Lisbon School of Economics & Management
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MASTER OF SCIENCE IN

FINANCE

MASTER'S FINAL WORK

DISSERTATION

THE IMPACT OF GREEN BONDS ISSUANCE ON COST OF CAPITAL

JOANA DOMINGUES RAMOS

JUNE - 2024

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SUPERVISION:
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Abstract

This dissertation investigates the impact of green bond issuances on the implied cost of capital among European firms listed on the STOXX600 index. Using a Difference-in-Differences (DID) methodology, the study examines a sample of 468 firms, applying the Implied Cost of Capital (ICC) methods proposed by Easton (2004) and Ohlson and Juettner-Nauroth (2005). Initial analyses revealed inconclusive results due to sample imbalance, prompting the application of robustness tests including Entropy Balance and Propensity Score Matching (PSM). The subsequent DID regressions, adjusted for cluster robust standard errors, consistently demonstrated a significant reduction in the implied cost of capital following green bond issuances. Further analysis explored the role of Environmental, Social, and Governance (ESG) scores, finding that higher ESG scores are associated with an increased cost of capital. However, the issuance of green bonds mitigates this effect, resulting in an overall reduction in the cost of capital. Additional investigations into the impact of Sustainability Linked Bonds (SLBs) revealed that while both SLBs and green bonds reduce the cost of capital, green bonds have a more pronounced effect. This dissertation contributes to the growing body of literature on sustainable finance, highlighting the effectiveness of green bonds in reducing financing costs and promoting environmental sustainability.

Keywords: Green Bonds, Cost of Capital, Environmental, Social, and Governance (ESG), Sustainability Linked Bonds (SLBs)

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AI disclaimer

In the preparation and completion of this dissertation, AI tools were ethically utilized to enhance both the quality and precision of the work. It was specifically employed to ensure the clarity and professionalism of the written content, aiding in the formulation and refinement of the text, and helping articulate complex ideas coherently throughout the dissertation. The use of AI in these capacities was carefully managed to preserve the originality and integrity of the research and its findings.

Additionally, AI assisted with coding in STATA, facilitating the construction and validation of the necessary models for this study. This application enabled more efficient data analysis and model building, ensuring robust and accurate results. The use of AI in this context adhered to ethical guidelines, ensuring that the assistance provided did not compromise the scientific rigor or authenticity of the research.

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Glossary

ESG – Environmental, Social and Governance

CSR – Corporate Social Responsibility

STOXX600 – STOXX Europe 600 index

ICC – Implied Cost of Capital

SLBs – Sustainable Linked Bonds

WACC – Weighted Average Cost of Capital

DID – Differences-in-Differences

PSM – Propensity Score Matching

VIF - Variance Inflation Factor

1. Introduction

The global challenge of climate change significantly impacts both societal and business operations worldwide. To address this pressing issue, the Paris Agreement of 2015 was enacted, aiming to forge a unified global effort in mitigating climate change and constraining global warming to below 2 degrees Celsius above pre-industrial levels. This landmark agreement underscores the critical need for sustainable practices, widespread adoption of renewable energy sources, and the establishment of resilient infrastructure capable of withstanding the impacts of climate change.

Within the realm of sustainable finance, Green Bonds have emerged as pivotal instruments. Unlike traditional bonds, Green Bonds are specifically designed to finance or refinance environmentally sustainable projects. This includes initiatives aimed at enhancing climate and environmental sustainability (Kidney & Oliver, 2014). By affixing a "green" label to corporate bonds, companies signal their environmental commitment to investors, potentially bolstering their reputation in Corporate Social Responsibility (CSR) and enhancing shareholder value (Baker et al., 2018; Merton, 1987). However, the benefits of Green Bonds come with associated costs, such as meeting stringent green bond standards and obtaining third-party verifications, which can elevate financing costs (Spiegeleer & Schoutens, 2019; Flammer, 2020).

This dissertation addresses a gap in the literature by examining the impact of Green Bonds on the cost of capital. Specifically, it investigates whether companies issuing Green Bonds experience lower cost of capital compared to non-issuers, as suggested by Zhang et al. (2021), and explores whether firms with higher Environmental, Social, and Governance (ESG) scores face higher implied cost of capital, as posited by Gabellone and Priem (2022). The study utilizes the Implied Cost of Capital models proposed by Easton (2004) and Ohlson and Juettner-Nauroth (2005) to analyze a sample of 468 European constituents of the STOXX 600 index, including 79 companies that have issued Green Bonds.

Methodologically, the study employs the Difference-in-Differences (DID) approach to evaluate the impact of Green Bond issuances on the cost of capital. To ensure robustness, two matching methods, Entropy Balance and Propensity Score Matching (PSM), are applied due to the dataset's inherent imbalance. Cluster robust standard errors and Placebo tests are utilized to validate the models and ensure reliable conclusions.

The findings highlight a significant reduction in the cost of capital following Green Bond issuances among European firms, aligning with previous research indicating similar effects in Chinese companies (Zhang et al., 2021).

Additional analyses include quantile regressions to assess model effectiveness, as well as examinations of the mediation effect of ESG on both Implied Cost of Capital and Weighted Average Cost of Capital.

Furthermore, the study explores the impact of Sustainability Linked Bonds (SLBs) on Implied Cost of Capital, contributing to a comprehensive understanding of financial instruments within the sustainable finance landscape.

2. Literature Review

Climate change is a demanding concern with significant repercussions for both society and businesses. Recognizing the urgency of the situation, the Paris Agreement was established in 2015, unifying countries to collectively address climate change. The agreement aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels. This commitment has far-reaching impacts on society, prompting the need for sustainable practices, widespread adoption of renewable energy, and the development of climate-resilient infrastructure. For businesses, aligning with the goals of the Paris Agreement is increasingly vital. Firms encounter rising expectations from stakeholders to embrace environmentally responsible practices, pioneer sustainable solutions, and disclose climate-related risks. Adapting to the evolving landscape of climate action is not only an ethical imperative but also a strategic need for long-term resilience and success in the ever-changing global economy.

In order to face this challenge, substantial funding becomes imperative. According to the Organization for Economic Cooperation and Development (OECD), an estimated $93 trillion in infrastructure investment, including transportation, energy, and water, is required over the next 15 years to realize a low-carbon future (OECD 2017), (Flammer 2020). Among this urgent call for action, companies are experiencing pressure from shareholders and stakeholders to overhaul their operations in a sustainable manner. This involves a comprehensive reconsideration of financing sources, with a particular focus on mechanisms such as the issuance of green bonds, the exploration of loans with environmental, social, and governance constraints, and strategic decisions regarding sustainable project investments and allocations (Madime and Gonçalves 2022).

Green bonds have emerged as a pivotal financial instrument within the sustainable finance landscape. These bonds represent a strategic response to the escalating global concern about climate change and the compelling need to support environmentally sustainable projects. A closer examination identifies green bonds as alternative financial tools, specifically designed to direct their income toward the financing or refinancing of green projects. These encompass various initiatives aimed at promoting climatic or environmental sustainability (Kidney & Oliver, 2014).

The analogy drawn between green bonds and conventional bonds serves a dual purpose. On one hand, it stimulates market growth by leveraging a well-tested financial product. On the other hand, it allows issuers to demonstrate their solid commitment to sustainability (Barclays, 2015). Several compelling reasons drive investments in green bonds, including ethical considerations, the desire for a positive reputation, adherence to regulatory standards, and considerations related to the long-term risk-revenue relationship (Zerbib, 2016). These factors collectively underscore the multifaceted appeal of green bonds in the contemporary financial landscape, where sustainability and responsible investment are gaining increasing prominence.

Shishlov, Morel, and Cochran (2016) defined seven categories of green bonds that reflect their adaptability to various financing needs and structures. These encompass corporate bonds or use-of-proceeds bonds, backed by the corporation's balance sheet. Additionally, there are project bonds, supported by a single or multiple projects, asset-backed securities (ABS) collateralized by a group of projects, covered bonds with recourse to both the issuer and a pool of underlying assets, and supranational, sub-sovereign, agency (SSA) bonds issued by international financial institutions (IFIs) and various development agencies. Furthermore, municipal bonds originate from municipal governments, regions, or cities, while financial sector bonds are issued by institutions to fund on-balance sheet lending.

