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Assessing the Additionality of Corporate Green Bonds in Europe: Impacts on Sustainable Investments and Environmental Outcomes

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Abstract

Green bonds have emerged as a significant financial instrument to support environmentally sustainable projects, particularly in areas such as renewable energy and climate change adaptation. These bonds are designed to raise capital for projects that promote sustainability and reduce greenhouse gas emissions. Despite their intended purpose, there are challenges in determining the financial additionality of green bonds, as many projects funded by these bonds could have secured financing through other means, thereby limiting their additional environmental benefits. Moreover, the extent to which green bonds achieve significant environmental impact remains a topic of ongoing debate. This thesis investigates the financial additionality and environmental impact of green bonds within existing labeling standards, assessing whether they genuinely promote new environmentally sustainable activities.

The study examines the impact of green bond issuance on GHG emissions among European companies, utilizing a Difference-in-Differences (DiD) model. The results indicate a general decrease in GHG emissions; however, the specific impact attributable to green bonds was not statistically significant. Additionally, a case study analysis using the Clean Development Mechanism (CDM) framework assessed the financial additionality of green bonds in funding offshore wind farm projects. The analysis revealed that green bonds were crucial for projects such as the Hohe See and Albatros Wind Farms, covering nearly 50% of the total investment, while their role in the Borkum Riffgrund 2 project was more modest.

The study reveals that green bonds typically have lower coupon rates than conventional bonds, a phenomenon referred to as "greenium." This can enhance the financial viability of green projects, potentially encouraging investment in initiatives that might not have been pursued otherwise. However, while specific projects demonstrate financial additionality under the CDM Framework, the overall necessity and environmental impact of green bonds remain uncertain. Further research is needed to fully understand the effectiveness of green bonds in delivering substantial environmental benefits.

Thesis Summary

Green bonds have become an important financial tool for supporting environmentally sustainable projects, such as renewable energy and climate change adaptation. They are specifically designed to raise capital for projects that aim to promote sustainability and reduce greenhouse gas emissions (International Capital Market Association, 2018; Flammer, 2021). However, there are challenges in determining the financial additionality of these bonds—whether the projects they fund would have proceeded without them. In many cases, green bonds finance projects that could have secured funding through other means (Bachelet, Becchetti, & Manfredonia, 2019; Bongaerts & Schoenmaker, 2020). Additionally, the effectiveness of green bonds in delivering substantial environmental impact remains a subject of debate (Bracking, 2024).

The fragmented and unclear landscape of labeling frameworks complicates the assessment of green bonds' true environmental impact. This challenge includes the difficulty in accurately measuring the specific reduction in greenhouse gas emissions attributable to green bond-funded projects (Berensmann, 2017; Samal & Tripathy, 2019; Flammer, 2021; Mao, 2023).

This thesis aims to evaluate the financial additionality and environmental impact of green bonds within existing labeling standards, exploring whether they genuinely increase environmentally sustainable activities. The lack of mandatory compliance with standards like the ICMA Green Bond Principles, the Climate Bond Standard, or the forthcoming EU Green Bond Standard (EU GBS) has led to criticisms of increased greenwashing risk and reduced market credibility (Baker McKenzie, 2019). The EU GBS, to be implemented in December 2024, aims to address these issues, but its voluntary nature may still lead to market fragmentation and regulatory uncertainty (Pyka, 2023).

We examined the impact of green bond issuance on GHG emissions among European companies using data from the London Stock Exchange, where bonds adhere to the ICMA Green Bond Principles. We aimed to address the following research question: "How do green bonds demonstrate their environmental impact, and how accurately can the specific reductions in greenhouse gas emissions from projects funded by green bonds be measured?". To this end, we used the Difference-in-Differences (DiD) model to compare changes in GHG intensity between companies that issued green bonds in 2020 and those that did not. Our findings showed a general decrease in GHG emissions, but the specific impact of green bonds was not statistically significant (Treatment coefficient decrease of 43.12, p-value of 0.704), offering no definitive evidence on the environmental benefits of green bonds (Mao, 2023; Flammer, 2021).

To investigate the second research question**,** "How do green bonds demonstrate financial additionality, and to what extent do they fund new environmentally friendly projects that would not have received financing otherwise?" we conducted a case study analysis. This analysis assessed the financial additionality of green bonds involved in the funding of two similar green projects at different scales, using the Clean Development Mechanism (CDM) framework

This framework assesses financial viability through the calculation of a deterministic internal rate of return (IRR), supplemented by sensitivity analysis. This IRR is then compared with a benchmark IRR of similar projects. Generally, projects with higher IRRs are more appealing as they indicate greater potential returns relative to their costs. If the calculated IRR is lower than those of comparable projects, it suggests that the project might be less attractive to investors and may, therefore, encounter difficulties in finding funding, indicating that the specific sustainable financing tool being used to fund it is financially additional (Carmichael, D. G., Lea, K. A., & Balatbat, M. C. A., 2015; Investopedia, n.d.).

We selected corporate European green bonds funding offshore wind farms due to the availability of extensive data and the importance of wind energy in Europe's renewable energy mix, which accounts for 15% of the total supply (European Environment Agency, 2024). Offshore wind farms are among the most expensive renewable energy sources, which can lead to difficulties in securing funding (IRENA,2023). We chose the Hohe See and Albatros wind farms by EnBW, along with the Borkum Riffgrund 3 Offshore Wind Farm developed by Ørsted, because these projects exhibit different levels of green bond involvement in their overall funding mix. These green bonds are evaluated by external reviewers both before and after issuance to ensure that the funds are used exclusively for environmentally sustainable projects. This approach excludes green bonds issued solely for refinancing existing projects, allowing us to focus our analysis on bonds that may be essential for funding new green projects.

For the Hohe See and Albatros wind farms, a sensitivity analysis of the Internal Rate of Return (IRR) was carried out using the Clean Development Mechanism (CDM) framework. The analysis revealed a Best Case Scenario IRR of 10.57% and a Worst Case Scenario IRR of 1.92%. Additionally, a statistical Monte Carlo simulation indicated a 57.38% probability that the IRR would fall below the benchmark threshold, which represents the minimum IRR retrieved from various research and consulting agencies for offshore wind farm projects. This suggests that the financial viability of the project may be lower than comparable offshore wind projects, potentially making it difficult to attract investors seeking returns. Consequently, the additionality of the green bonds under the CDM framework is probable, as

they are expected to be crucial in financing the project, covering 48.29% of the total initial investment cost.

For the Borkum Riffgrund 2 offshore wind farm, a sensitivity analysis using the CDM framework showed a Best Case Scenario IRR of 6.95% and a Worst Case Scenario IRR of 3.08%. These results indicate that even in the best case, the IRR falls short of the 8% benchmark threshold, suggesting the project's financial viability may be weaker than other similar projects. This may make it challenging to secure conventional funding without the support of the green bond, which covered 12.31% of the total initial investment cost, confirming the additionality of the green bond funding.

In comparison, the green bonds for the Hohe See and Albatros Wind Farms play a more vital role in the project's funding structure, covering nearly 50% of the total investment. This significant level of funding would likely be difficult to secure without green bonds, which attract investors with a focus on environmental sustainability. Furthermore, the broader range of potential IRRs, affected by forecasts of maximum and minimum production levels and energy prices, indicates a higher financial risk for the Hohe See and Albatros Wind Farms compared to the Borkum Riffgrund 2 offshore wind farm. This increased risk could deter conventional investors.

Additionally, we observed that green bonds issued by EnBW and Ørsted had lower coupon rates compared to their conventional bonds, a phenomenon known as "greenium". This indicates that investors are willing to accept lower returns for green bonds, as highlighted by Bachelet, Becchetti, and Manfredonia (2019) and Mao (2023). The greenium allows issuers to raise capital at reduced costs, improving the financial viability of green projects and potentially encouraging investment in initiatives that might not have been otherwise pursued.

While both projects demonstrate financial additionality under the CDM Framework, the issuance of green bonds for the Hohe See and Albatros Wind Farms appears particularly crucial. These bonds are likely vital for the project's execution and intended environmental impact, given the financial challenges and risks involved. However, it is important to recognize the limitations of our analysis, including uncertain IRR forecasts, potential inaccuracies in Monte Carlo simulations, potentially non-representative benchmark IRRs, and a narrow focus on financial metrics. Therefore, in addressing the research question, *"How do green bonds demonstrate financial additionality, and to what extent do they fund new environmentally friendly projects that would not have received financing otherwise?"*, we can only assert that the green bonds for these projects exhibit financial additionality within the scope of our assumptions and the CDM model's limitations. This may not represent the

general case for all green projects funded by green bonds, as noted in the literature and by Gabor Gyura (2020).

In conclusion, while our study demonstrates financial additionality for specific cases, the overall environmental impact and necessity of green bonds for initiating new projects remain unclear. We conclude that further research with comprehensive data and a broader scope is needed to fully understand the effectiveness of green bonds in delivering environmental benefits

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Chapter 1: Introduction

1.1 Background and Context

The Paris Agreement, established in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), signifies a global commitment to limit global warming to well below 2 degrees Celsius above pre-industrial levels. Achieving this objective necessitates that businesses and governments integrate Environmental, Social, and Governance (ESG) strategies into their long-term planning frameworks. Financing climate-friendly initiatives is a critical concern, with the International Energy Agency (IEA) estimating that approximately $55 trillion will be required by 2035 to facilitate the transition to a low-carbon economy (IEA, 2014;UNFCCC,2020).

Green bonds have become an essential financial tool for bridging the funding gap in environmentally sustainable projects. These bonds are specifically designed to generate capital for projects with environmental benefits, such as renewable energy, clean transportation, sustainable agriculture, and climate change adaptation initiatives. The proceeds from green bonds are intended to finance or refinance projects that contribute to reducing greenhouse gas emissions and promoting sustainability (International Capital Market Association, 2018; Flammer, 2021).

Despite their growing popularity and potential, green bonds face several critical issues that challenge their effectiveness in genuinely advancing environmentally sustainable activities.

Firstly, the absence of a universally accepted definition of what qualifies as a "green" bond leads to discrepancies in the standards and criteria used by different issuers and verifiers. This lack of consistency can result in "greenwashing," where bonds are promoted as environmentally beneficial without adequate verification or proof (Berensmann, 2017).

Secondly, it is challenging to determine whether projects funded by green bonds demonstrate financial additionality—meaning that the projects would not have occurred without this specific financing. In some cases, green bonds may finance projects that could have been funded through other means, thereby not providing additional environmental benefits (Bachelet, Becchetti, & Manfredonia, 2019). Furthermore, many green bonds are used primarily to refinance existing projects rather than to support new environmentally friendly initiatives, contradicting the intended purpose of these bonds to expand the number of green projects (Bongaerts & Schoenmaker, 2020).

Lastly, accurately gauging the true environmental impact of green bonds is highly challenging. Specifically, determining the exact reduction in greenhouse gas emissions

directly attributable to a particular green bond issuance involves complexities. This challenge arises from the difficulty in isolating and precisely measuring the specific emission reductions that can be solely attributed to the project funded by the bond (Samal & Tripathy, 2019; Flammer, 2021; Mao, 2023).

Previous research has examined various aspects of green bonds, including pricing differences, often referred to as the green bond premium. Studies such as those by MacAskill et al. (2020), Ehlers and Packer (2017), Hachenberg and Schiereck (2018), Gianfrate and Peri (2019), and Zerbib (2019) have explored whether green bonds consistently exhibit lower yields compared to conventional bonds. Zerbib (2019) found that green bonds issued between 2013 and 2017 generally had yields two basis points lower than comparable conventional bonds, a phenomenon attributed to high demand and limited supply. Fatica, Panzica, and Rancan (2021) highlighted that certified green bonds command a higher premium compared to self-labeled ones, with Pietsch and Salakhova (2022) emphasizing the crucial role of external reviews in establishing market trust and ensuring a significant greenium. However, there remains a substantial gap in understanding the actual allocation of proceeds and the tangible environmental impacts of green bond issuance, particularly within the corporate sector.

In light of this context, this thesis will focus on assessing the financial additionality and the actual extent of the environmental impact of green bonds. By investigating these underexplored areas, the study aims to address the core promise of green bonds—to increase the volume of environmentally friendly activities and ensure that these financial instruments fulfill their intended purpose effectively.

1.2 Problem Statement

It is challenging to determine whether projects financed by green bonds exhibit financial additionality, which means that these projects would not have occurred without the specific funding provided by the bonds. Additionally, there is concern that green bonds may be predominantly utilized for refinancing existing projects rather than for fostering new environmentally friendly initiatives, which could undermine their intended role in increasing the number of green projects (Bachelet, Becchetti, & Manfredonia, 2019; Bongaerts & Schoenmaker, 2020).

Moreover, assessing the environmental impact of green bonds—the additional reduction of greenhouse gas emissions directly attributed to these bonds—poses a complex problem. This complexity arises from the difficulty in isolating and accurately measuring the specific emission reductions associated with projects funded by green bonds (Samal & Tripathy, 2019; Flammer, 2021; Mao, 2023). The lack of clear understanding regarding the actual allocation

of proceeds and the tangible environmental benefits of green bond issuance, particularly in the corporate sector, further complicates the assessment of their effectiveness. These challenges underscore a significant gap in ensuring that green bonds achieve their primary objective of promoting genuinely sustainable environmental practices.

1.3 Relevance and Importance of the Study

Understanding the financial additionality and genuine environmental impact of green bonds is crucial for several reasons. Firstly, it provides insights into the effectiveness of green bonds in achieving sustainable development goals, helping policymakers and investors allocate resources more efficiently by determining if these bonds truly lead to new green investments.

Secondly, this research is relevant to the global challenge of financing the transition to a low-carbon economy, a key objective of agreements like the Paris Agreement (IEA, 2014).

Lastly, by assessing the risks of greenwashing and verifying the environmental impact of green bond issuances, this study can enhance the credibility and attractiveness of green bonds, encouraging greater investment in sustainable projects and supporting global environmental sustainability efforts.

1.4 Objectives of the Study and Research Questions

We will aim to answer two main questions through this thesis:

1. **How do green bonds demonstrate their environmental impact, and how accurately can the specific reductions in greenhouse gas emissions from projects funded by green bonds be measured?**

The goal of this research is to determine whether the issuance of green bonds significantly impacts the environmental metrics of the companies issuing them. Specifically, it aims to assess if these companies show measurable improvements in metrics such as greenhouse gas emissions reduction and overall environmental performance as a result of funding projects through green bonds.

2. **How do green bonds demonstrate financial additionality, and to what extent do they fund new environmentally friendly projects that would not have received financing otherwise?**

This question investigates the concept of financial additionality by examining whether green bonds generate new investments beyond what traditional financing methods would attract. It aims to determine if green bonds provide a unique source of capital for projects, particularly in the realm of renewable energy. Understanding this aspect is vital for assessing the role of green bonds in promoting sustainable development.

1.5 Methodology Overview

The research will involve a comprehensive examination of existing literature, focusing on the regulatory and economic landscape of green bonds in Europe. A rigorous analysis of the regulatory environment will be undertaken to understand the labeling and certifications of green bonds, with the aim of assessing their impact on the funding of green projects and the resulting environmental outcomes. Additionally, the literature will be reviewed to explore the evolution of the green bond market and pricing dynamics, such as the greenium, to evaluate their significance in green project funding and environmental results.

Furthermore, we will investigate the previous research done on the environmental impact of green bonds issuance and we will investigate the concept of additionality, including its definitions and the existing research and empirical analyses. To gain a thorough understanding of the subject, we have consulted with a Senior Research and Advocacy Officer at Finance Watch and a Wealth Management Actor at Rothschild & Co, thus incorporating diverse stakeholder perspectives.

An empirical analysis will be conducted using databases obtained from the London Stock Exchange. This analysis aims to assess the potential positive impact of green bond issuance on European firms' sustainability metrics, particularly focusing on the firms' greenhouse gas (GHG) intensity. The objective is to determine if empirical evidence can be found to address the question: How do green bonds demonstrate emission additionality, and how accurately can the specific reductions in greenhouse gas emissions resulting from green bond-financed projects be quantified?

To enhance our analysis, we will carry out case studies focusing on the financial additionality of bonds used to fund two major green projects in Europe: the Hohe See and Albatros offshore wind farms by EnBW, and the Borkum Riffgrund 2 project by Ørsted. This multi-method approach aims to provide a thorough understanding of the role green bonds play in financing high-cost green projects and their effectiveness as sustainable finance instruments in delivering environmental impact.

Chapter 2: Literature Review

2.1 Labeling Frameworks for Green Bonds in Europe

2.1.1 Overview of European Green Bond Labeling Frameworks

The Green Bond Principles (GBP) and the Climate Bond Standard (CBS) are the most widely used standards globally for labeling green bonds. In 2024, the European Union will introduce the EU Green Bond Standard, set to be implemented by the end of the year. These standards aim to ensure the integrity and consistency of green bonds:

Green Bond Principles (GBP): In 2014, the International Capital Market Association (ICMA) introduced the Green Bond Principles (GBP) as voluntary guidelines for green bond issuance. Developed collaboratively by market participants such as banks, issuers, and investors, these principles aim to enhance transparency, disclosure, and reporting in the green bond market. Widely recognized and adopted, the GBP supports the issuance of bonds for environmentally sustainable projects, emphasizing transparency and integrity in the disclosed information. This allows investors to track the use of proceeds and the environmental impact of funded projects, forming the basis for most other green bond standards (ICMA, 2018; ICMA, 2021).

The Climate Bond Standard (CBS): The Climate Bonds Initiative (CBI), a not-for-profit organization, issued the first Climate Bond Standard (CBS) in 2012. To enhance coherence and credibility in the green bond market, the CBS aligned with the Green Bond Principles (GBP) in 2014. The CBS provides a robust certification framework focused on specific criteria aligned with the Paris Agreement's objectives, ensuring financed projects contribute to climate mitigation and adaptation. It is particularly stringent and requires independent verification pre- and post-issuance, enhancing its credibility among investors and issuers (Climate Bonds Initiative, 2024; Climate Bonds Initiative, n.d.-a).

EU Green Bond Standard (EuGB): The EuGB, which will be introduced in December 2024, aims to enhance the credibility and transparency of green bonds within the EU. It aligns with the EU Taxonomy Regulation, ensuring that the proceeds from green bonds are used for activities meeting rigorous environmental criteria. The EuGB standard is expected to play a significant role in the green bond market by reducing greenwashing risks and improving investor confidence (Council of the EU, 2023).

Issuers are not required to adhere to specific standards such as the ICMA Green Bond Principles (GBP), the Climate Bond Standard (CBS), or the EU Green Bond Standard (EuGB) to classify their bonds as green. This voluntary nature has been criticized for increasing the

risk of greenwashing, where bonds are marketed as green without delivering real environmental benefits, thus undermining market credibility (Baker McKenzie, 2019). Additionally, the voluntary approach leads to market fragmentation with varied definitions of green bonds, reducing investor confidence and increasing transaction costs (Berensmann, 2017).

The European green bond market has predominantly been self-regulated through private governance entities, notably the International Capital Market Association (ICMA) and the Climate Bonds Initiative (CBI). These privately established standards have faced criticism for their inadequate enforcement mechanisms, a concern that became particularly pronounced following the 2008 financial crisis. The European Green Bond Standard (EU GBS) seeks to address these issues by providing a framework aimed at enhancing legitimacy and standardizing practices to mitigate risks such as greenwashing (Pyka, 2023).

