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The Impact of ESG Scores on Corporate Bond Spreads: An EU Analysis

Tomás Henriques Soares

Master in Finance

Supervisor:
PhD, Paulo Viegas Ferreira de Carvalho,
Assistant Professor, ISCTE-IUL

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BUSINESS SCHOOL

Department of Finance

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I would like to express my deepest gratitude to my parents, for their support, not only in life but in all of my student and academic journey. This dissertation is dedicated to them.

Next to my brother, who has always been there for me and has always had the endless patience of dealing with me.

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Resumo

Este estudo investiga o impacto das pontuações de Environmental, Social e Governance (ESG) nos spreads das obrigações corporativas no mercado da União Europeia (UE), procurando responder à questão de se o desempenho de ESG influencia os custos de financiamento. A investigação analisa um painel de dados composto por 6.818 observações referentes a 678 obrigações emitidas por 207 empresas da UE entre 2020 e 2024, recorrendo a modelos de regressão com efeitos fixos. A metodologia utilizada controla as características das obrigações, fatores específicos das empresas e variáveis macroeconómicas, com o objetivo de isolar os efeitos do ESG.

Os resultados revelam que a pontuação global de ESG, bem como os pilares Ambiental e Social, não apresentam uma relação estatisticamente significativa com os spreads das yields. Em contraste, o pilar da Governação revela um efeito negativo significativo e côncavo para pontuações abaixo da média, com um pequeno impacto negativo nos spreads, que se torna mais forte à medida que as pontuações se aproximam da média. Estes resultados desafiam a suposição de que o desempenho em ESG reduz consistentemente os custos de financiamento. O estudo contribui para a literatura ao preencher uma lacuna existente no contexto europeu.

Palavras-chave: ESG, Obrigações Corporativas, União Europeia, Regressão com Efeitos Fixos.

JEL Codes: G12 G32

Abstract

This study investigates the impact of Environmental, Social, and Governance (ESG) scores on corporate bond yield spreads in the European Union (EU) market, addressing the question of whether ESG performance influences borrowing costs. The research analyzes a panel dataset of 6,818 observations from 678 bonds issued by 207 EU firms between 2020 and 2024, using fixed-effects regression models. The methodology used controls for bond characteristics, firm-specific factors, and macroeconomic variables to isolate ESG effects.

Findings indicate that overall ESG scores and the Environmental and Social pillars does not exhibit a statistically significant relationship with yield spreads. In contrast, the Governance pillar reveals a significant concave negative effect for below-average scores, with a minor negative effect on spreads that becomes stronger as the scores moved closer to the average. These results challenge the assumption that ESG performance consistently lowers borrowing cost. The study contributes to the literature by addressing a gap in the European context.

Keywords: ESG, Environment, Social, Governance, Yield Spreads, Corporate Bonds, European Union, Fixed Effects Regression.

JEL Codes: G12 G32

Contents

List of Figures

List of Tables

Glossary

Acronyms

- CDS: Credit Default Swap
- CSRD: Corporate Sustainability Reporting Directive
- ESG: Environmental, Social, and Governance
- EU: European Union
- GSS: Green, Social, and Sustainability
- NFRD: Non-Financial Reporting Directive
- OECD: Organization for Economic Co-operation and Development
- ROA: Return on Assets
- RRF: Recovery and Resilience Facility
- SFDR: Sustainable Finance Disclosure Regulation
- VIF: Variance Inflation Factor

Symbols

- β: Regression coefficient
- CD_{it}: Callable dummy for bond i at time t
- E_{it}: Environmental score for firm i at time t
- ϵ_{it}: Error term for bond i at time t
- ESG_{it}: ESG score for firm i at time t
- $\overline{G}$: Mean governance score

- G_{it}: Governance score for firm i at time t
- $INFL_t$: Inflation at time t
- S_{it}: Social score for firm i at time t
- Y_{it}: Bond yield spread for bond i at time t

1 Introduction

ESG integration into corporate reporting and practices has increased exponentially since the start of the century, sustainability reporting rates for the largest 250 companies (G250) have risen from 35% in 1999 to 96% in 2024 and nearly 80% of the top 100 companies by revenue in each country (N100) do the same (KPMG, 2024). The European Union (EU) has been at the forefront in sustainable finance reporting through regulations such as the Non-Financial Reporting Directive (NFRD), Sustainable Finance Disclosure Regulation (SFDR), and Corporate Sustainability Reporting Directive (CSRD).

As firms increasingly adopt ESG practices, corporate bonds can serve as a lens to examine how ESG performance influences firms borrowing costs through an analysis of bond yield spreads — difference between a corporate bond's yield and that of a comparable risk-free bond. This study focuses on the relationship between ESG scores, both overall and across individual pillars (Environmental, Social, and Governance), and corporate bond yield spreads in the EU, issued between 2020 and 2024, with observations extending until the last quarter of 2024.

The research analyzes a panel dataset comprising 6,818 observations from 678 bonds issued by 207 EU firms, excluding financial institutions to ensure homogeneity. The scope includes some data filters, such as minimum issuance size, fixed coupon rates, and no Green, social, and sustainability (GSS) bonds, to have a better isolation of the ESG's impact while controlling for bond characteristics , firm-specific factors, and macroeconomic variables. By employing four fixed effects regression models, one Model for overall ESG scores and its three models for the Environmental, Social, and Governance individual factors.

This dissertation addresses a gap in the literature, by examining whether ESG performance has an effect on corporate bond spreads in the European Union. Literature has also grown on all topics related to Environmental, Social and Governance. The impact of these factors on corporate financial performance remains without consensus, with different authors reporting different types of results. Several studies already exist that analyze the impact of ESG on the cost of debt of an organization. Research focusing on the impact of these factors on corporate bond spreads is still small but generally report a negative effect of ESG on the spreads. Although some research papers have been made in Asian and US markets, there is a known gap for the EU market, with studies only made with Credit Default Swap (CDS) spreads and Green Bonds.

The main research question this study tries to answer is: Do higher ESG scores, overall or by individual pillar, have any relationship with corporate bond yield spreads in the EU market?

The objectives are to quantify the impact of ESG performance on bond pricing, test the significance of each ESG pillar, and provide insights for investors and firms. By analyzing a robust dataset and incorporating robustness checks, this study aims to strengthen the reliability of its findings and the relevance of its findings.

This work is structured as follows to address the main objective. The literature review synthesizes existing research on ESG and corporate financial performance, to establish a theoretical foundation used in the rest of the study. The methodology section details the dataset, choice of variables and definitions, and outlines the four regression models (A–D). The results section presents empirical findings from the fixed effects regressions, highlighting the significance (or lack thereof) of ESG scores and control variables. The discussion section interprets these findings, comparing them to prior studies and exploring implications for the EU market. Finally, the conclusion summarizes key insights, acknowledges limitations, and proposes directions for future research, such as incorporating multiple ESG rating providers or non-linear models.

2 Literature Review

2.1 Sustainability Reporting

According to the OECD Global Corporate Sustainability Report 2024, data from 2022 indicate that out of 43,970 listed companies worldwide, with a collective market capitalization of USD 98 trillion, 22% of these firms provide sustainability-related information. This subset represents a market capitalization of USD 85 trillion. Approximately 66% of these companies, based on market capitalization, have their sustainability reports assured, a process of verifying the reliability and truthfulness of financial disclosures by an external provider (PwC, 2016). Companies with assured sustainability reports demonstrate improved outcomes in their sustainability practices compared to previous years (Bentley-Goode et al., 2024).

Sector	GLOBAL	CHINA	JAPAN	ASIA (REST)	LATIN AMERICA	EUROPE	UNITED STATES
Consumer Goods	87%	52%	83%	78%	88%	99%	90%
Extractives & Minerals	91%	82%	90%	88%	88%	98%	94%
Financials	84%	98%	95%	86%	76%	96%	75%
Food & Beverage	90%	83%	83%	84%	89%	97%	96%
Health Care	87%	62%	89%	70%	76%	98%	90%
Infrastructure	82%	68%	81%	82%	77%	90%	90%
Renewables	82%	77%	86%	77%	84%	96%	92%
Transformation	80%	51%	88%	76%	89%	97%	90%
Services	78%	32%	79%	69%	66%	95%	82%
Tech & Communications	89%	52%	86%	91%	87%	96%	94%
Transportation	87%	69%	95%	85%	76%	97%	89%

Table 2.1: Share of Firms Providing Sustainability Disclosures, by Market Capitalization. Data sourced from OECD (2024).