In 2007, the first green bond was issued through the European Investment Bank (EIB), used for financing renewable energy and energy efficiency projects. Green bonds have become increasingly popular in recent years, with Morgan Stanley referring to this evolution as the "green bond boom." The subsequent years saw a surge in participation from various entities, with supranational agencies, led by the World Bank, actively contributing to climate change mitigation.

Following 2012, Sovereign, Supranational, and Agencies (SSA), municipalities, local government agencies, and national development banks significantly expanded the market. The momentum further accelerated in 2013 when corporations embraced green bonds, broadening the spectrum of issuers (Trompeter, 2017).

By the end of 2017, the green bond market had reached a noteworthy size, estimated at 270 billion dollars (Bos, Meinema, & Houkes, 2018), with a record issuance of 155.5 billion dollars from 239 issuers in that year (Climate Bonds Initiative, 2018). The market's rapid evolution is evident in its consistent year-on-year growth, with S&P (2018) reporting an annual increase of at least 80% over the past five years, consistently reaching new record levels. Diversification also became pronounced, with the number of countries issuing green bonds expanding from 27 to 39 in just one year (Mariani, Grimaldi, and Caragnano, 2019). The positive trend underscores a growing commitment to environmentally conscious initiatives, indicating a collective shift toward a low-carbon society (Campiglio, 2016).

In 2014, the International Capital Market Association (ICMA) introduced the Green Bond Principles (GBP), a significant advancement in market sophistication. These principles, serving as voluntary guidelines, advocate transparency, disclosure, and integrity in developing the green bond market. They have become the cornerstone for most issuers' green bond frameworks (Mariani, Grimaldi, and Caragnano, 2019). The GBP outlines a clear process and disclosure for issuers, emphasizing the transparency, accuracy, and integrity of information disclosed and reported to stakeholders. The four core components include the use of proceeds, process for project evaluation and selection, management of proceeds, and reporting (Mariani, Grimaldi, and Caragnano, 2019).

June 2018 witnessed the European Commission establishing a Technical Expert Group on sustainable finance (TEG) to guide the Action Plan's key areas. This includes the development of a unified classification system for sustainable economic activities, an EU Green Bond Standard, benchmarks strategies, and guidance for improved corporate disclosure of climate-related information. The TEG proposes a voluntary, non-legislative EU Green Bond Standard to enhance the effectiveness, transparency, comparability, and credibility of the green bond market, encouraging participants to align with the standard.

With an increasing influx of issuers and investors into the green bond market annually, a pressing need for heightened accountability and transparency arises to alleviate concerns surrounding *greenwashing*. In the context of the green bond market, *greenwashing* refers to the misallocation of bond proceeds to assets with minimal or no environmental value, undermining market confidence (Weber and Saravade, 2019). Addressing these transparency and accountability challenges has led to the development of market indices from key players such as S&P Dow Jones, Bank of America Merrill Lynch, Barclays MSCI, and Solactive. These indices have become pivotal tools for issuers, serving as benchmarks to assess their performance in the green bond market (Ehlers and Packer, 2017).

These indices, including those from S&P Dow Jones, Bank of America Merrill Lynch, Barclays MSCI, and Solactive, offer detailed and globally comprehensive coverage of green bonds. They provide invaluable insights for investors, facilitating an in-depth analysis of the various types of green bonds available for investment. By leveraging these indices and tools, investors can simulate, and construct portfolios tailored to accommodate their financial and geographical preferences in investment. Moreover, these tools empower users to scrutinize their exposure to climate and other environmental risks effectively.

Shareholders may be concerned in guaranteeing that the funds derived from these bonds are allocated to environmentally friendly projects. The agency problem manifests when there is a misalignment of interests between shareholders and management concerning the utilization of these funds. Shareholders may express apprehension regarding *greenwashing* or the improper allocation of funds toward projects lacking substantial environmental impact.

If agency problems are mitigated through mechanisms like transparency, disclosure, and independent verification of the use of green bond proceeds, it can enhance trust between shareholders and management. Greater trust can lead to a reduction in the perceived agency costs, potentially resulting in a positive impact on the cost of capital.

The emergence of the green bond market prompts the exploration of whether the issuance of green bonds yields benefits for both firms' financial performance and the perspective of lenders. When a company decides to issue green bonds, it implies a dedication to environmentally sustainable projects. Various stakeholders, encompassing environmentally conscious consumers, local communities, and advocacy groups, are likely to show keen interest in such endeavors. A company's ability to authentically demonstrate its commitment to sustainability through green bonds has the potential to strengthen its reputation and foster stronger relationships with stakeholders.

This, in turn, could have implications for the cost of capital. Positive stakeholder relationships, reinforced by a commitment to green financing, can contribute to a positive corporate image. A positive image, in turn, can potentially lower the perceived risk for investors and lenders. If stakeholders view the company as socially responsible and environmentally conscious, they may be more inclined to invest or lend at lower costs.

Tang and Zhang (2020) delved into the announcement returns and tangible impacts of firms issuing green bonds across twenty-eight countries from 2007 to 2017. Their results disclosed that stock prices positively respond to the issuance of green bonds, comprising a benefit to shareholders.

Daubanes, Mitali and Rochet, (2021) suggest that green bonds carry positive information to markets, evident in favorable announcement stock returns. Their model suggests that firms tend to issue more green bonds in sectors where managers display heightened interest in their firm's stock price, thereby amplifying other decarbonization incentives.

Upon announcing the issuance of certified green bonds, companies witness an increase in stock prices, constituting a notable advantage for shareholders. This phenomenon is underscored in studies by Baulkaran (2019), Tang and Zhang (2020), and Flammer (2021), all identifying abnormal stock returns within the range of 0.5 to 1.5%, coinciding with the announcement of certified green bonds. On other hand, conventional bonds, as evidenced by studies such as those by Eckbo (1986), Mikkelson and Partch (1986), and Antweiler and Frank (2006), fail to elicit abnormal stock returns.

Several factors can justify the positive stock returns generated by green bonds. Primarily, there is a growing emphasis on climate concerns. According to Pastor, Stambaugh, and Taylor (2022), this factor contributes to a green bond premium, leading to a reduction in the costs associated with certified green projects, benefiting green bond issuers. Additionally, Pastor et al. (2022) demonstrate that the climate concerns of investors have a direct impact on increasing the equity value of companies dedicated to climate-friendly projects.

The second point highlights that public policies, as indicated by OECD (2018), impose penalties on CO2 emissions using mechanisms such as carbon taxes or emission trading schemes, along with excise taxes on carbon energy sources. Despite not strictly aligning with economists' recommendations, these policies contribute to improving the anticipated performance of green projects, (Daubanes, Mitali and Rochet, 2022).

The significance of certification within the green bond market, emphasizing its efficacy as a private governance regime, is underscored by Flammer's (2020) findings that entities issuing green bonds, when compared to a matched sample of non-green bond issuers, exhibit sustained enhancements in both financial performance (measured by increased ROA and ROE) and environmental performance (measured by reduced CO2 emissions and heightened environmental ratings) over the long term. Notably, these outcomes hold significance solely for green bonds certified by independent third parties, underscoring the crucial role of certification as a governing mechanism for green bonds.

There are several studies investigating the relationship between sustainability and the cost of capital, but only Zhang et al, (2021), investigated the impact of green projects on corporations' performance and cost of capital, however it is restricted to the Chinese Market.

Zhang et al, (2021), employed a multi-faceted approach. Initially, the authors investigate the presence of a "green premium" by utilizing propensity scores to match green bonds with conventional ones. Their analysis, centered on whether green bonds exhibit a lower cost of capital compared to projects without environmental purposes, revealing a noteworthy finding. The average yield spread of green bonds was observed to be 24.9 basis points lower than that of non-green bonds. This aligns with the premise that environmental considerations correlate with higher debt financing costs and lower credit ratings, while proactive environmental practices associate with a reduced cost of debt.