In most cases, green bonds undergo formal third-party certification, making them generally more credible regarding their environmental benefits (Hyun, Park, & Tian, 2021). These evaluations are typically conducted by research institutes or consulting agencies like CICERO, Oekom, Deloitte, EY, and Vigeo Eiris. While these reviewers base their assessments on the GBP, they focus on defining green projects. However, a conflict of interest may arise since these reviewers are paid by the issuer. Additionally, the lack of a predefined standard for what qualifies as "green" leads to variability in assessments (Berensmann, 2017).

As we delve into each standard and principle, it becomes evident that each faces criticism regarding loopholes, concerns about greenwashing, and shortcomings in demonstrating additionality and accurately assessing their true environmental impact.

2.1.2 The Green Bond Principles (GBP)

The Green Bond Principles (GBPs) are foundational guidelines for issuing green bonds and were established in 2014 by a consortium of investment banks: Bank of America Merrill Lynch, Citi, Crédit Agricole Corporate and Investment Bank, JPMorgan Chase, BNP Paribas, Daiwa, Deutsche Bank, Goldman Sachs, HSBC, Mizuho Securities, Morgan Stanley, Rabobank and SEB (Climate Bonds Initiative, 2018). These principles, updated annually outline categories for eligible projects and mandate transparency in the use of proceeds. The GBPs' key components include: i) the use of proceeds; ii) the process for project evaluation and selection; iii) the management of proceeds; and iv) reporting requirements. These principles have achieved broad market acceptance and serve as the basis for most other green bond standards (ICMA, 2018; Climate Bonds Initiative, 2018).

i) Use of proceeds: To qualify a bond as a green bond under the GBP, the issuer must ensure that the proceeds are exclusively allocated to eligible green projects that provide clear environmental benefits. These projects can include renewable energy, energy efficiency, pollution prevention, sustainable management of natural resources, biodiversity conservation, clean transportation, sustainable water and wastewater management, climate change adaptation, circular economy initiatives, and green buildings. Issuers are required to disclose their process for project evaluation and selection, manage the proceeds in a transparent manner, and regularly report on the use of proceeds and the environmental impact of the funded projects. External reviews are recommended, though not mandatory, for verifying a green bond's alignment with the Green Bond Principles (GBP). Such reviews help enhance investor and stakeholder confidence in the bond's environmental credentials (ICMA, 2021;ICMA, 2024).

(ii) The process for project evaluation and selection: Issuers must develop a clear and comprehensive process for evaluating and selecting eligible green projects. This involves clearly communicating their environmental objectives to investors. The process includes outlining the criteria for project eligibility and ensuring alignment with GBP categories. Additionally, issuers must identify and manage potential social and environmental risks, detailing mitigation strategies. It is also important for issuers to position project information within their broader sustainability strategy, disclosing any relevant taxonomies or certifications used. By establishing a robust evaluation and selection process, issuers ensure transparency and investor confidence in the environmental integrity of the funded projects (ICMA, 2021;ICMA, 2024).

(iii) The management of proceeds: Proceeds from the green bond must be managed transparently. This involves tracking the proceeds by crediting them to a sub-account or sub-portfolio to ensure they are only used for eligible projects. Issuers must periodically adjust the balance of proceeds to reflect project allocations accurately. They should disclose the intended temporary placement of any unallocated proceeds. To enhance transparency and credibility, issuers are encouraged to use external auditors to verify the allocation of funds, although this is not mandatory (ICMA, 2021;ICMA, 2024).

(iv) The reporting: Reporting is an essential component for maintaining transparency in the use of green bond proceeds. Issuers are required to provide regular reports on the use of proceeds, which include detailed information on the projects financed, the amounts allocated, and their environmental impacts. These reports are often supplemented by external reviews or audits, though not mandatory for alignment with the GBP, to provide additional verification and enhance transparency (ICMA, 2021;ICMA, 2024).

Even with established principles, disputes can arise about which projects qualify as environmentally beneficial or whether the proceeds from green bonds are being properly used for the advertised projects. The ICMA Green Bond Principles do not specify which uses of proceeds qualify as green. Each issuer may define what constitutes an eligible green project, with definitions varying widely in specificity and detail. This approach provides issuers with considerable flexibility, leaving investors to rely on post-issuance reports to understand how their investments were utilized (Baker McKenzie, 2019).

Bartels, Holland, and Metzgen (2015) identify four typical scenarios where issuers could be criticized for greenwashing:

1. Skepticism over whether the funds are actually invested in genuinely sustainable projects.

2. Concerns that the fundamental operations of the issuers, such as those in the oil and gas sectors, might be viewed as inherently unsustainable.

3. Insufficient tracking and management of funds, leading to doubts about their specific use for intended green projects.

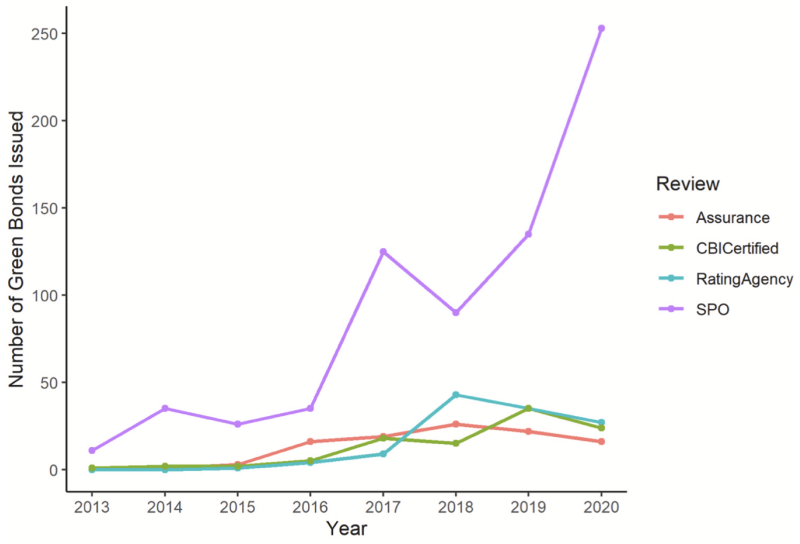
4. Difficulty in verifying that the funds have been used effectively to achieve environmental goals and produce a tangible positive impact on the environment.

To address these concerns about green credibility, green bond issuers are increasingly seeking independent reviews and certifications from third parties. The market for these voluntary green reviews and certification schemes is growing rapidly, with 80% of green debt sold undergoing external review in 2019, despite external reviews not being mandatory (Allman & Lock, 2024).

Pietsch and Salakhova (2022) describe certified green bonds as those subjected to an external review process to verify their compliance with established environmental standards. This process may include obtaining certifications, second-party opinions, or verifications. The bonds' credibility is determined by their alignment with frameworks such as the International Capital Market Association (ICMA) Green Bond Principles.

These third-party reviews, also called Green Bond External Reviews (GBERs), include Second-Party Opinions (SPOs), Third-Party Assurances (TPA), and Green Bond Ratings (GBR) (Ehlers & Packer, 2017).

Figure 1 - Global Corporate Green Bond Issuance Count by Review Type



Source: Allman, E., & Lock, B. (2024). External reviews and green bond credibility. *Journal of Climate Finance*, 7, 100036. https://doi.org/10.1016/j.jclimf.2024.100036

SPOs are prevalent, with expert consultants evaluating the environmental credibility of green bonds against the GBP. In 2018, nearly 90% of green bonds had external reviews, with corporate issuers increasingly obtaining them, reaching 86% in 2020 (CBI, 2018; Allman & Lock, 2024). However, SPOs mainly provide forward-looking assessments and do not verify the actual use of funds after issuance, with variability in the transparency and consistency of these evaluations (Bartels & Holland, 2015). Unlike other GBERs, second-party opinion providers do not necessarily adhere to a particular set of criteria or a consistent review

methodology, and this lack of standardization complicates comparisons across different reviews from various providers (Chen & Long, 2023).

Despite these shortcomings, the usage of SPOs has seen significant growth. Conversely, third-party assurances, typically provided by major accounting firms such as Deloitte and KPMG, account for a smaller segment of the market (7.7%) but rigorously check whether green bonds align with internationally recognized guidelines like the GBP (Allman & Lock, 2024).

Credit-rating agencies assume a crucial role in promoting green bond standards because they monitor and verify green bonds continuously. To an extent, rating agencies have aligned their assessments because they base their evaluations on the GBPs; however, it would be helpful for issuers and investors if rating agencies aligned their methodologies and criteria more closely (Berensmann, 2017). For instance, it is important to note that compared to Moody's, S&P does not provide an ex-post assessment of the use of proceeds. Overall, almost 10% of corporate green bonds are rated (Allman & Lock, 2024).

While external reviews and certifications provide some assurance of green bond credibility, they do not guarantee the genuine allocation of proceeds to intended green projects due to variability in review frameworks and methodologies. Therefore, it is crucial to critically assess the frameworks used by external reviewers to better evaluate the environmental impact and authenticity of green bonds.

Besides GBERs, issuers may also seek certification from the Climate Bonds Initiative (CBI), which certifies bonds that meet specific environmental standards. CBI certification involves pre- and post-issuance verification by approved verifiers to ensure that the bond meets the environmental standards set by the CBI.

2.1.3 The Climate Bond Standard (CBS)

The Climate Bonds Initiative (CBI) has rolled out the Climate Bond International Standards and Certification Scheme, a comprehensive process that involves both pre- and post-issuance requirements to certify green bonds. Launched in 2012, this voluntary system aims to solidify the credibility of green bonds that contribute to tackling climate change, aligning with the objective to keep global warming within 1.5°C above pre-industrial levels. To date, the scheme has authenticated over USD 300 billion of Use of Proceeds Green Bonds (Climate Bonds Initiative, 2024).

Developed in partnership with technical experts and industry leaders, and coordinated by an advisory board of institutional investors and environmental NGOs, the CBI standards do more than comply with the Green Bond Principles (GBPs). They offer more intricate, sector-

specific criteria focused on climate policies. Fundamental aspects of the Climate Bonds Standard include standardized rules for project eligibility on a sectoral level, stringent transparency mandates, and comprehensive external reviews (Climate Bonds Initiative, 2024)

The most recent update to the Standard has broadened its coverage to include general-purpose assets and entities. Certification under this updated Standard ensures that green bonds adhere to the specified criteria, which are transparently crafted based on scientific research and assessed by a network of Climate Bonds Approved Verifiers. An international, independent Climate Bonds Standard Board oversees these processes, ensuring rigorous governance as it reports back to the Trustees of the Climate Bonds Initiative (Climate Bonds Initiative, 2024).

The Certification Scheme offers two levels of certification for green bonds:

1. Aligned: This level indicates that the Climate Mitigation Performance Targets align with the Sector Criteria at the time of certification and continue to do so until the targets represent net zero emissions or the year 2050, whichever is sooner (Climate Bonds Initiative, 2024).

2. Transition: This level applies to targets that do not initially align with the Sector Criteria but are expected to align by December 31, 2030, and thereafter until they represent net zero emissions or the year 2050, whichever is sooner (Climate Bonds Initiative, 2024).

Besides the other Green Bond Evaluation and Ratings (GBERs), the Climate Bonds Initiative (CBI) certification plays the role of another identification and certification scheme, as it is also aligned with the Green Bond Principles (GBP) (Ehlers & Packer, 2017).

The certification process is rigorous and science-based, ensuring transparency and external verification by Climate Bonds Approved Verifiers before and after certification. In 2019, 17% of green bonds were certified by the CBI and historically, from 2013 to 2020, about 8% of corporate green bonds achieved CBI certification, with primary certifiers being ISS-Oekom, Sustainalytics, and Ernst & Young (E&Y) (Allman & Lock, 2024).

Despite its structured approach, the Climate Bonds Standard has faced criticism. While the Climate Bonds Initiative (CBI) certification ensures transparency and mandates external verification by approved verifiers both before and after certification, a notable limitation is that it does not necessarily require continuous monitoring and verification over time. For investors planning to maintain their investments over multiple years, the absence of mandated regular re-certification could be a concern. Continuous monitoring and periodic re-certification would provide investors with reassurance that the environmental benefits of the

bond persist over its duration and that the project maintains its alignment with green standards (Allman & Lock, 2024).

The CBI also uses an issuer-pay model, where issuers pay for certification. This model might incentivize GBERs to give favorable reviews to retain clients, potentially compromising integrity. Additionally, some GBERs are subsidiaries of credit rating agencies, creating potential conflicts of interest if they provide both green bond reviews and credit ratings (Allman & Lock, 2024).

A further limitation of the CBI standard is its binary classification system, which labels bonds strictly as either green or not green. This system lacks granularity and fails to capture the depth of information that could benefit investors, such as the specific environmental contributions of a bond or the sustainability of its long-term ecological impacts. A more nuanced, graded evaluation system could offer a more detailed spectrum of green credentials (Ehlers & Packer, 2017).

Lastly, a major critique concerns its complexity and the high costs associated with obtaining certification, which can be prohibitive for smaller issuers (Berensmann, 2017). The cost of obtaining certification under the Climate Bonds Standard varies depending on several factors, including the size of the bond and the fees charged by external verifiers. The Climate Bonds

The Climate Bonds Initiative charges 0.001% of the bond size for pre-issuance certification, plus a verification fee that varies by the approved verifier. As a result, the total cost for certification can be substantial, especially for larger bonds, as it includes both the CBI's certification fee and the verifier's fee (Climate Bonds Initiative, n.d.-b).

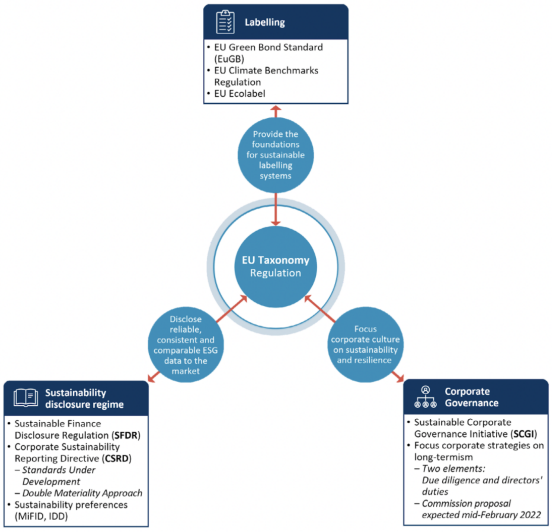
2.1.4 The European Green Bond Standard Regulation (EuGBS)

The European Green Bond Standard (EU GBS) is part of the European Taxonomy, aimed at creating a standardized sustainable labeling system for green bonds. The Green Deal promotes investments in sustainable projects by integrating ESG criteria into financial decision-making, fostering green bonds, sustainable investment funds, and sustainable infrastructure (Kappelhoff, 2022).

Effective from July 2020, the EU Taxonomy Regulation establishes a classification system for evaluating green bond proceeds for the EU green label. Eligible activities must significantly contribute to environmental goals, avoid causing significant harm, adhere to safeguards, and meet technical criteria (European Commission, Joint Research Centre, n.d.; Kappelhoff, 2022).

In January 2023, the European Commission, European Parliament, and Council introduced the European Green Bond Regulation to establish a high-quality standard for green bonds. While compliance is voluntary, entities can adopt the EuGB standard to obtain the EU green label, requiring alignment with the EU Taxonomy, transparency, external review, and oversight by the European Securities Markets Authority (European Parliament & Council of the European Union, 2023; Koch, 2023).

Figure 2 - Integration of Green Bonds in the EU Taxonomy Regulation



source: Kappelhoff, P. (2022, April 4). EU taxonomy and the future of reporting. Harvard Law School Forum on Corporate Governance. https://corpgov.law.harvard.edu/2022/04/04/eu-taxonomy-and-the-future-of-reporting/

The Council has adopted regulations establishing a European Green Bond Standard, setting uniform requirements for bond issuers who wish to use the "European Green Bond" or "EuGB" designation for their environmentally sustainable bonds. The regulation, adopted by the European Parliament on October 5, 2023, entered into force on December 21, 2023, and will apply from December 21, 2024, after a one-year transitional period (European Parliament, & Council of the European Union, 2023).

The proceeds from European Green Bonds will have to be fully allocated to economic activities that are aligned with the EU Taxonomy's sustainability objectives. These objectives include:

1. Climate change mitigation
2. Climate change adaptation
3. Sustainable use and protection of water and marine resources

4. Transition to a circular economy
5. Pollution prevention and control
6. Protection and restoration of biodiversity and ecosystems

Before the maturity of a European green bond, the proceeds (minus issuance costs) must be fully allocated to specific categories such as fixed assets, capital expenditures, operating expenditures, financial assets, and assets and expenditures of households. These allocations must adhere to criteria outlined in Article 3 of the EU Taxonomy Regulation, ensuring they contribute substantially to one or more environmental objectives, do no significant harm to other objectives, comply with minimum safeguards, and meet technical screening criteria (TSC). Additionally, issuers can allocate up to 15% of the proceeds to activities that do not yet have developed technical screening criteria, provided these activities meet the general criteria of the EU Taxonomy and do no significant harm to environmental objectives (European Commission, 2023).

Both pre-issuance and post-issuance reviews are mandated by the European Green Bond Standard (EuGB) to receive the EU green label:

- **Pre-Issuance Review**: Before a European Green Bond is issued, external reviewers must verify the EuGB factsheet. This factsheet details how the bond proceeds will be used and ensures alignment with the EU Taxonomy.
- **Post-Issuance Review**: After the proceeds have been fully allocated, external reviewers must assess and confirm that the funds were used as specified in the initial review. This involves reviewing annual allocation reports and impact reports to ensure ongoing compliance with the standards.

External reviewers are essential to the European Green Bond Standard (EuGB), ensuring compliance with the Taxonomy Regulation and maintaining the integrity of green bonds. These reviewers provide independent assessments both before and after bond issuance to verify that the bond proceeds are used as intended and align with sustainability criteria (European Commission, 2023). The European Securities and Markets Authority (ESMA) supervises these external reviewers, requiring all to be registered with ESMA, which evaluates their qualifications and processes to ensure regulatory standards are met. This supervision extends to both EU and non-EU reviewers, provided non-EU reviewers meet equivalence standards set by the European Commission. The regulation also establishes a registration system and oversight framework for external reviewers of European Green Bonds (European Commission, 2023).

The primary criticism of the EU Green Bond Standard (EU GBS) is its voluntary nature, which may not adequately address market fragmentation and could lead to competition between EU and private standards, resulting in regulatory uncertainty. This standard might diminish the role of private standards without offering a superior alternative, potentially disrupting the market and deterring investors due to the confusion and overlap between different regulatory frameworks. Consequently, this could hinder market unification and perpetuate existing fragmentation (Pyka, 2023). This is particularly problematic as the seemingly straightforward product is perceived as overly complex by many issuers due to the multiplicity of criteria, the overlapping roles of various market players, and the growing array of rules, disclosure reporting guidelines, and standards (Baker McKenzie, 2019;Koch, 2023).

Additionally, the EU GBS has been criticized for lacking private enforcement mechanisms, leaving bondholders vulnerable to "green defaults" when issuers fail to meet their environmental commitments. The standard prioritizes administrative enforcement, offering no direct legal recourse for bondholders in cases of non-compliance. This reliance on public enforcement over private mechanisms is seen as a significant drawback, potentially undermining investor confidence. Furthermore, the EU GBS does not include provisions to address green defaults or mechanisms to withdraw the green label or manage non-compliance after issuance (Pyka, 2023).

To enhance the effectiveness of the EU GBS in the European bond market, Michal Pyka proposes several measures:

1. The EU GBS should serve as an exclusive standard for all green bond issuances within the EU market, including those currently based on private standards. All green bonds issued in the EU should be classified as ‘European green bonds’.

2. Private standards for green bond issuance should be reconciled with the EU GBS to be applicable within the EU market. This reconciliation should involve mandatory alignment of green bonds with the EU Taxonomy, the introduction of external review obligations, and supervision by the European Securities and Markets Authority (ESMA) and national supervisory authorities. There should be no discrepancies between European green bonds regarding these public obligations.

