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The Impact of Green Bond Issuing on Corporate Financial and Market Performance: Evidence from the European Real Estate Sector

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Abstract

This dissertation investigates whether issuing green bonds leads to improved financial and market performance among publicly listed European real estate companies. Motivated by the sector's critical role in the energy transition, the study addresses key gaps in existing literature, which generally overlook Europe, despite its significance in global green bond markets, and lack sector-specific studies, such as real estate. The objective is to assess the impact of first-time green bond issuance on corporate profitability – measured by Return on Assets (ROA), Return on Equity (ROE), and EBITDA margin – and on annual stock market returns.

Examining 56 green bond issuers between 2013 and 2021, the research employs a Propensity Score Matching – Difference-in-Differences (PSM-DiD) approach. Additional robustness checks include several firm-level controls, while heterogeneity across Real Estate Investment Trusts (REITs) and Real Estate Operating Companies (REOCs) is also explored, alongside a dynamic DiD analysis to capture year-by-year effects.

Results indicate a statistically significant improvement in EBITDA margin of approximately 10 percentage points for issuers relative to non-issuers, with the strongest effect (23.5 percentage points) appearing in the third year following issuance. However, ROA, ROE, and annual stock returns do not exhibit statistically significant changes.

These findings suggest that green bond issuance enhances operational efficiency over time, supporting the signalling hypothesis that green bonds credibly reflect issuers' environmental commitment rather than mere greenwashing. The implications are relevant for various stakeholders: while green bonds can improve core profitability, these benefits may materialise only after several years.

Keywords: Green Bonds, Real Estate, Issuing, Profitability, Corporate Performance, Financial Performance, Market Performance, Corporate, Signalling Theory, ESG, Propensity Score Matching, Difference-in-Differences, Europe.

Resumo

Esta dissertação investiga se a emissão de obrigações verdes conduz a melhorias no desempenho financeiro e de mercado entre empresas imobiliárias cotadas em bolsa na Europa. Motivado pelo papel fundamental do setor na transição energética, este estudo aborda lacunas importantes na literatura existente, que geralmente negligencia a Europa, apesar da sua relevância nos mercados globais de obrigações verdes, e carece de estudos específicos por setor, como o imobiliário. O objetivo é avaliar o impacto da primeira emissão de obrigações verdes na rentabilidade das empresas – medida pelo *Return on Assets* (ROA), *Return on Equity* (ROE) e margem EBITDA – e nos retornos anuais do mercado de ações.

Analisando 56 emissores de obrigações verdes entre 2013 e 2021, a investigação recorre a uma abordagem de *Propensity Score Matching – Difference-in-Differences* (PSM-DiD). Verificações adicionais de robustez contemplam diversos controlos ao nível da empresa, a heterogeneidade entre *Real Estate Investment Trusts* (REITs) e *Real Estate Operating Companies* (REOCs) também é explorada, assim como uma análise DiD dinâmica para capturar efeitos ano a ano.

Os resultados indicam uma melhoria estatisticamente significativa na margem de EBITDA de aproximadamente 10 pontos percentuais para os emissores em relação aos não emissores, com o efeito mais forte a surgir no terceiro ano após a emissão (23.5 pontos percentuais). Contudo, o ROA, o ROE e os retornos anuais das ações não apresentam alterações estatisticamente significativas.

Estes resultados sugerem que a emissão de obrigações verdes melhora a eficiência operacional ao longo do tempo, apoiando a hipótese do *signalling*, segundo a qual as obrigações verdes refletem de forma credível o compromisso ambiental dos emissores, em vez de *greenwashing*. As implicações são relevantes para diferentes *stakeholders*: embora as obrigações verdes possam melhorar a rentabilidade operacional, estes benefícios poderão apenas materializar-se ao fim de alguns anos.

Palavras-chave: Obrigações Verdes, Imobiliário, Emissão, Lucratividade, Performance Empresarial, Performance Financeira, Performance de Mercado, Empresa, Teoria do *Signalling*, ESG, *Propensity Score Matching*, *Difference-in-Differences*, Europa.

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Chapter 1. Introduction

Green bonds have emerged as a transformative financial instrument in the context of sustainable finance, offering an innovative mechanism to fund projects with positive environmental impacts. Since their inception by the European Investment Bank in 2007, these instruments have gained remarkable traction, with the global market reaching €2.9 trillion (Demski et al., 2025). Their growing popularity reflects a broader emphasis on Environmental, Social, and Governance (ESG) integration among both investors and issuers. In particular, the real estate sector, as a significant contributor to carbon emissions, has become a focal point for sustainability efforts. Green bonds thus present a critical opportunity for this sector to align with international climate objectives, such as the Paris Agreement's goal to limit global warming to well below 2 ºC (United Nations, 2015) and the European Green Deal's target to cut net greenhouse gas emissions by at least 55% by 2030 relative to 1990 levels (European Union, 2021).

According to the Institute for Energy Economics and Financial Analysis (IEEFA), European countries issued USD 341 billion worth of green bonds in 2023, making it the largest issuance region in the world, accounting for more than half of global issuance (Leung, 2024). In this context, the European Green Bond Standard (EUGBS) serves as a vital regulatory framework, aimed at promoting transparency, accountability, and uniformity in green bond issuance (European Union, 2023). Its latest requirements came into effect on 21 December 2024, enabling issuers to adopt the new "European Green Bond" label when offering euro-denominated instruments. This framework is expected to strengthen investor confidence and incentivize issuers to commit to more rigorous environmental practices.

The real estate sector stands out as one of the most critical in the fight against climate change. According to the European Commission (2020), buildings are responsible for approximately 40% of energy consumption and 36% of greenhouse gas emissions across the European Union. As a result, the decarbonization of this sector has become a central priority within the broader climate targets of the European Green Deal, particularly regarding the "Fit for 55" package, which includes commitments to improve energy efficiency. Specifically, from 2030 onwards, every new construction in the EU will need to be zero-emission, and by 2050, every existing building should accomplish that goal (European Union, 2024). Real estate is therefore not only part of the problem, but also a necessary part of the solution.

Green bonds offer a particularly suitable financing and environmental mechanism for this transition. The capital-intensive and long-term nature of real estate investment aligns naturally with the structure of green bonds, which are frequently used to finance energy-efficient building renovations, renewable energy integration, and sustainable construction measures such as insulation upgrades, high-efficiency HVAC systems, or energy-saving windows. Reflecting this alignment, as of 31 December 2024, the real estate sector accounted for approximately 20% of the total cumulative European green bond issues (active and inactive), according to the LSEG Workspace database. Furthermore, Ehlers et al. (2020) verify that green bond issuing real estate firms achieve, in fact, lower carbon emissions compared to non-issuing ones, demonstrating its environmental significance for this sector.

While the academic literature on green bonds has grown significantly, important gaps remain. Research on the impact of green bond issuance on corporate profitability and market performance has received some attention in the literature; however, the topic is still underexplored and warrants further empirical investigation, as there is a noticeable lack of studies focusing specifically on the European market, despite its global leadership in green bond issuance, and also of sector-specific approaches, particularly in the real estate sector. Additionally, when it comes to market performance, the vast majority of research has concentrated on short-term stock market reactions to green bond announcements, while much less is known about the longer-term stock market performance of green bond issuers, particularly beyond the immediate reaction window, leaving another important gap in understanding how these instruments affect shareholder value over time.

This dissertation thus aims to assess whether the first-time issuance of green bonds has a measurable impact on corporate profitability and long-term stock market performance, specifically within the European real estate sector. It focuses on four key performance indicators: Return on Assets (ROA), Return on Equity (ROE), EBITDA margin, and annual stock market returns, with these metrics providing a multi-dimensional view of both accounting-based and market-based outcomes.

This study will also take into account the specific case of Real Estate Investment Trusts (REITs). These are subject to specific financial regulations, including mandatory dividend distribution requirements and favourable tax treatment, which will be discussed further in this work. Such structural differences from other real estate firms may shape how green bond issuance translates into financial or market outcomes, and thus, this distinction is considered in the empirical strategy of this dissertation.

To achieve this, the study adopts a quasi-experimental approach. After retrieving all relevant financial data from Orbis and LSEG Workspace, a matched sample is created using Propensity Score Matching (PSM), controlling for firm size, leverage, year, and company type (REOC vs. REIT). This is followed by a Difference-in-Differences (DiD) estimation with firm and year fixed effects, comparing 56 green bond issuers to similar non-issuing firms across a six-year window (two years pre-issuance, year of issuance, and three years post-issuance).

Since green bond literature is not unanimous regarding the use of controls in the DiD estimation, a robustness check using leverage, firm size, asset turnover, and growth as control variables is subsequently implemented. This investigation also employs a dynamic DiD approach, which analyses year-by-year effects of green bond issuance across the sample, helping to understand their precise timing on the dependent variables. Finally, a heterogeneity assessment between company types among the different models will also be explored.

Ultimately, this research finds a positive and statistically significant effect of green bond issuance on EBITDA margin of approximately 10 percentage points, with this result remaining robust even after the inclusion of the firm-level controls. The year-by-year analysis shows that this impact is the strongest after three years post-issuance, with a coefficient of 23.5 percentage points. On the other hand, the remaining performance metrics present in this study (ROA, ROE, and annual stock returns) do not show statistically significant results.

These findings contribute to the green bond literature by establishing a direct link between this financing instrument and the real estate sector, which has not been done previously. Furthermore, EBITDA margin has not been investigated in this field, and its significance here introduces a novel perspective on how green bond issuance may translate into operational efficiency gains.