Moving to the second set of analyses, the study delved into the impact of green bond issuances on the cost of capital. Employing an abnormal revenue model proposed by Easton (2004) and Ohlson and Juettner-Nauroth (2005), the authors calculated the implied cost of capital using analysts' forecast data. Applying a Difference-in-Difference method, they explored changes in the cost of capital following green bond issuances. Rigorous examinations, including parallel trend analyses and placebo tests, consistently confirmed the effect of green bond issuances on the cost of capital.

Further investigations were focused on potential influencing factors, testing their mediation effects. The study revealed improvements in stock liquidity, significant relief in information asymmetry, and a reduction in perceived company risk during post-issuing frames. Subsequently, three hypotheses concerning the corporate implied cost of capital after green bond issues were explored. Empirical results demonstrated that the impact of green financing strategies on companies' cost of capital operates through three channels—stock liquidity, information asymmetry, and perceived firm risk. These findings emphasized the value creation attributed to environmental risk management, supporting existing literature arguments that socially responsible practices contribute to higher corporate valuation and reduced risk.

Similarly, Bloom and Schauten, (2006) demonstrated a notable inverse correlation between the cost of debt and corporate governance quality. Their findings support the idea that firms with high corporate governance scores are perceived by debt holders to have lower default risk, leading to reduced costs of debt financing.

On the other hand, Chava (2014) shows that sustainability concerns contribute to a higher cost of debt. Notably, companies expressing concerns about climate change exhibit a significant elevated cost of equity and debt capital. This suggests that, despite the absence of current regulations on greenhouse gas emissions, investors are evidently factoring these concerns into their assessments. Thus, in a broader context, firms boasting environmental strengths do not experience a reduction in the cost of equity and debt capital. However, a distinct trend emerges as lenders opt to charge lower interest rates on bank loans to companies generating substantial revenue from environmentally beneficial products. This pattern underscores a financial incentive for firms engaged in environmentally friendly practices, manifesting in more favorable lending terms.

Findings from Sharfman and Fernando (2008) and El Ghoul et al. (2018) indicate a negative correlation between corporate social performance and the cost of equity. This suggests that investors, in contrast, bestow favorable outcomes upon firms exhibiting higher corporate social performance by demanding lower required equity premiums. On the contrary, Sharfman and Fernando (2008), Menz (2010), and Magnanelli and Izzo (2017) suggest a positive association between corporate social performance and the cost of debt. This implies that socially responsible companies face a penalty from lenders, resulting in higher interest rates.

Examining a dataset comprising 12,915 U.S. firm-year observations spanning from 1992 to 2007, Ghoul et al. (2011) conducted an analysis that considered various firm-specific determinants, alongside industry and year fixed effects. The outcomes of the study revealed a noteworthy correlation between higher Corporate Social Responsibility (CSR) scores and a marked reduction in the cost of equity capital.

Moreover, a nuanced examination of the six dimensions within the KLD social performance index unveiled that not all aspects relate to the cost of equity. Specifically, investments in employee relations, environmental policies, and product strategies under the CSR umbrella contribute significantly to reducing firms' cost of equity. In contrast, CSR-related activities focusing on community relations, diversity, and human rights do not exhibit a similar impact. The study also highlights a consistent finding with Hong and Kacperczyk (2009) regarding certain industries. Companies associated with the tobacco and nuclear power sectors tend to experience higher costs of equity financing.

To better understand the implications of the findings, it's essential to briefly define the cost of capital. The cost of capital represents the overall cost a company incurs to finance its operations, including equity and debt. It is a crucial metric in financial decision-making, influencing investment choices and overall corporate strategy. The issuance of green bonds, as evidenced by Zhang et al. (2021), can impact the cost of capital by demonstrating a tangible reduction in the cost of debt. This reduction is associated with the positive market response to environmentally sustainable practices, leading to lower debt financing costs. In essence, the issuance of green bonds not only contributes to corporate sustainability but also influences the financial landscape by potentially lowering the overall cost of capital for environmentally conscious firms.

This paper has the objective to fulfill the present gap identified on the literature in order to address the research question "What´s the impact of the usage of Green Bonds on Cost of Capital". In this sense the study will analyze the following:

Hypothesis I: Companies that issue green bonds experience a lower cost of capital compared to those that do not.

In this Hypothesis, Zhang et al. (2021) theory will be tested, to state whether the usage of green bonds affect the cost of capital by showing a decline in the cost of debt.

Hypothesis II: Companies with greater ESG scores experience a higher implied cost of capital.

Hypothesis II seeks to investigate the influence of companies' Environmental, Social, and Governance (ESG) scores on the Implied Cost of Capital. Gabellone and Priem (2022) conducted a study on this aspect focusing on companies listed in the STOXX600 index. Their findings suggest a positive relationship between ESG scores and the cost of capital, potentially attributed to firms with higher ESG scores being able to attain greater leverage. Furthermore, the authors note that the impact of ESG scores on the cost of capital is negative for firms operating in countries with weaker legal frameworks. Additionally, Cardoso (2020) observes that companies with superior ESG performance tend to exhibit a higher implied cost of equity, potentially indicative of concerns regarding investment quality or suspicions of managerial opportunism.

3. Sample and Methodology

3.1. Sample Construction

This study conducts a thorough analysis of European companies, using a sample[1] comprising 468 firms listed on the STOXX Europe 600 index spanning the period from 2015 to 2023. The rationale behind selecting this dataset stems from the STOXX600 index's uniformity in representing large, mid, and small capitalization companies across different European countries. All companies within the index are considered, excluding those in the financial sector, and with Leverage levels equal or higher to one. The exclusion of financial sector entities is justified by the distinct regulatory environment governing their capital market activities, which differs significantly from that of non-financial sectors (Pittman & Fortin, 2004).

This results in two distinct groups of interest: 79 companies that issued Green Bonds and 389 companies that did not.

In this dataset, observations corresponding to firm-years with negative shareholder equity values are omitted, as such instances typically indicate companies experiencing financial distress with financing structures and conditions diverging substantially from the study's focus. Moreover, companies possessing insufficient data for computing cost of capital metrics are also excluded from the sample.

3.2. Methodology

To test the previously outlined hypothesis, the Implied Cost of Capital (ICC) was obtained through two primary approaches: ICCES and ICCOJ, aligning with the frameworks proposed by Easton (2004) and Ohlson and Juettner-Nauroth (2005), respectively. Easton (2004) introduces the abnormal revenue growth model, ICCES, while ICCOJ is derived following the methodology

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[1] Appendix I and II present the sample composition by country and sector, respectively

detailed by Ohlson and Juettner-Nauroth (2005). Appendix A provides a comprehensive exposition of the two approaches employed in this study.

The impact on the Implied Cost of Capital after green bond issuances was analyzed using Difference-in-Differences models (DID), defining the following equation to test Hypothesis I:

$$ICC_{i,t} = \alpha_0 + \alpha_1 Issue_t * Treat_i + \alpha_2 Size_{i,t} + \alpha_3 Lev_{i,t} + \alpha_4 Vol_{i,t} + \alpha_5 CF_{i,t} + \alpha_6 Roe_{i,t} + \alpha_7 Growth_{i,t} + \varepsilon_{i,t} \quad (1)$$

where i designates each company and t the corresponding year.

The dummy variable *Treat* represents whether a company has issued green bonds, being equal to one if a firm has ever issued green bonds, and zero otherwise.

Issue is a dummy variable that takes the value of one for post-event yearly observations and zero for pre-event yearly observations. The primary focus lies on the interaction of both dummy variables, as it signifies the conduct effect. If the coefficient of the interaction term in Equation (1) is notably negative, it suggests a substantial reduction in the cost of capital.

The control variables, which could exert a significant influence on the company's financing, encompass Size, Leverage (Lev), Stock Volatility (Vol), Cash Flow (CF), Growth and Return on Equity (ROE). Detailed listings of all variables are provided in Appendix III.

Size of the firm (Size): Calculated as the natural logarithm of total assets. Research indicates that larger firms may experience a reduced impact of negative events on their cash flows, leading to lower default risk. Furthermore, larger firms can offer more collateral compared to smaller firms, contributing to their perception as less risky entities by lenders (Diamond, 1989; Goss & Roberts, 2011).