3. Private standards aligned with the EU GBS should incorporate effective private enforcement mechanisms to ensure issuers and holders of European green bonds meet their obligations, including protection against ‘green defaults’. Additionally, these standards should be allowed to introduce further private law obligations.

4. The scope of the EU GBS should be expanded to include the issuance of social bonds and sustainable bonds.

An interview with a Senior Research and Advocacy Officer at Finance Watch highlighted additional concerns regarding the upcoming EU Green Bonds Standard Regulation, set to be implemented in December 2024. The regulation may pose challenges for smaller projects and non-EU companies, as they might struggle to meet the stringent standards and reporting requirements. This could limit the regulation's effectiveness in promoting green investments in less developed regions and among smaller enterprises. There is a risk that the EU GBS may primarily benefit large companies that already have no difficulty funding their green projects, merely certifying their green bonds without fostering additionality or supporting smaller companies in need of financing (Annex 2).

2.2 Economic Landscape of Green Bonds

2.2.1 Evolution of the Green Bond Market

Green bonds have evolved significantly since their inception. The first green bond was issued by the World Bank in 2008, in collaboration with SEB (a leading Nordic financial services group), to fund climate-friendly projects. This bond established the blueprint for the modern green bond market by defining criteria for eligible projects, incorporating CICERO as a second opinion provider, and making impact reporting an essential component of the process. It also introduced a new model of collaboration among investors, banks, development agencies, and scientists (World Bank, 2019).

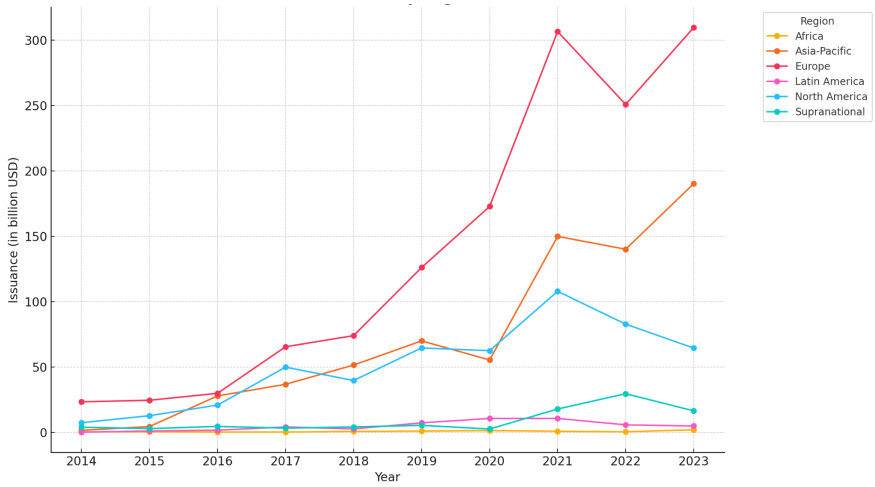
This initiative set a precedent for transparency and use of proceeds, integral to green bonds today. The market expanded rapidly, driven by the dual appeal of financial returns and environmental impact, and was bolstered by the introduction of the Green Bond Principles by the International Capital Market Association (ICMA) (World Economic Forum, 2023). Additionally, the Paris Agreement in 2015 further propelled the green bond market by underscoring the need for private capital in climate action. This period saw the emergence of national guidelines in countries like China and India, tailored to local contexts (World Economic Forum, 2023).

In an interview conducted to better understand the various sustainable finance tools available to investors, a Wealth Management Actor at Rothschild & Co highlighted the increasing importance of sustainable finance in the wealth management sector. They noted, "As investors become more aware of the environmental and social impact of their investments, there will be a growing demand for sustainable investment options." This trend is expected to result in the

creation of more innovative financial products and enhanced transparency and reporting standards to ensure accountability in sustainable investing (Interview, Annex 1).

In 2023, the issuance of green, social, and sustainability (GSS) bonds reached a total of USD 871.6 billion, underscoring the expanding significance and magnitude of the sustainable debt market. Green bonds dominated this segment with 2,743 issuances globally, amounting to USD 587.6 billion, which represents approximately 67.5% of the total GSS bond issuance (Climate Bonds Initiative, 2024). Moreover, the GSSSB (Green, Social, Sustainability, and Sustainability-linked Bonds) market accounted for approximately 14% of the total global bond market issuance. Within this segment, green bonds constituted a significant portion, representing about 8.5% of the total bond market (S&P Global, 2024).

Figure 3 – Annual Green Bond Issuance by Region in Billions of USD (2014-2023)



Source: *Data for the graph was sourced from the Climate Bonds Initiative (2023). Market Data. Retrieved from https://www.climatebonds.net/market/data/#country-map. The graph was created using Python to visualize the distribution of green bond amount issuance per region per year and its evolution.*

The biggest players in the global green bond market by region are Europe, Asia, and North America. The green bond market has seen remarkable growth across various regions from 2014 to 2023:

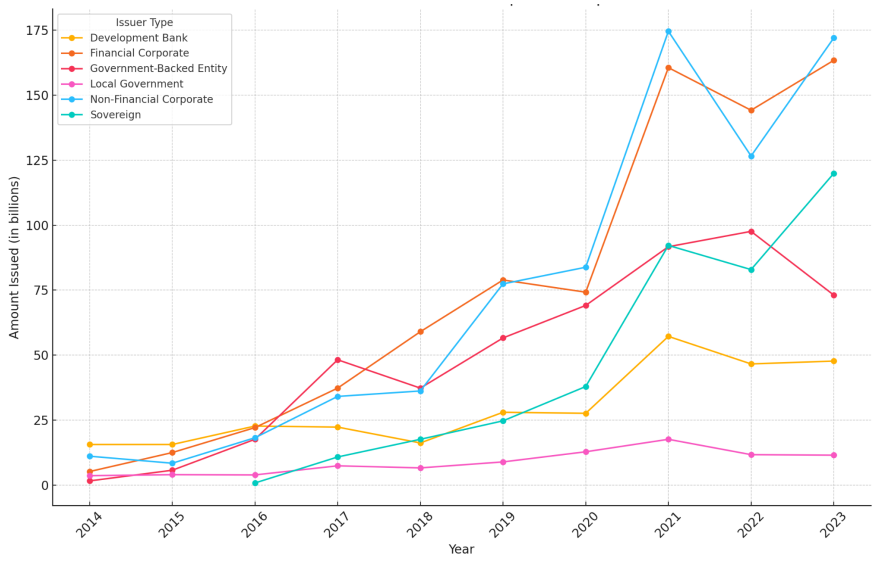
- **Europe**: As the leading market in terms of green bonds, Europe has experienced substantial growth, with an increase of 1,223.08% from 2014 to 2023. The total amount issued in Europe reached $309.6 billion in 2023, highlighting its dominant position in green finance. Europe's strong regulatory frameworks and supportive policies have been pivotal in propelling this growth (European Environment Agency, 2023).

- **Asia-Pacific**: This region follows closely with an astonishing increase of 11,787.50% over the same period. By 2023, the issuance in Asia-Pacific soared to $190.2 billion.

Several factors contribute to this exponential growth. Key among them is the strong regulatory push and policy support within major economies like China. The Chinese government has been particularly proactive, implementing stringent regulations and aligning with international standards to attract global investors. China's updated green taxonomy, which includes the principle of "do no significant harm," has been integral in bridging the gap with international markets and fostering investor confidence (S&P Global Market Intelligence, 2023)

- **North-America**: Between 2014 and 2023, green bond issuance in North America experienced notable growth. Starting from a relatively modest level in 2014, issuance had substantially increased to $64.5 billion by 2023, representing a remarkable growth rate of approximately 771.62% over the nine-year period. However, from 2021 to 2023, green bond issuance in North America decreased by 40.22%. This decline can be attributed to several factors. The issuance of green, social, sustainable, and sustainability-linked bonds (GSSSB) in the U.S. has faced political challenges, likely to persist, especially in an election year, creating an unfavorable environment for green bond issuance. Additionally, the persistent high-interest-rate environment has been a significant disincentive for issuers, as higher borrowing costs make it less attractive for entities to issue new bonds, including green bonds (S&P Global Market Intelligence, 2023).

Figure 4 – Yearly Distribution of Global Green Bond Issuance by Issuer Type (2014-2023)



Source: *Data for the graph was sourced from the Climate Bonds Initiative (2023). Market Data. Retrieved from Climate Bonds Market Data. The graph was generated using Python to visualize the distribution of green bond amount issuance per issuer type per year and its evolution.*

This graphic reveals several key trends and highlights the diversity within the global green bond market:

1. **Development Banks**: The development banks have shown a steady growth in green bond issuance, reflecting their continuous commitment to funding sustainable development projects. Starting from an issuance of 15.6 billion in 2014, they increased their issuance to 47.7 billion in 2023. Examples of development banks include the European Investment Bank (EIB), the Inter-American Development Bank (IDB), and the International Finance Corporation (IFC) (Organisation for Economic Co-operation and Development, 2024).

2. **Financial Corporates**: Financial corporates have experienced rapid growth in green bond issuance, particularly notable from 2017 onwards. This trend indicates a strong interest from the financial sector in financing green initiatives. The issuance by financial corporate green bond issuances grew from 5.2 billion in 2014 to a significant 163.4 billion in 2023, representing 27.81% of the total green bond issuance in 2023.

3. **Non-Financial Corporates**: Non-financial corporates have seen significant growth in green bond issuance, especially from 2017. This growth highlights their corporate sustainability goals and market confidence in green investments. The issuance by non-financial corporate green bonds issuances grew from 77.4 billion in 2019 to 172.0 billion in 2023, representing 29.27% of the total issuance in 2023.

4. **Government-Backed Entities**: Government-backed entities have shown fluctuations in their green bond issuance, with periods of significant increases likely influenced by regulatory support and policy changes. Their issuance grew from a modest 1.6 billion in 2014 to 73.1 billion in 2023.

5. **Local government:** Local governments have demonstrated modest growth in green bond issuance, indicating their ongoing but limited engagement in green bond markets for regional and municipal projects. The issuance by local governments increased from 3.6 billion in 2014 to 11.5 billion in 2023.

6. **Sovereign issuers:** Sovereign issuers have shown a rising contribution to the green bond market in recent years, reflecting governmental efforts to support large-scale green projects. Their issuance increased from 24.7 billion in 2019 to 119.9 billion in 2023. This rise indicates a growing governmental focus on financing environmental initiatives through green bonds.

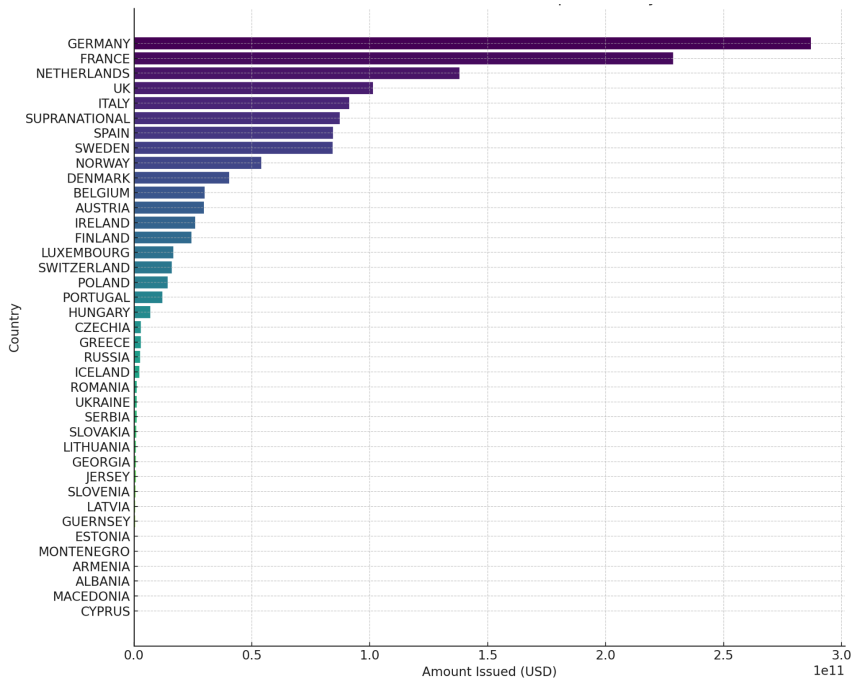
In 2023, financial corporates issued 27.81% of the total green bonds, while non-financial corporates accounted for 29.27%. Combined, the percentage of corporate green bonds issued

in 2023 is approximately 57.08%. This significant proportion underscores the critical role that corporations play in the green bond market, contributing over half of the total funds raised through these sustainable financing instruments.

2.2.2 An In-Depth Analysis of the European Corporate Green Bond Market

Between 2014 and 2022, the proportion of green bonds issued within the EU rose dramatically from 0.6% to 8.9% of total bonds issued. This surge reflects a growing appetite for financing sustainable investments, spurred by initiatives such as the European Green Deal and the pressing need to support the transition to a low-carbon, green economy. These efforts have been pivotal in driving investor interest and commitment towards environmentally sustainable projects (European Environment Agency, 2023).

Figure 5 – Distribution of Green Bond Issuance by European country (2014-2023)



Source: *Data for the graph was sourced from the Climate Bonds Initiative (2023). Market Data. Retrieved from Climate Bonds Market Data. The graph was generated using Python to visualize the distribution of green bond amount issuance per issuer type per year.*

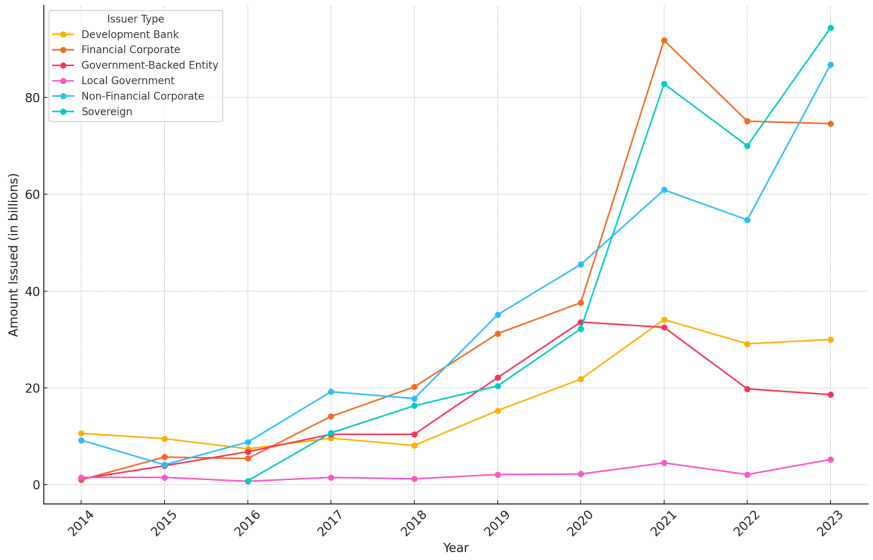
Germany and France have become leading issuers of green bonds, a result of a combination of economic, policy, and market factors that have positioned them at the forefront of the sustainable finance movement.

Germany's ambition to become a global hub for sustainable finance is supported by the government's comprehensive Sustainable Finance Strategy. This includes policies such as CO2 pricing and the promotion of investments in renewable energy, highlighting the country's

commitment to fostering a sustainable financial ecosystem (German Federal Government, 2021).

Similarly, France has adopted an extensive approach to advancing sustainable finance, as evidenced by the efforts of the Autorité des marchés financiers (AMF). Since 2018, the AMF has prioritized sustainable finance, establishing a dedicated Strategy and Sustainable Finance Unit to oversee and promote related initiatives (Autorité des marchés financiers, 2023).

Figure 6 – Yearly Distribution of Green Bond Issuance by Issuer Type in Europe (2014-2023)



Source: *Data for the graph was sourced from the Climate Bonds Initiative (2023). Market Data. Retrieved from Climate Bonds Market Data. The graph was generated using Python to visualize the distribution of green bond amount issuance per issuer type per year.*

This graphic reveals several key trends and highlights the diversity within the European green bond market:

- **Development Banks:** The development banks in Europe have shown a steady growth in green bond issuance, reflecting their continuous commitment to funding sustainable development projects. Starting from an issuance of 10.6 billion in 2014, they increased their issuance to 30.0 billion in 2023. This steady increase indicates the persistent role of development banks in supporting environmental initiatives across Europe. It is important to note that European development banks accounted for approximately 62.9% of the total global issuance by development banks in 2023.

  This underscores the crucial role of European development banks in the sustainable transition. For example, the European Investment Bank (EIB) raised €14.6 billion in green bonds and sustainability bonds in 2023. The EIB's issuance attracts investors

who may not typically invest in European projects but contribute indirectly to Europe's sustainable initiatives by investing in EIB bonds (European Investment Bank, 2023).

- **Financial Corporate:** Financial corporates have experienced rapid growth in green bond issuance, particularly notable from 2017 onwards. This trend indicates a strong interest from the financial sector in financing green initiatives. The issuance by financial corporate green bonds issuances grew from 1.0 billion in 2014 to a significant 74.6 billion in 2023.

- **Government-Backed Entity:** Government-backed entities have shown fluctuations in their green bond issuance, with periods of significant increases likely influenced by regulatory support and policy changes. Their issuance grew from a modest 1.2 billion in 2014 to 18.6 billion in 2023. These fluctuations suggest that government policies and support play a crucial role in the issuance dynamics of this sector.

- **Local Government:** Local governments have demonstrated modest growth in green bond issuance, indicating their ongoing but limited engagement in green bond markets for regional and municipal projects. The issuance by local governments increased from 1.5 billion in 2014 to 5.2 billion in 2023. This growth, though modest, underscores the gradual adoption of green bonds at regional and municipal levels especially since European local governments make up for half of this specific type of issuance globally.

- **Non-financial corporate:** Non-financial corporate Green Bonds in Europe have shown remarkable growth in green bond issuance, particularly from 2017 onwards. In 2014, the issuance was almost negligible, but it has risen dramatically, reaching 75.1 billion in 2023.

- **Sovereign:** Sovereign issuers have shown a rising contribution to the green bond market in recent years, reflecting governmental efforts to support large-scale green projects. From a modest start, sovereign bond issuance has increased steadily, reaching 18.6 billion in 2023.

The corporate green bonds (combining financial and non-financial corporate bonds) made up 52.13% of the total green bond issuance in Europe in 2023, with financial corporates accounting for 24.10% and non-financial corporates for 28.04%. This breakdown highlights the significant role of private corporations in the green bond market.

Considering corporate green bonds, their role appears to be less significant in the European market compared to the global market. Corporate green bonds make up 52.13% of the European market, whereas they account for 57.08% of the global market. Additionally, public type bonds (Development Bank, Government-Backed Entity, Local Government, and Sovereign) play a more crucial role in the European market, accounting for 47.87% of the overall issuance. In comparison, the percentage of public type bonds in the global market is only 42.92% of the total green bond issuance in 2023.

The relatively higher proportion of public-type bonds in Europe reflects the strong commitment and determination of European institutions and governments towards sustainable finance. This active involvement in promoting and financing green projects indicates a clear prioritization of regional policy goals, supportive regulatory environments, and a significant emphasis on public sector-led initiatives compared to the global market.

We will thus focus our analysis on European corporate green bonds, as the efforts in this market segment are less well-defined.