This dissertation is structured as follows: Chapter 2 presents a literature review on this subject; Chapter 3 outlines the data, variable selection, and methodological framework, as well as presenting the study's hypotheses; Chapter 4 presents and discusses the empirical findings; and Chapter 5 concludes with a summary of the results, as well as its implications, potential limitations, and suggestions for future research.

Chapter 2. Literature Review

A thorough review of the existing green bond literature is essential in order to understand the motivations for issuance and its potential impacts on corporate outcomes. This chapter first explores the theoretical arguments behind firms' decisions to issue green bonds, followed by an examination of empirical studies assessing how green bond issuance affects both financial and market performance, and other relevant research focused on the effect of broader sustainability factors and the specific case of the real estate sector.

2.1. Motivations for Green Bond Issuance: Signalling, Greenwashing, and Cost of Capital

Beyond their environmental objectives, green bonds also carry strategic implications for issuing firms. Flammer (2021) presents three possible rationales behind the issuance of corporate green bonds: the signalling, greenwashing, and cost of capital arguments.

The signalling theory, first introduced by Spence (1973), explains how firms can convey unobservable qualities (such as environmental commitment) through costly, observable actions. Green bonds fit this framework: Flammer (2021) provides evidence that they act as credible signals, showing that issuers improve environmental performance, attract long-term and ESG-focused investors, and trigger positive market reactions, especially for certified or first-time issuers. Other studies support this view by linking green bond issuance to increased visibility, reduced information asymmetry, and enhanced financing terms, while also showing that green bond issuance leads to measurable improvements in firms' environmental performance and attracts greater ownership by long-term or ESG-focused investors, consistent with a credible signalling effect (Jiang et al., 2022; Khurram et al., 2023; Pinto et al., 2024; Tang & Zhang, 2020; Zhou & Cui, 2019).

In contrast, greenwashing – a term coined by environmentalist Jay Westerveld in 1986 – refers to the practice of misleading consumers regarding the environmental practices of a company (Delmas & Burbano, 2011), in order to achieve a reputational gain. Lyon and Maxwell (2011) suggest that greenwashing involves the selective disclosure of positive environmental information while withholding negative aspects, a behaviour that undermines investor trust. Several studies within green finance emphasize that information asymmetry, especially among financial and large corporate issuers, can obscure whether funds are genuinely directed toward green projects (Baldi & Pandimiglio, 2022; Fatica et al., 2021). As

a result, the effectiveness of third-party verification has become critical to deterring greenwashing and preserving market integrity, with Yeow and Ng (2021) showing that only certified green bonds lead to significant improvements in firms' environmental performance, while non-certified green bonds do not.

Lastly, the cost of capital argument suggests that investors are willing to accept lower yields in exchange for environmentally friendly investments, ultimately enabling green bond issuing companies to obtain cheaper financing. This phenomenon, known as the "greenium", highlights how pro-environmental investor preferences can directly affect funding costs.

Empirical studies have sought to test whether this greenium consistently materialises in financial markets. Gianfrate and Peri (2019), using propensity score matching on 121 Euro-denominated green bonds, identify an average greenium of approximately 18 basis points, which is consistent with multiple works on a global scale (Agliardi & Agliardi, 2021; Caramichael & Rapp, 2022; Ehlers & Packer, 2017; Hachenberg & Schiereck, 2018; Kapraun et al., 2021; Löffler et al., 2021; Nanayakkara & Colombage, 2019; Zerbib, 2019). In the U.S., Baker et al. (2022) find that green municipal bonds also trade at premiums, especially when certified, while Larcker and Watts (2020) report little consistent evidence of greeniums when adjusting for risk. Notably, Karpf and Mandel (2018) document a shift in U.S. municipal green bonds from initial discounts to later premiums, suggesting evolving investor sentiment over time.

2.2. Impact on Financial Performance

A growing body of research investigates whether issuing green bonds translates into improved corporate financial outcomes, such as profitability and operational efficiency. This section reviews empirical studies assessing the relationship between green bond issuance and key financial performance metrics, including ROA, ROE, and related indicators, across different regions and industries.

Flammer (2020) offers one of the most comprehensive global studies, analysing publicly listed firms issuing green bonds between 2007 and 2018. Using a difference-in-differences (DiD) approach, the author finds that green bond issuance leads to significant long-term improvements in profitability, with ROA increasing by 0.006, representing an 11% gain relative to the mean ROA, with similar positive effects observed for ROE. These benefits emerge specifically two or more years post-issuance and are statistically significant only when bonds are certified by third parties.

Supporting the positive profitability narrative, Piao and Mei (2025) analyse Chinese firms issuing green bonds and green ABSs (asset-backed securities) from 2016 to 2023, reporting significant positive effects on ROE for green bond and ABS issuers compared to brown securities. Within the Chinese market, Tan et al. (2022) and Zhou and Cui (2019) also find profitability improvements for listed companies issuing green bonds. The former observe a significant overall profitability improvement of 1.65% while using a dynamic DiD model, with even greater effects (up to 1.71%) in high-pollution sectors, while the second study finds a 0.0116 percentage point improvement in ROA through a PSM-DiD approach.

Evidence from Europe is provided in a working paper by Pinto et al. (2024), who similarly apply a PSM-DiD model to a panel of public European firms between 2013 and 2021. The authors find a positive ROA result of 1.34 bps (basis points) one year after issuance, while ROE increases by 4.65 and 4.03 bps one and two years after issuance, respectively. EBIT and operational cash flow also demonstrate significant increases for every year following green bond issuance.

In contrast, several studies report limited or even negative profitability impacts. Jiang et al. (2022) analyse Chinese firms through a PSM-DiD model and find that green investments following green bond issuance erode profitability, with ROE tests yielding a significant negative coefficient of -3.407. The authors attribute this to high costs of green technologies, low market demand for green products, and insufficient government support, particularly outside green finance pilot zones. Hoang et al. (2022) further highlight regional differences by studying 75 green bond issuers worldwide from 2016 to 2020. Using the proportion of green bonds issued relative to total bonds as their engagement measure, they find no significant relationship between green bond issuance and ROA or ROE overall. Strikingly, they report a negative correlation between green bond issuance and both profitability metrics specifically for European firms, contradicting the findings of Pinto et al. (2024). Yeow and Ng (2021) also examine global issuers between 2015 and 2019 using a PSM-DiD framework, finding that green bonds do not significantly affect ROA or asset turnover in the short term, which is consistent with Makpotche et al. (2024), who are similarly unable to detect a significant increase in operating performance (measured by ROA) for green bond issuers across the world.

Turning to evidence specific to the real estate sector, Morri et al. (2021) investigate the link between "greenness" (measured by GRESB ratings and its components) and the operating financial performance of 50 listed European REITs between 2012 and 2016,

finding a positive relationship between overall GRESB rating and both ROE and ROA. Eichholtz et al. (2012) also document a positive effect of the "greenness" of U.S. REITs (through LEED or Energy Star certificates) on both metrics, with a particularly stronger effect for ROE, while Ooi and Dung (2019) conclude that greener REIT portfolios in Singapore deliver better operating performance, measured through ROA and operating margins. Furthermore, Morri et al. (2024) detect a positive relationship between environmental factors (such as resource use, emissions, and innovation) and ROA, while analysing over 680 publicly listed real estate companies globally between 2006 and 2020. In contrast, Mariani et al. (2018) find that European green REITs underperform in ROA relative to their non-green counterparts, while Piao and Mei (2025) observe that green REITs in China exhibit insignificant immediate effects and a notable negative impact of approximately -1.9% on ROE one year after launch. Although not centred on green bonds, these studies contribute important evidence concerning the link between the real estate sector and sustainability.

Other research similarly does not focus directly on green bonds, but rather on broader sustainability practices, providing supporting context. Margolis et al. (2011) provide a meta-analysis of 251 studies on the relationship between corporate social performance and financial performance, reporting a small but positive overall correlation with profitability metrics like ROA and ROE. Eccles et al. (2014) find that U.S. high sustainability companies exhibit superior ROA and ROE compared to low-sustainability firms. Lastly, Miroshnychenko et al. (2017), analysing firms from 58 countries, show that internal green practices like pollution prevention and green product development strongly correlate with profitability, reinforcing the potential for sustainability initiatives (including green bond issuance) to enhance financial performance.

2.3. Impact on Market Performance

As mentioned in **Chapter 1**, the literature on market performance following green bond issuance is primarily centred on market reactions on the short run.

Makpotche et al. (2024) describe their study as the first that investigates the long-run effect of corporate green bond issuance on firms' stock market performance. Examining 259 corporate green bond issuers from 2013 to 2020, the authors find that issuers outperformed matching firms, on average, by 11.81% over one year and 22.32% over three years after

issuance, an effect which was particularly distinct for multiple-time issuers and firms operating in industries where the natural environment is financially material.

Flammer (2021) provides global evidence, finding positive average cumulative abnormal returns (CAR) of 0.49% around announcement dates, especially pronounced for certified bonds, first-time issuers, and in industries where environmental issues are financially material, consistent with Makpotche et al. (2024). Baulkaran (2019) and Tang and Zhang (2020) similarly report positive announcement returns globally, while Verma and Bansal (2021) find positive CARs in the 10 days following announcements in the Indian market. It is also worth mentioning the innovative perspective of Badía et al. (2024), who examine portfolios of stocks from green bond issuers worldwide, ultimately observing that these portfolios deliver comparable or superior risk-adjusted returns over 12-month horizons compared to portfolios of non-green issuers.