Europe leads in adopting sustainability assurance, followed by Asia Pacific and the Americas, while the practice remains less prevalent in the Middle East and Africa (KPMG, 2024). The European Union's Corporate Sustainability Reporting Directive (CSRD) came into effect for the fiscal year 2024 and mandates assurance on sustainability information. This directive is expected to increase the proportion of companies obtaining external assurance across Europe and potentially in other regions.

Among companies disclosing their assurance providers, 82% of sustainability reports are assured by auditors, while the remaining 18% employ alternative verification methods (OECD, 2024). Research indicates that the quality of sustainability reporting is significantly higher for clients of accounting firms compared to those verified by non-accounting firms (Bentley-Goode et al., 2024).

From a total of 2,957 sustainability reports that received independent assurance, 1,668 reports (56%) were subject to limited assurance, which provides a lower level of confidence. Conversely, 405 reports (14%) received reasonable assurance, offering a higher level of trust. The remaining 30% of reports likely used a mix of assurance levels or varying verification methods (OECD, 2024).

2.2 Concept of ESG

ESG serves as a framework for assessing an enterprise's impact beyond financial performance, integrating environmental responsibility, social responsibility, and corporate governance.

The environmental pillar of ESG focuses on how businesses impact the natural world and their commitment to sustainability. It examines various environmental externalities caused by business activities, including greenhouse gas (GHG) emissions, carbon footprints, management of soil, water, and air resources, waste management strategies, product sustainability initiatives, compliance with environmental regulations, and management of hazardous materials (Maksimov et al., 2023; Zatonatska et al., 2024).

The social pillar of ESG captures how companies interact with employees, customers, and surrounding communities (Matos, 2020). Core segments of the Social (S) factor include community engagement, employee health and safety, workforce development, diversity and inclusion, ethical business conduct, fair treatment of customers, and regional sustainable development (Maksimov et al., 2023; Matos, 2020; Zatonatska et al., 2024).

Corporate governance establishes the framework and processes that guide a company's direction, set its goals, and ensure performance is effectively monitored. Key elements of governance include executive compensation, anti-corruption measures, political independence, business metrics transparency, board diversity and structure, ethical financial management, and board decision-making transparency (Maksimov et al., 2023; Zatonatska et al., 2024).

2.3 ESG in the EU

In recent years, the European Union (EU) has accelerated its transition to a sustainable economy. The Directive 2014/95/EU (amending Directive 2013/34/EU), known as the Non-Financial Reporting Directive (NFRD), aims to increase transparency among large undertakings and groups regarding sustainability reporting. This directive targets large public-interest entities, such as listed companies, banks, and insurance firms, with an average of 500 employees during the financial year. These organizations must submit a non-financial statement reporting, at a minimum, on performance, policies, and impacts related to the environment, human rights, anti-corruption, and employee and social issues. The NFRD supports frameworks such as the OECD Guidelines and GRI. Affected organizations published their first reports for the financial year 2017.

The EU also introduced Regulation 2019/2088, the Sustainable Finance Disclosure Regulation (SFDR), and Regulation 2020/852, the Taxonomy Regulation. The SFDR establishes harmonized rules for financial market participants and financial advisers in the EU at the entity and product levels. These rules include sustainable risk policies, due diligence on principal adverse impacts of investment decisions and products on sustainability factors, alignment of remuneration policies with sustainability risks, and transparency regarding financial products' environmental and social characteristics. This regulation came into force in March 2021.

The EU Taxonomy Regulation establishes a classification system to categorize economic activities as environmentally sustainable. An economic activity is sustainable if it significantly contributes to one of the following objectives without harming others: climate change mitigation and adaptation, sustainable use of water and marine resources, circular economy transition, pollution prevention, and biodiversity and ecosystem protection. This regulation is mandatory for organizations subject to the NFRD and requires them to report the proportion of turnover, capital expenditure, and operational expenditure linked to sustainable activities. These requirements had a phased application, with the first two objectives becoming mandatory on 1 January 2022 and the remaining objectives on 1 January 2023.

The European Green Deal, established in 2019 by the European Commission, aims for the EU to become climate neutral by 2050. The EU Climate Law, enacted in 2021, mandates a 55% net emissions reduction by 2030 and proposes a 90% reduction by 2040 compared to 1990 levels.

In December 2019, as part of the Green Deal, the EU committed to reviewing the NFRD. Consequently, Directive (EU) 2022/2464, the Corporate Sustainability Reporting Directive (CSRD), was published. This directive expands the scope to include small and medium public-interest entities and subsidiaries/branches of third-country undertakings with a net turnover exceeding €150 million. It also demands more detailed disclosures and the use of European

Sustainability Reporting Standards, mandating external assurance of reported sustainability information. Companies previously reporting under the NFRD began reporting under the CSRD in the financial year 2024.

In July of 2025, the European Commission, to ease the initial reporting burden, allowed the companies affect by the first wave reporting requirements, to defer from certain disclosures, such as anticipated financial effects of sustainability-related risks for the 2025 and 2026 financial years (European Commission, 2025a).

In 2021, the Recovery and Resilience Facility (RRF) was launched to mitigate the impact of the COVID-19 pandemic. The RRF's total volume approaches €650 billion, comprising €359 billion in non-repayable support and €291 billion in loans (Binder et al., 2025). Additionally, €21 billion in grants aim to reduce dependence on Russia's fossil fuels. Repayment of RRF funds will begin in 2028 and continue until 2058.

The European Commission aims for one third of the €1.8 trillion investment (European Commission, 2024) from the RRF and the EU's seven-year budget (2021–2028) to align with the Green Deal. The European Sustainability Reporting Standards (ESRS) establish detailed requirements for organizations to disclose material impacts, risks, and opportunities related to sustainability under Commission Delegated Regulation (EU) 2023/2772.

2.4 ESG and Corporate Financial Performance

The relationship between corporate sustainability performance and financial performance (CFP) attracts significant scholarly attention, yielding varied results. Most studies suggest that companies engaging in ESG activities achieve better financial outcomes, enhancing firm value, profitability, and market performance. However, a notable number of studies report negative or negligible effects, indicating that ESG's financial impact depends on factors such as industry, region, company size, and research methods. This section explores these perspectives, analyzing the relationship between ESG, both as a collective concept and for each pillar, and corporate financial performance.

2.4.1 ESG

A growing body of research highlights that firms prioritizing ESG initiatives experience enhanced market value and improved performance metrics. Bhaskaran et al. (2020) observe that companies emphasizing ESG achieve higher market valuation, while Eccles et al. (2014)

find that U.S. firms with strong sustainability measures significantly outperform both stock market and accounting metrics over the long term.

Maletic et al. (2015) demonstrate that sustainability-driven innovation positively influences organizational outcomes. Similarly, Gonçalves et al. (2023) show that high ESG scores contribute positively to the market value of large European firms between 2015 and 2020. Duan et al. (2023) confirm that positive ESG performance enhances firm valuation in the Chinese manufacturing sector from 2009 to 2021, with this effect being more pronounced in non-state and heavily polluting firms. Cheng et al. (2023) emphasize a significant boost in firm value attributable to disclosing ESG-related information, particularly in the post-pandemic landscape. E-Vahdati et al. (2023) find a positive correlation between ESG initiatives and firm valuation in Japan and Malaysia.

Cek and Eyupoglu (2020) identify a connection between ESG and economic performance in SP 500 firms, while Zeb et al. (2024) underscore the impact of ESG factors on the Return on Assets (ROA) of Pakistani firms. Chininga et al. (2023) indicate that investing in ESG initiatives enhances both accounting and market metrics, such as Return on Equity (ROE) and Tobin's Q ratio, for companies listed in the FTSE/JSE Responsible Investment Index. Che et al. (2024) find a positive influence of ESG practices on corporate financial performance in Shanghai and Shenzhen A-share companies, moderated by factors like property rights and industry characteristics.

Conversely, some studies suggest that higher ESG scores lead to negative financial outcomes. Bifulco et al. (2023) find, in a study of all STOXX Europe 600 companies, that higher ESG scores correlate with a drop in share prices. Padgett and Moura-Leite (2012) note that social benefit-led innovations negatively impact financial performance.

Khan and Liu (2023) conclude that while ESG activities enhance a company's reputation, they may harm financial performance in Chinese manufacturing firms. Makridou et al. (2023) report that ESG factors negatively influence profitability in the European energy sector (1995–2020).