2.2.3 Pricing Dynamics and the Greenium Effect

Green bonds adhering to the Green Bond Principles (GBP) often command a premium at issuance, known as a "greenium". This indicates that investors are willing to pay a higher price for securities funding environmentally beneficial projects. This greenium reflects the added value investors place on the positive environmental impact and the perceived lower risk of these bonds due to their adherence to GBP standards. Despite this initial premium, green bonds tend to perform similarly to conventional bonds in the secondary market, showing comparable yields and price stability over time (Ehlers & Packer, 2017).

The literature on green bonds has largely focused on two strands:

1. **Green Bond Premium**: The first strand examines whether there is a systematic pricing difference between conventional bonds and similar green bonds, known as the green bond premium. This literature generally documents mixed evidence, with more recent studies pointing to the existence of a negative green premium meaning that green bonds often have lower yields compared to similar conventional bonds. Studies by MacAskill, S., Roca, E., Liu, B., Stewart, R. A., & Sahin, O. (2021), Ehlers and

Packer (2017), Gianfrate and Peri (2019) and Zerbib (2019) contribute to this debate. A recent study of green bonds issued between 2013 and 2017 finds that the yields of green bonds are on average two basis points lower than those of comparable conventional bonds (Zerbib, 2019). One common explanation for this yield difference is the high demand and limited supply of green bonds. However, the presence and extent of any pricing difference is still debated in empirical studies (e.g., Larcker and Watts, 2020).

2. **Issuer Advantages**: The second strand explores the advantages for issuers when a bond is labeled as green. Results show that issuers benefit from lower interest rates, with green bonds on average having interest rates 18 basis points (0.18%) lower than conventional bonds. This advantage is achieved by both corporate and non-corporate entities such as municipalities and governmental agencies. These findings suggest that, even accounting for the extra costs needed to obtain green certification, green bonds are more cost-effective for issuers, reducing the cost of debt financing (Gianfrate and Peri, 2019).

In a recent interview with a Senior Research and Advocacy Officer at Finance Watch, the officer emphasized the concept of the "greenium" in the context of green bonds. He described the greenium as the lower interest rates issuers can enjoy due to the higher attractiveness of green bonds to sustainable investors. This attractiveness, resulting from the alignment of green bonds with GBP, enhances their appeal and leads to cost savings for issuers compared to conventional bonds. This perspective helps confirm the existence of the greenium, adding practical insight to the ongoing debate in the literature (Annex 2).

In addition to these findings, Fatica, Panzica, and Rancan (2019) report that certified green bonds enjoy a larger premium compared to self-labeled green bonds. Pietsch and Salakhova (2022) further assert that only green bonds with external reviews (certified green bonds) trade at a statistically significant greenium, underscoring the importance of certification in enhancing market trust and preference for green bonds. This supports the notion that external reviews are crucial in this emerging market.

The presence of a greenium, particularly for certified bonds, lowers the cost of debt financing for issuers according to the majority of studies reviewed. It is therefore crucial to consider this factor when assessing the role of green bonds in funding projects that might not have been otherwise financed, as it has a significant impact on financial additionality.

2.3 Previous Research on the Environmental Impacts of Green Bonds

In her article, "Green Bond Market Practices: Exploring the Moral ‘Balance’ of Environmental and Financial Values," Sarah Bracking explores the intricacies of the green bond market using digital ethnography, content analysis, and expert interviews. She finds that while green bonds aim to integrate environmental and financial values, they often struggle to prove their environmental benefits. The market's practices are influenced by a combination of ethical goals and financial motivations, with standards and certifications playing a key role in validating these bonds. However, the effectiveness of green bonds in achieving substantial environmental impact is still debated.

In "Decoding Corporate Green Bonds," Mao (2023) specifically investigates the impact of green bonds on greenhouse gas (GHG) emissions. The study employs rigorous methods like the Difference-in-Differences (DID) and event-study DID (stacked DID) analyses to measure the causal impact of green bond issuance on firm-level GHG intensity. By comparing firms that issued green bonds with a control group that did not, the study isolates the effect of green bonds from other variables. The findings indicate that green bonds often do not lead to additional GHG reductions beyond those achieved by traditional bonds.

Conversely, Flammer (2021) provides evidence that green bonds can effectively signal a company's commitment to environmental sustainability. Her research shows that firms issuing certified green bonds tend to see improvements in environmental ratings and reductions in CO2 emissions post-issuance, more so than those issuing non-certified green bonds. Flammer used data from Bloomberg's database (2013-2018) and the DID approach to compare the outcomes for firms issuing green bonds with a matched sample of firms issuing non-green bonds, thereby isolating the impact of green bond issuance.

In summary, while green bonds have the potential to demonstrate a commitment to environmental sustainability and improve related performance metrics, their actual environmental benefits are still contested. Further research and the development of more stringent standards and certifications could provide clearer insights into their effectiveness in promoting meaningful environmental change.

2.4 The Concept of Additionality in Sustainable Finance

2.4.1 The definitions

Additionality fundamentally assesses causation, determining whether a proposed activity is caused by a policy intervention. According to the Oxford Dictionary, "additional" means "added, extra, or supplementary to what is already present or available." The complexity of additionality lies in establishing the counterfactual—what would have happened without the intervention. Therefore, additionality testing should be tailored to the type of activity proposed, such as projects, programs, or policy instruments (Michaelowa, Hermwille, Obergassel, & Butzengeiger, 2019).

In an interview with a Senior Research and Advocacy Officer at Finance Watch, it was highlighted that additionality can be defined in various ways depending on the objective. It might involve creating an impact that wouldn't have happened with traditional funding or making investments that wouldn't occur without green bonds. The officer noted the complexity in proving whether green bonds truly catalyzed changes that would not have occurred with conventional financing (Annex 2).

The OECD evaluates the concept of additionality through two primary definitions and dimensions: financial additionality and development additionality.

1. **Financial Additionality:** Financial additionality occurs when finance is mobilized, leading to an investment that would not have materialized otherwise. According to the OECD, an official transaction is considered financially additional if it is extended to an entity that cannot obtain finance from local or international private capital markets on similar terms or in similar quantities without official support. Furthermore, it is financially additional if it mobilizes investment from the private sector that would not have been invested otherwise (OECD, 2021).

2. **Development Additionality:** Development additionality pertains to the development impacts resulting from an investment that otherwise would not have occurred. The OECD Development Assistance Committee (DAC) defines impact as the extent to which an intervention has generated, or is expected to generate, significant positive or negative, intended or unintended, higher-level effects. This definition underscores the necessity of establishing a causal relationship between the intervention and the resulting development outcomes (OECD, 2021).

These definitions highlight the importance of assessing both financial mobilization and development impacts to ensure that interventions lead to genuine additional benefits that would not have been realized without such interventions.

2.4.2 Financial additionality

In the context of green bonds, financial additionality occurs when a green project receives funding that it would not have secured without the issuance of the green bond.

Bachelet, Becchetti, and Manfredonia (2019) emphasize that green bonds have the potential to attract a broader spectrum of investors, particularly those focused on sustainability. This influx of capital increases the total funds available for green projects, facilitating the initiation of initiatives aimed at climate change mitigation and adaptation that might not have been possible without such financial support.

However, ensuring that green bonds finance projects that would not have occurred without this specific funding is challenging. Some projects may receive green bond financing even though they would have proceeded without it, thereby not providing additional environmental benefits (Bachelet, Becchetti, & Manfredonia, 2019).

Bachelet, Becchetti, Manfredonia (2019), and Mao (2023) highlight that the increased demand from environmentally conscious investors leads to green bonds having lower yields compared to conventional bonds, a phenomenon referred to as the "greenium." This occurs because investors are willing to accept lower returns in exchange for supporting environmentally beneficial projects. The greenium significantly contributes to financial additionality by enhancing the financial attractiveness and viability of green projects through lower yields and more favorable financing terms.

Pietsch and Salakhova (2022) contend that the presence of a greenium is inconsistent and tends to be more pronounced for green bonds that are verified. They advocate for more stringent standards and transparent reporting practices to fully harness the potential of green bonds in channeling capital towards projects with a genuine positive environmental impact. As a result, the financial additionality of green bonds largely depends on the effectiveness of labeling frameworks and certifications.

In evaluating the purported financial additionality of sustainable finance efforts, Carter, Van de Sijpe, and Calel (2021) argue that establishing quantitative evidence is challenging due to the complexities in reliably measuring the impact of interventions. As a result, qualitative evidence, such as surveys of project sponsors and investors, is often utilized. However, this type of evidence is susceptible to biases and cannot always be deemed definitive. Their study

concludes that, while traditional methods for assessing additionality are fraught with biases and difficulties, adopting a probabilistic approach and integrating qualitative evidence can offer a more nuanced and potentially accurate assessment.

In the context of carbon credits under the Clean Development Mechanism (CDM) framework established by the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), financial additionality is crucial for demonstrating that a project would not be financially viable without the revenue from carbon credits. This requirement ensures that only projects needing the financial support from carbon credits are accepted as CDM projects. Typically, financial additionality is demonstrated through a deterministic internal rate of return (IRR), benchmark analysis and a sensitivity analysis. However, this traditional approach has its limitations as it fails to account for variability or uncertainty in cash flows. By incorporating uncertainty into cash flows, the IRR can be treated as a random variable, resulting in a probability distribution. This probabilistic approach offers a more nuanced assessment by identifying the likelihood that a project meets the additionality criteria (Carmichael, D. G., Lea, K. A., & Balatbat, M. C. A., 2015).

Gabor Gyura (2020) reports that a survey conducted among green bond issuers indicates that many green bonds do not lead to additional green projects. Most respondents stated that the projects financed by green bonds would have proceeded even without their issuance.

It is crucial to consider in our study that many green bonds are primarily utilized for refinancing existing projects rather than funding new environmentally friendly initiatives. This practice contradicts the intended purpose of these bonds, which is to expand the number of green projects (Bongaerts & Schoenmaker, 2020).

Chapter 3: Empirical Analysis of the Environmental Impact of Green Bonds in Europe

3.1 Objective, Methodology and Empirical Framework of the Analysis

The objective of this empirical analysis is to assess the environmental impact of green bond issuance and to determine whether it has a significant and sustainable effect on companies, particularly regarding their greenhouse gas (GHG) intensity. GHG intensity is a metric that normalizes a company's greenhouse gas emissions by its revenue, enabling standardized comparisons of environmental efficiency across companies of different sizes and industries. It is calculated as the total GHG emissions (Scope 1 and Scope 2) per unit of revenue (e.g., per million dollars of revenue). This metric provides a clear indication of a company's efficiency in generating revenue while minimizing its greenhouse gas emissions.

Null Hypothesis: Issuing green bonds does not correlate with a measurable change in GHG emissions compared to non-issuers.

Alternative Hypothesis: Issuing green bonds is associated with a reduction in GHG emissions.

Methodology: The Difference-in-Differences (DiD) Model

To rigorously assess the impact of green bonds, we will utilize the Difference-in-Differences (DiD) model. This statistical method enables us to compare changes in GHG intensity before and after 2020 between a treatment group of European companies that issued a green bond in 2020 and a control group of European companies that did not issue any green bonds that year.

The DiD model is a quasi-experimental design used to estimate causal relationships. It controls for confounding variables by examining the differences in outcomes over time between the treatment and control groups. The basic form of the DiD model can be represented as:

$$Y_{it} = \alpha + \beta_1 Treatment_i + \beta_2 Post_t + \beta_3 (Treatment_i \, x \, Post_t) + \epsilon_{it}$$

Where:

- Y_{it} is the outcome variable (GHG intensity) for company i at time t.
- $Treatment_i$ is a binary indicator that equals 1 if the company issued a green bond in 2020 and 0 otherwise.

- $Post_t$ is a binary indicator that equals 1 for the years 2020 and beyond, and 0 for the years prior to 2020.
- $Treatment_i \, x \, Post_t$ is the interaction term that captures the differential effect of the treatment post-2020.
- ϵ_{it} is the error term.

The coefficient β_3 on the interaction term ($Treatment_i \, x \, Post_t$) represents the DiD estimator. It measures the average treatment effect on the treated (ATT), indicating the causal impact of green bond issuance on the outcome variables.

The DiD model offers several significant advantages for this analysis:

1. Control for Unobserved Heterogeneity: The DiD model helps control for unobserved heterogeneity by comparing changes in outcomes over time between the treatment and control groups. This allows us to account for factors that may influence GHG intensity but are not directly observable or measurable (Angrist & Pischke, 2008).

2. Robustness to Time-Invariant Confounders: The DiD approach controls for confounders that do not vary over time, which is crucial in analyzing the impact of green bonds since many factors influencing environmental performance remain stable over short periods (Imbens & Wooldridge, 2009).

3. Flexibility in Application: The DiD model can be easily adapted to different contexts and datasets, making it suitable for examining both GHG intensity and ESG scores. This flexibility allows us to tailor the analysis to the specific characteristics of the data and research questions (Angrist & Pischke, 2008).

For this empirical analysis, we selected a peer group of 20 European companies that issued a green bond in 2020. This group serves as the treatment group for our Difference-in-Differences (DiD) analysis. The companies were chosen to represent a diverse range of industries, ensuring a comprehensive assessment of the impact of green bonds across various sectors.

Table 1– Panel of 20 European Companies Issuing Green Bonds in 2020 and Their Respective Industries/Sectors

Rank	Company Name	Industry/Sector
1	Mercedes-Benz Group AG	Automobiles & Auto Parts
2	Volvo AB	Automobiles & Auto Parts
3	Volkswagen AG	Automobiles & Auto Parts
4	BNP Paribas SA	Banking Services
5	Banco Santander SA	Banking Services
6	Raiffeisen Bank International AG	Banking Services
7	ING Groep NV	Banking Services
8	Kbc Groep NV	Banking Services
9	Iberdrola SA	Energy
10	Engie SA	Energy
11	E On Se	Energy
12	Edp SA	Energy
13	Oersted A/S	Energy
14	Terna Rete Elettrica Nazionale SpA	Energy
15	EVN AG	Energy
16	Snam SpA	Energy
17	Fabege AB	Real Estate
18	Atrium Ljungberg AB	Real Estate
19	Telia Company AB	Telecommunications
20	BASF SE	Chemicals

We aimed to include a diverse representation of sectors within the panel group. The availability of data allowed us to select companies from various industries, which enhances the robustness of the statistical models we will use. This diversity helps to ensure that our findings are not biased toward a specific industry and can be more broadly applicable. Specifically, 40% of the companies are in the Energy sector, 25% are in the Banking Services sector, and 15% are in the Automobiles & Auto Parts sector. Additionally, 10% of the companies are in the Real Estate sector, and the Chemicals and Telecommunications sectors each represent 5% of the companies.

By choosing these 20 companies, we ensure that our analysis captures the effects of green bond issuance across a broad spectrum of industries and business models. This approach allows for a more nuanced understanding of how green bonds influence environmental performance and sustainability metrics such as GHG intensity. The diverse industry representation also helps control for industry-specific factors that might affect the outcomes, providing a more robust and generalized assessment of the additionality of green bonds.

We have a diverse control group consisting of 628 companies from various industries. A large and diverse control group increases the statistical power of the analysis, making the DiD model more likely to detect significant differences in the outcomes between the treatment and control groups, if they exist.

3.2 Database on European Corporate Green Bond Issuance

3.2.1 Source and Metrics

The dataset on European Corporate Green Bond Issuance, sourced from the London Stock Exchange Group (LSEG), offers a comprehensive overview of green bonds issued by various corporations from 2018 to 2023. This database covers both the financial and non-financial corporate Green Bonds. Each green bond listed on the London Stock Exchange (LSEG) aligns with the Green Bond Principles (GBP) established by the International Capital Market Association (ICMA). This ensures transparency and integrity, with clear disclosure of the use of proceeds and ongoing reporting requirements. Many bonds also receive certification from the Climate Bonds Initiative (CBI), further validating their environmental benefits and compliance with high standards (London Stock Exchange, n.d.).

Key Metrics of the Database:

1. Issuer: This variable denotes the name of the organization issuing the green bond, providing insight into the entities participating in green financing.

2. Code: A unique identifier assigned to each issuer, facilitating the differentiation and tracking of bonds.

3. Maturity Date: This field specifies the date on which the bond matures, indicating the time horizon for the bond's financial commitments.

4. Currency: The currency in which the bond is issued, providing context for the bond's financial and economic environment.

5. ESG Bond Type: This field specifies the type of Environmental, Social, and Governance (ESG) bond, with many being aligned with the Climate Bonds Initiative (CBI) standards, ensuring their environmental credibility.

6. ISIN: The International Securities Identification Number, a globally recognized unique code that identifies the bond, facilitating international tracking and trading.

7. Issue Date: The date on which the bond was issued, marking the commencement of the bond's financial and environmental commitments.

8. Issued Amount (USD): The initial amount raised through the bond issuance, expressed in U.S. dollars, reflecting the financial scale of the green initiative.

9. TRBC Sector: The Thomson Reuters Business Classification sector, categorizing the issuer's industry sector and aiding in sector-specific analysis.

10. Yield: The bond's yield, representing the return on investment for bondholders.

3.2.2 Data Cleaning

We cleaned the data by excluding dual-currency bonds, bonds with incomplete data for the variables studied, and hybrid bonds. Additionally, labeled bonds such as sustainability-linked or social bonds are not part of the sample. These stringent selection criteria were applied to create a reliable database, facilitating effective merging with other databases and enabling robust statistical analysis.

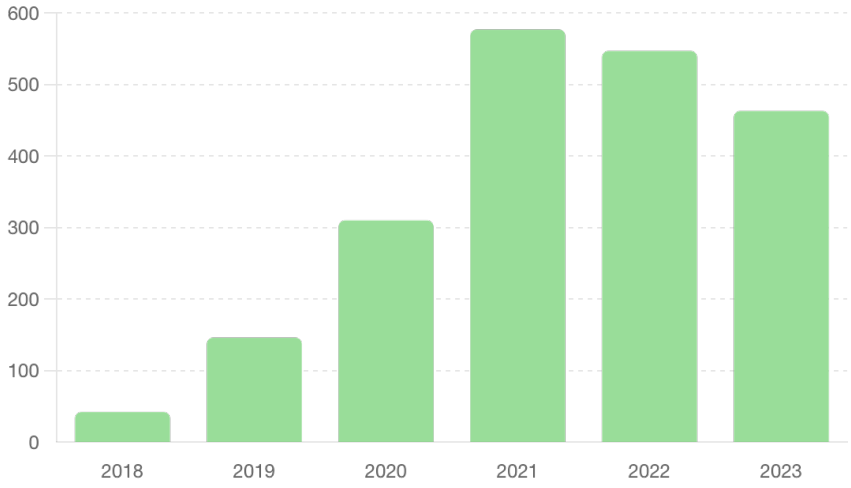
3.2.3 Descriptive Statistics and Exploratory Data Analysis (EDA)

From 2018 to 2023, a total of 2,081 bonds were issued, as reported in this cleaned database. The mean issued amount was €372.81 million, while the median issued amount was €271.93 million. The standard deviation, indicating the dispersion of issued amounts, was €360.21 million. The issued amounts ranged from a minimum of €0.31 million to a maximum of €1,631.55 million. The highest issuance of €1,631.55 million was by ING Groep NV in 2018, and the lowest issuance of €0.31 million was by BKS Bank AG in 2019.

The average yield from 2018 to 2023 was 4.28%, with a median yield of 3.89%. The standard deviation of the yields was 1.56%, indicating variation. The yields ranged from a minimum of 0.26% to a maximum of 21.70%. The bond with the lowest yield of 0.26% was issued by Iberdrola Finanzas SA in 2022 in the Electric Utilities (NEC) sector. The bond with the highest yield of 21.70% was issued by DTEK Renewables Finance BV in 2019 in the Fossil Fuel Electric Utilities sector.

