis. All values are well below 5.

C Implied cost of equity capital models

C.1 Easton 2004 model

$$P_t = \frac{FEPS_{t+2} + ICC_{ES}DPS_{t+1} - FEPS_{t+1}}{ICC_{ES}^2} \quad (13)$$

where:

P_t: Stock price at time t

$FEPS_{t+1}$: Forecasted earnings per share in year t+1

$FEPS_{t+2}$: Forecasted earnings per share in year t+2

DPS_{t+1}: Expected dividend per share in year t+1

ICC_{ES}: Implied cost of equity calculated with Easton (2004) model

C.2 Price-Earnings-Growth (PEG) ratio

$$P_t = \frac{FEPS_{t+2} - FEPS_{t+1}}{ICC_{PEG}^2} \quad (14)$$

where:

P_t: Stock price at time t

$FEPS_{t+1}$: Forecasted earnings per share in year t+1

$FEPS_{t+2}$: Forecasted earnings per share in year t+2

ICC_{PEG}: Implied cost of equity calculated with the Price-Earnings-Growth model

D Summary statistics for the implied cost of equity methods

Variable	N	Mean	Std. Dev.	Min	Q1	Q3	Max
COE OJ	4469	1192	519	362	827	1434	3125
COE Easton	4173	1221	538	436	843	1464	3286
COE PEG	4173	1022	516	201	647	1274	2835
COE Average	4173	1148	495	425	787	1375	3065

Table B: Overview of values generated using different methods of computing the cost of equity capital. We note that the OJ model, as used in this thesis, has a mean value close to the average.

E Cost of equity across industries, regions and years

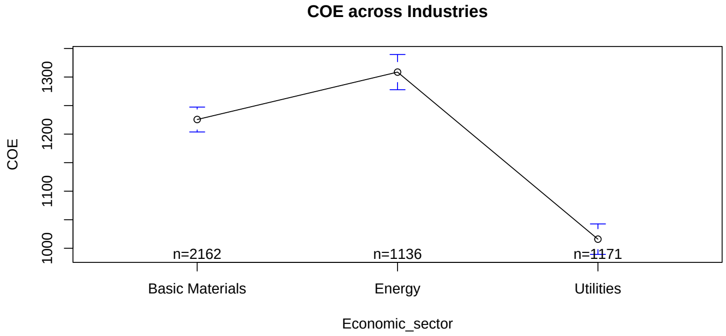

Figure C: Overview of differences in cost of equity, as well as the number of observations, across industries. Energy firms firms exhibit the highest equity financing costs, while utilities have the lowest. However, we note that the variation within each sector is large.

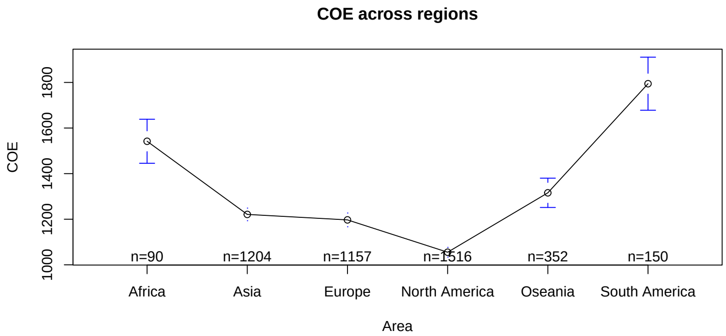

Figure D: Overview of differences in cost of equity, as well as the number of observations, in different regions. We note a considerably higher cost of equity in Africa and South America compared to other regions.