Leverage (Lev): Calculated as the ratio of total debt to the market value of equity. The leverage ratio has exhibited substantial impacts on the cost of capital, suggesting that firms with elevated leverage and growth may encounter heightened risks, consequently resulting in increased capital costs (Zhang et al., 2021).

Stock Volatility (Vol): The variable is determined by regressing daily stock returns on the STOXX600 index, over the preceding 9 years. Previous research indicates an adverse impact of a firm's systematic risk on its creditworthiness and default probability (Attig et al., 2013). The stock volatility exhibits substantial positive effects on the cost of capital, as highlighted by Zhang et al. (2021).

Other standard control variables encompass: Cash Flow (CF); Return-on-Equity (ROE), a measure of profitability calculated by dividing the net income by the shareholder's equity; Growth ability (Growth), demonstrated by the Operating income growth rate.

To examine Hypothesis II, the ESG score supplied by Refinitiv for each analyzed company was incorporated in the main regression, and the effect was observed through a mediation test described in section 4.5.2. Refinitiv offers several proprietary scores enabling investors to evaluate company or government disclosure and performance across various ESG and thematic issues.

4. Empirical Results

4.1. Descriptive Statistics

Table I presents the comprehensive descriptive statistics pertaining to all continuous variables incorporated within the empirical models of cost of capital. According to the Easton Model (ICCES), the average implied cost of capital estimate for European firms during the observed timeframe stands at 10,70%, surpassing the mean estimate of 9,70% derived from the OJ model (ICCOJ), aligning with findings by El Ghoul et al. (2011).

The statistics reveal an average ESG score of 60,54, indicative of a moderate level of ESG performance across the sample, with a notable standard deviation of 24,47, underscoring significant variability in ESG performance among these firms.

The average size of companies, measured by the logarithm of their total assets, is 9,78, with a standard deviation of 1.31, highlighting a diverse range of companies, from smaller to larger firms in this sample.

Additionally, the average leverage ratio (Lev) is approximately 0.57, implying that, on average, companies have a moderate level of debt relative to their equity.

Furthermore, the analyzed companies demonstrate an average Return on Equity of 18.80% and a commendable growth rate in operating income, reaching 34.50%.

Table 1 - Descriptive Statistics

	Obs.	Mean	Standard Deviation	Minimum	Maximum
ESGscore	4 177	60,541	24,470	0	59,389
Size	4 177	9,778	1,312	0	11,778
Lev	4 177	0,570	0,183	0	0,996
Vol	4 177	-0,015	0,322	-0,732	2,888
CF	4 177	1,87E+09	4,20E+09	-1,54E+10	5,75E+10
Growth	4 177	0,345	8,793	-147,934	385,531
ROE	4 177	0,188	0,802	-20,833	26,050
ICCOJ	4 177	0,097	0,058	1,00E-04	0,738
ICCES	4 177	0,107	0,062	0,022	0,738

To provide a more detailed analysis, Tables II and III present the descriptive statistics separately for the treatment group and the control group, respectively.

Table 2 - Descriptive Statistics of the Treatment Group

Treatment Group								
Variable	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	**95% Conf**		**T-test**	**P-value**
ICCES	711	0,100	0,002	0,054	0,096	0,104	3,205	0,001
ICCOJ	711	0,093	0,002	0,055	0,089	0,097	2,080	0,038
Size	711	10,173	0,035	0,932	10,104	10,241	-8,882	0,000
Lev	711	0,589	0,006	0,149	0,578	0,600	-2,987	0,003
Vol	711	-0,008	0,010	0,276	-0,029	0,012	-0,608	0,544
CF	711	2,96E+09	2,21E+08	5,90E+09	2,53E+09	3,40E+09	-7,6686	0,000
Growth	711	-0,046	0,213	5,683	-0,465	0,372	1,303	0,193
ROE	711	0,126	0,004	0,093	0,119	0,133	2,263	0,024

Table 3 - Descriptive Statistics of the Control Group

Control Group								
Variable	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	**95% Conf**		**T-test**	**P-value**
ICCES	3466	0,108	0,001	0,063	0,106	0,110	-3,205	0,001
ICCOJ	3466	0,098	0,001	0,058	0,096	0,100	-2,080	0,038
Size	3466	9,697	0,023	1,363	9,652	9,743	8,882	0,000
Lev	3466	0,567	0,003	0,189	0,560	0,573	2,987	0,003
Vol	3466	-0,016	0,006	0,331	-0,027	-0,005	0,608	0,544
CF	3466	1,65E+09	6,31E+07	3,72E+09	1,52E+09	1,77E+09	7,6686	0,000
Growth	3466	0,425	0,158	9,302	0,116	0,735	-1,303	0,193
ROE	3466	0,201	0,015	0,879	0,172	0,230	-2,263	0,024

4.2. Correlation Matrix

The correlation matrix is presented in Appendix IV. While a negative correlation is observed between the treatment effect *Treat*Issue*, (presented by Treat_Issue) and the two measures of Implied Cost of Capital (ICCOJ and ICCES), these correlations are not statistically significant. Additionally, the ESG score exhibits a weak negative correlation with the two dependent variables.

Among the independent variables, *Size*, *Lev*, and *Vol* demonstrate the most significant correlations, suggesting a greater impact on the Implied Cost of Capital.

Furthermore, the Variance Inflation Factor (VIF) was computed to assess multicollinearity among the independent variables. The results, with a mean VIF of 1.29, suggest low to moderate collinearity.

Table 4- Variance Inflation Factor

	VIF	**1/VIF**
Treat	1,61	0,61920
Issue	1,61	0,62108
Size	1,58	0,63175
Lev	1,32	0,75500
ESGscore	1,30	0,76841
CF	1,17	0,85558
Vol	1,02	0,98232
ROE	1,01	0,99143
Growth	1,00	0,99783
Mean VIF	1,29	

4.3. Implied Cost of Capital changes after Green Bond issuances – Base Model

In this section, a Differences-in-Differences (DID) model was employed using the full sample to examine the impact on the two measures of Implied Cost of Capital (ICCES and ICCOJ).

The results of the regression, exhibited in Table 5, show a significant positive impact on both ICC methods following green bond issuances, with an increase of 0.00739 in the Easton model (ICCES) and an increase of 0.00906 in the OJ model (ICCOJ).

However, despite these significant results, they do not constitute a reliable conclusion since the full sample is unbalanced, presenting a treatment group of only 79 green bond issuers against a control group of 389 firms that never issued green bonds.

Table 5 - Differences-in-Differences Base Model

	ICCES (1)	ICCOJ (2)
Treat x Issue	0,00739**	0,00906***
	(2,08)	(2,65)
Size	0,00085	-0,00092
	(0,65)	(-0,86)
Lev	0,01646	0,02265
	(1,00)	(1,57)
Vol	0,03396***	0,03042***
	(12,74)	(12,21)
CF	-1,15E-12***	-1,08E-12***
	(-3,01)	(-2,96)
Growth	-1,35E-05	-9,44E-06
	(-0,64)	(-0,36)
ROE	-0,00090	-0,00140*
	(-1,40)	(-1,91)
Constant	0,10855***	0,11414***
	(13,05)	(24,07)
Year	Yes	Yes
Industry	Yes	Yes
Country	Yes	Yes
Observations	4 177	4 177
Adj R^2	0,0547	0,0535
F	17,10	16,74

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.

4.4. Robusteness Tests

4.4.1. Entropy Balance and Propensity Score Matching

Recognizing the unbalanced nature of the dataset that consists of 468 entities, with 79 identified as Green Bond issuers and the remaining as non-issuers, and to ensure robust findings in this study, two matching techniques were utilized to estimate two separate Difference-in-Differences outcomes. Initially, Entropy Balancing was implemented to adjust the sample weights and enhance covariate balance between the treatment and control cohorts.