We will now closely examine the issuance trends over the period 2018-2023. Following this, we will study the distribution of the frameworks used for labeling these green bonds within this specific database. Lastly, we will analyze the trends in issued amounts, focusing on the trends over time and the roles of different sectors and companies in these issues.

Figure 7 – Trends in the Number of Corporate Green Bonds Issued in the European Market Database (EU)



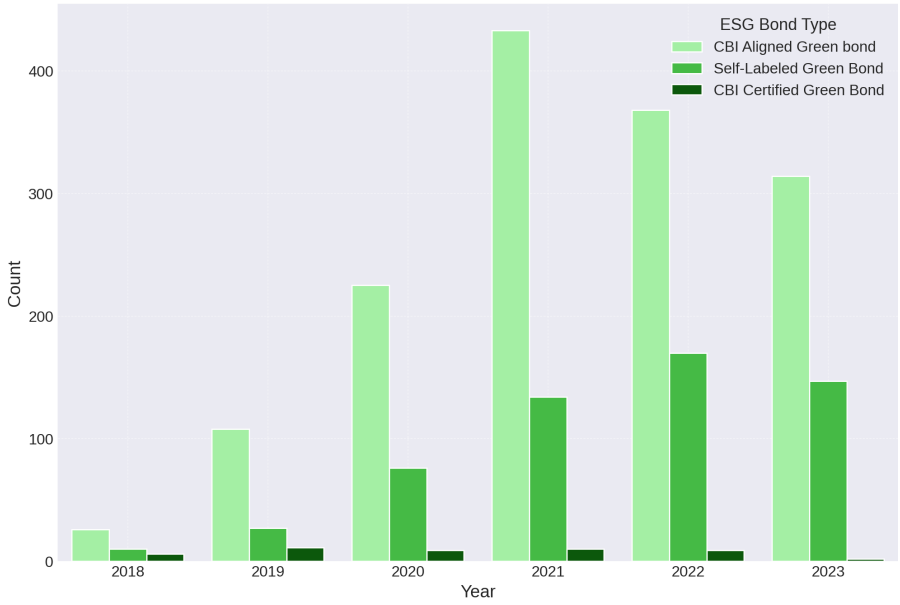
Source: *The dataset on European Corporate Green Bond Issuance, sourced from the London Stock Exchange Group (LSEG). This graph was created using Python*

The overall trend from 2018 to 2023 shows strong and sustained growth in the issuance of green bonds, based solely on the database at our disposal. This data indicates a 995.24% increase in issuances over the six-year period, primarily driven by the years from 2018 to 2021. However, it's important to note that this is not a comprehensive view of the entire European green bond market.

From 2021 to 2022, there was a slight decrease of 4.55% in the number of issuances, suggesting a potential temporary slowdown or market saturation. The decline continued from 2022 to 2023, with a decrease of 15.60%, possibly due to market adjustments or external factors affecting the issuance of green bonds.

As reported by the Financial Times, the decline in green bond issuance in late 2022 was influenced by rising interest rates, inflationary pressures, and economic uncertainty. These conditions led to increased investor caution and reduced activity in the market. Additionally, geopolitical tensions and shifts in monetary policies further impacted investor confidence, creating a challenging environment for green bond issuances during that period. However, this analysis is limited to the data available in our database and does not represent the entire market.

Figure 8 – Distribution of ESG Bond Types Regarding Labeling and Framework Used in Relation to the Number of Issuances in the European Market Database (EU)



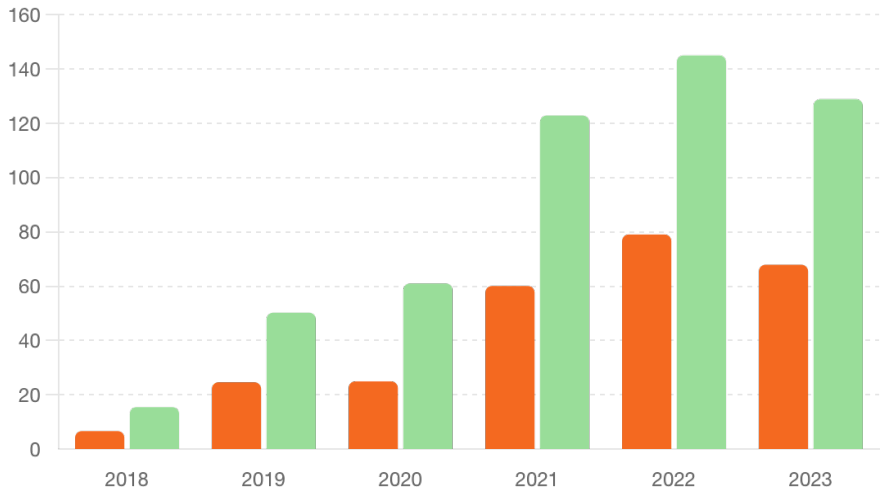
Source: *The dataset on European Corporate Green Bond Issuance, sourced from the London Stock Exchange Group (LSEG). This graph was created using Python*

CBI Aligned Green Bonds consistently dominate the ESG bond market in terms of the number of issuances each year, according to the data available in our database, ranging from 65.71% to 76.37% of total issuances. These bonds adhere to the standards and guidelines set by the Climate Bonds Initiative (CBI). However, it is important to note that this analysis is based solely on the available dataset and may not reflect the entire market.

In contrast, CBI Certified Green Bonds, which undergo a more rigorous certification process, remain a smaller fraction of the total issuances, ranging from 0.26% to 10.00% each year. Self-Labeled Green Bonds have seen a steady increase, peaking in 2022 and 2023, and representing 24.29% to 33.73% of total issuances.

The cost and time associated with achieving CBI certification, due to the required verification and compliance processes, make it challenging for smaller issuers to participate. The Climate Bonds Standard, despite its structured approach, has faced criticism for its complexity and high certification costs, which can be prohibitive for smaller issuers (Berensmann, 2017). The detailed reporting and third-party verification requirements, while promoting transparency, are resource-intensive, potentially limiting the participation of smaller entities (Chiesa & Barua, 2019). Some scholars argue that the stringent criteria may exclude projects that could significantly contribute to climate goals (Ehlers & Packer, 2017). These factors help explain the higher percentage of CBI aligned green bonds compared to certified bonds, as reflected in the data available in our database, not representing the entire market.

Figure 9 – Amount of Money Issued through Financial Corporate Green Bonds Compared to the Total Amount Issued by Corporate Green Bonds in the European Market Database (EU) in Billions of USD

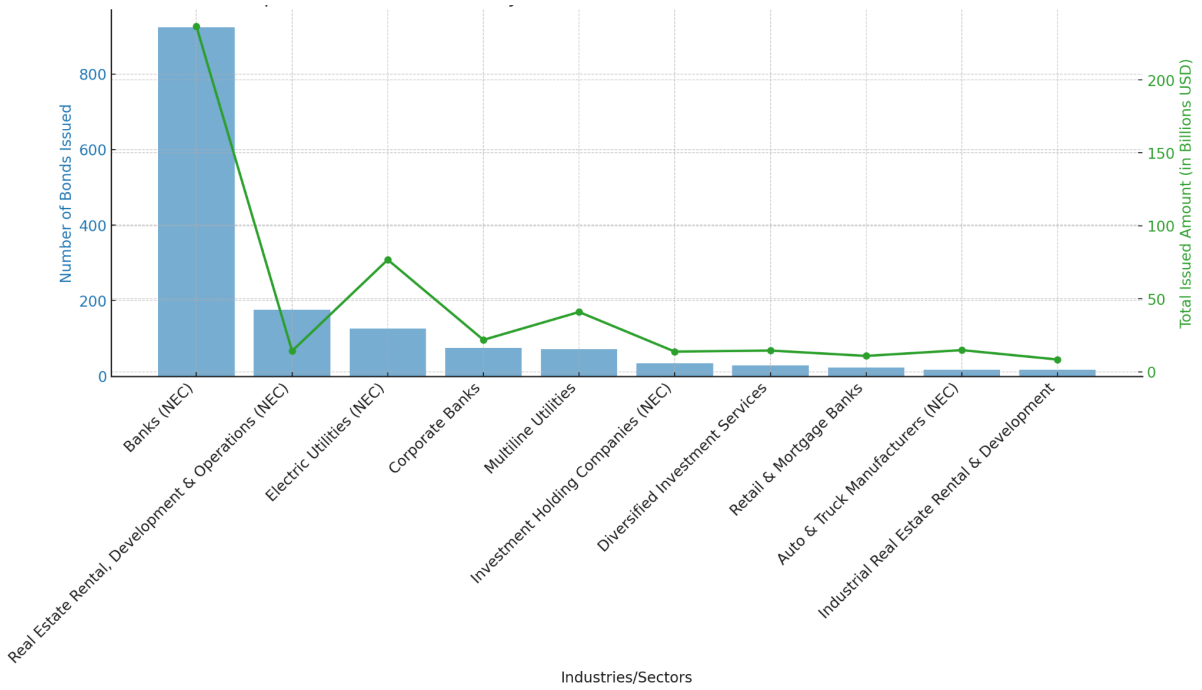


Source: *The dataset on European Corporate Green Bond Issuance, sourced from the London Stock Exchange Group (LSEG). This graph was created using Python*

According to the data available in our database, the Financial sector has consistently contributed a significant portion of the total green bond issuance in Europe. This sector's share has ranged from 25.7% to 64.8% of the total issuance over the years, underscoring its pivotal role in driving the green bond market and supporting sustainable development initiatives. However, it is essential to note that these figures reflect only the database's scope and may not represent the entire European market.

The contribution of financial corporate green bonds has been particularly notable since 2020, maintaining a substantial share in subsequent years. This trend indicates the growing involvement of financial institutions in promoting environmentally sustainable projects. Nonetheless, this analysis is limited to the data available and does not provide a comprehensive view of the entire market's dynamics.

Figure 10 – Top 10 Industries/Sectors by Number of Corporate Green Bonds Issued and Total Amount Issued in Billions of USD (Top 10 by Number of Bonds Issued) Based on the European Market Database



Source: *The dataset on European Corporate Green Bond Issuance, sourced from the London Stock Exchange Group (LSEG). This graph was created using Python*

The chart highlights the dominance of the banking sector, which issued the highest number of bonds, significantly outpacing other industries. Banks and Corporate Banks issued the highest number of bonds, with a combined total of 999 bonds out of the 2,067 bonds issued across all industries, accounting for almost half of the green bond issuances in our database. When including Investment Holding Companies, which issued 34 bonds, the financial sector's total rises to 1,033 bonds. This highlights the significant role of financial corporate green bonds in the overall issuance landscape.

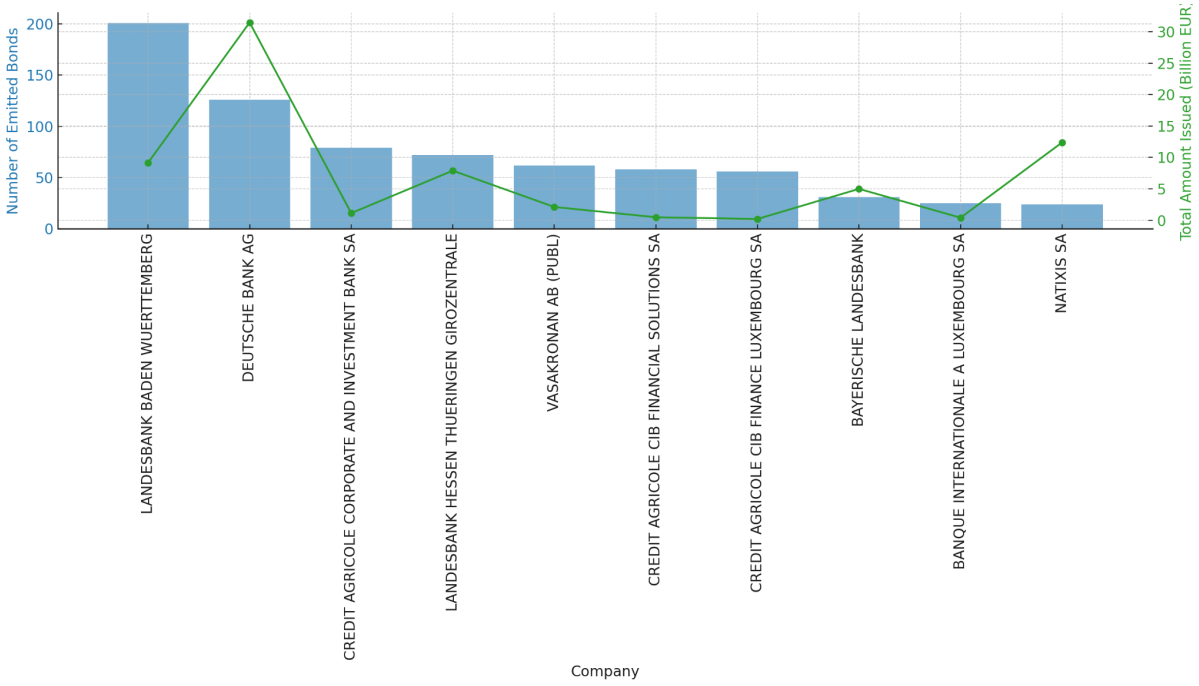
Despite fewer bonds, sectors like Electric Utilities and Multiline Utilities show substantial total issuance amounts, indicating larger average bond sizes. The diverse range of industries in the top 10 reflects a broad adoption of bond issuance strategies. This trend underscores the critical role of both financial and non-financial sectors in the green bond market.

We can observe that the industry with the highest number of bonds issued does not have the highest total amount issued, indicating that the bonds may vary significantly in size.

Conversely, some industries with fewer bonds have higher total issuance amounts, suggesting they might be issuing larger bonds in terms of value. Industries with a larger number of bonds might be targeting diversification or may have ongoing series of projects that require funding

through multiple smaller bonds. On the other hand, industries with fewer but larger bonds might be focusing on larger projects or a different financial strategy.

Figure 11 – Distribution in Number of Emitted Corporate Green Bonds and Total Amount issued per Company in the European Market Database (EU) in Billions of Euros from 2018 to 2023 (Top 10 by Number of Bonds issued)



Source: *The dataset on European Corporate Green Bond Issuance, sourced from the London Stock Exchange Group (LSEG). This graph was created using Python*

The preponderance of banking institutions among the top 10 issuers—comprising eight entities—underscores the pivotal role of the banking sector in the green bond market, according to the data at our disposal. These financial institutions are not merely financiers of green projects; they are also leveraging their substantial financial capacities to support and drive sustainable development initiatives.

We can observe that companies within the same industry, specifically financial services, employ different issuance strategies. Some issue a large number of bonds with smaller amounts, while others do the opposite. Landesbank Baden Wuerttemberg appears to pursue a strategy of high bond volume with lower individual values, possibly to fund numerous smaller projects or appeal to a wide range of investors. In contrast, Deutsche Bank AG issues fewer bonds but with higher individual values, likely targeting larger projects or investors with substantial investment capacity.

3.3 Database on Environmental Metrics of European Companies

3.3.1 Source and Metrics

The environmental metrics database for European firms from 2018 to 2022 was sourced from the London Stock Exchange Group (LSEG). This comprehensive database includes environmental metrics for European companies across various sectors and industries. The LSEG gathers Greenhouse Gas (GHG) emissions data using a meticulous and systematic methodology, which incorporates publicly accessible information and direct company submissions. LSEG's ESG data collection process primarily relies on publicly available sources, such as company websites, annual reports, and corporate social responsibility reports. The collected data is then subjected to a thorough audit and standardization process by LSEG's ESG specialists. This database offers a detailed overview of environmental metrics, including the following variables:

1. Company Name: The name of the company.

2. Code: The stock code of the company.

3. HQ: The headquarters country code of the company.

4. Industry Group: The industry group the company belongs to.

5. Mkt. Cap (M): The market capitalization of the company in millions.

6. ESG Score: The Environmental, Social, and Governance score of the company.

7. Total CO2 Emissions / Million in Revenue $: The total CO2 emissions per million dollars in revenue.

8. CO2 Equivalent Emissions Direct, Scope 1: The direct CO2 equivalent emissions.

9. CO2 Equivalent Emissions Indirect, Scope 2: The indirect CO2 equivalent.

3.3.2 Data Cleaning

To ensure the accuracy and reliability of our analysis, we performed a data cleaning procedure on the environmental metrics database for European firms from 2018 to 2022, sourced from the London Stock Exchange Group (LSEG).

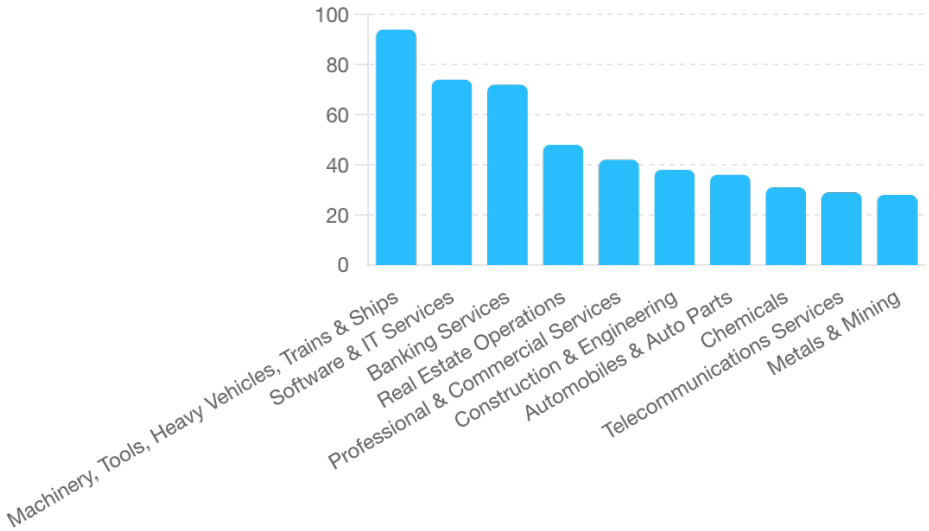
During the data cleaning procedure, we removed entries that lacked data before or after 2020. This step was crucial to prevent the reduction in the explanatory power of our model. By focusing on entries with continuous data across the specified period, we ensure a more robust and reliable analysis.

3.3.3 Descriptive Statistics and Exploratory Data Analysis (EDA)

This database comprises environmental metrics for 648 European companies, including the 20 companies in our peer group. Our initial analysis will primarily focus on CO2 emissions per million in revenue.

The Total CO2 Emissions per Million in Revenue has a mean of 121.86 and a standard error of 388.58, with a minimum reported emission of 0 and a maximum of 4728. The company with the minimum non-zero CO2 emission per million in revenue is Aegon Ltd, operating in the Insurance industry. The company with the maximum CO2 emission per million in revenue is Buzzi SpA, operating in the Construction Materials industry.