Some scholars argue that ESG's impact may be limited or vary over time. Rojo-Suárez and Alonso-Conde (2022) find that ESG has minimal influence on short-term value creation but contributes positively to long-term market-book value convergence in 487 European firms. Xie et al. (2018) report that most ESG activities exhibit a non-negative relationship with corporate efficiency, Return on Assets (ROA), and market value.

Ersoy et al. (2022) find no significant linear relationship between ESG scores and the market value of 176 U.S. banks from 2016 to 2020, but identify a statistically significant inverted U-shaped relationship. Similarly, Sun et al. (2018) highlight an inverted U-shaped relationship between CSR and shareholder value in publicly traded U.S. firms, with high marketing capability mitigating the downward trend. Azmi et al. (2020) find that ESG initially boosts performance in emerging market banks but leads to diminishing returns.

2.4.2 Environmental Pillar

Numerous studies underscore the beneficial impact of the environmental pillar on financial performance. Matuszewska-Pierzynka (2024) observes that Polish companies benefit from improved sales revenue when implementing sustainable environmental practices. Chininga et al. (2023) find that environmental initiatives enhance firm performance for companies listed in the FTSE/JSE Responsible Investment Index.

Hao et al. (2021) reveal a lagged positive impact of green innovation on the value of Chinese A-share companies, noting that a 1% rise in green patent applications increases enterprise value by 0.023%. Although Khan and Liu (2023) acknowledge that some environmental ESG activities negatively affect financial performance, they note that green innovation mitigates these adverse effects. However, Makridou et al. (2023) find that environmental responsibility significantly reduces profitability in European energy firms.

Other studies highlight non-linear or inconclusive relationships. Ersoy et al. (2022) identify a U-shaped connection between environmental scores and market value in U.S. banks. Cek and Eyupoglu (2020) conclude that environmental performance shows no significant correlation with overall ESG performance or economic performance in SP 500 firms.

Jacobs et al. (2010) find that the market responds positively to philanthropic environmental gifts and ISO certifications but negatively to voluntary emissions reductions. Xie et al. (2018) suggest that only cost-cutting environmental policies positively relate to corporate financial performance.

2.4.3 Social Pillar

Bhaskaran et al. (2020) highlight that initiatives focused on employee welfare contribute to firm wealth creation. Gonçalves et al. (2023) emphasize the importance of the social ESG component in influencing financial outcomes in large European public firms. E-Vahdati et al.

(2023) find that the social pillar has a strong impact on market value in Japan.

Cek and Eyupoglu (2020) demonstrate a connection between social ESG factors and economic performance among S&P 500 companies from 2010 to 2015. Xie et al. (2018) note that firms minimizing demographic discrimination and implementing training programs often achieve better financial results compared to competitors.

However, Khan and Liu (2023) suggest that social ESG initiatives may detract from potential positive financial outcomes. Padgett and Moura-Leite (2012) find a significant negative correlation between high social benefit innovation and financial performance in a sample of 418 firms. Chininga et al. (2023) report that the social pillar negatively impacts corporate financial performance in FTSE/JSE Responsible Investment Index firms.

Ersoy et al. (2022) identify an inverted U-shaped relationship between social ESG scores and market value in U.S. banks. Doni and Fiameni (2023) highlight that firms in the Euro Stoxx index with high innovation benefit from social initiatives, while those with lower innovation experience negative correlations.

2.4.4 Governance Pillar

Cek and Eyupoglu (2020) point to a significant link between governance metrics and the relationship between overall ESG performance and economic performance in S&P 500 companies. Bayrakdaroglu et al. (2012) emphasize the beneficial impact of corporate governance on Economic Value Added (EVA), Market Value Added (MVA), and Cash Value Added (CVA) in Turkish firms. Bhaskaran et al. (2020) demonstrate that adhering to best practices in corporate governance effectively enhances wealth creation.

Matuszewska-Pierzynka (2024) notes that sustainable governance positively impacts return on sales for Polish firms from 2016 to 2021. Xie et al. (2018) highlight the role of independent directors in reducing agency costs and boosting shareholder value in global companies, noting that women on boards strongly correlate with better financial performance.

However, Khan and Liu (2023) assert that governance can exacerbate negative financial outcomes. Doni and Fiameni (2023) suggest that governance negatively affects financial performance in high-innovation firms within the Euro Stoxx index. Chininga et al. (2023) indicate that the governance pillar negatively affects the corporate financial performance of FTSE/JSE Responsible Investment Index firms.

Ersoy et al. (2022) find that governance scores do not significantly influence the market value of U.S. banks. Cheng et al. (2023) report no substantial effect of governance scores on the value of Chinese firms. Makridou et al. (2023) observe an insignificant effect on profitability in European energy sector firms. Nollet et al. (2015) identify a U-shaped relationship between governance scores and key financial performance indicators, such as Return on Assets and Return on Capital.

2.5 Corporate Bonds

A corporate bond represents an obligation, where failure to pay constitutes default, issued by companies to raise capital, with investors lending money in exchange for interest payments and repayment of the principal at maturity (SEC, n.d.). Compared to government debt, corporate bonds carry higher risk but offer higher yields to compensate investors. The risk premium, or spread, is defined by Loo (2024) as:

$$Spread = Yield_{corp} - Yield_{rf} \tag{2.1}$$

where:

- $Yield_{corp}$ = Yield to maturity of the corporate bond (in %)
- $Yield_{rf}$ = Yield to maturity of the risk-free bond (typically a government bond with similar maturity, in %)
- $Spread$ = Credit spread (in basis points)

2.5.1 Determinants of Corporate Yield Spreads

Bond characteristics significantly influence yield spreads. Time to maturity plays a critical role, as bonds with longer maturities exhibit higher sensitivity to interest rate changes. Typically, the term structure of credit spreads slopes upward as maturity increases, though it may be downward sloping or humped depending on the bond's rating (Krylova, 2016).

Coupon payments also affect bond yields. Beyond shaping duration and convexity, the coupon rate influences credit spreads due to tax implications. In several countries, tax rates on capital gains differ from those on interest income, requiring higher yields for bonds with higher coupon rates to remain attractive to investors (Elton et al., 2001). Bond features, such as being callable, puttable, sellable, convertible, or having a floating rate, contribute to spread variation. Macroeconomic and systematic factors also influence corporate bond yield spreads. Luo and Liu (2020) demonstrate, through a no-arbitrage model, that three macroeconomic risk factors—inflation, real GDP growth, and financial market fluctuations—correlate with bond credit spreads. Industry-specific effects impact all firms within a sector, and researchers often control for these. The slope of the benchmark yield curve, measured as the difference between 10- and 2-year maturity bonds, predicts bond spreads (Krishnan et al., 2009).

Moussa (2015) highlights a strong correlation between inflation and market liquidity. Tao et al. (2022) identify economic policy uncertainty, particularly political risk, as a factor in U.S. corporate bond pricing.

Although systemic risk factors show a notable linear relationship with credit spreads, idiosyncratic risk factors primarily determine spreads (Gemmill & Keswani, 2011). Default risk significantly affects the value of corporate debt, as proposed by Merton (1974). A firm's financial health, estimated by its Distance to Default (DD), serves as a quantitative model based on Merton's principles.

Issuer leverage and profitability are key contributors to default risk. Increased debt raises interest obligations, widening bond yield spreads, while higher profitability reduces perceived risk, leading to lower yields (Che-Yahya et al., 2017). Financial ratios, such as the market-to-book ratio, indicate a firm's future potential and risks (Fama & French, 1993).

Credit ratings reflect a firm's default risk and directly impact risk premiums, serving as key indicators for investors assessing bond securities (Hammami & Bahri, 2016). Empirical studies show that a company's leverage, size, and profitability correlate with higher ratings (Kim, 2022). The quality of financial reporting positively influences rating changes (Sengupta, 1998).

Bond liquidity influences yield spreads, as illiquid bonds command higher premiums to compensate for trading costs and price uncertainty. Liquidity decreases with a bond's age and maturity (Bao et al., 2011). Measures of bond liquidity include issuance size and bid-ask spread (Longstaff et al., 2005). During market turmoil, bond market illiquidity increases significantly, except for AAA-rated bonds, as investors seek higher-quality securities (Dick-Nielsen et al., 2011).

2.5.2 ESG and Corporate Yield Spreads

A growing body of literature examines the relationship between ESG performance and corporate bond spreads. Evidence suggests that ESG engagement lowers downside risk, enhancing debt market confidence (Hoepner et al., 2020).