Table 6 - Entropy Balance Treatment Group

	Treatment Group					
	Pre-Balancing			Post-Balancing		
	Mean	**Variance**	**Skewness**	**Mean**	**Variance**	**Skewness**
Size	10,170	0,869	-7,184	10,170	0,869	-7,184
Lev	0,589	0,022	-0,545	0,589	0,022	-0,545
Vol	-0,008	0,076	1,991	-0,008	0,076	1,991
CF	2,96E+09	3,48E+19	3,964	2,96E+09	3,48E+19	3,964
Growth	-0,046	32,300	-24,800	-0,046	32,300	-24,800
ROE	0,126	0,009	0,586	0,126	0,009	0,586

Table 7 - Entropy Balance Control Group

	Control Group					
	Pre-Balancing			Post-Balancing		
	Mean	**Variance**	**Skewness**	**Mean**	**Variance**	**Skewness**
Size	9,697	1,858	-5,340	10,170	0,401	-0,184
Lev	0,567	0,036	-0,620	0,589	0,032	-0,521
Vol	-0,016	0,110	2,116	-0,008	0,098	2,044
CF	1,65E+09	1,38E+19	5,51	2,96E+09	2,87E+19	3,767
Growth	0,425	86,540	33,210	-0,046	6,732	-6,182
ROE	0,201	0,772	15,400	0,126	0,784	-22,050

Secondly, propensity score matching was employed to select the control group using nearest-neighbor matching. Logistic regression and the nearest-neighbor matching processes exclusively utilized continuous control variables—Size, Leverage (Lev), Cash-Flow (CF), Growth, and Return on Equity (ROE)—to derive optimal Propensity Scores aligning with the treatment sample. Following the implementation of propensity score matching, the resulting control sample comprised 88 firms.

Table 8 - Propensity Score Matching

Treat	Coefficient	Std. Err.	Z	P > |z|	[95% conf.	Interval]
Size	0,304	0,375	8,100	0,000	0,231	0,378
Lev	-0,299	0,150	-1,990	0,046	-0,593	-0,005
Vol	-0,019	0,075	-0,260	0,796	-0,167	0,128
CF	1,04E-11	5,64E-12	1,850	0,064	-6,2E-13	2,15E-11
Growth	-0,010	0,007	-1,420	0,155	-0,023	0,004
ROE	-0,140	0,048	-2,930	0,003	-0,234	-0,046
Constant	-3,805	0,348	-10,92	0,000	-4,487	-3,122
Year			Yes			
Industry			Yes			
Country			Yes			
Observations			4177			
Pseudo R			0,038			

Table 9 - Neighbor Matching

Nº Treatment	Nº Control	ATT	Std. Err.	T-test
711	582	-0,007	0,003	-2,155

4.4.2. Differences-in-Differences with cluster-robust standard errors

Following the implementation of both matching methods, two distinct regressions were estimated with adjustments made for cluster-robust standard errors.

Bertrand, Duflo, and Mullainathan (2004) argue that DID estimates' standard errors may become inconsistent if they do not account for the serial correlation of the outcome of interest. The authors demonstrate that using cluster-robust standard errors at the group level where treatment occurs ensures accurate coverage in the presence of serial correlation, particularly when the number of groups is not too small. Given the typical variability of outcomes at both group and time levels in this study, addressing serial correlation is crucial.

The results of the DID with Entropy Balance are exhibited in Table 10 and indicate non-significance when analyzing the Easton model (ICCES). In contrast, the OJ model shows a statistically significant positive impact at the 5% level, suggesting an increase in ICC following green bond issuances. However, since this model involves sample re-weighting and significant results are observed for only one of the ICC measures, conclusive findings cannot be assured.

Table 10 - Differences-in-Differences Model with Entropy Balance

	ICCES (1)	**ICCOJ (2)**
Treat x Issue	0,00361	0,00481**
	(3,2)	(19,11)
Size	-0,00052	-0,00362*
	(-0,33)	(-9,57)
Lev	0,03653	0,04185*
	(4,7)	(6,63)
Vol	0,03072*	0,02872**
	(12,24)	(14,08)
CF	-1,18E-12***	-1,09E-12***
	(-80,95)	(-64,69)
Growth	-3,98E-05	-3,74E-05
	(-3,23)	(-1,44)
ROE	-0,00202	-0,00224
	(-1,21)	(-1,51)
Constant	0,10523*	0,12546**
	(8,17)	(21,64)
Year	Yes	Yes
Industry	Yes	Yes
Country	Yes	Yes
Observations	4 177	4 177
Adj R^2	0,0438	0,0446

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.

To strengthen the analysis, a DID was also applied to the matched sample using nearest-neighbor matching. Instead of conducting a single regression with observations across all years, four regressions were performed, each using one year of treatment as the baseline, with one year after and two years prior as comparators. This approach enhances robustness by examining entities where treatment occurred in the same year across multiple regressions.

The results, presented in Appendix V, consistently show a negative impact on both ICC measures across all four regressions, with significant findings in the majority of tests. The most pronounced effects are observed in regressions 3 and 4, where the negative impacts are -0.01069 and -0.01142, respectively, at a 5% significance level, corresponding to observations where the treatment effect occurred in 2020.

These findings support Hypothesis I, indicating that companies issuing green bonds experience lower costs of capital compared to those that do not, consistent with the findings of Zhang et al. (2021).

Regarding the control variables, Leverage and Stock Volatility present significant coefficients in most of the regressions, illustrating their positive impact on the dependent variables ICCES and ICCOJ. For the remaining variables, Size does not exhibit significant coefficients in any of the observations, while the signs of the coefficients for CF, Growth, and ROE vary across the different regressions.

4.4.3. Parallel Trends Assumption

The Parallel Trends Assumption is fundamental in the context of Difference-in-Differences (DID) analysis, serving as a cornerstone for the credibility of its estimates. This assumption posits that absent any treatment, the outcome variable would have exhibited similar trends between the treatment and control groups. A robust parallel trend assumption strengthens the reliability of DID estimates, indicating that any observed differential change post-treatment is more plausibly attributed to the treatment itself rather than extraneous factors.

To assess the validity of the parallel trend assumption—specifically, whether the outcome variable trends of the control group mirrors those of the treated group before the bond issuance event—four regressions using DID after propensity score matching were conducted.

The results indicate that the null hypothesis (H0) is upheld across all regressions, suggesting that linear trends remained parallel between the treatment and control groups during the pre-treatment period. In each regression, both models yield p-values exceeding the conventional significance threshold of 0.05, indicating a lack of statistically significant evidence to reject the null hypothesis. Thus, this analysis suggests similarity in the trends of the outcome variable between the treatment and control groups before treatment.

Consequently, the non-rejection of the null hypothesis, which supports parallel linear trends, is reassuring and underscores the critical assumption essential for the validity of DID analysis. This outcome enhances confidence in the causal interpretation of the treatment effect as estimated by the DID model.

Table 11 - Parallel Trends Assumption

	Treatment = 2019		**Treatment = 2020**		**Treatment = 2021**		**Treatment = 2022**	
	ICCES	**ICCOJ**	**ICCES**	**ICCOJ**	**ICCES**	**ICCOJ**	**ICCES**	**ICCOJ**
F	0,65	0,69	1,05	1,06	2,13	2,3	0,51	0,02
P-value	**0,429**	**0,4162**	**0,3171**	**0,315**	**0,1543**	**0,1392**	**0,4807**	**0,8862**

4.4.4. Placebo Test with a Pseudo Green-Bond-Issue Time

To mitigate concerns regarding potential influence from unobserved random factors on DID results, a Placebo Test was conducted. Following the methodology of Cai et al. (2016), 79 companies that had never issued green bonds were randomly assigned from the total sample to serve as the experimental group.

The placebo test simulated the pseudo issuance time of green bonds by restricting the sample interval to periods when green bonds were not actually issued. Specifically, companies that only issued green bonds in 2023 were selected, and data from previous years (2015 to 2022) was used. Regression analysis using the benchmark model (Equation 1) was then applied to assess the robustness of prior findings.

If the interaction term remains statistically significant at this stage, it could indicate that the original estimation results may be biased, potentially influenced by other random factors or policy changes.

As indicated in Table 12, the coefficients of the interaction terms for both measures of Implied Cost of Capital are not statistically significant, suggesting the robustness of the previous findings.