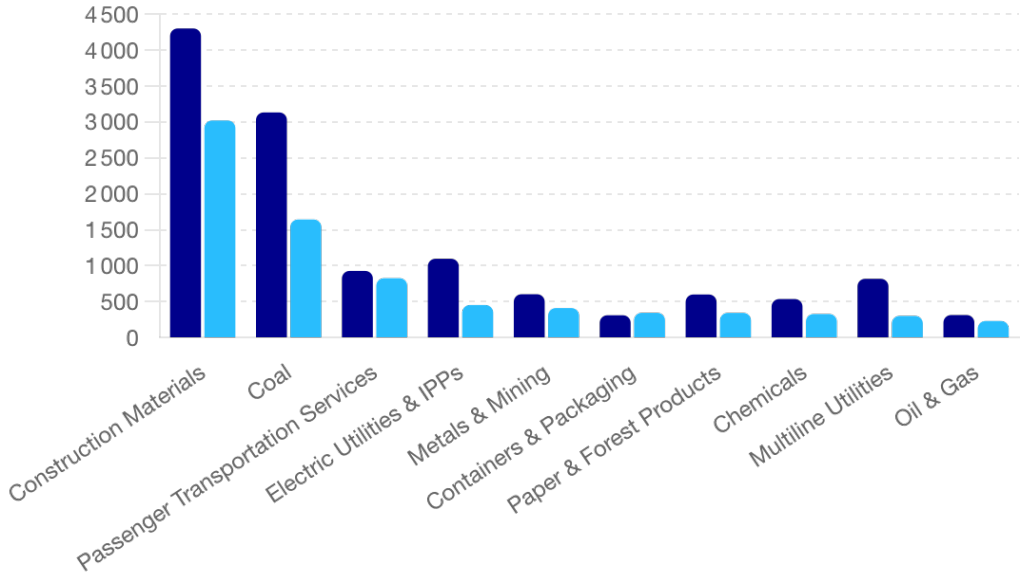
Figure 12– Top 10 Sectors Represented in the Environmental Metric Database by Number of Companies



Source: *The environmental metrics database for European firms from 2018 to 2022, sourced from the London Stock Exchange Group (LSEG). This table was created using Python.*

The database from LSEG (London Stock Exchange Group) provides extensive environmental information on various industries, with certain sectors being better represented than others as shown in this graphic. Since the sectors and industries are not represented equally, we will continue our Exploratory Data Analysis (EDA) by comparing them to gain a clearer view of the GHG emissions landscape for Europe in our database.

Figure 13 – Comparison of Average GHG Intensity for the Top 10 Emitting Industries in 2018 and 2022 Based on the Database on Environmental Metrics of European Companies



Source: *The environmental metrics database for European firms from 2018 to 2022, sourced from the London Stock Exchange Group (LSEG). This table was created using Python.*

The highest emitting industries, such as Coal, Construction Materials, Electric Utilities, Multiline Utilities, Paper & Forest Products, Chemicals, Metals & Mining, and Passenger Transportation Services, are major contributors to GHG emissions due to the energy-intensive nature of their operations and historical reliance on fossil fuels (IEA, 2022). These industries typically involve processes that require significant amounts of energy, often sourced from carbon-intensive fuels like coal, oil, and natural gas. The scale of their operations further amplifies their emissions. Technological and regulatory factors also play a role, with some industries slower to adopt cleaner technologies or operating in regions with less stringent environmental regulations (UNFCCC, 2022). Despite these challenges, many of these industries have made notable strides in reducing their emissions from 2018 to 2022 through advancements in technology, shifts towards renewable energy sources, and improvements in operational efficiencies (IEA, 2022; UNFCCC, 2022). However, ongoing efforts and targeted strategies are essential to further mitigate their environmental impact (UNFCCC, 2022).

3.4 Difference-in-Differences Analysis of Greenhouse Gas Emissions: A Comparative Study of European Companies Issuing Green Bonds in 2020 and Those That Did Not

3.4.1 Methodology

The aim of this analysis is to evaluate the impact of green bond issuance on the greenhouse gas (GHG) emissions of European companies. Green bonds are financial instruments designated for funding projects with environmental benefits, such as renewable energy, energy efficiency, and pollution prevention. By analyzing the changes in GHG emissions before and after the issuance of green bonds, we seek to determine whether these financial instruments effectively fund green initiatives and contribute to reducing companies' carbon footprints. This study focuses on a peer group of 20 European companies that issued green bonds in 2020, comparing their GHG intensity with companies that did not issue green bonds during the same period.

To conduct this analysis, we added a variable "Green bond issuance 2020" as a marker for the peer group of 20 companies, indicating "Yes" or "No" for whether they issued green bonds in 2020. We utilized the Difference-in-Differences (DID) model in Python to obtain the regression results.

Greenhouse gas (GHG) emissions are categorized into three scopes based on their source and the level of control the reporting entity has over them:

- **Scope 1 Emissions**: Direct emissions from sources that are owned or controlled by the organization, such as combustion in boilers.
- **Scope 2 Emissions**: Indirect emissions from the generation of purchased electricity, heat, or steam consumed by the organization. These emissions occur at facilities owned by another entity but are a consequence of the organization’s energy consumption.
- **Scope 3 Emissions**: Other indirect emissions that encompass a broader range of activities, including supply chain emissions, employee commuting, and waste disposal.

For this study, the focus is on the total of Scope 1 and Scope 2 emissions via the GHG intensity (also called carbon intensity). This focus is chosen because these emissions are directly influenced by the organization’s operational choices and energy consumption, making

them most relevant for assessing the impact of green bond issuance. GHG intensity is calculated by dividing the total Scope 1 and Scope 2 GHG emissions by the total company revenue, providing a measure of emissions per unit of economic activity.

3.4.2 Results

Table 2 – Regression Results from the Difference-in-Difference (DID) Model: Impact Assessment of Green Bonds on Greenhouse Gas Emissions Pre and Post Issuance

Variable	Coefficient	Standard Error	t	P>|t|	[0.025	0.975]
Intercept	193,8485	16,209	11,96	0	162,068	225,629
Treatment	92,4079	88,436	1,045	0,296	-80,991	265,807
Post	-41,1042	20,552	-2	0,046	-81,402	-0,807
Treatment:Post	-43,1189	113,549	-0,38	0,704	-265,758	179,521

Source: *Derived from a Python analysis script. The intercept, treatment effect, and time effect estimations were computed using Python's statistical modeling capabilities.*

Intercept: The average GHG emissions for the control group before 2020 is 193.85. This result is highly significant (p-value = 0.000).

Treatment (Treatment Effect Before 2020): The difference in GHG emissions between the treatment and control groups before 2020 is 92.41, but this difference is not statistically significant (p-value = 0.296). This means there is no strong evidence that the treatment group had different GHG emissions compared to the control group before 2020.

Post (Time Effect for Control Group): There is a decrease of 41.10 in average GHG emissions for the control group after 2020 compared to before 2020. This decrease is statistically significant (p-value of 0.046).

Treatment:Post(Treatment Effect After 2020 (DiD Estimator)): The treatment effect, which represents the effect of issuing a green bond in 2020, is associated with a decrease of 43.12 in GHG emissions. However, this effect is not statistically significant (p-value = 0.704).

The overall trend indicates a notable reduction in GHG emissions over time, as evidenced by the significant post coefficient. However, the specific effect of green bond issuance in 2020 on this reduction is not statistically significant, as indicated by the Treatment coefficient, which shows a decrease of 43.12 in GHG emissions with a p-value of 0.704. This lack of statistical significance suggests that the observed decrease cannot be conclusively attributed to green bond issuance.

3.4.3 Limitations of the Analysis

The first limitation of this analysis is the small sample size of 20 companies, which may not accurately represent the broader market. This constraint is primarily due to the limited availability of data on green bond issuances and GHG emissions for a wider range of companies. The study focuses on emissions changes immediately following the issuance of green bonds in 2020, constrained by data availability from LSEG, which only covers green bond issuances from 2018 to 2023 and GHG intensity data from 2018 to 2022. This short timeframe may underestimate the longer-term impact of projects financed by green bonds.

Additionally, the analysis is limited to Scope 1 and Scope 2 emissions, excluding Scope 3 emissions, which also play a critical role in assessing a company's overall environmental impact.

Despite efforts to include a diverse set of companies in the treatment group, there may still be unobserved differences between companies that issued green bonds and those that did not, potentially influencing the results. Furthermore, variations in data accuracy and reporting practices could also affect the study’s conclusions.

These limitations underscore the need for more comprehensive data and longer-term studies to better understand the true impact of green bonds on corporate environmental performance.

3.4.4 Discussions of Findings

The findings from this analysis highlight the complexity and nuances of the impact of green bond issuance on greenhouse gas (GHG) emissions among European companies. While the study aimed to assess the effectiveness of green bonds in reducing GHG emissions by analyzing changes in GHG intensity before and after the issuance, the results do not provide conclusive evidence.

Using a Difference-in-Differences (DID) methodology, the study found an overall trend of decreasing GHG emissions among the companies studied. However, the specific effect of green bond issuance in 2020 on this reduction is not statistically significant, as indicated by the Treatment coefficient, which shows a decrease of 43.12 in GHG emissions with a p-value of 0.704. This lack of statistical significance suggests that the observed decrease cannot be conclusively attributed to green bond issuance.

Consequently, these findings offer limited clarity on the environmental impact of green bond issuance. They neither fully endorse nor refute Mao and Flammer's arguments. Mao (2023)

suggests that while green bonds may be linked with environmental improvements like reduced GHG intensity, these outcomes might result from existing green initiatives rather than the bonds themselves. Conversely, Flammer's (2021) research indicates that companies issuing certified green bonds often experience better environmental ratings and reduced CO2 emissions post-issuance, more so than those issuing non-certified green bonds.

In conclusion, this study's results do not provide the necessary evidence to resolve the debate between Mao and Flammer on the environmental impact of green bond issuance. Further research, particularly with longer-term data and a focus on the quality and impact of projects funded by green bonds, is needed to better understand their effectiveness in delivering substantial environmental benefits. Enhanced standards and certifications may also play a crucial role in ensuring that green bonds fulfill their environmental promises.

Chapter 4: Assessment of Additionality through Case Studies

4.1 Methodology and Objective

4.1.1 Overall Methodology and Objective

To evaluate the additionality of corporate European green bonds, we will focus on green bonds financing one of the most costly sources of renewable energy. According to the *Renewable Power Generation Costs in 2022* report by the International Renewable Energy Agency (IRENA), the three most expensive renewable energy sources to produce in 2022, based on the global weighted average total installed cost, are:

1. Geothermal: USD 3,478 per kW
2. Offshore Wind: USD 3,461 per kW
3. Concentrating Solar Power (CSP): USD 4,274 per kW

We have opted to examine corporate European green bonds used to fund offshore wind farms in Europe, as these projects and their corresponding bonds have extensive available data. This decision is further supported by the European Environment Agency's report indicating that wind energy accounts for 15% of Europe's total energy supply, ranking second only to solid biomass (European Environment Agency, 2024). Given that offshore wind farms are costly ventures and that wind energy plays a significant role in Europe's renewable energy mix, our objective is to evaluate the additionality of green bonds in financing these projects. This analysis will offer valuable insights into the role of green bonds in supporting essential projects for the European energy transition, which may face funding challenges due to their high costs.

To accomplish this, we will analyze the financial additionality of green bonds across two major offshore wind projects, where green bonds contribute at different levels or proportions to the overall funding mix. By comparing these projects, we aim to provide a comprehensive and robust assessment, ensuring that our final discussions are well-supported by diverse data points and perspectives. This approach will allow us to evaluate the varying impacts and significance of green bonds in the financing of high-cost renewable energy projects depending on their level of involvement in the funding mix.

On one hand, we will analyze the Hohe See and Albatros wind farms developed by EnBW, as well as the Borkum Riffgrund 2 Offshore Wind Farm, both located in the German North Sea. These projects are significant examples of large-scale offshore wind developments, each with distinct financial structures and levels of green bond involvement.

We chose these specific projects because they were financed in part by green bonds and because they have significant databases available, which simplify and strengthen the robustness of our analysis. The availability of detailed financial and operational data allows for a thorough examination of the impact and effectiveness of green bond financing in these projects, facilitating a comprehensive evaluation of both financial and emissions additionality.

4.1.2 Financial Additionality Assessment Methodology

To evaluate the financial additionality of bonds financing offshore wind projects—specifically determining whether a green project secures funding that it otherwise would not have without the issuance of the green bond within the context of Green Bonds (OECD, 2021)—we will utilize the Clean Development Mechanism (CDM) framework.

This framework assesses financial viability through the calculation of a deterministic internal rate of return (IRR), supplemented by sensitivity analysis. This IRR is then compared with a benchmark IRR of similar projects. Generally, projects with higher IRRs are more appealing as they indicate greater potential returns relative to their costs. If the calculated IRR is lower than those of comparable projects, it suggests that the project might be less attractive to investors, indicating that the specific sustainable financing tool being used to fund it provides additional benefits (Carmichael, D. G., Lea, K. A., & Balatbat, M. C. A., 2015; Investopedia, n.d.).

In order to do this, we are using this formula:

$$0 = \text{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1 + IRR)^t} - C_0$$

Where:

$C0$ = Total Initial Investment Cost

Ct = Cash Flow at year t = (Energy production at year t) x (Price for energy supply at year t)

T = Lifespan of the project

IRR = Internal Rate of Return

t = Time period

The reason we set the Net Present Value (NPV) to zero when calculating the Internal Rate of Return (IRR) is that the IRR represents the discount rate at which the present value of all future cash flows (both positive and negative) equals the initial investment or outflows. In other words, it is the rate at which the investment breaks even.

We will apply this formula using projections and assumptions about future energy production and price trends. By considering both the minimum and maximum forecasts for energy production, along with the potential minimum and maximum energy prices in Germany, we can perform a comprehensive sensitivity analysis on the project's IRR.

To establish a benchmark for the European market's offshore wind power IRR, our research shows that companies are citing internal rates of return (IRR) of 8-12% for offshore wind projects, according to Wood Mackenzie (2023). This range is consistent with the findings of Zhao, W., Han, Y., & Niu, D. (2018), who reported an IRR range of 8.05% to 11.23% for offshore wind farms in the Chinese market. Despite the geographical differences, the IRR ranges indicate similar investment returns across these regions.

Additionally, Prässler, T., & Schaechtele, J. (2012) assessed the financial prospects of offshore wind parks in various European countries. They found that projects in Germany, especially those further offshore, can achieve an IRR of approximately 14.5%. Furthermore, Green Giraffe, a financial advisory firm specializing in the energy sector, reports a target IRR of around 10% for offshore wind projects in Germany (Guillet, J., 2014).

The most common IRR range for European offshore wind projects, as cited by sources like Wood Mackenzie (2023) and Green Giraffe (2014), falls between 8% and 12%. This range serves as a standard return expectation for the majority of projects. We will use this benchmark to assess the financial viability of projects and their attractiveness to potential investors. If the IRR of the projects we analyze falls within this range, we can conclude that the bonds linked to their funding are not financially additional. This is because these projects would likely have secured funding even without the issuance of green bonds, indicating that the bonds are not necessary for the project's financial viability.

4.2 Hohe See and Albatros Wind Farms Case Study

4.2.1 Description of the project

The EnBW Hohe See and Albatros wind farms are offshore wind projects located in the North Sea, approximately 95-105 kilometers from the coast of Germany. Combined, they have a

total capacity of 639,45 megawatts (MW), with 71 turbines at Hohe See and 16 at Albatros. The wind farms are expected to generate around 2.5 billion kilowatt-hours annually, supplying approximately 710,000 households. They utilize Siemens SWT-7.0-154 turbines, each with a 7.35 MW capacity. The projects were developed jointly, with full commissioning completed by January 2020. The lifespan of the Hohe See and Albatros wind farms is typically expected to be around 25 years (EnBW Energie Baden-Württemberg AG, 2024).

4.2.2 Cost and Funding Data

The total cost of the project amounted to €2.2 billion (EnBW Energie Baden-Württemberg AG, 2024).

In terms of funding trough green bonds, we found from the data provided in the annual Green Bond Impact reports and Allocations report of EnBW and the overall project was financed by a Senior Green Bond and two Subordinated Green Bonds:

- **Green Senior Bond October 2018 (XS1901055472):**

  The Green Senior Bond issued in October 2018, identified by ISIN XS1901055472, holds ratings of Baa1 from Moody's and A- from S&P. It has a total issue size of €500 million, with net proceeds of €496.42 million. The bond offers a coupon rate of 1.875% per annum over a term of 15 years. Of the total proceeds, €222.8 million were allocated to the Hohe See and Albatros Wind Farms, representing approximately 10.13% of the total project cost (€2.2 billion) (EnBW Energie Baden-Württemberg AG, 2024).

- **Green Subordinated Bonds August 2019 (XS2035564975 & XS2035564629):**

  The Green Subordinated Bonds, issued in August 2019 with ISINs XS2035564629 and XS2035564975, have ratings of Baa3 from Moody's and BBB- from S&P. Each bond was issued at €500 million, with net proceeds of €498.25 million. They feature coupon rates of 1.625% for XS2035564629 and 1.125% for XS2035564975, with terms of 60 and 60.25 years, respectively. A total of €839.7 million from these bonds was allocated to the Hohe See and Albatros Wind Farms, covering approximately 38.16% of the project's total cost (€2.2 billion). The allocation of €269.8 million from the total proceeds to the offshore wind project Hohe See and Albatros Wind Farms represents approximately 12.27% of the total project cost of €2.2 billion (EnBW Energie Baden-Württemberg AG, 2024).

The total funding from green bonds for the Hohe See and Albatros Wind Farms project amounts to approximately 48.29% of the total project cost (€2.2 billion). This includes

10.13% from the Green Senior Bond issued in October 2018 and 38.16% from the Green Subordinated Bonds issued in August 2019.

Both the Green Senior Bonds and Green Subordinated Bonds issued by EnBW are certified under the same sustainability certification schemes. Specifically:

1. Climate Bonds Initiative (CBI) Certification: All of EnBW's green bonds, including both senior and subordinated bonds, are certified under the high standards of the Climate Bonds Initiative. This certification ensures that the bonds fund projects that are aligned with the goals of climate change mitigation (EnBW, 2022).

2. Second Party Opinion by ISS ESG: EnBW has obtained a Second Party Opinion from ISS ESG, a rating agency specializing in sustainability. ISS ESG has confirmed that EnBW's green bonds comply with the Green Bond Principles based on criteria set by the International Capital Market Association (ICMA). This includes an assessment of the sustainability quality of the bonds and EnBW's overall sustainability performance (EnBW, 2022).

3. Ratings by Moody's and S&P: All EnBW green bonds, both senior and subordinated, have been rated by the credit rating agencies Moody's and S&P. This provides an independent assessment of the creditworthiness of the bonds, reflecting both the financial stability of EnBW and the risk profile of the investments funded by these bonds (EnBW, 2022).

4.2.3 Financial Additionality Assessment of Hohe See and Albatros

The Hohe See and Albatros wind farms have a combined capacity of 639.45 MW (EnBW, n.d.). In their study titled "An Overview of the Offshore Wind Energy Potential for Twelve Significant Geographical Locations Across the Globe," Diaconita, A. I., Andrei, G., & Rusu, L. (2022) found that offshore wind farms in the North Sea typically achieve capacity factors ranging from 40% to 50%, demonstrating the strong potential for successful wind energy projects in this region.

Conservative Estimate (Floor): Using a lower capacity factor of around 40%, these wind farms could produce approximately 2.24 billion kWh (639.45 MW * 8760 hours * 0.4).

Optimistic Estimate (Cap): With a capacity factor of 50%, they could yield around 2.81 billion kWh (639.45 MW * 8760 hours * 0.50).