Evidence from China further supports these findings, with several studies consistently reporting positive short-term market reactions (Fan et al., 2023; Jian et al., 2021; Tan et al., 2022; Wang et al., 2020; Zhou & Cui, 2019). Also in China, Jiang et al. (2022) find that firm value (measured by Tobin's Q) increases by 18.3% post-issuance compared to controls, rising to 24.5% after matching; however, the authors note the positive effect weakens after about a year. Khurram et al. (2023) further investigate this market, finding that green bond issuance significantly raises corporate value (Tobin's Q coefficient of 0.187) in a long-term and stable way, with the effect being amplified by improvements in corporate innovation performance.

Despite the general trend of positive reactions, other studies report contrasting results. Wu (2022), examining Chinese and global markets, finds that first-time green bond issuances can negatively impact stock performance, whereas subsequent issuances show no significant effect. Lebelle et al. (2020), analysing a global sample of 475 green bonds, document negative CARs (between -0.5% and -0.2%), with stronger negative reactions in developed countries and first-time issuances, directly contrasting Flammer (2021). Furthermore, Khiari et al. (2024) highlight heterogeneity in market responses: using a Multidimensional Scaling and clustering approach on 29 global companies, they show that factors like firm size, issue volume, governance quality, and country GDP can lead to both positive and negative post-announcement stock price dynamics, underscoring that no universal pattern exists.

Similarly to the previous section, various studies focus on how sustainability affects the market performance of real estate firms and REITs, though none specifically address the role of green bond issuance. In the U.S., Eichholtz et al. (2012) document no significant abnormal stock returns in REITs with greener property portfolios, whereas Cajias et al. (2014) report that real estate firms with stronger ESG profiles experienced higher firm value (Tobin's Q) but lower stock returns. More recently, Coën and Desfleurs (2022) find that although analysts exhibit relatively greater optimism about green REITs, market reactions to earnings surprises are asymmetric, with negative news being penalized more strongly for green REITs than for their conventional peers. Ooi and Dung (2019) find no abnormal return effects for Singaporean REITs associated with portfolio "greenness", while Mariani et al. (2018) show that European green REITs underperform peers on a risk-adjusted basis, with lower alphas and higher betas, implying that investors associated green certification with higher risk and weaker returns. This underperformance is attributed to incremental costs associated with the refurbishments, as well as adjustments necessary to obtain green certifications.

Overall, the existing literature provides a significant but limited view of green bond issuance and its effects on corporations. Theoretical arguments suggest that firms issue green bonds to credibly signal environmental commitment, enhance their reputation, or achieve financing advantages through a potential greenium, whereas empirical findings indicate that green bonds can, in fact, enhance financial performance, though results may vary across regions and contexts. Studies of market performance generally reveal positive short-term equity market reactions to green bond announcements, yet some evidence suggests heterogeneous or even negative responses depending on firm characteristics and market conditions. Evidence concerning the real estate sector mostly suggests a positive link between sustainability factors and corporate financial performance, while market effects appear to be largely neutral or even negative.

Despite these insights, clear gaps remain in green bond literature. As discussed earlier, the European market is largely overlooked, even though it plays a key role in the global green bond landscape, especially compared to more thoroughly examined regions such as China. There's also a notable shortage of sector-specific studies that could shed light on industry-level dynamics, which are very relevant, since different sectors face unique environmental risks, regulatory pressures, and opportunities that can shape how green financing impacts

their performance. While real estate has been a focus of sustainability-related studies, literature connecting it to green bonds specifically is clearly lacking. Finally, research on market performance after issuance tends to focus only on the short run. Makpotche et al. (2024) is the only study to investigate longer-term effects, and these could be just as or even more important to shareholders and investors interested in sustained value. These gaps, along with inconsistent findings across existing studies, highlight an opportunity for this dissertation to contribute valuable new evidence on how green financing affects corporate outcomes, particularly within a sector that is central to the energy transition.

Chapter 3. Methodology

This chapter describes the empirical strategy used to assess the impact of green bond issuance on the financial and market performance of European real estate firms. It details the processes for data selection, variable construction, and the setup of the Propensity Score Matching (PSM) and Difference-in-Differences (DiD) procedures. The chapter concludes with the development of hypotheses grounded in both theoretical motivations and prior empirical findings from the literature review.

3.1. Data Selection

This study was conducted through the retrieval of data relative to the first green bond issuance of publicly traded European real estate companies, comprised between the years of 2013 and 2021. For each one, six years of financial data were analysed: two years before the firm's first green bond issue, the issuing year, and the three following years post-issuance.

Green bond issuing firms were identified using the "Advanced Search – Corporate and Government bonds" application within LSEG (formerly Refinitiv) Workspace. The TRBC sector classification was used to find companies from the Real Estate sector, as well as to categorize them within its two main subdivisions – Real Estate Operations, and Residential & Commercial REITs.

Every green bond issuer within this segment and time frame ended up being included in the matching, except for two firms. First, Covivio Hotels SCA, a subsidiary of fellow issuer Covivio SA, was excluded to avoid duplication, with only the parent company being retained. Second, Unibail-Rodamco-Westfield (previously Unibail-Rodamco), was excluded due to missing and non-comparable financial data prior to its 2018 merger. The final sample therefore comprised a total of 56 companies.

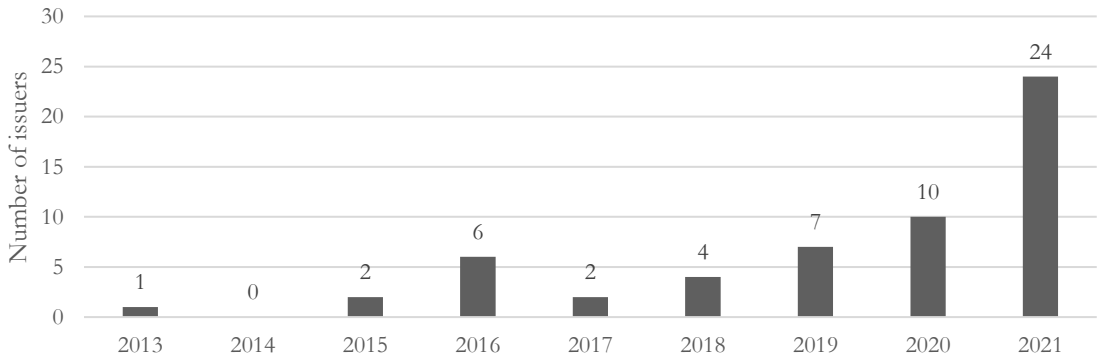

Figure 1. Number of green bond issuing companies per year of first issue

As shown in the graph, most of this study's firms issued their first green bond in the most recent years of analysis, with the highest number occurring in 2021, accounting for almost 43% of all issues.

The Real Estate Operations category includes companies involved in the ownership, development, and management of real estate assets, without operating under a Real Estate Investment Trust (REIT) structure. These firms – often referred to as Real Estate Operating Companies (REOCs) – typically reinvest earnings into new projects and are taxed at the corporate level. By contrast, REITs are open real-estate funds that own and operate income-generating properties and are allowed to avoid corporate taxation, provided they distribute at least 90% of taxable income to shareholders and follow other legal requirements. In total, REOCs made up for a total of 47 firms, compared to only 9 REITs.

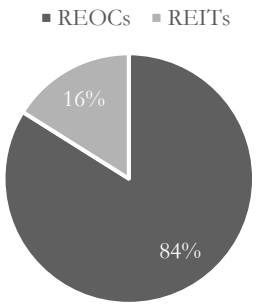

Figure 2. Percentage of issuers by corporate structure type

Geographically speaking, this research focuses on firms headquartered in European Union (EU) member states, as well as countries which, despite not being EU members, are part of the European Economic Area (EEA), such as the case of Norway and Iceland, or maintain strong regulatory and financial integrations with the EU, like Switzerland. These three are the only non-EU countries which contain firms that met the criteria for selection; however, they share environmental policies, sustainability reporting frameworks, and capital market access with the rest of the sample's nations. For instance, the EU's Corporate Sustainability Reporting Directive (CSRD) applies to both EU and EEA countries, which includes Norway and Iceland, while Switzerland enforces comparable non-financial reporting obligations under its Code of Obligations, ensuring alignment with EU sustainability disclosure frameworks (Swiss Federal Council, 2022).

Conversely, the United Kingdom, along with Jersey and Guernsey, was excluded from the sample due to regulatory differences post-Brexit. The UK has developed distinct sustainability reporting frameworks, such as the Sustainability Disclosure Requirements (SDR) and the UK Green Taxonomy, which differ from the EU's CSRD and Taxonomy Regulation. This divergence introduces inconsistencies in sustainability reporting and regulatory environments, potentially affecting comparability within the sample.