Table 12 - Placebo Test with a Pseudo Green-Bond-Issue Time

	ICCES (1)	**ICCOJ** (2)
Treat x Issue	0,00855	0,00973
	(0,34)	(0,81)
Size	0,00576	0,00535
	(1,27)	(1,04)
Lev	-0,04290	-0,00963
	(-0,64)	(-0,12)
Vol	0,02791**	0,02730**
	(2,87)	(2,88)
CF	-8,33E-13	-9,62E-13
	(-0,40)	(-0,56)
Growth	-0,00644	-0,01724*
	(-1,72)	(-1,82)
ROE	-0,09660*	-0,02562
	(-1,74)	(-0,47)
Constant	0,11800***	0,08150***
	(7,54)	(7,3)
Year	Yes	Yes
Industry	Yes	Yes
Country	Yes	Yes
Observations	142	142
Adj. R^2	0,2024	0,0917
F	5,47	2,78

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.

4.5. Additional Tests

4.5.1. Quantile regressions

To enhance the robustness and depth of the previous findings, quantile regressions[2] were conducted using the full sample. This analytical approach is particularly valuable for understanding the heterogeneity of effects across different segments of the data, providing insights into how factors may differentially influence the lower, median, and upper ends of the outcome

[2] Quantile Regressions are exhibited in Appendix VI

distribution. The primary objective of employing quantile regressions is to examine how different percentiles of the conditional distribution of the dependent variable respond to changes in the independent variables.

The negative and significant coefficients across all quantiles for both ICCES and ICCOJ suggest that the issuance of green bonds is associated with a reduction in the implied cost of capital, with a stronger effect observed in the lower quantile (25th percentile) and slightly weaker but still significant effects in the median and upper quantiles.

These quantile regression results robustly support the hypothesis that green bond issuances lead to a reduction in the implied cost of capital across different segments of the distribution. Furthermore, the effects of control variables such as Size, Leverage, Volatility, and ROE vary across quantiles, providing a nuanced understanding of their impacts on ICCES and ICCOJ. For instance, Leverage and Stock Volatility exhibit significant positive effects on both ICC measures, highlighting their influence on the implied cost of capital.

4.5.2. Mediation Effect of ESGscore to ICC and WACC

In this section, the mechanism by which green bond issuances affect the cost of capital is explored by testing Hypothesis II as previously outlined. Two systems of equations were established to analyze the mediating effect of the ESG score provided by Refinitiv on the relationship between green bond issuances and the cost of capital. In System (2), the independent variable is the interaction term Treat*Issue, the mediating variable is the ESG score, and the dependent variable is the implied cost of capital (ICC). The existence of a mediation effect will be determined by the significance of the coefficients (α, β, γ) or the Z statistic.

To examine the mediation effect of ESG on ICC, System (2) was estimated:

$$ICC_{i,t} = \alpha_0 + \alpha_1 Treat * Issue_t + \alpha_2 Size_{i,t} + \alpha_3 Lev_{i,t} + \alpha_4 Vol_{i,t} + \alpha_5 CF_{i,t} + \alpha_6 ROE_{i,t} + \alpha_7 Growth_{i,t} + \varepsilon_{i,t}$$

$$ESG_{i,t} = \beta_0 + \beta_1 Treat * Issue_t + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Vol_{i,t} + \beta_5 CF_{i,t} + \beta_6 ROE_{i,t} + \beta_7 Growth_{i,t} + \varepsilon_{i,t}$$

$$ICC_{i,t} = \gamma_0 + \gamma_1 Treat * Issue_t + \gamma_2 Size_{i,t} + \gamma_3 Lev_{i,t} + \gamma_4 Vol_{i,t} + \gamma_5 CF_{i,t} + \gamma_6 ROE_{i,t} + \gamma_7 Growth_{i,t} + \lambda_8 ESG_{i,t}\, \varepsilon_{i,t} \qquad (2)$$

The mediation effect was also examined for the Weighted Average Cost of Capital (WACC) to provide an additional measure for testing the impact of green bond issuances and the effect of the ESG score on this component. For this purpose, System (3) was estimated:

$$WACC_{i,t} = \alpha_0 + \alpha_1 Treat * Issue_t + \alpha_2 Size_{i,t} + \alpha_3 Lev_{i,t} + \alpha_4 Vol_{i,t} + \alpha_5 CF_{i,t} + \alpha_6 ROE_{i,t} + \alpha_7 Growth_{i,t} + \varepsilon_{i,t}$$
$$ESG_{i,t} = \beta_0 + \beta_1 Treat * Issue_t + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Vol_{i,t} + \beta_5 CF_{i,t} + \beta_6 ROE_{i,t} + \beta_7 Growth_{i,t} + \varepsilon_{i,t}$$
$$WACC_{i,t} = \gamma_0 + \gamma_1 Treat * Issue_t + \gamma_2 Size_{i,t} + \gamma_3 Lev_{i,t} + \gamma_4 Vol_{i,t} + \gamma_5 CF_{i,t} + \gamma_6 ROE_{i,t} + \gamma_7 Growth_{i,t} + \lambda_8 ESG_{i,t}\, \varepsilon_{i,t} \quad (3)$$

The results, presented in Appendix VII, indicate that ESG scores have a positive relationship with the cost of capital, suggesting that higher ESG scores are associated with an increase rather than a reduction in the cost of capital. Specifically, in the Ohlson and Juettner-Nauroth model (ICCOJ), the coefficient for ESG score on ICCOJ is 0.00136 without treatment, indicating that each unit increase in ESG score is associated with an increase of approximately 0.0014 units in ICCOJ. This effect intensifies with treatment, with the interaction term coefficient at 0.0046. For the Easton model (ICCES), the coefficient for ESG score on ICCES is 0.00274 without treatment, suggesting higher ESG scores lead to an increase in ICCES. However, the mediation effect becomes insignificant when the treatment effect is included. In the WACC analysis, ESG scores show a significant positive relationship with WACC, with a coefficient of 0.00791 without treatment. When the treatment effect is included, the influence of ESG scores on WACC decreases, as shown by the interaction term coefficient of -0.00790.

These results, consistent with findings by Gabellone and Priem (2022) and Cardoso (2020), suggest that higher ESG scores are associated with an increase in the cost of capital across different models. However, the treatment effect of green bond issuances reduces the cost of capital, indicating that while ESG scores alone may not reduce the cost of capital, the issuance of green bonds can counteract this effect and lead to an overall reduction.

4.5.3. Sustainability Linked Bonds impact on ICC

This section delves into the effects of Sustainability Linked Bonds (SLBs) on the Implied Cost of Capital (ICC). While Green Bonds funds are earmarked exclusively to finance projects with clear environmental benefits, Sustainability Linked bonds encourage broader sustainability improvements by linking financial performance to the issuer's sustainability achievements. In this sense a Difference-in-Differences (DID) regression analysis was conducted using a sample comprising fifteen companies that issued SLBs and fifteen that did not, spanning from 2020 to 2023, with the treatment occurring in 2022. For this purpose, equation (1) was employed and the results are showed in Table 13.

The findings reveal a reduction in both ICC measures following the issuance of SLBs, although statistical significance was observed only in the Easton model (ICCES), showing a coefficient of -0.00773.

Among the control variables, stock volatility exhibited a significant positive impact on both ICC measures, whereas Growth demonstrated a negative and significant effect on ICC. The remaining control variables did not show significant impacts on the cost of capital.

Table 13 - Differences-in-Differences with Sustainable Linked Bonds

	ICCES (1)	ICCOJ (2)
Treat x Issue	-0,00773*	-0,00373
	(-6,83)	(-2,7)
Size	-0,00106	-0,00025
	(-0,7)	(-0,15)
Lev	-0,00303	-0,01950***
	(-3,11)	(-94,38)
Vol	0,01949***	0,01846**
	(76,69)	(32,98)
CF	-5,39E-13	-5,82E-13
	(-1,6)	(-1,25)
Growth	-0,00006**	-0,00008**
	(-38,12)	(-31,05)
ROE	-0,02537	-0,01919
	(-1,79)	(-0,98)
Constant	0,11653*	0,10944*
	(8,36)	(6,86)
Year	Yes	Yes
Industry	Yes	Yes
Country	Yes	Yes
Observations	120	120
F	3,16	1,53
Adj R^2	0,1127	0,0300

5. Conclusion

This study examines the impact of green bond issuances on the implied cost of capital among European firms listed on the STOXX600 index. A Difference-in-Differences (DID) approach was employed on a comprehensive sample of 468 firms, utilizing the Implied Cost of Capital (ICC) methods proposed by Easton (2004) and Ohlson and Juettner-Nauroth (2005). Initial analyses on the full sample, which included 79 green bond issuers and 389 non-issuers, yielded inconclusive results due to sample imbalance. To address potential selection biases and ensure robustness, Entropy Balance and Propensity Score Matching (PSM) methods were implemented. Subsequent DID regressions, adjusted for cluster robust standard errors, revealed that the issuance of green bonds significantly reduced the implied cost of capital, particularly in models where treatment effects were observed in 2020.