Based on the prices taken into account by EnBw's annual reports via the the entity EPEX SPOT SE (European Power Exchange) which is a European electricity market platform that facilitates the trading of electricity on the spot market, energy prices per year were:

2018: €44.47/MWh

2019: €37.67/MWh

2020: €30.47/MWh

2021: €96.85/MWh

2022: €235/MWh

2023: €95,18/MWh

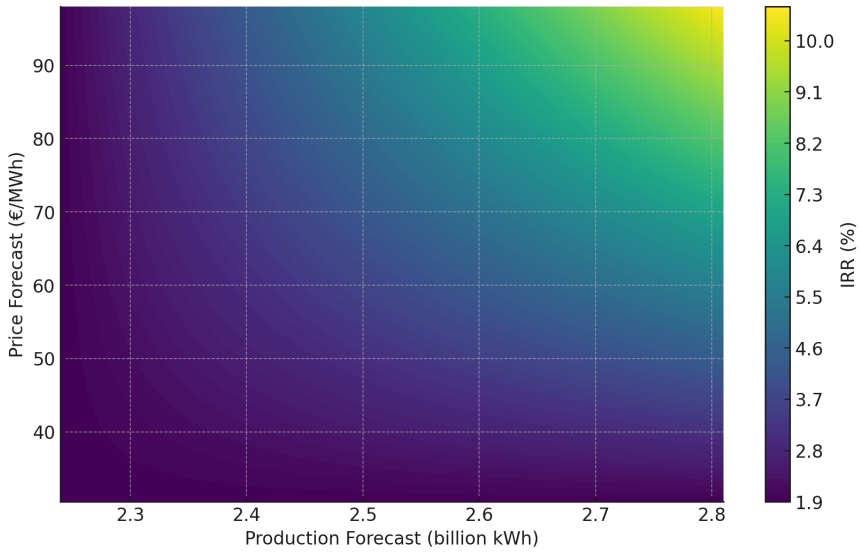
2024: €93,81/MWh

In addition, according to a report by the Swiss research center Prognos, commissioned by the Bavarian Industry Association (VBW), various scenarios affecting future electricity prices were examined. The report highlights factors such as the availability of Russian gas, renewable energy sources, and the use of hydrogen. It projects that by 2030, the electricity price could reach a maximum of 98 euros per MWh, before potentially decreasing to around 80 euros per MWh by 2040. Therefore, for the Borkum Riffgrund 2 project, we consider the cap on electricity prices to be 98 euros per MWh, aligning with these projections (vbw – Vereinigung der Bayerischen Wirtschaft e. V., 2022).

We will use the 2020 price of €30.47/MWh as the minimum forecast price for energy and set €98/MWh as the maximum cap price.

Based on these data and assumptions, we can evaluate the project's IRR under the best and worst-case scenarios for production and price. This allows us to conduct a sensitivity analysis and derive the corresponding results:

Figure 14 – Sensitivity analysis for the IRR of the Hohe See and Albatros Wind Farms



Source: *Created using Python. Based on the data and assumptions*

The calculated Internal Rate of Return (IRR) for the project in both scenarios is as follows:

- Best Case Scenario IRR: 10.57%
- Worst Case Scenario IRR: 1.92%

To provide a probability distribution of the IRR over different ranges, we'll assume a probability distribution for the key variables: energy production and energy prices. Given the data, we can assume that these variables might follow a normal distribution (though other distributions could also be used, this is a common choice for such analyses).

We'll then simulate a large number of potential outcomes (Monte Carlo simulation) based on these distributions and calculate the corresponding IRRs for each simulation. This will allow us to estimate the probability of the IRR falling within specific ranges.

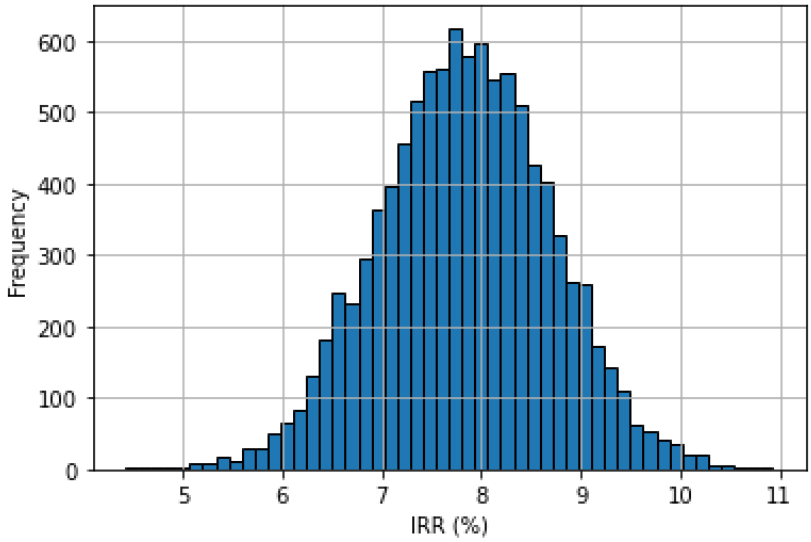
Assumptions:

1. Energy Production: We will assume it follows a normal distribution with a mean of 2.525 billion kWh annually (average of 2.24 and 2.81billion kWh) and a standard deviation calculated as the difference between the best and worst case (to cover a range of roughly 95% of cases).

2. For the years 2020 to 2024, actual energy production and prices are utilized. From 2025 to 2044, future energy prices are assumed to follow a normal distribution. The

mean of this distribution is set at the average of the best case (€98/MWh) and worst case (€30.47/MWh) price forecasts, with the standard deviation calculated as half the difference between these two values.

Figure 15 – Monte Carlo Simulation of the IRR of the Hohe See and Albatros Wind Farms



Source: *Created using Python. Based on the data and assumptions*

The Monte Carlo simulation for the Hohe See and Albatros Wind Farms shows a mean and median IRR of 7.83%, reflecting the average expected return. The 5th percentile IRR is 6.41%, indicating a low probability of returns falling below this level, while the 95th percentile IRR is 9.24%, suggesting that most returns are expected to be below this upper threshold.

The most common IRR range for European offshore wind projects, as cited by sources like Wood Mackenzie (2023) and Green Giraffe (2014), falls between 8% and 12%. This range serves as a standard return expectation for the majority of projects. As mentioned in our methodology for the analysis of financial additionality, we are using this benchmark to assess the financial viability of projects and their attractiveness to potential investors.

The likelihood of the project's IRR being below or above the benchmark for financial viability is as follows:

- Probability of achieving an IRR of less than 8%: 57.38%
- Probability of achieving an IRR of 8% or more: 42.62%

Based on our sensitivity analysis of the IRR for the Hohe See and Albatros wind farms, along with the probabilistic study of IRR ranges, it appears that this project is more likely to have an

IRR below 8%. This suggests that it may be less attractive to investors compared to other similar offshore wind projects. Consequently, the green bonds associated with the funding of these projects are likely to be financially additional, as they could provide essential support that might not be available otherwise.

4.3 The Borkum Riffgrund 2 Offshore Wind Farm Case Study

4.3.1 Description of the project

Borkum Riffgrund 2 is a major offshore wind farm located in the German North Sea, around 60 kilometers from the coast of Lower Saxony. As a project developed by Ørsted, a global leader in renewable energy, Borkum Riffgrund 2 reflects the company's commitment to advancing offshore wind technology and contributing significantly to Germany's renewable energy targets (Ørsted, n.d.; Power Technology, n.d.).

The wind farm features 56 MHI Vestas V164-8.0 MW turbines, each with a capacity of 8 megawatts, which collectively deliver a total installed capacity of 450 megawatts (MW). This capacity is sufficient to generate clean energy for approximately 460,000 households, significantly reducing CO2 emissions compared to conventional fossil fuel sources. The project utilizes state-of-the-art turbine technology, enhancing efficiency and output, and positioning Borkum Riffgrund 2 as one of the most advanced offshore wind farms in operation (Ørsted, n.d.; Power Technology, n.d.).

Construction of Borkum Riffgrund 2 commenced in 2016, and the wind farm started generating energy in August 2018. The project reached full operational status in 2019. (Ørsted, n.d.).

4.3.2 Cost and Funding Data

Debt Financing: The project secured €832 million in debt financing from a group of institutional investors. This funding arrangement was crucial for covering part of the construction and operational costs. Some of the investors include DekaBank, Edmond de Rothschild AM's BRIDGE platform, La Banque Postale Asset Management, NN Investment Partners and Wiener Städtische Versicherung (Power Technology, n.d.).

Bond Issuance: Ørsted issued two Green Structured Securities (GSS) Bonds to support the project. The total amount raised was €355.03 million. The details of these bonds are:

- **Green Bond**: The Borkum Riffgrund 2 offshore wind farm received partial funding from a Green Bond issued by Ørsted. This bond, with the ISIN code XS1721760541, allocated €288.03 million of the total €736.03 million

proceeds to the project. Issued in 2017, the bond has a maturity date in 2029 and offers a 1.5% coupon rate. About 39% of the total proceeds were dedicated to the Borkum Riffgrund 2 project (Ørsted, 2022).

- **Hybrid Bond**: The Borkum Riffgrund 2 offshore wind farm was also financed through a Hybrid Bond issued by Ørsted. This Hybrid Bond, with ISIN code XS1720192696, allocated €67 million of the total €492.24 million proceeds to the project. Issued in 2019 with a maturity in 2027 and a 2.25% coupon, approximately 13.61% of the bond's total proceeds were allocated to the Borkum Riffgrund 2 project (Ørsted., 2022).

The Green Bond accounts for 12.31% of the total project funding, while the Hybrid Bond contributes 2.86% of the total funding.

Ørsted's green bonds have received the highest possible rating, 'dark green', from CICERO Shades of Green, indicating a strong alignment with long-term environmental goals. Additionally, Ørsted achieved an AAA rating in the MSCI ESG Ratings assessment. To further ensure transparency and accountability, PricewaterhouseCoopers (PwC) was engaged to provide limited assurance on selected ESG data, including avoided emissions and the allocation of green bond proceeds. Consequently, Ørsted's green bonds are considered certified green bonds (Ørsted., 2023)

Ørsted sold a 50% stake in Borkum Riffgrund 2 to GIP for approximately €1.17 billion. This sale included GIP's commitment to fund half of the project's capital expenditures and operational costs under a full-scope EPC (Engineering, Procurement, and Construction) contract (Ørsted, 2017). We can therefore take €2.34 billion as a reasonable estimate for the project's total cost.

4.3.3 Financial Additionality Assessment of Borkum Riffgrund 2

The Borkum Riffgrund 2 offshore wind farm began producing electricity in August 2018 and is designed for a 25-year operational lifespan. Situated 54 kilometers off the coast of Lower Saxony in the German North Sea, the farm comprises 56 MHI Vestas V164-8.0MW turbines. The installation of these turbines was completed ahead of schedule on August 31, 2018, allowing the wind farm to commence operations sooner than anticipated (Power Technology, n.d.; Ørsted A/S, n.d.).

The Borkum Riffgrund 2 offshore wind farm operates under fixed feed-in tariffs as specified in Ørsted's asset book for the first quadrimestre of 2024. These tariffs are defined as follows: from 2018 to 2026, the rate is set at 184 EUR/MWh, and from 2026 to 2028, it decreases to 149 EUR/MWh. These fixed feed-in tariffs (FiTs) are a key component of the Renewable Energy Sources Act (EEG) established in Germany in 2000. The FiTs guarantee a specific price per kilowatt-hour (kWh) for electricity fed into the grid, providing financial stability and investment security. This mechanism is instrumental in encouraging the development of renewable energy projects such as wind, solar, and biomass (World Future Council, n.d.).

Based on information retrieved from Ørsted's asset book, after 2028, the Borkum Riffgrund 2 offshore wind farm will have a guaranteed floor price of 39 euros per MWh for its electricity production. This floor price ensures a minimum revenue level for the project.

In addition, A recent report from the Swiss research center Prognos, commissioned by the Bavarian Industry Association (VBW), investigates various scenarios that could influence future electricity prices. The report examines key factors like the availability of Russian gas, the role of renewable energy sources, and the adoption of hydrogen technologies. According to the projections, electricity prices could climb to a peak of 98 euros per MWh by 2030, before potentially declining to about 80 euros per MWh by 2040. Consequently, for the Borkum Riffgrund 2 project, we are considering a price cap of 98 euros per MWh, in line with these forecasts (vbw – Vereinigung der Bayerischen Wirtschaft e. V., 2022).

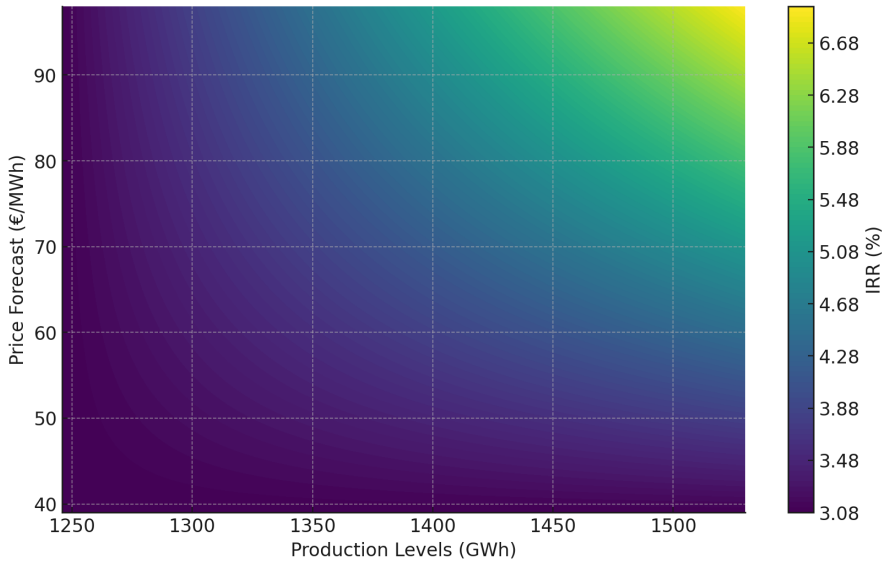
We retrieved the production levels for the Borkum Riffgrund 2 offshore wind farm from Ørsted's Green Bond Impact Reports for the years 2018 to 2023. These reports provided detailed data on the actual energy output, which was as follows:

- **2018:** 380 GWh
- **2019:** 1246 GWh
- **2020:** 1530 GWh
- **2021:** 1348 GWh
- **2022:** 1304 GWh
- **2023:** 1340 GWh

In order to forecast post-2023 production, we anticipate the output will fluctuate within the range—**from 1246 GWh (considered the worst-case scenario) to 1530 GWh (considered the best-case scenario)**.

This approach allows us to account for variations in production due to factors like wind availability, maintenance schedules, and other operational variables, ensuring a comprehensive analysis of the wind farm's potential output.

Figure 16 – Sensitivity analysis for the IRR of the Borkum Riffgrund 2 Wind Farm



Source: *Created using Python. Based on the data and assumptions*

The updated IRR values for the Borkum Riffgrund 2 project, including the sensitivity of production levels for post-2023 years, are:

- Best Case Scenario IRR: 6,95%
- Worst Case Scenario IRR: 3.08%

Sources such as Wood Mackenzie (2023) and Green Giraffe (2014) indicate that the typical Internal Rate of Return (IRR) for European offshore wind projects ranges from 8% to 12%. This range is generally regarded as a standard return expectation for most projects. In our analysis of financial additionality, we use this benchmark to evaluate the financial viability of projects and their appeal to potential investors.

Based on the sensitivity analysis of the estimated IRR for the Borkum Riffgrund 2 project, our findings indicate that the project is unlikely to be attractive to investors compared to other offshore wind power projects, as determined by benchmarks from various articles and research. Given these results, we can conclude that the green financing tools, including the green bond (ISIN code XS1721760541), used in funding Borkum Riffgrund 2 are financially additional. This means that the project would not likely have secured funding without the support of these green financing instruments, highlighting their critical role in the project's financial viability.

4.4 Limitations of the Case Studies

The primary challenge in assessing additionality under the Clean Development Mechanism (CDM) framework lies in the heavy reliance on Internal Rate of Return (IRR) analysis. This approach depends on forecasts for key variables such as energy production, electricity prices, and operational costs. Although a sensitivity analysis was conducted to address uncertainties, the projected upper and lower limits (cap and floor) are not guaranteed. These projections carry inherent uncertainties and can be influenced by unpredictable factors like technological advancements, regulatory changes, and market conditions, particularly regarding energy price forecasts and potential subsidies. Moreover, unexpected maintenance issues or operational challenges that could impact the project's profitability were not thoroughly considered in the sensitivity analysis.

A specific limitation of this study is the use of Monte Carlo simulation for the case study of the Hohe See and Albatros Wind Farms. The Monte Carlo simulation was used to estimate a probability distribution of the IRR, assuming normal distributions for key variables like energy production and energy prices, including forecasts for both cap and floor levels. While this method provides a range of potential outcomes, it has its limitations. The assumption of normal distributions and reliance on forecasted caps and floors may not fully capture the complexities and potential non-normal behavior of these variables in real-world scenarios.

Additionally, comparing the project's IRR to benchmark IRR ranges from other projects also has limitations. These benchmarks may not fully account for regional, technological, and temporal differences that influence project risks and returns. Moreover, comparing IRRs across different markets and periods may not accurately reflect the specific circumstances of the projects being evaluated. The sources used to determine benchmark IRRs, such as reports from consulting firms or industry experts, may contain biases or lack full objectivity, potentially affecting the neutrality and accuracy of the additionality assessment.

Determining whether a project is financially additional based solely on its IRR compared to a benchmark is challenging. Even if a project's IRR falls within the benchmark range, other barriers to obtaining traditional financing may not be captured in the financial analysis. Furthermore, the study's emphasis on financial aspects as the primary motivator for investors, as outlined by the CDM Framework, overlooks other significant factors influencing investment decisions. These include environmental benefits, social impact, long-term sustainability, and regulatory and policy incentives. Consequently, the findings may not fully capture the diverse motivations driving investor behavior in various contexts.

4.5 Discussion on Findings

For the Hohe See and Albatros wind farms, a sensitivity analysis of the Internal Rate of Return (IRR) was carried out using the Clean Development Mechanism (CDM) framework. The analysis revealed a Best Case Scenario IRR of 10.57% and a Worst Case Scenario IRR of 1.92%. Additionally, a statistical Monte Carlo simulation indicated a 57.38% probability that the IRR would fall below the benchmark threshold. This suggests that the financial viability of the project may be lower than comparable offshore wind projects, potentially making it difficult to attract investors seeking returns. Consequently, the additionality of the green bonds under the CDM framework is probable, as they are expected to be crucial in financing the project, covering 48.29% of the total initial investment cost.

Similarly, for the Borkum Riffgrund 2 offshore wind farm, a sensitivity analysis on IRRs using the CDM framework resulted in a Best Case Scenario IRR of 6.95% and a Worst Case Scenario IRR of 3.08%. The analysis clearly indicates that even in the best case, the IRR does not meet the 8% threshold set by our benchmark. This suggests that the project may not be as financially viable as other similar offshore wind projects, potentially making it difficult to secure conventional funding without the support of the green bond issued for this purpose. The analysis confirms the additionality of the green bond funding under the CDM framework, which played a modest role, covering 12.31% of the total initial investment cost.

In comparison, the green bonds for the Hohe See and Albatros Wind Farms play a more vital role in the project's funding structure, covering nearly 50% of the total investment. This significant level of funding would likely be difficult to secure without green bonds, which attract investors with a focus on environmental sustainability. Furthermore, the broader range of potential IRRs, affected by forecasts of maximum and minimum production levels and energy prices, indicates a higher financial risk for the Hohe See and Albatros Wind Farms compared to the Borkum Riffgrund 2 offshore wind farm. This increased risk could deter conventional investors.

However, we have to note that with Gabor Gyura's (2020) view on financial additionality, as he points out that many projects funded by green bonds might have gone ahead without them, implying that the necessity of these bonds can sometimes be exaggerated, thus questioning their true additionality. The financial additionality confirmed through the CDM Framework for our two case studies on offshore wind farm projects may therefore not be typical for all green bond issuances, especially considering the limitations of our analysis.