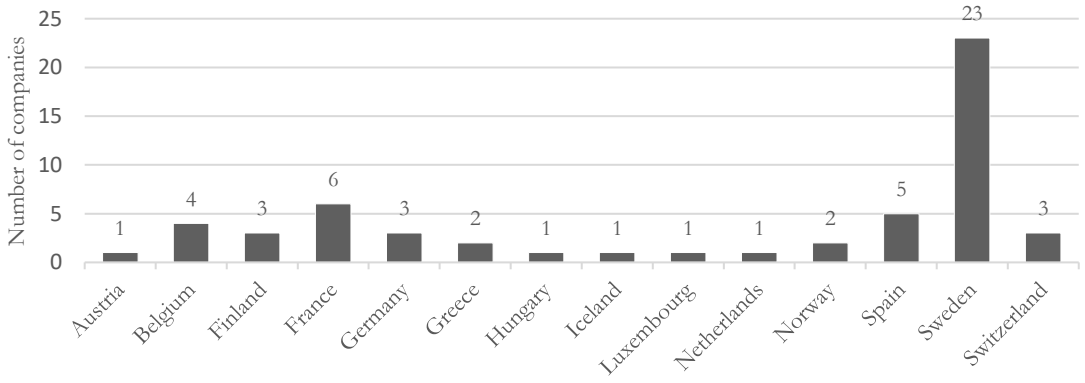

Figure 3. Number of issuers per country

As the graph shows, Sweden stands out significantly regarding its quantity of companies within the sample, accounting for approximately 41% of the total number.

Torvanger et al. (2021) attribute this strong green bond activity among Swedish real estate companies to a combination of favourable timing and market dynamics. The country already had a well-established bond market for real estate firms, and the emergence of green bonds provided an attractive opportunity to secure broader and potentially cheaper financing, with the funding being particularly geared toward refurbishments and new developments aligned with environmental building certifications, such as BREEAM and LEED. The authors also mention that real estate companies were responsible for approximately 82% of Sweden's total green bond issuance between 2013 and 2019.

This concentration is further supported by Maltais and Nykvist (2020), who identify Sweden as a frontrunner in sustainable finance, with green bonds accounting for 10% of its domestic bond market as early as 2018. The paper suggests that the country's unusually high share of green bonds reflects a national financial culture where sustainability has become a norm, beyond direct financial benefits.

3.2. Variable Selection

As previously mentioned, the selected variables for investigation in this study were Return on Assets (ROA), Return on Equity (ROE), and EBITDA margin, as measures of corporate profitability, and annual stock market returns, as a way of assessing long-run market performance.

Both ROA and ROE are frequently examined metrics within green bond literature as a measure of corporate profitability (Flammer, 2020; Hoang et al., 2022; Jiang et al., 2022; Makpotche et al., 2024; Piao & Mei, 2025; Pinto et al., 2024; Yeow & Ng, 2021; Zhou & Cui, 2019). ROA measures how efficiently a company uses its assets – such as buildings, lands, and other real estate holdings – to generate net income, while ROE reflects how effectively it generates those earnings from shareholders' equity. These are particularly relevant in the context of real estate companies, given the capital-intensive nature of the sector, where asset management and financing decisions play a key role in overall performance.

EBITDA margin, on the other hand, has not been explored in previous green bond studies. However, it is relevant to include it as another measure of profitability, as it offers a different, more direct view of a firm's operational efficiency, through the exclusion of the effects of financing decisions (which impact ROE) and total asset base (which affects ROA). This metric represents the ratio between EBITDA (earnings before interest, taxes, depreciation, and amortization) and total revenue of a firm. It isolates underlying operating performance, making it particularly insightful when evaluating the financial outcomes of green investments that aim to enhance energy efficiency, reduce costs, or improve building quality – all of which are expected to influence earnings.

Year-by-year figures regarding the profitability ratios were primarily collected from Orbis. When data for specific years was unavailable in this source, the missing values were complemented with information from LSEG Workspace, ensuring a complete and consistent dataset across the sample period.

In regard to market performance, annual stock market returns following green bond issuance were studied, as they provide a straightforward measure of how investors value a firm's performance over a longer horizon beyond immediate announcement effects. This data was retrieved exclusively from LSEG Workspace.

3.3. Propensity Score Matching

To assess the impact of green bond issuance on corporate performance, this study adopts a quasi-experimental model that first relies on Propensity Score Matching (PSM) to construct a comparable control group of non-issuing firms. This method was first introduced by Rosenbaum and Rubin (1983), and aims to mitigate selection bias by matching firms with similar pre-treatment characteristics. This approach is widely used in applied research to construct balanced treatment and control groups in non-experimental settings such as the one in this study. PSM has shown that it helps to reduce sample selection bias and focus on comparable units (Dehejia & Wahba, 2002), thereby addressing the non-random nature of firms' decisions to issue green bonds. In fact, as seen throughout the literature review, this is a commonly used methodology in studies in this field (Gianfrate & Peri, 2019; Jiang et al., 2022; Pinto et al., 2024; Ruan et al., 2025; Yeow & Ng, 2021; Zhou & Cui, 2019).

The non-issuers pool which was used for matching contained a total of 586 firms – all publicly-traded real estate non-green bond issuing companies from EEA countries, plus Switzerland. Propensity scores were estimated via a logistic regression model, which capture the probability of a firm issuing a green bond based on pre-treatment covariates, specifically, leverage and firm size. These two metrics are regularly used among green bond matching-based studies (Flammer, 2020, 2021; Jiang et al., 2022; Pinto et al., 2024; Ruan et al., 2025; Zhou & Cui, 2019). The leverage metric employed in this study was the Debt-to-Assets ratio, while firm size was proxied by the natural logarithm of total assets. This is a widely employed measure in corporate finance, due to its ability to reduce skewness and account for economies and diseconomies of scale effects across companies (Hitt et al., 1997). Data concerning leverage and firm size (total assets and total debt) was retrieved from Orbis.

The resulting propensity scores represent the conditional probability of treatment given these covariates. The dependent variable in this regression was the treatment status (1 = green bond issuer).

$$\hat{p}(X_i) = P(T_i = 1 \mid X_i) = \frac{e\beta_0 + \beta_1 Leveragei + \beta_2 log(Assets_i)}{1 + e\beta_0 + \beta_1 Leveragei + \beta_2 log(Assets_i)}$$

The matching process was also performed exactly on two key categorical variables: the previously mentioned TRBC sector classification and year.

As discussed in section **3.1.**, the differences between REOCs and REITs are substantial from a financial standpoint, hence the imperative need to perform an exact match

on company type between the treatment and control groups. In fact, it has been proven that legal requirements are significant determinants of the capital structure of REITs (Dogan et al., 2019), and many studies within the corporate finance literature exclude REITs for their different capital structures and distinctive regulation (Ghosh et al., 2012). For these reasons, it was imperative to perform an exact match on sector classification between the treatment and control groups, ensuring more methodological consistency and comparability across firms with similar financial incentives and reporting obligations.

An exact match on the year of issuance was also implemented during the PSM procedure. This means that each treated company (i.e., a green bond issuer) was only matched to a non-issuing firm operating in the same calendar year – the year before their first green bond issuance. Matching on year helps to control for time-specific factors, such as macroeconomic environments, regulatory changes, or market-wide investment trends, which could independently affect corporate financial performance. By isolating these temporal effects, the estimation of the green bond impact becomes more robust and less prone to those influences.

To guarantee that firms were only matched within the same year and company type, an adjusted propensity score variable was constructed. This adjustment helps in enforcing exact matching on those characteristics, while still allowing for nearest-neighbour matching based on the estimated propensity scores. Specifically, a unique identifier was generated for each year-type combination, and the propensity score was added to a scaled version of this identifier to create a composite score (ps_adj).

$$ps\_adj_i = 1000 \times GroupYear_i, Sector_i + \hat{p}(Xi)$$

Matching was then performed using 1-to-1 nearest-neighbour matching without replacement on unique year-firm combinations. It was also limited to the common support region, meaning that matching only occurred in the region where the propensity score distributions of both the treated and control groups overlapped, following the best practices outlined by Caliendo and Kopeinig (2008).

It is important to note that in the specific context of this study, matching without replacement meant that the same unique year-firm combination was not used more than once in the control group. However, the same non-issuer company could be matched more than one time to different green bond issuers, in different years. For example, LEG Immobilien SE, a control group company, ended up getting matched to PSP Swiss Property

AG and Fastighets AB Balder, both in the treatment group, for their respective issuance years of 2014 and 2018.

Although some non-issuers were matched to more than one treated firm, no control company was used more than once for the same year. This approach preserves matching quality without resorting to matching with replacement, as each control firm-year observation remains unique.

Finally, the propensity score matching was ran on Stata through the "psmatch2" command developed by Leuven and Sianesi (2003). The resulting matched sample contained all 56 green bond issuers, as well as 43 non-issuer control firms. As previously noted, the same non-issuer company could be matched more than one time to different green bond issuers, which explains why the number of non-issuer firms compared to green bond issuers is lower. This approach is not unique, as prior studies have also employed a larger treatment than control group (Makpotche et al., 2024; Mariani et al., 2018). In the present study, however, each control firm was not matched more than three times.

The final sample totalled 672 firm-year observations. In the following table, we can assess the quality of the matching results.

Table 1. Covariate balance after propensity score matching

Variable	Treated Mean	Control Mean	% Bias	t-statistic	p-value	Variance Ratio (V(T)/V(C))
Leverage	0.550	0.539	0.3	0.46	0.647	0.55
Firm size	14.705	14.553	6.5	0.61	0.546	0.86

These results indicate a high-quality match. Firstly, the standardized mean differences results (0.3% and 6.5%) show how well covariates are balanced after matching, with both falling below the 10% threshold for being considered appropriate. The p-values test whether the differences in means remain statistically significant after matching, and since both values are high, they show no significant imbalance. Variance ratios help ensure similar dispersion in covariates and should be between 0.5 and 2.0, and while firm size shows a stronger figure, leverage's result is borderline, but still acceptable. Lastly, the mean overall bias (not shown in **Table 1**) was also considered very good: 3.4%, below the standard 5% mark.