The Entropy Balance re-weighted the full sample for the DID regression, yet significant results were only achieved using PSM, which identified a control group through nearest-neighbor matching on continuous control variables such as Size, Leverage, Cash Flow, Growth, and Return on Equity. Across multiple DID regressions, the findings consistently indicated a negative impact on both ICC measures, with the most substantial reductions observed in 2020, with coefficients of -0.01069 and -0.01142 for regressions 3 and 4, respectively. Control variables, including Leverage and Stock Volatility, significantly impacted ICCES and ICCOJ, while Size, Cash Flow, Growth, and ROE presented varying levels of significance across different models.

To further validate these results, robustness checks were conducted, including the Parallel Trend assumption and Placebo Tests. The Parallel Trend test confirmed the parallelism of linear trends between treatment and control groups in the pre-treatment period, while the Placebo Test, using a pseudo green bond issuance time, corroborated the robustness of the DID models. Additionally, quantile regressions across the full sample of 468 firms demonstrated significant reductions in both ICCES and ICCOJ, supporting the hypothesis that green bond issuances lower the implied cost of capital.

The influence of ESG scores on the cost of capital was also explored using the same ICC methods and the Weighted Average Cost of Capital (WACC). Mediation analysis revealed that higher ESG scores are associated with increased cost of capital, consistent with Gabellone and Priem (2022) and Cardoso (2020). However, green bond issuances counteract this effect, resulting in an overall reduction in the cost of capital.

Additionally, the study assessed the impact of Sustainability Linked Bonds (SLBs) on ICC. Unlike green bonds, which fund projects with clear environmental benefits, SLBs link financial performance to broader sustainability achievements. DID regression results indicated a reduction in ICC following SLB issuances, with significant results only in the Easton model (ICCES), showing a coefficient of -0.00773. These findings suggest that while both green bonds and SLBs reduce the cost of capital, green bonds have a more pronounced effect.

In summary, this study supports the hypothesis that green bond issuances significantly reduce the implied cost of capital, aligning with Zhang et al. (2021), and that firms with higher ESG scores tend to have a higher implied cost of capital, as observed by Gabellone and Priem (2022) and Cardoso (2020). Additionally, the issuance of green bonds has a greater impact on reducing the cost of capital compared to SLBs.

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Appendices

Appendix A. Implied Cost of Capital models

Model 1. Ohlson and Juettner-Nauroth model (2005) - ICCOJ

This model represents a generalization of the Gordon constant growth model, where the current stock price (P_0) is linked with various factors, including estimated one-year-ahead earnings per share (EPS_1), two-year-ahead earnings per share (EPS_2), forecasted dividends per share (DPS_{t+1}), and an assumed perpetual growth rate gamma (γ). To yield a positive root, the model needs positive 1-year-ahead and 2-year-ahead earnings forecasts.

The short-term growth (($EPS_2 - EPS_1$)/ EPS_1) is envisaged to decay asymptotically to (γ), representing a predetermined long-term economic growth rate.

Pursuing the implementation of the model by Gode and Mohanram (2017), the near-term earnings growth rate (g_2) is computed as the difference between 2-year-ahead and 1-year-ahead earnings forecasts scaled by 1-year-ahead earnings forecasts. Establishing the risk-free rate from the yield on the 10-year Eurozone Central Government Bond, the term ($\gamma - 1$) is defined to be equal to the risk-free rate minus 3%. The ICC is represented by the following equation:

$$r_e = A + \sqrt{A^2 + \frac{EPS_1}{P_0}(g_2 - (\gamma - 1))} \qquad \text{(A-1)}$$

where,

$$A = \frac{1}{2}\left((\gamma - 1) + \frac{DPS_1}{P_0}\right) \qquad \text{(A-2)}$$

$$DPS_1 = DPS_0 \qquad \text{(A-3)}$$

$$g_2 = \frac{EPS_2 - EPS_1}{EPS_1} \qquad \text{(A-4)}$$

$$(\gamma - 1) = r_f - 0.03 \qquad \text{(A-5)}$$

Model 2. Easton (2004) – ICCES

The Easton model, derived from the abnormal earnings growth valuation model developed by Ohlson and Juettner-Nauroth (2005), represents a distinctive application. It employs one-year-ahead (EPS_1) and two-year-ahead (EPS_2) earnings per share forecasts, along with the cost of equity (KES) and forthcoming dividends per share (DPS_1), to ascertain abnormal earnings growth. The model adopts a clear forecast horizon of 2 years, beyond which forecasted abnormal earnings are presumed to perpetually grow at a constant rate. A positive change in both one-year-ahead and two-years-ahead earnings per share forecasts is requisite for deriving a numerical solution in this model. The valuation equation is formulated as follows:

$$r_e = \sqrt{\frac{EPS_2 + r_e * DPS_1 - EPS_1}{P_0}} \tag{A-6}$$

where,

$$P_0 = \frac{EPS_1}{r_e} - \left(\frac{EPS_1}{r_e} - \frac{P_1 + DPS_1}{1 + r_e}\right) \tag{A-7}$$

Appendix I. Sample composition by Country

Country	Nº Companies	%
Austria	5	1%
Belgium	11	2%
Denmark	18	4%
Finland	16	3%
France	67	14%
Germany	61	13%
Ireland	5	1%
Italy	23	5%
Netherlands	24	5%
Norway	14	3%
Poland	6	1%
Portugal	4	1%
Spain	18	4%
Sweden	46	10%
Switzerland	43	9%
United Kingdom	107	23%
Total	**468**	**100%**

Appendix II. Sample composition by Sector

NAICS Sector Name	Nº Companies	%
Accommodation and Food Services	6	1%
Administrative and Support and Waste Management and Remediation Services	10	2%
Agriculture, Forestry, Fishing and Hunting	1	0%
Arts, Entertainment, and Recreation	4	1%
Construction	17	4%
Health Care and Social Assistance	2	0%
Information	43	9%
Manufacturing	226	48%
Mining, Quarrying, and Oil and Gas Extraction	12	3%
Other Services (except Public Administration)	2	0%
Professional, Scientific, and Technical Services	31	7%
Real Estate and Rental and Leasing	26	6%
Retail Trade	28	6%
Transportation and Warehousing	16	3%
Utilities	28	6%
Wholesale Trade	16	3%
Total	**468**	**100%**

Appendix III. Description of the Variables

Type	Name	Symbol	Definition	
Dependent Variables	Implied Cost of Capital	ICCES	$\sqrt{\frac{EPS_2 + r_e * DPS_1 - EPS_1}{P_0}}$	Easton (2004)
	Implied Cost of Capital	ICCOJ	$A + \sqrt{A^2 + \frac{EPS_{t+1}}{P_t}(g_2 - (\gamma - 1))}$	Ohlson and Juettner-Nauroth model (2005)
Explanatory Variables	Issue	Issue	For observations before first green bond issuance, it is 0. Otherwise, it is 1.	
	Treat	Treat	For companies that have issued green bonds, it is 1. Otherwise, it is 0.	
	ESG score	ESG	ESG score provided by Refinitiv	

	Size	Size	The logarithm of total assets.
	Leverage	Lev	Total liabilities scaled by total assets.
	Stock Volatility	Vol	The standard deviation of the company's stock return over the last 9 years
Control Variables	Cash Flow	CF	Net cash flow from operating activities scaled by Operating income.
	Profitability	ROE	Net income by the shareholder's equity
	Growth Ability	Growth	Operating income growth rate.