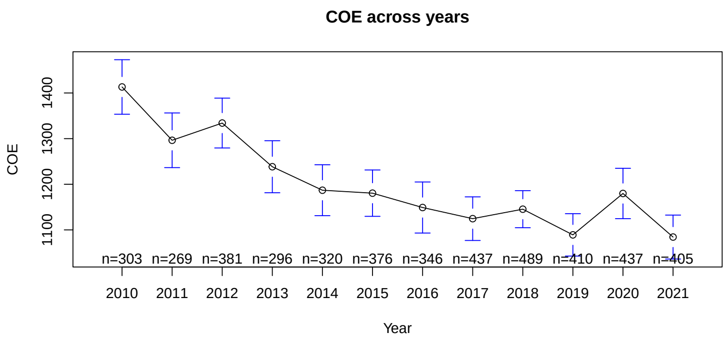

Figure E: Overview of differences in cost of equity, as well as the number of observations, per year. We note that the number of observations generally increases as we get closer to more recent figures due to higher availability of data and more ESG reporting. A decrease in cost of equity throughout the period 2010-2021 is expected as interest rates have decreased significantly over the same period. By subtracting a reference rate for the cost of equity, leaving us with just the risk premium, we would expect to see less of a decline in the cost of equity.

F Cost of debt across industries, regions and years

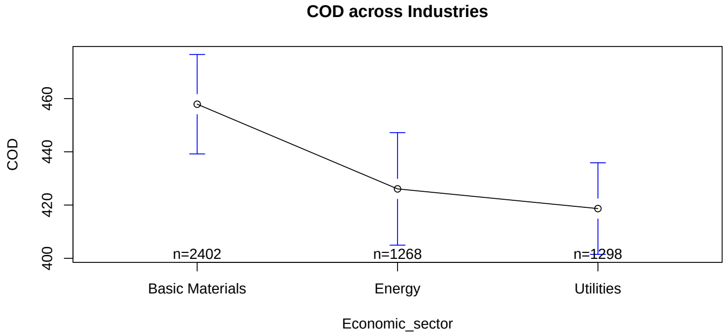

Figure F: Overview of differences in cost of debt, as well as the number of observations, across industries. Basic materials firms firms exhibit the highest debt financing costs, while utilities have the lowest.

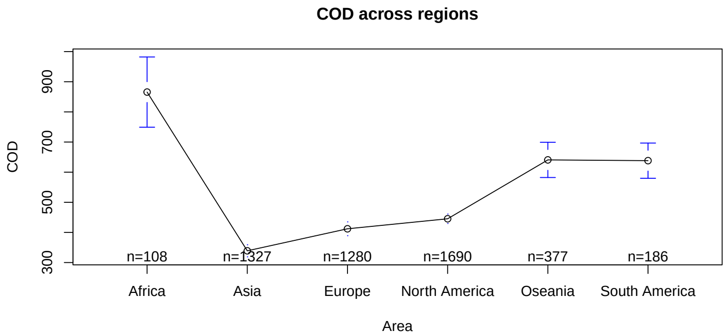

Figure G: Overview of differences in cost of equity, as well as the number of observations, in different regions. We note a considerably higher cost of debt in Africa compared to other regions.

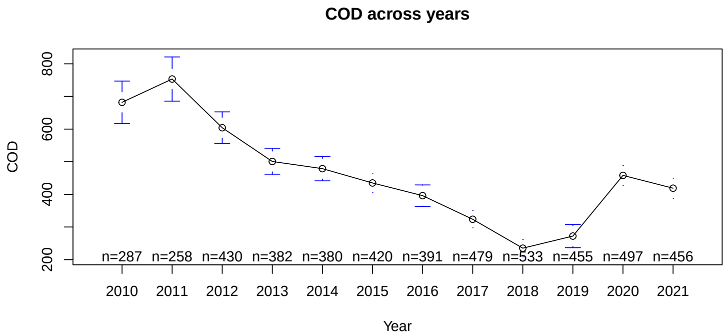

Figure H: Overview of differences in cost of equity, as well as the number of observations, per year. We note that the number of observations generally increases as we get closer to more recent figures due to higher availability of data and more ESG reporting. Note that we subtract the LIBOR rate to compute the cost of debt. Total cost of debt financing is therefore the LIBOR rate plus the margin as shown in the figure.