The **Annex** includes the full list of matched green bond issuers and non-issuers, as well as relevant characteristics, such as year of first issue, country of origin, and company type.

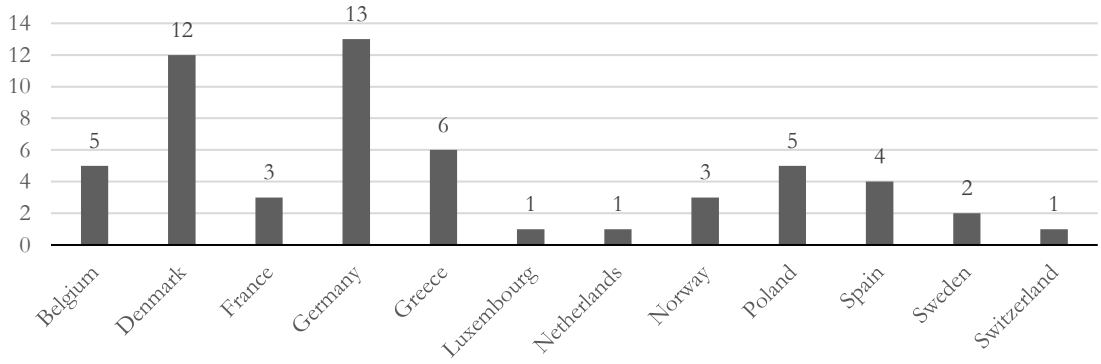

Figure 4. Number of control observations per country

It is important to recall that this graph includes all 56 matched entries rather than unique firms, which were only 43. We can detect that the distribution of observations per country is significantly different compared to that of the treatment firms, which leads to a potential limitation of this study: disparity in country.

While exact matching on country of origin was tested, it led to a worse quality of matching, such as higher biases, loss of several companies due to the necessity of using calipers, and the same control firms being matched up to five different treatment companies. This happened mainly because of Sweden's over-representation in the sample – it was difficult to find similar non-issuer companies from the same country, particularly when exact matching on both country and firm structure type.

While this could raise concerns about potential bias, it is important to consider why Sweden dominates the issuer pool: the country has been a leader in sustainable finance, with green bonds representing a significant share of its domestic bond market and a culture of strong institutional commitment to sustainability, as discussed in the **3.1.** section. Maltais and Nykvist (2020) note that although Sweden has a particularly strong sustainability profile, its leadership in green bonds may reflect broader trends in European markets with comparable financial systems and sustainability norms.

The primary focus of this research lies within the European Union and EEA countries (plus Switzerland), which share a high degree of regulatory, financial, and sustainability-related convergence. For instance, at the time of issuance of the green bonds present in this study, these countries were already largely aligned through voluntary but widely adopted frameworks, such as the ICMA Green Bond Principles (first released in

2014), which became the *de facto* market standard across Europe. Additionally, a 2018 report by the Climate Bonds Initiative states that 98% of European green bonds benefitted from at least one external review, with 93% of those including a second party opinion (Filkova, 2018), which helps to ensure consistency and comparability in environmental credibility regardless of issuer location. Moreover, several EU-level regulatory initiatives, including the Non-Financial Reporting Directive (NFRD, implemented in 2017) and early developments toward the EU Taxonomy Regulation (introduced in 2020), contributed to a more harmonized sustainability disclosure environment.

Lastly, while the number of firms from each country varies between the treatment and control groups, the countries of origin in both samples are largely similar. It is also worth mentioning that some peer-reviewed green bond matching studies, such as Gianfrate and Peri (2019), do not include exact matching on country, instead using regional dummy variables within a global sample.

In conclusion, while certain national differences may exist, these were not deemed as critical to justify imposing exact country-level matching. In contrast, exact matching on company type was deemed as vital, as the financial differences between REOCs and REITs are much more significant than country-wise variances among European countries. It was also key for retaining the entire sample, without losing firms through the potential use of calipers.

3.4. Difference-in-Differences

After the matching process was completed, this study employed the Difference-in-Differences (DiD) method to assess the potential disparities between treatment and control groups following green bond issuance. This technique compares the evolution of outcomes between both groups before and after an intervention (in this case, the first green bond issue). It is implemented through the comparison between average behaviours before and after that specific event, and can therefore be a powerful tool in measuring the average effect of the treatment on the treated (Blundell & Costa Dias, 2009). This is another commonly used method within green bond investigations (Flammer, 2020, 2021; Jiang et al., 2022; Khurram et al., 2023; Pinto et al., 2024; Ruan et al., 2025; Tan et al., 2022; Yeow & Ng, 2021; Zhou & Cui, 2019).

As stated at the beginning of section **3.1.**, the panel dataset consists of observations over six years per firm: two years prior to green bond issuance, the year of issuance, and the

three years which follow it. This window allows for a stronger assessment of both pre-treatment trends and the persistence of any post-issuance effects, particularly through the inclusion of two pre-treatment years, which is key to verify the parallel trends assumption – central to the validity of DiD estimation.

This estimation was implemented in Stata using a fixed effects model with firm and year fixed effects. Standard errors were clustered at the firm level to allow for arbitrary correlation of error terms within firms over time, thereby ensuring robustness to heteroskedasticity and serial correlation.

The main regression model can be expressed as follows:

$$Y_{it} = \alpha + \beta_1 Post_{it} + \beta_2 Treated_i + \delta(Post_{it} \times Treated_i) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where Y_{it} denotes the outcome variable for firm i at time t (ROA, ROE, EBITDA margin, or annual stock return), $Post_{it}$ is a dummy variable equal to 1 for years after issuance, $Treated_i$ is another dummy for firms that issued a green bond, and the interaction term $Post_{it} \times Treated_i$ captures the treatment effect δ, which ultimately measures the causal effect of green bond issuance. Additionally, μ_i represents firm fixed effects (controls for all time-invariant characteristics of each firm), and λ_t denotes year fixed effects (such as macroeconomic trends which affect all companies). X_{it} includes potentially applicable controls, while ε_{it} is the error term.

The baseline estimation of this research, whose results are later presented in section **4.2.**, does not include any additional control variables, following the methodology of several studies within this field (Flammer, 2020, 2021; Makpotche et al., 2024; Pinto et al., 2024). Flammer (2021), one of the most widely recognized corporate green bond studies, justifies the exclusion of controls in the regression by arguing that the matching process already balances the treatment and control groups on relevant covariates, while also verifying that including these characteristics as controls does not materially change the results. That said, since the inclusion of control variables in DiD estimations is not universally agreed upon within green bond literature and several studies do include them, this research also performs a robustness analysis with additional controls (further discussed in **4.3.**). Specifically, leverage, firm size, asset turnover, and growth are introduced as controls, following the practice of prior studies (Jiang et al., 2022; Ruan et al., 2025; Tang & Zhang, 2020; Yeow & Ng, 2021; Zhou & Cui, 2019). Firm size and leverage were computed as described in the

previous section. Asset turnover was measured as the ratio of operating revenue to total assets, while growth was defined as the annual change in operating revenues. The latter displayed extreme outliers (e.g., exceeding +7,000,000% in one case due to a near-zero revenue base), so in order to prevent such anomalies from distorting the results, the variable was winsorized at the 1st and 99th percentiles. Once again, all variables were sourced from Orbis.

In addition to the baseline DiD model, a dynamic specification was also estimated using a "relative year" variable, to assess how the treatment effect evolved over time, allowing for the identification of heterogeneous effects across each year, as well as potential anticipation or delayed treatment effects, presented in the **4.4.** section. This type of study is also common among green bond research (Flammer, 2020, 2021; Jiang et al., 2022; Khurram et al., 2023; Pinto et al., 2024; Tan et al., 2022). Finally, a heterogeneity test (reviewed in **4.5.**) was conducted by interacting the treatment with firm type dummies (REIT vs. REOC) and exploring differences in effects across both.

3.5. Hypotheses Development

To conclude this methodology chapter, I will now present the two main hypotheses (**H1** and **H2**) of this dissertation, as well as three sub-hypotheses (**H1a**, **H1b** and **H1c**):

H1: Green bond issuance has a positive impact on corporate financial performance in the European real estate sector, compared to non-issuing firms.

H1a: Green bond issuance leads to a relative increase in Return on Assets (ROA).

H1b: Green bond issuance leads to a relative increase in Return on Equity (ROE).

H1c: Green bond issuance leads to a relative increase in EBITDA margin.

H2: Green bond issuance has a relatively positive impact on market performance in the European real estate sector, as measured by annual stock returns.

These hypotheses follow the empirical and theoretical insights reviewed in **Chapter 2**, suggesting that issuing green bonds can positively affect a firm's financial and market performance through multiple channels. First, green bonds can act as credible signals of a company's commitment to sustainability, reducing information asymmetry and attracting long-term, ESG-focused investors (Flammer, 2021). This signalling effect can enhance a firm's reputation, improve stakeholder relationships, and potentially lead to better operational outcomes as green investments improve energy efficiency or asset quality, all of

which are expected to boost profitability measures such as ROA, ROE, and EBITDA margin. This is supported by the literature: while not every study reports positive results, most do find a link between green bond issuance and improved profitability metrics (Flammer, 2020; Piao & Mei, 2025; Pinto et al., 2024; Tan et al., 2022; Zhou & Cui, 2019). Real estate-based research also generally upholds this positive link between sustainability and financial performance, despite not focusing on green bonds in particular (Eichholtz et al., 2012; Morri et al., 2021; Morri et al., 2024; Ooi & Dung, 2019).