Appendix IV. Correlation Matrix

	Treat	Issue	Treat_Issue	ESG score	Size	Lev	Vol	CF	Growth	ROE	ICCOJ	ICCES
Treat	1											
Issue	0,6098***	1										
Treat_Issue	0,6098***	1	1									
ESG score	0,1576***	0,1737***	0,1737***	1								
Size	0,1362***	0,1060***	0,1060***	0,4232***	1							
Lev	0,0462***	0,0458***	0,0458***	0,2616***	0,4846***	1						
Vol	0,00940298	0,0378**	0,0378**	0,1040***	0,0629***	0,0601***	1					
CF	0,1179***	0,0784***	0,0784***	0,2930***	0,3300***	0,1548***	-0,0209511	1				
Growth	-0,0201569	-0,021186033	-0,021186	0,00803371	0,02013403	0,0309**	-0,0208009	0,00701044	1			
ROE	-0,0350003	-0,025182669	-0,0251827	0,00280153	-0,0252435	0,0544***	-0,0250159	0,00827491	0,00010411	1		
ICCOJ	-0,0321712	-0,052360576	-0,0523606	-0,1044276	-0,016203	0,0719***	0,1338***	-0,0311213	-0,0150389	-0,0137091	1	
ICCES	-0,0495339	-0,060303214	-0,0603032	-0,0507585	0,0258*	0,0727***	0,1640***	-0,0456162	-0,0145509	-0,0370344	0,7104***	1

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.

Appendix V. Differences-in-Differences with Cluster Robust standard errors

	Treatment Year = 2019		Treatment Year = 2020		Treatment Year = 2021		Treatment Year = 2022	
	ICCES	**ICCOJ**	**ICCES**	**ICCOJ**	**ICCES**	**ICCOJ**	**ICCES**	**ICCOJ**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Treat x Issue	-0,00692*	-0,00004	-0,01069**	-0,01142**	-0,00473	-0,00479	-0,00584**	-0,00542**
	-(11,71)	(-0,03)	(-58,90)	(-44,46)	(-2,69)	(-2,64)	(-29,83)	(-22,94)
Size	-0,04622	-0,02896	-0,04249	-0,04395	-0,02332	-0,02687	0,00085	0,00184
	-(3,12)	(-0,98)	(-2,71)	(-1,94)	(-1,16)	(-1,38)	(1,81)	(4,15)
Lev	0,21440**	0,04198	0,04404	0,04837*	0,03244*	0,03974*	-0,01554	-0,02932
	(14,06)	(0,70)	(2,92)	(7,25)	(8,18)	(7,24)	(-1,09)	(-3,39)
Vol	0,03284	0,03322	0,02689*	0,02726*	0,03038	0,03186	0,01266**	0,01156**
	(3,2)	(2,74)	(8,99)	(9,06)	(2,73)	(2,98)	(19,86)	(20,86)
CF	5,59E-13	-2,45E-14	-7,49E-13	-8,47E-13*	-4,56E-13	-4,29E-13	-5,86E-13	-5,49E-13
	(1,52)	(-0,05)	(-5,8)	(-12,63)	(-3,93)	(-3,98)	(-1,30)	(-1,50)
Growth	-0,00268*	-0,00177*	0,00021	0,00022	-8,06E-05	-7,60E-05	-6,81E-05***	-9,06E-05***
	-(12,41)	(-8,29)	(1,53)	(0,67)	(-0,63)	(-0,56)	(-133,74)	(-281,14)
ROE	0,00199	-0,01460	-0,03184**	-0,03077*	0,00824	0,01087	-0,05229	-0,03386
	(0,08)	(-0,82)	(-19,64)	(-12,18)	(2,36)	(3,45)	(-2,73)	(-5,39)
Constant	0,44222	0,37403	0,53869	0,54725	0,33534	0,36398	0,10334**	0,87153***
	(2,68)	(1,38)	(3,38)	(2,29)	(1,6)	(1,8)	(19,74)	(81,95)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	80	80	96	96	136	136	152	152
F	7,48	8,09	2,61	2,71	10,68	10,48	1,17	0,54
Adj. R^2	0,3648	0,3859	0,1061	0,1117	0,3342	0,3296	0,0081	-0,0217

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.

Appendix VI. Quantile Regressions

	Quantile 25		Quantile 50		Quantile 75	
	ICCES	**ICCOJ**	**ICCES**	**ICCOJ**	**ICCES**	**ICCOJ**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Treat x Issue	-0,01158***	-0,01234***	-0,00840***	-0,00914***	-0,00971**	-0,00784*
	(-3,91)	(-3,18)	(-2,91)	(-3,13)	(-2,04)	(-1,78)
Size	0,00388***	-0,00064	0,00206***	-0,00076	-0,00251**	-0,00401***
	(5,71)	(-0,72)	(3,12)	(-1,14)	(-2,3)	(-3,97)
Lev	0,17158***	0,02331***	0,03515***	0,03826***	0,04934***	0,05422***
	(3,70)	(3,84)	(7,80)	(8,38)	(6,63)	(7,88)
Vol	0,01338***	0,13011***	0,02214***	0,02190***	0,03475***	0,03008***
	(5,77)	(4,28)	(9,82)	(9,59)	(9,33)	(8,74)
CF	-3,37E-14*	1,34E-14	-5,57E-13***	-1,60E-13	-1,55E-13	-1,83E-13
	(-1,80)	(0,05)	(-3,06)	(-0,86)	(-0,52)	(0,66)
Growth	-0,00013	-0,00013	-0,00006	-0,00008	-0,00011	-0,00143
	(-1,59)	(-1,15)	(-0,74)	(-0,97)	(-0,84)	(-1,14)
ROE	-0,00011	-0,00040	-0,00163*	-0,00176*	-0,00315**	-0,00335**
	(-0,12)	(-0,33)	(-1,81)	(-1,93)	(-2,12)	(-2,43)
Constant	2,18228***	3,14458***	5,01110***	5,86616***	8,42410***	8,15391***
	(3,66)	(4,02)	(8,63)	(9,97)	(8,78)	(9,20)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4 177	4 177	4 177	4 177	4 177	4 177
Pseudo R^2	0,0254	0,015	0,0375	0,0372	0,0456	0,0452

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.

Appendix VII. Mediation effect of ESG scores on Cost of Capital

	ESGscore (1)	ICCES (2)	ICCOJ (3)	WACC (4)
Treat x Issue	0,10287***	-0,30715*	-0,44115**	0,63447***
	(7,64)	(-1,70)	(-2,15)	(3,89)
NIE		0,00366**	0,00375**	8,17E-06
		(2,33)	(2,21)	(0,01)
NDE		-0,12107***	-0,01061***	0,00527**
		(-3,71)	(-3,17)	(2,13)
TE		-0,00844**	-0,00686**	0,00528**
		(-2,53)	(-2,03)	(2,41)
ESGscore		0,00274**	0,00136	0,00791***
		(2,20)	(1,13)	(7,58)
Treat_Issue x ESGscore		0,00251	0,00446*	-0,00790***
		(1,08)	(1,69)	(-3,79)
Size	0,15425**	0,00400	-0,02911*	0,05632**
	(2,52)	(0,19)	(-1,75)	(2,41)
Lev	0,19688***	0,19207*	0,17667	-0,35045***
	(2,58)	(1,71)	(1,52)	(3,13)
Vol	0,04142*	0,25758***	0,22245***	0,07136
	(1,8)	(4,58)	3,69	(1,52)
CF	0,00265	-0,00480**	-0,00054	0,00523***
	(0,94)	(-2,24)	(-0,24)	(3,11)
Growth	0,00043	0,00154	0,00206	-0,00271
	(0,44)	(0,55)	(0,63)	(0,76)
ROE	0,04896	-0,01229	-0,00770	0,00285
	(1,29)	(-1,40)	(-1,15)	(0,25)
Constant	2,49664***	-2,61669***	-2,27184***	-3,53354***
	(4,09)	(-12,33)	(-13,29)	(-16,54)
Year		Yes	Yes	Yes
Industry		Yes	Yes	Yes
Country		Yes	Yes	Yes
Observations		1 293	1 293	1 293
F		7,02	3,64	16,67
Adj. R^2		0,0402	0,0181	0,0984

Significance levels are denoted as *, **, and ***, representing thresholds of 10%, 5%, and 1%, respectively.