G Residual distribution

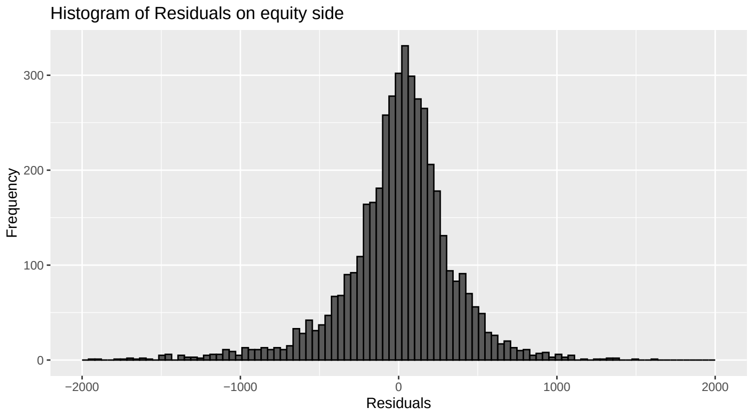

Figure I: Distribution of residuals for the cost of equity regression (model 1)

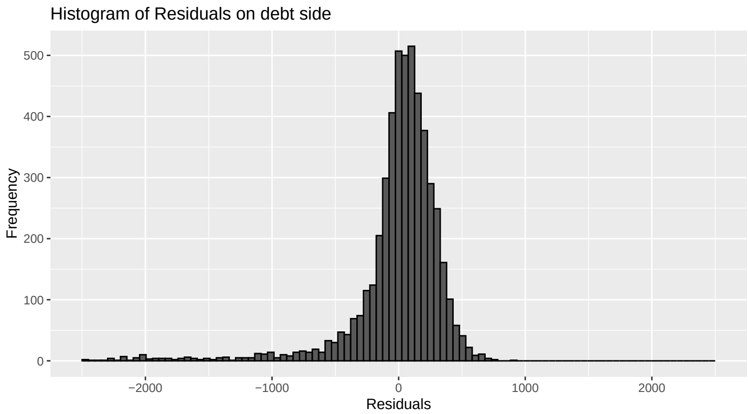

Figure J: Distribution of residuals for the cost of debt regression (model 1)

H LASSO

	ESG	Env Soc Goc
Intercept	2057.6651683	2196.7806594
ESG	0.8060483	
Env		-0.7925899
Soc		2.0984417
Gov		-0.5326667
BtM	323.9795632	325.7804585
Beta	126.2505913	127.9869876
Lev	45.5533484	51.6417584
LTG	1368.7257337	1377.3630665
Size	-32.8671506	-34.2884488
VIX	8.5880191	8.6615941
Infl	-4.0078839	-4.4594220
Slope	.	-4.8793727
Spot	-12.2329231	-17.2717848
Brent	1.6967873	1.9596331

Table C: Results from LASSO regression on the equity side as described in Section 4.2.2.

	ESG	Env Soc Goc
(Intercept)	2709.3254470	2695.2451066
ESG	0.7361454	
Env		-1.6866783
Soc		2.1238769
Gov		0.5811178
Beta	20.4050146	18.7582018
ROA	476.5213945	556.1656136
LTG	27.7822054	35.6454695
Size	-81.0588480	-78.7619448
IntCov	-1.1514483	-1.1463464
Tang	32.1935471	28.0546187
Lev	-12.0635877	-9.3797269
Liq	29.7730079	30.2814108
AssetG	-1.8704440	-6.6733606
Perf	-173.4077036	-190.4337315
CashFlow	151.2787337	137.8243743
RevG	88.4976015	91.3747934
TobinQ	-46.5169145	-51.7986093
VIX	6.2496009	6.1955032
Brent	1.1298210	1.1902848
Infl	-2.7221942	-2.9242062
Slope	133.0484742	135.3711413
Spot	-79.3722394	-82.2322527

Table D: Results from LASSO regression on the debt side as described in Section 4.2.2.

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