Second, the literature indicates that positive investor perceptions around green bonds may result in increased demand for the issuer's shares on a global level, driving up stock prices in the period following issuance (Baulkaran, 2019; Flammer, 2021; Tang & Zhang, 2020). As green bonds align firms with environmental regulations and future-proof their operations against sustainability risks, shareholders may also view issuers as better positioned for long-term success. This is supported by Makpotche et al. (2024), who find continued outperformance by global issuers up to three years after issuance, and Khurram et al. (2023), who find a sustained and stable increase in corporate value following green bond issuance. Although literature focused on the real estate sector offers less consistent results, it does not specifically address green bond issuance but rather wider sustainability factors, with the largely positive evidence from the green bond literature providing a strong counterbalance, reinforcing the expectation of a favourable stock market impact.

In summary, these factors together form the basis for hypothesizing that green bond issuance should have a positive impact on both corporate financial performance and annual stock returns in the European real estate sector.

Chapter 4. Results

4.1. Descriptive Trend Analysis

Before presenting the DiD results, this subsection provides a simple visual overview of the year-by-year average evolution of the financial and market performance indicators. Each graph compares the average values for treated and control firms from two years prior to issuance (t-2) to three years after (t+3). It is important to clarify that this visual representation aims merely for understanding the overall trend across the different performance metrics over time, as well as allowing for a direct inspection of any visible divergence between the two groups around the issuance event.

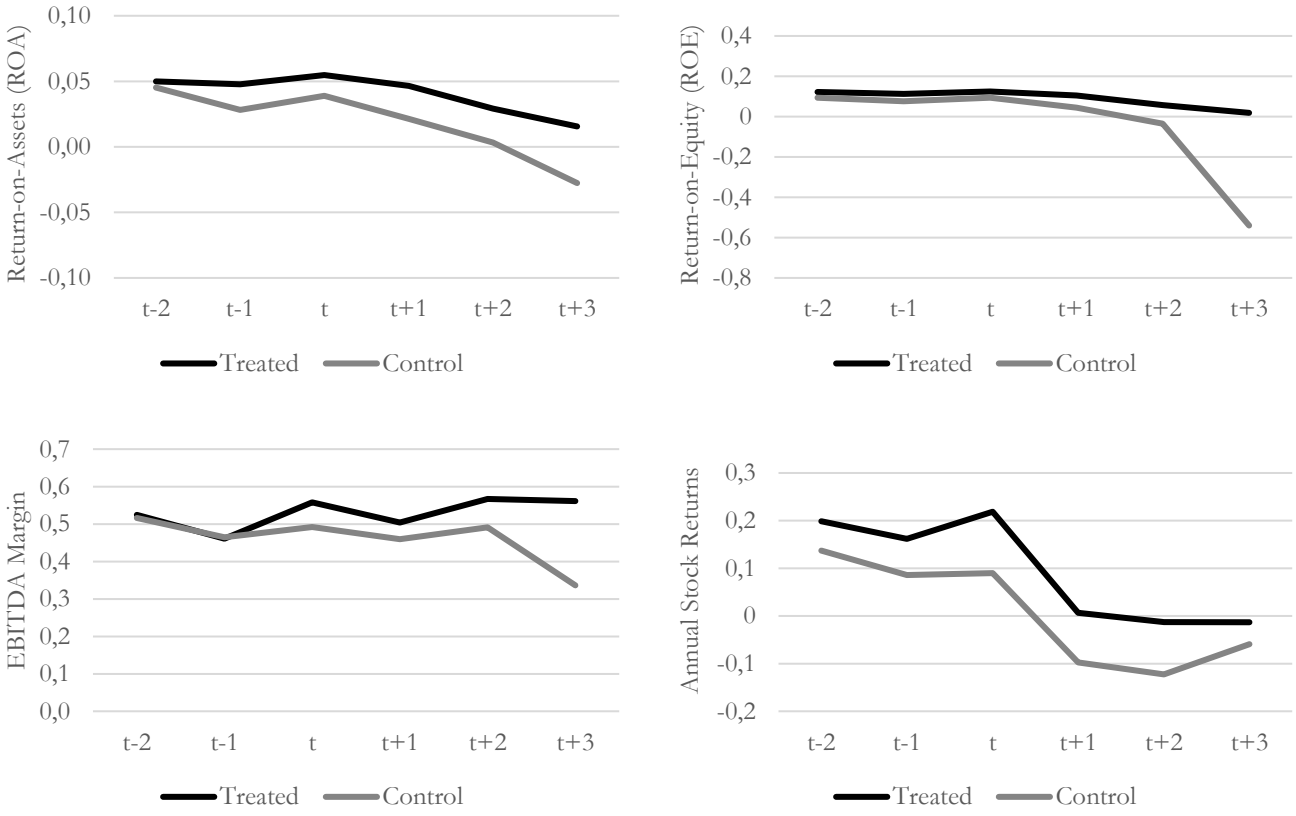

Figure 5. Year-by-year evolution of indicators (Treated vs Control groups)

The graphs indicate an overall decline in every studied variable over time, for both issuers and non-issuers. In fact, both groups show a general drop in every metric across the six years of data, except for the treatment group regarding the EBITDA margin variable.

The reason for this overall deterioration can be tied to the macroeconomic conditions of the market. As previously reported in section **3.1.**, most green bond issues present in the study occurred in the most recent years, particularly in 2021. This means that a high portion

of the years included in this regression are therefore situated within the time period that followed (early 2020s), which was characterised by high macroeconomic instability: COVID-19, the Ukraine war, rising interest rates, and inflation across Europe. The period between 2022 and 2023 was particularly damaging for the European real estate market, with DWS reporting an 80-basis-point increase in all-property prime yield, a decline of 20% in property values, and the total transaction volume being at 50% below the 10-year historical average (Wallace & Bos, 2024).

It is also interesting to note that there seems to be an apparent drift between green bond issuers and non-issuers' average figures through time, regarding profitability measures. However, this trend is merely suggestive, and needs to be further assessed through the DiD estimation to prove its significance.

4.2. Difference-in-Differences Results: Average Treatment Effects

This section discusses the results from the core model of the investigation, as presented in **Chapter 3**: the Difference-in-Differences estimation.

Table 2. Difference-in-Differences estimates of the effect of green bond issuance on firm performance

Variable	ROA	ROE	EBITDA Margin	Stock Returns
Post-issuance	-0.005	-0.073	0.003	-0.059
	(0.008)	(0.068)	(0.026)	(0.059)
Treatment × Post (DiD effect)	0.016	0.151	**0.101****	0.006
	(0.0133)	(0.131)	(0.041)	(0.056)
Observations	664	664	662	624
R^2 (within)	0.127	0.035	0.023	0.294
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

Note: The "Treated" dummy variable is not reported because it is perfectly collinear with firm fixed effects and therefore absorbed in the model estimation.
Standard errors clustered at the firm level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Among the profitability indicators, only EBITDA margin shows a statistically significant effect: the **Treatment × Post** coefficient suggests an average increase of approximately 10 percentage points relative to non-issuers ($p < 0.05$). This value indicates that green bond issuers experienced an improvement in operating profitability in the years following issuance, potentially reflecting efficiency gains from sustainability-driven investments such as energy-efficient refurbishments, which can reduce costs or improve asset quality in ways that affect core earnings. Importantly, this represents a novel contribution to the literature, as EBITDA margin has not been previously analysed in green bond-focused research, suggesting that core operational efficiency may be an overlooked dimension of post-issuance financial performance.

By contrast, the results for ROA, ROE, and annual stock market returns are not statistically significant. Their coefficients are positive in direction, but given the standard errors, they cannot be distinguished from zero, which implies that the evidence is insufficient to conclude that green bond issuance affected balance-sheet profitability or long-term market valuation for real estate firms within the period in study. Nonetheless, the point estimates do not contradict the expectation of improved performance, and they may hint at underlying patterns that could be tested more robustly with larger datasets or longer observation periods.

Ultimately, these outcomes suggest that while balance-sheet profitability (ROA, ROE) and market-based performance (annual stock returns) do not provide sufficient statistical evidence to confirm **Hypotheses 1a**, **1b**, or **2**, the significant improvement in operating profitability supports **Hypothesis 1c** and offers partial evidence in favour of **Hypothesis 1** overall, implying that the benefits of green bond issuance in the European real estate sector may be more visible in the efficiency of day-to-day operations than in broader accounting or market outcomes, pointing to a promising and innovative direction for future research within this field.

4.3. Difference-in-Differences Results: Robustness Check

To assess the robustness of the results, a re-estimation of the DiD model is performed while including the firm-level control variables discussed in **Chapter 3**: financial leverage (total debt to total assets), firm size (proxied by the natural logarithm of total assets), asset turnover (operating revenue to total assets) and growth, measured through annual operating revenues' evolution.