Fiorillo et al. (2025) analyzed an international dataset of 25,234 corporate bonds issued between 2002 and 2024, finding that high-ESG-rated issuers enjoy yield spreads approximately 10 basis points lower than low-ESG counterparts. Their study highlights the role of financial market development and bankruptcy regulations, where stronger investor protections and reduced information asymmetries amplify the ESG premium. Sustainable Disclosure Regulations further strengthen the link between ESG performance and bond pricing.

Lian et al. (2024) researched on China's corporate bond market, analyzing bonds issued between 2009 and 2020. Their findings show that firms with superior ESG performance exhibit lower credit spreads. Okimoto and Takaoka (2023) document that ESG performance significantly reduces credit spreads in Japanese corporate bonds from 2007 to 2018, particularly for low-rated firms, suggesting that ESG metrics serve as a stronger signal for firms with higher perceived default risk. Among the ESG pillars, resource use (E), human rights (S), and management quality (G) exhibit the most spread-reducing effects.

Roggi et al. (2023) conducted their analysis with Green, Social, and Sustainability (GSS) bonds, using a global sample of 3,960 bonds issued between 2008 and 2023. Their results indicate a robust negative relationship between ESG performance and bond spreads, with environmental (E) scores showing the strongest risk-reducing effect. While social (S) and governance (G) dimensions yield mixed results in emerging markets, the findings reinforce the de-risking role of ESG factors in fixed-income markets. Huang (2024) notes that climate risk affects long-term bond yields more than short-term debt, as sustainability factors gain relevance with extended maturities.

In European companies, Barth et al. (2022) find, using Credit Default Swap (CDS) spreads, that the risk-reducing effect of ESG is strongest for firms with moderate ESG performance, exhibiting a U-shaped relationship. This effect is stronger in Europe than in the U.S. Grishunin et al. (2023) document a "greenium" in European corporate green bonds, with yields 3 to 3.6 basis points lower than same-risk conventional bonds, a trend also observed in emerging markets (Ivashkovskaya & Mikhaylova, 2020). However, Cicchiello et al. (2022) note that European green bonds showed increased risk sensitivity during the COVID-19 pandemic.

In the U.S., Li and Adriaens (2023) analyzed bond data from 2010 to 2021 using machine learning techniques, finding an ESG benefit of 10 basis points across all sectors. Governance scores have the most significant impact on spreads, with a coefficient of -5.6 basis points, controlling for bond characteristics. The industry sector also plays a significant role, with financial and engineering sectors demonstrating the most pronounced ESG advantages.

3 Hypotheses

The empirical studies in the limited body of literature on ESG scores and bond spreads showed a lack of consensus, with authors reporting different results. Building on these findings and extending the analysis to the European Union (EU) corporate bond market, where ESG integration had become increasingly relevant in financial decision-making, the main hypothesis was:

H_1**: A statistically significant relationship existed between overall ESG performance and corporate bond issuance spreads within EU firms.**

Furthermore, literature suggested that each component of ESG influenced bond spreads in distinct ways (Roggi et al., 2024; Li and Adriaens, 2023; Okimoto & Takaoka, 2023), leading to these individual hypotheses:

H_2**: Environmental (E) pillar scores exhibited a statistically significant relationship with bond spreads within EU firms.**

H_3**: Social (S) pillar scores exhibited a statistically significant relationship with bond spreads within EU firms.**

H_4**: Governance (G) pillar scores exhibited a statistically significant relationship with bond spreads within EU firms.**

Figure 3.1 provides a simplified representation of the dissertation logic and structure:

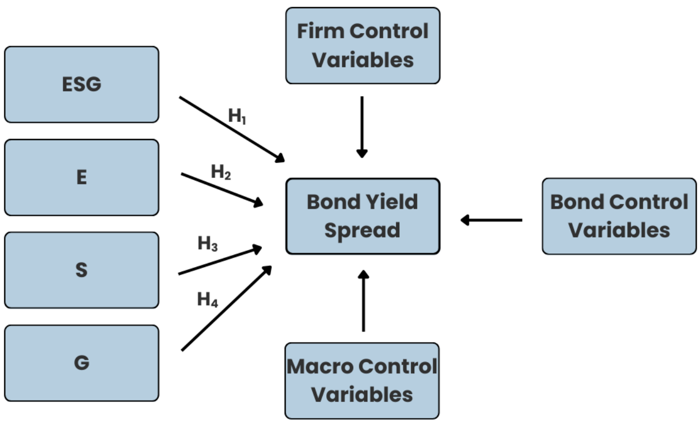

Figure 3.1: Conceptual Model

4 Methodology

4.1 Sample Description

This study focused on corporate bonds issued by firms headquartered in the European Union between Q1 2020 and Q4 2024. This five-year window encompassed major macroeconomic disruptions, such as the COVID-19 Pandemic, a cost-of-living crisis, the Ukraine-Russia War, and the resulting energy crisis, which intensified focus on non-financial risks and opportunities.

During this period, a significant increase in ESG adoption by companies and investors occurred, accompanied by a rise in sustainability-linked financial products (e.g., green bonds). The EU established itself as a leader in ESG regulation with directives such as the EU Taxonomy, SFDR, NFRD, and its successor, CSRD. Additionally, a third of the investments made through the Recovery and Resilience Facility (RRF) and the EU's seven-year budget (2021–2027) aligned with the objectives of the European Green Deal.

The sample included EU fixed-rate senior unsecured corporate bonds - issued between 2020 and 2024- that met the following criteria:

- Issued in euros - to eliminate exchange rate effects on yield spreads.
- Minimum issue size of $500 million - to reduce liquidity risks.
- No convertible or floating-rate features - to maintain homogeneity in bond structure.
- Issuer classified as non-financial under Bloomberg BICS Level 1 - to exclude financial institutions whose regulatory and capital structures differed significantly.
- Complete data available for all selected variables - to ensure comparability across the regression.

After applying these filters and removing bonds with incomplete data, the final sample consisted of 6818 bond observations, collected until the last quarter of 2024, from 678 corporate bonds, issued by 207 firms.

4.2 Variables

The variables included in the regression model were grounded in established literature on corporate bond yield spreads and models designed to explore the relationship between ESG and credit spreads.

The dependent variable of the analysis was the bond yield spread, as reported by LSEG Data & Analytics (formerly Refinitiv Data & Analytics) spread to Benchmark. The independent variable was the issuer's sustainability scores, for which four model variations were tested: Model A used the overall ESG score, Model B,C and D used the individual pillar scores correspondingly: Environmental, Social, and Governance. ESG scores, just like all variables used in the models, were retrieved to reflect the most recent available assessment before the observation date. Sustainability scores were provided by LSEG Data & Analytics.

In the literature analyzing sustainability scores, non-linearity was often demonstrated and explored (Ersoy et al., 2022; Nollet et al., 2015; Sun et al., 2018). To account for non-linearity in the relationship between ESG and bond spreads, polynomial terms were tested for the ESG pillars. The only variable retained was a squared specification in the Governance Pillar, as it displayed non-linear effects.

To control bond-specific characteristics, the model included the coupon rate and time to maturity, which affected the bond's cash flows, sensitivity to interest rates, and taxation (Elton et al., 2001). Since the term structure of credit spreads could be downward sloping or have a humped shape (Krylova, 2016), the time to maturity was also included as a squared variable to control for non-linear effects of this variable. Additionally, a dummy variable was included to control for callability, as removing callable bonds would have significantly reduced the dataset.

Liquidity-related factors were controlled by focusing on corporate bonds with a minimum issuance size of 500 million dollars and by including the Bid-Ask spread as a control variable. These two factors were known measures of bond liquidity (Longstaff et al., 2005).

Firm-level creditworthiness was proxied by the credit score of the issuer, as these were a well-established proxy for default risk that strongly influenced yield spreads (Hammami & Bahri, 2016). The squared variable of the credit score was also incorporated into the regression to control for diminished effects shown in previous studies (Okimoto & Takaoka, 2023). For each bond, the score was assigned according to this order: S&P issuer rating, Moody's issuer rating, and Fitch issuer rating. This hierarchy reflected the number of ratings accessible in the database from each agency, which were gathered and converted into a standardized numerical scale.

Given the multidimensional nature of firm risk, one variable could not capture all relevant data (Hilscher & Wilson, 2016). To address this, the regression model incorporated firm fixed effects, which accounted for other financial characteristics that could influence spreads. These fixed effects also captured firm size, which could affect sustainability scores, as larger firms disclosed more information, artificially inflating their scores (Drempetic et al., 2019). However, firm size was not directly targeted, as the Total Assets variable was excluded due to its high multicollinearity with other variables. Aligning with similar recent studies (Roggi et al., 2024; Lian et al., 2024; Fiorillo et al., 2025), the model further controlled for profitability (Return on Assets).

Macroeconomic variables, including GDP growth, inflation, economic policy uncertainty, market volatility (Stoxx50 Volatility Index), and the interest rate difference between 10-year and 2-year government bonds, were initially considered due to their effects on bond spreads (Luo & Liu, 2020; Tao et al., 2022). However, the model incorporated quarterly fixed effects, which captured shifting macroeconomic and financial market fluctuations over time, meaning that retaining all variables would have risked overfitting the model. To minimize this problem, only inflation was retained, as its monthly variations provided insights into yield fluctuations that quarterly fixed effects might not have fully captured. Moreover, compared to the other macroeconomic variables considered, inflation was chosen due to its improvement of model fit while having the lowest multicollinearity.

Lastly, since the model contained firm fixed effects, sector-specific risks and characteristics were controlled to ensure that variable effects were not conflated with industry risk patterns (Luo & Liu, 2020).

Table 4.1: Variables Table

Name	Definition	Source	Measurement and Transformations	Frequency
Bond Yield Spread	Difference between the corporate bond's yield and a benchmark yield: $\mathrm{YieldSpread} = \mathrm{CorporateYield} - \mathrm{BenchmarkYield}$	LSEG Data & Analytics	Logged value of basis points	Daily
ESG	LSEG Issuer ESG score	LSEG Data & Analytics	Score 0 to 100	Annualy
E	LSEG Issuer Environmental score	LSEG Data & Analytics	Score 0 to 100	Annualy
S	LSEG Issuer Social score	LSEG Data & Analytics	Score 0 to 100	Annualy
G	LSEG Issuer Governance score	LSEG Data & Analytics	Score 0 to 100	Annualy
$G^2_{\text{BelowMean}}$	Squared term of Governance (G) for values below the sample mean: $G^2 \cdot \mathbf{1}\{G < \overline{G}\}$, where: $\mathbf{1}\{G < \overline{G}\} = \begin{cases} 1 & \text{if } G < \overline{G} \\ 0 & \text{otherwise} \end{cases}$	Derived from G	Squared Variable	Annualy
Coupon Rate	Annual interest rate paid by the bond	Bloomberg	Basis Points	-
Time to Maturity[a]	Time to maturity of the bond at observation date	Bloomberg	Years, centered to reduce structure multicollinearity with squared variable	Daily
Time to Maturity Squared	Squared term of time to maturity to capture non-linear effects	Derived from Time to Maturity	Squared Variable	Daily
Callable Dummy	Dummy variable indicating if the bond is not callable (1 = not callable, 0 = callable)	Bloomberg	Binary (0 or 1)	-
Bid-Ask Spread	Difference between ask and bid price, relative to ask price: $\mathrm{BAS} = \frac{\mathrm{Ask} - \mathrm{Bid}}{\mathrm{Ask}}$	LSEG Data & Analytics	Percentage	Daily
Credit Score[a]	Issuer creditworthiness	Bloomberg (via S&P, Moody's, or Fitch)	Numerical scale (AAA = 21, AA+ = 20, ..., C = 1), centered to reduce structure multicollinearity with squared variable	Reviewed at least every 12 months
Credit Score Squared	Squared term of Credit Score to capture non-linear effects	Derived from Credit Score	Squared Variable	Reviewed at least every 12 months
ROA	A measure of profitability, dividing the net income by average Total Assets: $\mathrm{ROA} = \frac{\mathrm{NetIncome}}{\mathrm{TotalAssets}}$	Bloomberg	Percentage	Semi-Annualy or Quarterly
Inflation	EU's Consumer price index Growth rate (Year on Year): $\mathrm{Infl}_t = \frac{\mathrm{CPI_t} - \mathrm{CPI_{t\text{-}12}}}{\mathrm{CPI_{t\text{-}12}}} \times 100$	LSEG Data & Analytics	Percentage	Monthly

[a] Centered variables were adjusted by subtracting their mean to the observed values.
[b] All variables were from the most recent available data at the time of the bond observation.

4.3 Econometric Model

A fixed effects regression model was chosen to assess the relationships between corporate yield spreads and ESG scores. The model included firm-fixed effects and time-fixed effects to minimize unobserved characteristics that were fixed across quarters and across the same firms.

This led to four model equations:

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1 ESG_{it} + \beta_2 CD_{it} + \beta_3 INFL_t + \vec{\mathbf{Firm}}_{it}\beta_F + \vec{\mathbf{Bond}}_{it}\beta_B \\ + \vec{\mathbf{W}}_i\beta_W + \vec{\mathbf{Z}}_t\beta_Z + \epsilon_{it} \end{aligned} \tag{4.1}$$

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1 E_{it} + \beta_2 CD_{it} + \beta_3 INFL_t + \vec{\mathbf{Firm}}_{it}\beta_F + \vec{\mathbf{Bond}}_{it}\beta_B \\ + \vec{\mathbf{W}}_i\beta_W + \vec{\mathbf{Z}}_t\beta_Z + \epsilon_{it} \end{aligned} \tag{4.2}$$

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1 S_{it} + \beta_2 CD_{it} + \beta_3 INFL_t + \vec{\mathbf{Firm}}_{it}\beta_F + \vec{\mathbf{Bond}}_{it}\beta_B \\ + \vec{\mathbf{W}}_i\beta_W + \vec{\mathbf{Z}}_t\beta_Z + \epsilon_{it} \end{aligned} \tag{4.3}$$

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1 G_{it} + \beta_2 G_{it}^2 \cdot \mathbf{1}\{G_{it} < \overline{G}\} + \beta_3 CD_{it} + \beta_4 INFL_t + \vec{\mathbf{Firm}}_{it}\beta_F + \vec{\mathbf{Bond}}_{it}\beta_B \\ + \vec{\mathbf{W}}_i\beta_W + \vec{\mathbf{Z}}_t\beta_Z + \epsilon_{it} \end{aligned} \tag{4.4}$$

where Y_{it} denoted the yield spread for bond i at time t. The first model examined the ESG score (ESG_{it}), while the second, third and fourth model analyzed the individual factors: environmental (E_{it}), social (S_{it}), governance (G_{it}), $G_{it}^2 \cdot \mathbf{1}\{G_{it} < \overline{G}\}$, which corresponds to $G^2_{\text{BelowMean}}$. The variable CD_{it} represented the callable dummy, and $INFL_t$ denoted the inflation at time t. The vector $\vec{\mathbf{Firm}}_{it}$ included firm-level controls (return on assets, credit score, and credit score squared) at time t for firm i. The vector $\vec{\mathbf{Bond}}_{it}$ encompassed bond-specific variables: coupon rate, Bid-Ask spread, time to maturity, and time to maturity squared at time t for bond i. The vectors $\vec{\mathbf{W}}_i$ and $\vec{\mathbf{Z}}_t$ represented the firm and quarterly time fixed effects, respectively, with $\vec{\mathbf{W}}_i$ capturing unobserved heterogeneity across firms i and $\vec{\mathbf{Z}}_t$ accounting for temporal variations at time t.

Diagnostic tests were conducted to assess the key assumptions of linear regressions: low multicollinearity, autocorrelation of errors, heteroscedasticity, linearity, and normality (Tanni et al., 2023; Osbourne & Waters, 2002). The Variance Inflation Factor (VIF) was used to check for multicollinearity, the Wooldridge test to detect autocorrelation, the Wald test to examine heteroscedasticity, the RESET test to check linearity, and the Jarque-Bera test to assess normality of residuals.

Given the panel structure of the data (moderate to large N, moderate to low T) and the need for robustness against autocorrelation, two-way clustered standard errors (firm and time) were applied, following Cameron et al. (2011). Robustness checks were conducted to test the sensitivity of the model to diverse factors and specifications.

5 Results

To address the research gap regarding the relationship between ESG scores and bond spreads in the European corporate bond market, the present study examined a dataset of 6,818 observations across 207 entities from 2020 to 2024, with an average of approximately 33 observations per firm and 341 observations per time period (quarters).