Table 3. Results from DiD estimation, controlling for leverage, firm size, asset turnover, and growth

Variable	ROA	ROE	EBITDA Margin	Stock Returns
Post-issuance	0.007	0.008	0.039	-0.054
	(0.005)	(0.016)	(0.034)	(0.052)
Treatment × Post (DiD)	0.005	0.014	**0.077****	0.003
	(0.008)	(0.022)	(0.038)	(0.055)
Leverage	-0.232***	-0.459***	-0.651*	-0.343
	(0.060)	(0.139)	(0.341)	(0.417)
Firm Size	0.000	0.030	0.080*	-0.019
	(0.008)	(0.023)	(0.046)	(0.049)
Asset Turnover	0.016	0.240	0.522	-0.340
	(0.136)	(0.438)	(0.510)	(0.447)
Growth	0.006*	0.014	0.050	0.036
	(0.003)	(0.010)	(0.061)	(0.054)
Observations	635	635	633	595
R^2 (within)	0.333	0.300	0.066	0.304
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

Note: Standard errors clustered at the firm level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The inclusion of firm-level controls confirms the previous finding of a significant positive effect of green bond issuance on operating profitability, with the coefficient on the **Treatment × Post** interaction for EBITDA margin remaining positive and statistically significant at the 5% level, indicating that issuers outperformed non-issuers by approximately 7.7 percentage points following issuance. By contrast, and similarly to the baseline model, no statistically significant effects are observed for ROA, ROE, or annual stock returns, suggesting that neither balance-sheet profitability nor market-based performance measures

were systematically affected by issuance in the studied period, even with the inclusion of controls.

Regarding the control variables, the results reveal a strongly negative association between leverage and all profitability measures, which is in line with financial theory that higher debt ratios constrain firm performance. Firm size is generally insignificant, though its weak positive association with EBITDA margin is marginally significant at the 10% level, while growth similarly displays a small positive effect on ROA at the 10% level. On the other hand, asset turnover does not appear to play a meaningful role in explaining variation across the dependent variables.

In essence, the addition of these firm-level control variables provides consistent results with the ones found in the baseline model discussed in **4.2.**, aligning with Flammer (2021)'s suggestion that adding controls in this type of study does not materially change its outcomes. Nevertheless, this robustness test adds credibility to the findings, while also helping to support **Hypothesis 1c**.

4.4. Dynamic Difference-in-Differences Results: Year-by-Year Treatment Analysis

To further investigate the timing of potential effects, this section analyses treatment impacts on a year-by-year basis, through a dynamic DiD specification. By interacting the treatment status with each individual relative year following green bond issuance, this approach allows for the assessment of the evolution of financial and market performance effects over time. This method expands on the baseline DiD regression from **4.2.**, replacing the post-period dummy with separate dummies for each relative year. In the following **Table 4,** we can observe those interaction terms' coefficients, where "t" represents year of issuance, while "t+1", "t+2" and "t+3" indicate subsequent years.

Table 4. Year-by-year dynamic Difference-in-Differences estimates

Variable	ROA	ROE	EBITDA Margin	Stock Returns
t	-0.004	-0.006	0.069	0.032
	(0.007)	(0.015)	(0.070)	(0.103)
t+1	0.005	0.022	0.048	0.021
	(0.009)	(0.021)	(0.044)	(0.105)
t+2	0.006	0.055	0.077	0.016
	(0.012)	(0.045)	(0.098)	(0.101)
t+3	0.026	0.546	**0.235****	-0.059
	(0.034)	(0.533)	(0.113)	(0.096)
Observations	553	553	551	531
R^2 (within)	0.138	0.044	0.049	0.294
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

Note: Each relative year (t, t+1, t+2, t+3) represents its own interaction with the "Treated" variable. Standard errors clustered at the firm level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Through the interaction of treatment status with each post-issuance year, these regressions revealed that ROA, ROE, and annual stock market returns failed once more to demonstrate statistically significant coefficients, across each year after issuance. However, EBITDA margin showed a statistically significant positive effect, specifically in the third year following issuance (**t+3**), with an outcome of 23.5 percentage points, much higher than this variable's coefficient in the baseline model concerning the overall improvement in the entire post-issuance period (around 10 percentage points).

This finding aligns with Flammer (2020), who observed that significant improvements in corporate profitability (measured by ROA and ROE) only emerged in the long run (two or more years after green bond issuance) following initially positive but statistically insignificant short-term effects. Similarly, Yeow and Ng (2021), despite finding

no significant short-term impact on financial performance, proposed that a longer interval of 3-5 years might be needed for financial benefits to appear, given the high upfront costs of transitioning to greener operations. Zhou and Cui (2019) also recognized the limitations of their shorter study period (2016–2019) given the green bond market's early stage in China, suggesting that as bonds mature over time, their positive effects on corporate profitability and financial performance are likely to become more pronounced.

A potential explanation for these lagged benefits lies within the nature of projects typically financed by green bonds. As Flammer (2020) highlights, green bonds are often used to fund large-scale, long-term environmental and energy projects, which require substantial initial investments and extended implementation periods before efficiency gains or cost savings begin to improve a firm's earnings. Moreover, the prevalence of lower coupons on green bonds (the greenium) means issuers may initially accept cheaper financing as part of a long-term strategy, with the financial advantages only gradually manifesting through reduced interest expenses over time, reinforcing the expectation that the positive effects of green bond issuance on profitability metrics will only become measurable several years after issuance.

4.5. Difference-in-Differences Results: REITs vs REOCs

As a final step, in order to explore potential heterogeneity across company types in the real estate market, this study also tested whether the impact of green bond issuance differs between REITs and REOCs. This was done by introducing a triple interaction term (**Post × Treated × REIT**) in the baseline, controlled, and dynamic DiD specifications, with "REIT" being a dummy variable representing this firm type. Across all models, the triple interaction coefficients are statistically insignificant, indicating no systematic difference in the effect of issuance between the two corporate structures. Although these outcomes may suggest that the findings reported in Sections **4.2.**, **4.3.**, and **4.4.** apply broadly to real estate firms regardless of organizational form, it should be noted that the limited presence of REITs in the sample compared to the number of REOCs may limit statistical power and partly explain the absence of significant results. The full regression outputs are provided in the **Appendix**.

Chapter 5. Conclusion

This dissertation set out to investigate the impact of green bond issuance on the financial and market performance of publicly traded European real estate companies. Motivated by the increasing importance of green bonds in financing the energy transition and the limited evidence available on their effects within a sector as crucial as real estate, as well as in regard to the European context as a whole, this research aimed to fill important gaps. A sample of 56 green bond issuers and 43 matched non-issuer controls was analysed, covering the years between 2013 and 2021. The empirical strategy combined Propensity Score Matching (PSM) with a Difference-in-Differences (DiD) estimation, with exact matching on company type and timing of issuance, to assess outcomes over a six-year window around the first green bond issue. In addition, a robustness check was implemented through the control of firm-level variables, as well as a dynamic DiD model, which was utilized as a helping instrument to analyse year-by-year effects. Lastly, a heterogeneity test between REOCs and REITs was performed, though it did not present significant differences in effects.

The results of the empirical analysis indicate that only EBITDA margin demonstrated a statistically significant improvement: approximately 10 percentage points, while the strongest outcome appears in the third year following issuance, with a 23.5 percentage point effect. This represents a novel contribution, as EBITDA margin has not previously been examined in the green bond literature, and it helps to demonstrate that green bond issuance may, in fact, enhance a firm's operational efficiency over time, as proposed by **Hypothesis 1** (even if traditional balance sheet-driven measures do not immediately reflect these benefits) and fully confirming **Hypothesis 1c**. The finding of a delayed significant effect aligns with Flammer (2020), who similarly reports stronger financial performance improvements two or more years post-issuance. The inclusion of leverage, firm size, asset turnover and growth as control variables in the DiD model help to validate the robustness of EBITDA margin's positive effect. In contrast, ROA, ROE, and annual stock market returns consistently failed to demonstrate significant results across the different estimations.

The study's findings lend support to the signalling argument discussed in the literature review. As highlighted by Flammer (2021), green bond issuance can serve as a credible signal of a firm's commitment to sustainability, attracting long-term investors and enhancing stakeholder perceptions. The significant improvement observed in EBITDA margin suggests that issuers may be achieving real operational efficiencies consistent with

greener practices, which provides indirect evidence that green bond issuance reflects genuine commitment rather than mere greenwashing.

Some important implications for different stakeholders can also be drawn from the results. For real estate firms, they suggest that issuing green bonds can improve operational efficiency, though patience may be needed before these benefits are visible in financial statements. Investors should be aware that long-term market outperformance of firms following green bond issuance is not guaranteed, while for policymakers, the results highlight the value of supporting frameworks that enable firms to capitalize on green bond financing and recognizing that the financial benefits of these instruments often unfold over a longer horizon.

Despite these contributions, it is worth pointing out some of this work's limitations. The sample, though including every green bond issuer within this segment apart from only two, is still not very large. It also displays a strong concentration of issuers from Sweden, as well as disparities in the country distribution between treatment and control groups. Even though regulatory convergence across the EU and EEA helps to mitigate this concern, it may affect the generalizability of the findings. Additionally, the observation period, even including multiple post-issuance years, may still be too short to fully capture the effects of green bond-funded long-term projects, as the lagged positive effects suggest.

Future research should therefore extend this analysis by incorporating longer post-issuance timeframes in order to capture delayed effects more comprehensively, as the green bond market becomes more mature. Examining other key sectors of the economy, such as energy or utilities, would help to assess whether these results generalize beyond real estate, particularly in Europe. Given that EBITDA margin has not been studied previously in the green bond literature, future research could also further explore this metric across other sectors and contexts. Exploring qualitative factors, such as changes in company culture, stakeholder perceptions, or innovation, may also deepen understanding of how green bond issuance influences corporate performance, while analysing whether effects can become stronger after subsequent green bond issues following the first one could also provide an interesting perspective. Finally, as new frameworks like the EU Green Bond Standard become widely adopted, future studies may evaluate whether enhanced transparency and standardized certification amplify the financial and market impacts of green bonds in Europe.