Before presenting the main regression results, an understanding of the database and its characteristics emerged from the descriptive statistics, detailed in Table 5.1. The variables in the table are reported in their original form, with no centering, logging, or polynomial transformations applied.

Table 5.1: Descriptive Statistics of Main Variables

Variable	**N**	**Mean**	**SD**	**Min**	**25%**	**Median**	**75%**	**Max**
Bond Yield Spread	6818	144.16	81.79	2.80	94.06	124.56	168.39	979.05
ESG	6818	76.29	11.71	9.42	70.58	78.07	84.39	94.98
E	6818	76.52	15.19	0.00	67.84	78.53	88.43	98.80
S	6818	81.03	12.63	2.15	75.72	83.84	90.15	97.74
G	6818	68.34	19.37	4.11	55.29	72.51	84.89	98.21
ROA	6818	3.16	4.88	-39.25	0.82	2.82	5.43	40.97
Coupon Rate	6818	191.82	152.61	0.00	62.5	162.5	325	1050
Callable Dummy	6818	0.09	0.28	0.00	0.00	0.00	0.00	1.00
Inflation	6818	4.23	2.87	-0.31	2.23	2.75	6.09	10.62
Credit Score	6818	13.77	1.74	5.00	13.00	14.00	15.00	19.00
Bid-Ask Spread	6818	0.49	0.30	0.01	0.30	0.42	0.60	3.92
Maturity	6818	6.59	3.25	0.75	4.25	6.15	8.25	20.00

Note: The variables in the table are reported in their original form, with no centering, logging, or polynomial transformations applied. Variables defined in Table 4.1.

The analysis revealed that the dependent variable, Bond Yield Spread, ranged from 2.80 to 979.05 with a mean of 144.16 and a substantial variation of 81.79 (standard deviation). ESG scores and its individual pillars E and S showed means ranging from 76 and 81, with governance having the lower mean (68.34) and more dispersed values. The E pillar was the only one with a minimal value of zero.

Credit scores had at the 25% level a score of 13, this indicated at least 75% of the observations were of investment grade firms. The sample had approximately 9% of non callable bonds, as the mean of the callable Dummy was 0.09. Bond-specific variables showed a mean coupon rate of 1.9% and an average maturity of 6.6 years. Firm profitability, measured by ROA, averaged 3.2% with a high standard deviation of 4.88. Inflation averaged 4.2% over the period of the sample, with a peak above 10%. Bid-ask spreads averaged 0.49, pointing to relatively liquid bonds.

The sample included observations from 15 countries, with France (29.16%), the Netherlands (24.66%), and Germany (17.20%) representing the largest shares. Sector-wise, Consumer Discretionary (21.85%) and Industrials (17.45%) had the biggest percentage of observations. Additionally, 91.84% of bond observations were classified as Investment Grade (>11). A detailed breakdown of the sample distribution is provided in the Appendix (Table 9.2).

To provide an overview of the relationships between the variables, Table 5.2 presents the Pearson correlation matrix for the variables without centering, logging or polynomials.

Table 5.2: Pearson Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1. Bond Yield Spread	1.00											
2. ESG	-0.16	1.00										
3. E	-0.12	0.73	1.00									
4. S	-0.17	0.83	0.57	1.00								
5. G	-0.10	0.70	0.18	0.35	1.00							
6. ROA	-0.18	0.00	-0.01	-0.01	0.05	1.00						
7. Coupon Rate	0.30	-0.07	-0.03	-0.07	-0.07	-0.09	1.00					
8. Callable Dummy	-0.07	0.13	0.07	0.12	0.11	-0.06	-0.05	1.00				
9. Inflation	0.33	0.02	0.01	0.00	0.03	0.09	-0.15	0.01	1.00			
10. Credit Score	-0.61	0.26	0.23	0.27	0.15	0.23	-0.26	0.15	-0.02	1.00		
11. Bid-Ask Spread	0.39	-0.07	-0.07	-0.08	-0.04	-0.10	0.08	-0.08	0.03	-0.29	1.00	
12. Maturity	0.08	0.04	0.03	0.01	0.06	0.00	-0.02	-0.06	0.01	0.13	0.31	1.00

Note: Correlations are Pearson coefficients. Variables are defined in Table 4.1.

The analysis showed that Yield Spread exhibited a strong negative correlation with Credit Score ($r = -0.61$), indicating an association with credit quality. The spread also displayed high positive correlations with Bid-Ask Spread ($r = 0.39$) and Inflation ($r = 0.33$). The ESG variables (ESG, E, S, and G) demonstrated positive correlations with each other, with a notable correlation between the individual pillar Environmental and Social ($r = 0.57$). Their correlations with Bond Yield Spread ranged from -0.10 to -0.17.

Diagnostic tests showed that for every model all VIFs were below 10 and the residuals displayed autocorrelation but no evidence of groupwise heteroskedasticity. Additionally, normality was rejected, although the large sample mitigates this issue; no evidence of nonlinearity was found, and the Hausman test confirmed the use of fixed effects over random effects. The results of all assumption tests are shown in the appendix (Table 9.1).

5.1 Model A (ESG) Results

Table 5.3: Fixed Effects Regression Results – Model A

	Model without control variables	Model with control variables
ESG	-0.0012 (-0.65)	-0.0007 (-0.55)
ROA		-0.0064*** (-3.05)
Coupon Rate		0.0003*** (7.44)
Callable Dummy		-0.0757*** (-2.99)
Inflation		0.0627 (1.61)
Credit Score		-0.0912*** (-5.63)
Credit Score^2		0.0128*** (3.35)
Bid-Ask Spread		0.0681*** (3.13)
Maturity		0.0641*** (16.33)
Maturity^2		-0.0038*** (-6.36)
Constant	4.94 (35.79)	4.6 (22.40)
Observations	6818	6818
Entities	207	207
Time Periods	20	20
R^2 (Within)	0.0006	0.4806
F-statistic (robust)	0.43	88.34***

Note: T-values in parentheses; ***p<0.01, **p<0.05, *p<0.1. All models include entity and time fixed effects.

The fixed model had a within R² of 0.4806, meaning the model explained nearly half of the within-firm variation in corporate bond yield spreads. The robust F statistic value is approximately 88.34 and was highly significant (p < 0.01).

The fixed effects regression results showed that ESG scores were not statistically significant at a conventional level ($p > 0.1$) with bond yield spreads in the predetermined intervals, both without controls ($\beta = -0.0012$, $t = -0.65$, $p > 0.1$) and after including control variables ($\beta = -0.0007$, $t = -0.55$, $p > 0.1$). This result did not indicate a statistically significant effect of ESG scores on spreads.

Once controls were added, credit ratings emerged as an important predictor. The linear term for credit score was negative and highly significant ($\beta = -0.0912$, $t = -5.63$), indicating that bonds with better credit quality were linked to lower spreads. However, the positive and significant squared term ($\beta = 0.0128$, $t = 3.35$) pointed to a non-linear relationship: while upgrades in credit quality reduce spreads, the effect diminished with each credit rating improvement.

Additionally, ROA was negatively related to spreads ($\beta = -0.0064$), more profitable firms had lower borrowing costs. The coupon rate had a strong positive effect (($\beta = 0.0003$, $t = 7.44$), higher coupon bonds were associated with wider spreads. Non callable bonds exhibited significantly lower spreads ($\beta = -0.0757$, $t = -2.99$). Maturity displayed an inverted U effect: with a positive coefficient for the linear term ($\beta = 0.0641$, $t = 16.33$) and a negative coefficient for the squared term ($\beta = -0.0038$, $t = -6.36$).

Higher bond liquidity in the form of bid-ask spreads was linked to higher yield spreads ($\beta = 0.0681$, $t = 3.13$). Inflation demonstrated a positive but not significant, in the tested p values, relationship with spreads ($\beta = 0.0627$, $t = 1.61$, $p > 0.1$).

Since the coefficients of the control variables remained broadly consistent across all specifications, for the subsequent models (E, S, and G), the focus was on the variables of interest.