Appendix

Table A1. Baseline triple interaction results (REIT vs REOC)

Variable	ROA	ROE	EBITDA Margin	Stock Returns
Post-issuance	-0.008	-0.099	0.015	-0.061
	(0.010)	(0.088)	(0.031)	(0.068)
Post × Treated	0.016	0.172	0.089*	-0.004
	(0.015)	(0.153)	(0.046)	(0.064)
Post × REIT	0.200	0.171	-0.078	0.009
	(0.022)	(0.137)	(0.057)	(0.083)
Post × Treated × REIT	-0.004	-0.130	0.073	0.058
	(0.025)	(0.145)	(0.097)	(0.133)
Observations	664	664	662	624
R^2 (within)	0.128	0.035	0.024	0.295
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

Note: Standard errors clustered at the firm level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2. Controlled triple interaction results (REIT vs REOC)

Variable	ROA	ROE	EBITDA Margin	Stock Returns
Post-issuance	0.006	0.004	0.058	-0.056
	(0.006)	(0.017)	(0.038)	(0.061)
Post × Treated	0.004	0.011	0.049	-0.008
	(0.009)	(0.025)	(0.039)	(0.062)
Post × REIT	0.006	0.021	-0.118**	0.013
	(0.016)	(0.034)	(0.048)	(0.080)
Post × Treated × REIT	0.007	0.020	0.163	0.062
	(0.020)	(0.044)	(0.120)	(0.129)
Leverage	-0.232***	-0.459***	-0.671*	-0.347
	(0.060)	(0.139)	(0.341)	(0.419)
Firm Size	0.001	0.031	0.087**	-0.017
	(0.008)	(0.023)	(0.043)	(0.048)
Asset Turnover	0.015	0.237	0.544	-0.344
	(0.137)	(0.439)	(0.510)	(0.454)
Growth	0.006*	0.014	0.049	0.036
	(0.003)	(0.010)	(0.061)	(0.054)
Observations	635	635	633	595
R^2 (within)	0.335	0.301	0.068	0.305
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

Note: Standard errors clustered at the firm level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3. Dynamic DiD triple interaction results (REIT vs REOC)

Variable	ROA	ROE	EBITDA Margin	Stock Returns
t	-0.009	-0.022	0.135	0.032
	(0.016)	(0.032)	(0.162)	(0.103)
t+1	-0.011	-0.050	0.189	0.021
	(0.021)	(0.007)	(0.151)	(0.105)
t+2	0.018	0.007	0.169	0.016
	(0.036)	(0.089)	(0.196)	(0.101)
t+3	-0.017	-0.558	0.103	-0.059
	(0.049)	(0.598)	(0.227)	(0.096)
Observations	553	553	551	531
R^2 (within)	0.146	0.047	0.052	0.294
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm

Note: Each relative year (t, t+1, t+2, t+3) represents its own interaction with the "Treated" and "REIT" dummy variables.
Standard errors clustered at the firm level are reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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Annex

Annex. Matched sample of green bond issuers and control firms

Green Bond Issuer	Year	Country of Origin	Company Type	Matched Control Firm
Gecina SA	2013	France	Real Estate Investment Trust (REIT)	Klepierre SA
PSP Swiss Property AG	2015	Switzerland	Real Estate Operating Company (REOC)	LEG Immobilien SE
Wallenstam AB	2015	Sweden	Real Estate Operating Company (REOC)	Allreal Holding AG
Castellum AB	2016	Sweden	Real Estate Operating Company (REOC)	Olav Thon Eiendomsselskap ASA
Entra ASA	2016	Norway	Real Estate Operating Company (REOC)	Pandox AB
Fabege AB	2016	Sweden	Real Estate Operating Company (REOC)	Aroundtown SA
Inmobiliaria Colonial SOCIMI SA	2016	Spain	Real Estate Investment Trust (REIT)	Klepierre SA
Merlin Properties SOCIMI SA	2016	Spain	Real Estate Investment Trust (REIT)	Alstria Office AG
Atrium Ljungberg AB	2017	Sweden	Real Estate Operating Company (REOC)	Allreal Holding AG
Covivio SA	2017	France	Real Estate Investment Trust (REIT)	Klepierre SA
Icade SA	2017	France	Real Estate Investment Trust (REIT)	Carmila SA
FastPartner AB	2018	Sweden	Real Estate Operating Company (REOC)	Realia Business SA
Fonciere Inea SA	2018	France	Real Estate Investment Trust (REIT)	Immobiliere Dassault SA
Societe Fonciere Lyonnaise SA	2018	France	Real Estate Operating Company (REOC)	Nepi Rockcastle NV
Sagax AB	2019	Sweden	Real Estate Operating Company (REOC)	Jeudan A/S
Citycon Oyj	2019	Finland	Real Estate Operating Company (REOC)	Deutsche Euroshop AG
CPI Property Group SA	2019	Luxembourg	Real Estate Operating Company (REOC)	Altarea SA
Fastighets AB Balder	2019	Sweden	Real Estate Operating Company (REOC)	Leg Immobilien SE
Nexity SA	2019	France	Real Estate Operating Company (REOC)	Nepi Rockcastle NV
Samhallsbyggnadsbolaget I Norden AB	2019	Sweden	Real Estate Operating Company (REOC)	Testa Residencial SOCIMI SA
Zug Estates Holding AG	2019	Switzerland	Real Estate Operating Company (REOC)	Demire Deutsche Mittelstand Real Estate AG

Green Bond Issuer	Year	Country of Origin	Company Type	Matched Control Firm
Bonava AB	2020	Sweden	Real Estate Operating Company (REOC)	Patrizia SE
CA Immobilien Anlagen AG	2020	Austria	Real Estate Operating Company (REOC)	Olav Thon Eiendomsselskap ASA
Cibus Nordic Real Estate AB	2020	Sweden	Real Estate Operating Company (REOC)	Fundamenta Real Estate AG
Corem Property Group AB	2020	Sweden	Real Estate Operating Company (REOC)	Brack Capital Properties NV
Ctp NV	2020	Netherlands	Real Estate Operating Company (REOC)	TAG Immobilien AG
Genova Property Group AB	2020	Sweden	Real Estate Operating Company (REOC)	Brinova Fastigheter AB
Heimar HF	2020	Iceland	Real Estate Operating Company (REOC)	Gateway Real Estate AG
K2A Knaust & Andersson Fastigheter AB	2020	Sweden	Real Estate Operating Company (REOC)	Accentro Real Estate AG
Nivika Fastigheter AB	2020	Sweden	Real Estate Operating Company (REOC)	Artea SA
NP3 Fastigheter AB	2020	Sweden	Real Estate Operating Company (REOC)	Echo Investment SA
Swiss Prime Site AG	2020	Switzerland	Real Estate Operating Company (REOC)	Grand City Properties SA
Aedas Homes SA	2021	Spain	Real Estate Operating Company (REOC)	Peach Property Group AG
Atenor SA	2021	Belgium	Real Estate Operating Company (REOC)	Fastighets AB Trianon
Besqab AB	2021	Sweden	Real Estate Operating Company (REOC)	Artea SA
Branicks Group AG	2021	Germany	Real Estate Operating Company (REOC)	KMC Properties ASA
Catena AB	2021	Sweden	Real Estate Operating Company (REOC)	Patrizia SE
Deutsche Wohnen SE	2021	Germany	Real Estate Operating Company (REOC)	Aroundtown SA
Dios Fastigheter AB	2021	Sweden	Real Estate Operating Company (REOC)	Globe Trade Center SA
Eastnine AB	2021	Sweden	Real Estate Operating Company (REOC)	Capelli SA
HEBA Fastighets AB	2021	Sweden	Real Estate Operating Company (REOC)	Bassac SA
Hufvudstaden AB	2021	Sweden	Real Estate Operating Company (REOC)	Allreal Holding AG
Compagnie Immobiliere de Belgique	2021	Belgium	Real Estate Operating Company (REOC)	VIB Vermoegen AG
Intershop Holding AG	2021	Switzerland	Real Estate Operating Company (REOC)	Hamborner Reit AG
Kojamo Oyj	2021	Finland	Real Estate Operating Company (REOC)	Nepi Rockcastle NV
Lar Espana Real Estate SOCIMI SA	2021	Spain	Real Estate Investment Trust (REIT)	Vitura SA

Green Bond Issuer	Year	Country of Origin	Company Type	Matched Control Firm
Logistea AB	2021	Sweden	Real Estate Operating Company (REOC)	Accentis NV
Neinor Homes SA	2021	Spain	Real Estate Operating Company (REOC)	Brack Capital Properties NV
Noval Property Real Estate Investment Co	2021	Greece	Real Estate Operating Company (REOC)	GIEAG Immobilien AG
Nyfosa AB	2021	Sweden	Real Estate Operating Company (REOC)	Metrovacesa SA
Platzer Fastigheter Holding AB	2021	Sweden	Real Estate Operating Company (REOC)	Lamda Development SA
Prodea Real Estate Investment Company SA	2021	Greece	Real Estate Investment Trust (REIT)	GMP Property SOCIMI SA
SunDell Estate Nyrt	2021	Hungary	Real Estate Operating Company (REOC)	Apodaca Inversiones Inmobiliarias SOCIMI SA
VGP NV	2021	Belgium	Real Estate Operating Company (REOC)	Victoria Eiendom AS
Vonovia SE	2021	Germany	Real Estate Operating Company (REOC)	Adomos SA
Wereldhave Belgium NV	2021	Belgium	Real Estate Investment Trust (REIT)	Castellana Properties Socimi SA