5.2 Model B (E Pillar) Results

Table 5.4: Fixed Effects Regression Results – Model B

	Model without control variables	Model with control variables
E	0.0012 (0.78)	0.0006 (0.58)
ROA		-0.0064*** (-3.09)
Coupon Rate		0.0003*** (7.44)
Callable Dummy		-0.0753*** (-2.97)
Inflation		0.0632 (1.63)
Credit Score		-0.0921*** (-5.81)
Credit Score^2		0.0127*** (3.35)
Bid-Ask Spread		0.0679*** (3.12)
Maturity		0.0640*** (16.28)
Maturity^2		-0.0038*** (-6.33)
Constant	4.7588*** (39.57)	4.4756*** (24.25)
Observations	6818	6818
Entities	207	207
Time Periods	20	20
R^2 (Within)	4.913e-05	0.4809
F-statistic (robust)	0.61	88.26***

Note: T-values in parentheses; ***p<0.01, **p<0.05, *p<0.1. All models include entity and time fixed effects.

The fixed effects regression model results exhibited a robust F-statistic of 88.26 ($p < 0.01$) and an R^2 Within of 0.4809, meaning that it explained 48.09% of within-firm variation of corporate bond yield spreads.

In Model B, the variable of interest was the environmental score (E), Without controls its coefficient was $\beta = 0.0012$ ($t = 0.78$), and $\beta = 0.0006$ ($t = 0.58$) with the addition of control variables. The coefficient showed a p-value that exceeded the thresholds of 0.01, 0.05, and 0.1, not supporting a relationship with the corporate bond yield spreads.

5.3 Model C (S Pillar) Results

Table 5.5: Fixed Effects Regression Results – Model C

	Model without control variables	Model with control variables
S	-0.0017 (-1.02)	-0.0014 (-1.24)
ROA		-0.0064*** (-3.1)
Coupon Rate		0.0003*** (7.50)
Callable Dummy		-0.0764*** (-2.98)
Inflation		0.0624 (1.6)
Credit Score		-0.0908*** (-5.64)
Credit Score^2		0.0128*** (3.36)
Bid-Ask Spread		0.0683*** (3.16)
Maturity		0.0641*** (16.33)
Maturity^2		-0.0038*** (-6.37)
Constant	4.9879*** (37.67)	4.6395*** (22.39)
Observations	6818	6818
Entities	207	207
Time Periods	20	20
R^2 (Within)	0.0005	0.4802
F-statistic (robust)	1.0403	88.231***

Note: T-values in parentheses; ***p<0.01, **p<0.05, *p<0.1. All models include entity and time fixed effects.

The fixed effects regression results showed that the model had a similar fit to the previous models, as it explained 48.02% of within-firm variation (R^2 Within = 0.4802) had a robust F-statistic of 88.231.

The coefficient of the Social Score was -0.0014 with a t-value of -1.24, indicating a negative relationship that was not statistically significant at $p < 0.1$. When compared to the fixed model that used just the variable of interest ($\beta = -0.0017$, $t = -1.24$) the inclusion of controls retained the negative result but failed to have a p value under 0.10. Therefore, the results indicated no statistically significant relationship between S scores and the dependent variable.

5.4 Model D (G Pillar) Results

Table 5.6: Fixed Effects Regression Results – Model D

	Model without control variables	Model with control variables
G	-0.0013 (-1.35)	-0.0003 (-0.36)
$G^2_{\text{BelowMean}}$	-1.276e-05** (-2.09)	-1.002e-05** (-2.01)
ROA		-0.0061*** (-2.82)
Coupon Rate		0.0003*** (7.40)
Callable Dummy		-0.0732*** (-3.02)
Inflation		0.0624 (1.60)
Credit Score		-0.0921*** (-5.74)
Credit Score^2		0.0130*** (3.58)
Bid-Ask Spread		0.0689*** (3.18)
Maturity		0.0640*** (16.23)
Maturity^2		-0.0038*** (-6.32)
Constant	4.9555*** (72.05)	4.5491*** (26.13)
Observations	6818	6818
Entities	207	207
Time Periods	20	20
R^2 (Within)	0.0037	0.4812
F-statistic (robust)	2.3308*	81.514***

Note: T-values in parentheses; ***p<0.01, **p<0.05, *p<0.1. All models include entity and time fixed effects.

The fixed effects regression results of Model D explained 48.12% of within-firm variation (R^2 Within = 0.4812) and a F-statistic (robust) of 81.514 ($p < 0.01$). In terms of model performance, this result had a higher explanatory power compared to the other models (A-C), although this was a very small improvement. In terms of R^2, this model demonstrated a very small improvement compared to Models A-C.

The effect of the G variable was negative ($\beta = -0.0003$, $t = -0.36$) and did not have a p value below the defined threshold of 0.1. However, the variable $G^2_{\text{BelowMean}}$ was significant and negative ($\beta = -1.276e - 05$, $t = -2.01$, $p > 0.05$), as firms with lower governance (< 68.34), experienced a non linear relationship between G scores and corporate bond spreads. The governance score exhibits a concave negative effect, (negative first and second order derivative), that is, the negative effect of governance on spreads became progressively stronger as governance scores moved closer to the average of 68.34.

The figure 5.1 illustrates how G scores affected bond spreads below the mean, if every other variable stayed the same:

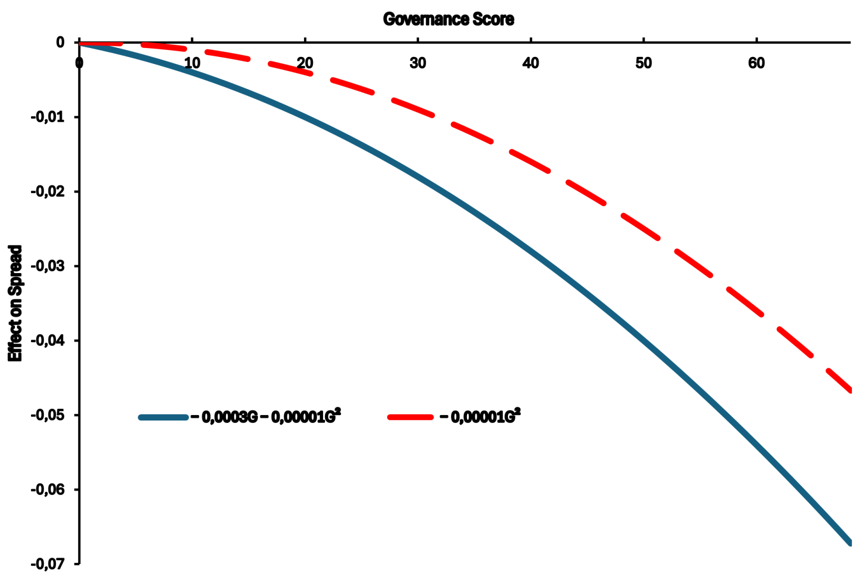

Figure 5.1: Effect of G Scores on Bond Yield Spread
Note: The solid line represents the effect of G and $G^2_{\text{BelowMean}}$; the dashed line represents the effect of only $G^2_{\text{BelowMean}}$.

5.5 Robustness Checks

Table 5.7: Robustness Checks Results

	(1)	(2)	(3)	(4)
ESG	-0.0008 (-0.6)	-0.0007 (-0.91)	-0.0007 (-0.57)	
E	0.0006 (0.62)	0.0006 (1.17)	0.0005 (0.7)	
S	-0.0016 (-1.36)	-0.0014** (-2.25)	-0.0012 (-1.07)	
G	-0.0003 (-0.39)	-0.0003 (-0.48)	-0.0005 (-0.76)	
$G^2_{\text{BelowMean}}$	-8.262e-06* (-1.7)	-1.002e-05*** (-4.15)	-1.068e-05*** (-3.38)	
GCentered				0.0016 (1.63)
$GCentered^2_{\text{BelowMean}}$				6.243e-05** (2.18)
R^2 (Within)	0.4922	0.4806	0.464	0.4805
	0.4925	0.4809	0.4647	
	0.4917	0.4802	0.4637	
	0.4926	0.4812	0.4653	
Observations	6818	6818	6818	6818
Entities	207	207	207	207

Note: T-values in parentheses; ***p<0.01, **p<0.05, *p<0.1. R^2 corresponds vertically to each individual model.

The first robustness test, represented as (1), winsorized the bond spread at the 1% and 99% percentiles, which reduced the influence of extreme outliers by capping rather than removing observations entirely. The second test (2) employed Driscoll-Kraay standard errors, which were robust to cross-sectional and temporal dependence, offering an alternative to the clustered standard errors applied in the baseline model. The third test (3) replaced quarterly time fixed effects with annual time fixed effects to assess the sensitivity of the results to different time aggregations. The fourth test (4) was conducted only on the Governance model by centering the G variable, and the $GCentered^2_{\text{BelowMean}}$ was derived from that variable.

The ESG and E scores consistently remained not statistically significant at $p < 0.1$ and with similar coefficients across all robustness checks, reinforcing their lack of explanatory power. The S score, however, became statistically significant in the Driscoll-Kraay model (2) with a negative coefficient ($\beta = -0.0014$, $p < 0.05$), this was worth noticing but this effect was not stable across the other tests.

Governance effects again showed significance only through the squared below-mean terms, although its coefficient had a few changes and its significance level varied between models. In the model with centered variables (4), the positive coefficient on the centered governance squared term ($\beta = 6.243e - 05$, $p < 0.05$) indicated that the non-linear effect persisted even after adjusting the variable's scale.

6 Discussion

This study addressed the research problem of determining the impact of ESG scores on bond yield spreads within the European corporate bond market, utilizing a panel dataset spanning 6,818 observations across 207 entities from 2020 to 2024. The findings of this work, revealed that the control variables were the main drivers of the yield spreads, consistently explained substantial within-firm variation (R^2 Within ranging from 0.4802 to 0.4812 across models). The robust F-statistics were always above 80 (p < 0.01) further validated the fit of these models and its variables.

The results from Model A, showing a negative but not significant association between overall ESG scores and bond yield spreads (p > 0.1). General consensus in the literature, with works such as those made by Fiorillo et al. (2025) and Lian et al. (2024), report a significant cost reducing effect of higher ESG performance. This discrepancy may reflect the European Union context's market dynamics or timeline specific factors.

Model B's results found that the environmental (E) score had a positive, not significant effect on spreads (p > 0.1). This contrasts with Roggi et al. (2024) paper, who documented a risk-reducing effect of environmental scores based on a global sample of green, social, and sustainability bonds. However, European-specific research by Cicchiello et al. (2022) identified that green bonds had an increased risk sensitivity during the COVID-19 pandemic. Model B's non-significant results suggest that environmental performance may not influence bond yield spreads in the EU sample, potentially due to conditions of heightened uncertainty during the 2020–2024 period.

Model C did not indicate a significant association between the social (S) score and spreads (($\beta = -0.0014$, $t = -1.24$, $p > 0.1$). The literature on social performance appears to lack a consensus of results, Okimoto & Takaoka (2023) highlighted human rights (S) as a spread reducer and Li and Adriaens (2023) found that the significance of social scores on spreads, can depend on the firm sector and the control variables used. The absence of significance in Model C may reflect this variability.

In contrast to all other sustainability scores, the governance (G) score in Model D exhibited no significant linear effect, but its squared term below the mean ($G^2_{\text{BelowMean}}$) was significant ($p < 0.05$). This result suggested a concave negative effect for lower governance scores, with each unit increase of Governance leading to further reduced spreads. However, this non linear effect had a small impact on bond spreads, with a coefficient of -1.002e-05. Prior research, such as the Li and Adriaens (2023) made in the US market, reported governance as the most influential sustainability factor in bond spreads at issuance, with a coefficient of -5.6 bps, highlighting its relevance across markets.

Accordingly, only the H_4**: Governance (G) pillar scores exhibit a statistically significant relationship with bond spreads within EU firms** was not rejected, while the hypotheses related to ESG, E, and S were rejected.

The findings imply that ESG scores exert only a limited direct influence on bond pricing in the EU market, challenging the assumption that sustainability lowers borrowing costs. Instead, the evidence points to governance as the most relevant dimension, though its effect was small and nonlinear. This suggests that, in the studied European bond market sample, investors may place greater weight on credit fundamentals than on ESG when assessing debt risk.

7 Conclusion

This research examined whether higher ESG performance influences corporate bond yield spreads in the EU market. Based on a fixed effects panel analysis of 6,818 observations from 678 bonds issued by 207 European Union firms between 2020 and 2024, the analysis shows that overall ESG scores have no significant effect on bond yield spreads. Among the individual ESG pillars, only governance demonstrates a significant relationship, where lower-than-average scores are associated with slightly narrower spreads, and each unit increase leads to a progressively greater reduction in spreads.

The lack of statistical significance ($p > 0.1$) of the overall ESG score is unexpected, given the significant effects documented in prior studies conducted in different markets and time periods. Similarly, results not statistically significant at conventional levels for the E and S scores are surprising, considering the European Union's emphasis on sustainable finance. This research provides insights for both investors and firms, assessing how sustainability performance shapes debt financing costs in the EU through its impact on bond yield spreads.

The methodology employed strict filters in the selection of the bond database, such as requiring a minimum issuance size, fixed coupon rates, and excluding financial institutions. This approach, combined with a selection of control variables based on previous research, supported the isolation of the role of ESG scores in bond yield spreads. Additionally, robustness checks enhanced the reliability of the models' results, remaining largely consistent, except for the Driscoll-Kraay standard errors, which indicated a negative significant effect of the Social Scores.

Limitations exist in this research. The time frame of 2020–2024, selected to reflect recent sustainable finance developments, was heavily influenced by extraordinary events, such as the COVID-19 pandemic and subsequent monetary policy shifts, which may limit the application of the results beyond this period. Secondly, the use of only one ESG score rating provider may be a limitation, given the documented divergence between rating providers. Additionally, given the focus on the EU and the methodology used, the 207 entities may not capture the full diversity of the European Union bond market.

Future research using more extensive databases that incorporate multiple rating providers could determine whether these results remain consistent. Given the non-linear effects of the Governance factor ($G^2_{\text{BelowMean}}$), exploring non-linear models and machine learning techniques could be beneficial in future research. Cross-market studies could also provide results across different bond market regions. Lastly, as more time passes since the introduction of new regulations and frameworks in the EU, further research could use an extended timeline and a larger dataset, potentially enhancing the analysis of long-term ESG impacts.

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9 Annex

Annex A: Assumption Tests Results

Table 9.1: Assumption Tests Results for ESG, E, S, and G Models

Test	**ESG Model**	**E Model**	**S Model**	**G Model**
		Manual Hausman Test		
Statistic (χ^2)	142.0874	130.0029	128.0053	168.5151
p-value	0.0000	0.0000	0.0000	0.0000
Conclusion	Reject H0 (Fixed Effects)	Reject H0 (Fixed Effects)	Reject H0 (Fixed Effects)	Reject H0 (Fixed Effects)
		Wooldridge Test for Autocorrelation		
Statistic	1100.1715	1101.6912	1094.4931	1085.1443
p-value	0.0000	0.0000	0.0000	0.0000
Conclusion	Autocorrelation present	Autocorrelation present	Autocorrelation present	Autocorrelation present
		Modified Wald Test for Groupwise Heteroskedasticity		
Statistic	207.7078	209.1276	206.1604	208.6721
p-value	0.4535	0.4262	0.4837	0.4349
Conclusion	No heteroskedasticity	No heteroskedasticity	No heteroskedasticity	No heteroskedasticity
		RESET Test		
F-statistic	0.8484	1.0448	0.8363	0.8462
p-value	0.4282	0.3518	0.4333	0.4291
Conclusion	No nonlinearity	No nonlinearity	No nonlinearity	No nonlinearity
		Jarque-Bera Test for Normality of Residuals		
Statistic	115731.6666	116181.8393	116213.2584	115755.2090
p-value	0.0000	0.0000	0.0000	0.0000
Conclusion	Non-normal residuals	Non-normal residuals	Non-normal residuals	Non-normal residuals

Annex B: Percentage Distribution of Sample

Table 9.2: Percentage Distribution of Country of Risk, Sector, and Credit Score

Category	Subcategory	Percentage (%)
	Country of Risk	
Country	France (FR)	29.16
	Netherlands (NL)	24.66
	Germany (DE)	17.20
	Italy (IT)	8.29
	Luxembourg (LU)	4.81
	Spain (ES)	3.30
	Ireland (IE)	2.99
	Sweden (SE)	2.95
	Belgium (BE)	2.10
	Denmark (DK)	1.85
	Austria (AT)	1.33
	Finland (FI)	0.81
	Hungary (HU)	0.25
	Czech Republic (CZ)	0.23
	Poland (PL)	0.07
	Sector	
Sector	Consumer Discretionary	21.85
	Industrials	17.45
	Consumer Staples	13.52
	Utilities	13.44
	Materials	9.20
	Health Care	8.23
	Communications	7.17
	Technology	4.74
	Energy	4.40
	Credit Score	
Credit Score	Investment Grade (>11)	91.84
	Non-Investment Grade ($\leq$11)	8.16