The Ørsted green bond with ISIN XS1721760541 offers a 1.5% coupon rate and matures in November 2029. In contrast, Ørsted's conventional bonds provide higher coupon rates, such

as 5.75% for ISIN XS0499449261 and 4.875% for ISIN XS0730243150. Similarly, EnBW issues both conventional and green bonds. For instance, the conventional bond with ISIN XS2722717472 has a 4.3% coupon rate maturing in 2034, and another with ISIN XS2862984510 has a 3.85% rate maturing in 2031. These conventional bonds generally have higher coupon rates compared to their green counterparts, which range from 1.125% to 1.875% (Markets Insider,n.d.;EnBW Energie Baden-Württemberg AG,n.d.).

This difference illustrates that investors are willing to accept lower returns on green bonds, a phenomenon referred to as the "greenium." This trend, as observed by Bachelet, Becchetti, and Manfredonia (2019), along with Mao (2023), suggests that the greenium enables issuers to raise capital at reduced costs. These lower funding costs can significantly enhance the financial viability of green projects, thereby promoting more environmentally sustainable initiatives and potentially impacting financial additionality by making such projects more attractive and feasible.

In conclusion, while both projects demonstrate financial additionality under the CDM Framework, the issuance of green bonds for the Hohe See and Albatros Wind Farms appears particularly crucial. These bonds are likely vital for the project's execution and intended environmental impact, given the financial challenges and risks involved. However, it is important to recognize the limitations of our analysis, including uncertain IRR forecasts, potential inaccuracies in Monte Carlo simulations, potentially non-representative benchmark IRRs, and a narrow focus on financial metrics. Therefore, in addressing the research question, *"How do green bonds demonstrate financial additionality, and to what extent do they fund new environmentally friendly projects that would not have received financing otherwise?"*, we can only assert that the green bonds for these projects exhibit financial additionality within the scope of our assumptions and the CDM model's limitations. This may not represent the general case for all green projects funded by green bonds, as noted in the literature and by Gabor Gyura (2020).

Chapter 5: Conclusion and Future Research Directions

5.1 Summary of Key Findings

The empirical analysis investigated the impact of green bond issuance on greenhouse gas (GHG) emissions among European companies using a Difference-in-Differences (DID) methodology. The study identified an overall trend of decreasing GHG emissions among the companies examined. However, the specific effect of green bond issuance in 2020 was not statistically significant, with a Treatment coefficient decrease of 43.12 in GHG emissions and a p-value of 0.704. This indicates that the observed emission reductions cannot be conclusively attributed to the issuance of green bonds. The results neither fully support nor refute the arguments made by Mao (2023) and Flammer (2021) regarding the environmental impact of green bonds. In response to the research question, "How do green bonds demonstrate their environmental impact, and how accurately can the specific reductions in greenhouse gas emissions from projects funded by green bonds be measured?", the analysis does not provide significant evidence that green bonds demonstrate their environmental impact. Further research with longer-term data and a focus on project quality is necessary to understand the true environmental benefits of green bonds.

In assessing the financial additionality of green bonds through case studies of two different-scale green projects—the Hohe See and Albatros Wind Farms, and the Borkum Riffgrund 2 offshore wind farm—several key findings emerged. For the Hohe See and Albatros Wind Farms, a sensitivity analysis within the Clean Development Mechanism (CDM) framework indicated a Best Case Scenario IRR of 10.57% and a Worst Case Scenario IRR of 1.92%. A Monte Carlo simulation revealed a 57.38% probability of the IRR falling below the benchmark threshold, suggesting potential challenges in attracting investors. Green bonds covered 48.29% of the initial investment, underscoring their critical role in project financing.

For the Borkum Riffgrund 2 offshore wind farm, the sensitivity analysis showed a Best Case Scenario IRR of 6.95% and a Worst Case Scenario IRR of 3.08%, both below the 8% benchmark. Green bonds financed 12.31% of the initial investment, highlighting their necessity for project viability given the financial constraints.

In comparison, the green bonds issued for the Hohe See and Albatros Wind Farms were more vital to the project's funding structure, covering nearly 50% of the total investment. This significant level of funding, likely unattainable without green bonds, is attractive to investors focused on environmental sustainability. Furthermore, the wider range of potential Internal Rates of Return (IRRs), influenced by fluctuating forecasts of production levels and energy prices, suggests a higher financial risk for the Hohe See and Albatros Wind Farms compared

to the Borkum Riffgrund 2 offshore wind farm. This increased risk may discourage conventional investors.

However, it's essential to consider Gabor Gyura's (2020) perspective on financial additionality, where he argues that many projects funded by green bonds might have proceeded without them, suggesting that the necessity of these bonds can sometimes be overstated, thus questioning their true additionality. The financial additionality demonstrated through the Clean Development Mechanism (CDM) Framework for our two offshore wind farm case studies may not be representative of all green bond issuances, particularly given the limitations of our analysis.

Additionally, we observed a striking difference in coupon rates between the green bonds issued by EnBW and Ørsted and the conventional bonds they issued, highlighting investors' willingness to accept lower returns on green bonds—a phenomenon known as the "greenium." This willingness reflects a broader trend, as noted by Bachelet, Becchetti, and Manfredonia (2019), and Mao (2023), where the greenium allows issuers to raise capital at reduced costs. Pietsch and Salakhova (2022) further assert that only green bonds with external reviews (certified green bonds) trade at a statistically significant greenium. These lower funding costs enhance the financial viability of green projects, making them more attractive and feasible. This, in turn, promotes more environmentally sustainable initiatives and may impact financial additionality by encouraging investment in projects that might otherwise not have been pursued. Crucially, the fact that all the green bonds issued by EnBW and Ørsted have their post-issuance use of proceeds verified by an external reviewer not only enhances their credibility but also reinforces the greenium effect.

Although both projects demonstrate financial additionality under the CDM Framework, the issuance of green bonds for the Hohe See and Albatros Wind Farms appears particularly vital. These bonds likely play a crucial role in enabling the project's execution and achieving its intended environmental impact, given the associated financial challenges and risks. However, it's essential to recognize the limitations of our analysis, such as uncertain IRR forecasts, potential inaccuracies in Monte Carlo simulations, possibly unrepresentative benchmark IRRs, and a narrow focus on financial metrics. In addressing our second research question, "How do green bonds demonstrate financial additionality, and to what extent do they fund new environmentally friendly projects that would not have received financing otherwise?", we can only assert that the green bonds examined in our case studies demonstrate financial additionality within the scope of our assumptions and the CDM model's limitations. This finding may not necessarily generalize to all green projects funded by green bonds, as noted in the literature and by Gabor Gyura (2020).

In conclusion, while green bonds demonstrate financial additionality in certain cases, their broader environmental impact and necessity for new projects remain uncertain. Further research with more comprehensive data and a wider scope is needed to better understand the effectiveness of green bonds in delivering environmental benefits.

5.2 Limitations of the Study

Our empirical analysis of the impact of green bond issuance on the GHG intensity of European companies faces a primary limitation due to the small sample size of 20 companies. This limited sample may not adequately represent the broader market, primarily because of the restricted availability of data on green bond issuances and GHG emissions across a wider array of companies. The study is constrained to examining emissions changes immediately following the issuance of green bonds in 2020, limited by data from LSEG, which covers green bond issuances from 2018 to 2023 and GHG intensity data from 2018 to 2022. This narrow timeframe may underestimate the longer-term effects of projects financed through green bonds.

Furthermore, the analysis focuses only on Scope 1 and Scope 2 emissions, excluding Scope 3 emissions, which are crucial for assessing a company's overall environmental impact. Despite efforts to include a diverse set of companies in the treatment group, unobserved differences between companies that issued green bonds and those that did not might influence the results. Additionally, variations in data accuracy and reporting practices could affect the study's conclusions. These limitations highlight the need for more comprehensive data and extended studies to fully understand the impact of green bonds on corporate environmental performance.

Regarding the case studies aimed at assessing the financial additionality of green bonds in funding green projects, the primary limitation lies in the dependence on Internal Rate of Return (IRR) analysis. This method relies on forecasts for key variables such as energy production, electricity prices, and operational costs. While sensitivity analysis was conducted to account for uncertainties, the projected caps and floors are not guaranteed, and these forecasts are susceptible to unforeseen factors like technological advances, regulatory changes, and market dynamics. Additionally, the analysis did not fully account for unexpected maintenance issues or operational challenges that could affect project profitability.

A specific limitation arises from using Monte Carlo simulation for the Hohe See and Albatros Wind Farms case study. While this method estimates a probability distribution of the IRR by assuming normal distributions for key variables, it may not adequately capture the complexities and potential non-normal behavior of these variables in real-world scenarios.

Furthermore, comparing the project's IRR to benchmark IRR ranges from other projects is limited because these benchmarks might not fully consider regional, technological, and temporal differences affecting project risks and returns.

Lastly, the emphasis on financial aspects as the primary motivator for investors, as outlined by the CDM Framework, overlooks other significant factors influencing investment decisions, such as environmental benefits, social impacts, long-term sustainability, and regulatory and policy incentives.

5.3 Contributions to the Literature and Practice

The empirical analysis utilizing a Difference-in-Differences (DID) methodology adds to the growing body of research by investigating the specific impact of green bond issuance on greenhouse gas (GHG) emissions among European companies. Although the study identified a general trend of decreasing GHG emissions, it did not find statistically significant evidence that these reductions could be directly attributed to the issuance of green bonds. This finding nuances the claims made by previous studies, such as those by Mao (2023) and Flammer (2021), by highlighting the complexity and limitations in measuring the direct environmental impact of green bonds. The study suggests that further research with extended time horizons and a focus on the quality of funded projects is necessary to fully understand the environmental benefits of green bonds.

Through case studies on the Hohe See and Albatros Wind Farms, the research explores the role of green bonds in providing financial additionality. By employing the Clean Development Mechanism (CDM) framework, as described by Carmichael, D. G., Lea, K. A., & Balatbat, M. C. A. (2015), the study reveals that green bonds were crucial for these projects, covering significant portions of the initial investment. Notably, this framework was originally applied to assess the financial additionality of revenue from carbon credits and had not yet been applied in research to green bonds to assess their financial additionality, making this study particularly interesting. This contribution is important in illustrating how green bonds can be pivotal in financing projects that might otherwise struggle to attract funding due to higher financial risks and uncertainties. The analysis also considers Gabor Gyura's (2020) perspective on financial additionality, recognizing that the necessity of green bonds might be overstated in some cases, thus offering a balanced view.

5.4 Suggestions for Future Research

Future research should focus on extending the analysis of green bonds' environmental and financial impacts, addressing the limitations identified in the current study. Specifically, further studies should consider longer-term data to capture the sustained effects of european corporate green bond issuance on greenhouse gas (GHG) emissions. This extended timeframe will help determine whether observed trends in emission reductions can be attributed to green bonds or other factors. Additionally, a closer examination of the quality and characteristics of the projects funded by green bonds is essential to accurately assess their environmental benefits.

Another important avenue for future research is to expand the application of the Clean Development Mechanism (CDM) framework beyond carbon credit revenues to systematically evaluate the financial additionality of green bonds. It could be highly interesting to generalize the application of this framework to different green bonds financing various types of green projects across different sectors. Since this framework has not yet been widely applied to green bonds, exploring its broader applicability could provide valuable insights into the conditions under which green bonds truly enable projects that would not have been financed otherwise. This would also help clarify the circumstances in which the necessity of green bonds is potentially overstated, as suggested by Gabor Gyura (2020)

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Annexes

Annex 1: Interview with a Wealth Management Actor at Rothschild & Co

Interview Date: 11 April 2024
Interviewer: Amina Abene
Interviewee: Wealth Management Actor at Rothschild & Co
Duration: 25 minutes and 28 seconds

Interviewer: (0:00) I'm going to start recording. Can you introduce yourself?

Wealth Management Actor at Rothschild: (0:11) I am a wealth management actor at Rothschild & Co, Wealth Management Belgium. My role involves supporting entrepreneurs and large Belgian families in managing their wealth by assisting private bankers with their daily portfolio management.

Interviewer: (0:36) Ok, understood, perfect. Could you explain how your work involves sustainable finance or the link it might have?

Wealth Management Actor at Rothschild: (0:46) There is a very significant link between what we do and sustainable finance, which simply comes through the fact that we invest—that's one thing, and the second thing is that we invest for clients. On the investment side, the link goes through investments in companies that take into account non-financial issues in their business. This generally involves three pillars, namely E, S, and G. In other words, today we have an offering called our 4Change offering, which considers non-financial issues.

In other words, we invest in companies that do not just aim for profit, but also include non-financial measures in their KPIs. That's one thing, that's on the investment side, and then for investors, that's the second thing, we serve, as I mentioned in the introduction, entrepreneurs and large Belgian families who sometimes are of a certain age, but who have wealth that passes from hand to hand, generally into younger hands.

Nowadays, we often deal with entrepreneurs who want to take into account non-financial issues and therefore want to invest in sustainable projects, in projects that are healthy at the

social or governance level. So, I would say there's an analytical side to ESG and there's a side of being aware of what's happening today for the type of clients we serve.

Interviewer: (2:46) Ok, understood, and could you explain what tools you use to analyze these shifts? Is it only for sustainable finance in terms of the environment or also for the social aspects?

Wealth Management Actor at Rothschild: (3:11) Just the environment. To explain a bit more, to go a bit deeper into our mandate for change, actually, there are many things. I will just introduce a bit about what this mandate for change is to then explain the tools I use.

This mandate starts from the premise that with the current regulation, notably the SFDR, Sustainable Finance Disclosure Regulation, something like that, we must provide clients who want to take non-financial issues into their decision criteria a mandate tailored to their needs. This means that today we have standards at Rothschild & Co, Wealth Management that are well established from the start, and these standards actually exclude certain sectors from the start.

That's in all our mandates that we give to our clients. So, to come back to your question on the tools used to analyze this, we have several tools. First, we have an in-house ESG scoring tool that allows us to assess companies based on their ESG criteria. This tool provides us with a score for each company that we can integrate into our investment decisions. In addition to this internal tool, we also use external ESG rating agencies to complement our analysis.

These agencies provide us with additional insights and perspectives on companies' ESG performance, helping us make more informed investment decisions. So, it's a combination of internal and external tools that allows us to effectively analyze shifts in sustainable finance.

Interviewer: (5:02) That's fascinating. It sounds like you have a robust framework in place for integrating ESG considerations into your investment process. How do you see the future of sustainable finance evolving, especially in the wealth management sector?

Wealth Management Actor at Rothschild: (5:16) Indeed, we believe that sustainable finance will continue to play an increasingly important role in the wealth management sector. As investors become more aware of the environmental and social impact of their investments, there will be a growing demand for sustainable investment options.

We expect to see more innovative financial products tailored to meet this demand, as well as greater transparency and reporting standards to ensure accountability in sustainable investing.

Overall, we are optimistic about the future of sustainable finance and its potential to drive positive change in the wealth management industry.

There are several sectors that are excluded, there are what we call normative exclusions, where it actually comes from the Oslo Convention, and here we exclude everything related to sectors in biological and chemical armaments, or a combination of both. We also exclude sectors again with weapons that produce cluster munitions, landmines, etc. We exclude companies that have practices that are not in line with the fundamental principles of human rights and labor rights, where there is corruption, we exclude. And then we have standards that are specific to Rothschild where, in fact, I will get to the tools, don't worry, but it's just to give an introductory framework, we have standards that are specific to Rothschild where we will exclude, for example, everything related to palm oil, GMOs, we will exclude thermal coal, etc. So, where I want to go with this is that I'm not an ESG analyst, so I don't have access to the tools that the people who are supposed to do that have. However, the tool that we have as portfolio managers, in quotation marks because we work with a partner called MSCI ESG Research. So, it's an independent actor, knowing that since 2017 we launched this change mandate, we chose the best independent actor in the market in our opinion, which was MSCI ESG Research, which is not a company that provides ESG advice, it's a company that sells itself as a risk manager in fact.

It's not a rating agency. It's a rating agency in the sense that it gives a rating to companies from 1 to 10 based on the non-financial criteria that the underlying companies integrate into their decision-making process, and these ratings are transformed into a slightly more qualitative scale ranging from triple A for the best companies to triple C for the worst. So, it's a rating, on the other hand a rating doesn't mean that one company is more sustainable than another. So, is it legal for them to say that or not? Basically, they market themselves as a risk manager, so that means that a company with a good rating has good risk management in terms of ESG controversies. But that doesn't mean it's more ESG.

The correlation is very high, the correlation is super high, but we can't say, even legally, we can't say that we have a data provider that allows us to give an ESG rating. That's a big difference. I'll give you an example, LVMH has many factories, especially in France, and LVMH's MSCI ESG Research rating was downgraded because it has too many factories in France.

So, you say it's surprising, why? Because in France there is more risk of protests, etc. So, that means that the business is partly at risk because we have factories in France. So, that's an example, that's the quintessential counterexample. Normally, ESG ratings aren't like that.

Normally, ESG rating downgrades with MSCI ESG Research are because you've had controversies. Last year, you had Shell which flooded rivers and farms in Nigeria because their pipeline was leaking. So, that's also an ESG downgrade, because there were controversies. Anyway, all that to say that we use that actor. That's at the Wealth Management level and at the Asset Management level, we have other tools. Personally, I'm not concerned, but we work with other partners who provide us with data that I couldn't mention.

And so, Rothschild sees MSCI as the best independent actor to work with. There was really a market study that was done. There were others in competition, we did a sort of call for tenders. That's the only partner we work with today. Afterwards, we have internal solutions. In particular, the Rothschild & Co group acquired the Redburn Atlantic group which is a data group, data crunching, and which also provides a lot of data.

Interviewer: (9:51) And financially, how do you perceive the risks associated with non-ESG investments compared to ESG investments?

Wealth Management Actor at Rothschild: (10:00) For me, today, I would answer the question by saying not investing in energy transition and in ESG today. Well, for me, there's no risk in doing it. But in fact, when you say risk, you mean risk in terms of performance, from a financial perspective, so return on investment. Again, again, you see, not doing it, not investing in this ESG side, it's a risk in terms of performance. Because as I was telling you earlier, if MSCI and ESG Research see themselves as a risk manager, it's because there's a reason, it's because companies that don't do it, that are not in this transition, have very strong market and speculation risks. You see, for example, I take Nestlé. Today, Nestlé, there have been a lot of controversies because they are not very active in this area. Look at last year, there was a controversy.

In 2021, in fact, they extracted water and they had it robbed with thermal coal and ultraviolet, which is totally forbidden, because they are supposed to take healthy water. So, you see that we no longer have the right to make mistakes today. A company no longer has the right to make a mistake if it doesn't want its stock market listing to be affected by the speculation that results from it. So today, for an actor like Rothschild & Co and a private bank, we must be in the energy transition.

Moreover, we, precisely, our mandate philosophy, I explained our exclusions, etc., but really the philosophy of the mandate for change is to accompany the best in class. What does that mean? It means that we are active in terms of investment in the most polluting sectors. That's our basic statement. On the other hand, we accompany the best students in each sector in their transition towards a decarbonized economy. I'll take an example. It's the quintessential

example Total. Total Energy, we have it in our portfolios. It can shock some clients, some prosperous people, anyone. So why would we put oil & gas, the oil & gas sector, in a portfolio that claims to be ESG? For the simple reason that Total Energy has a lot of activities in renewable energies. Total Energy is an actor in the energy transition. And if we want to invest in companies that are in this transition, we invest in Total Energy. When you look at their balance sheet for 2023, they have 54% less CO2 emissions than the sector average.

They invested 5 billion euros in 2023 in low-carbon energies, which is less than their investments in fossil energies, in the gas sector, in the oil sector... They want to reduce their greenhouse gas emissions in scope 1 and 2. I don't know if you're a little familiar with emission scopes. Scope 1, for a company, is everything that is direct at the workplace, at the headquarters. It can be heat in a room, it can be employees' company vehicles. Then, scope 2, it's going to be pollution via building electricity, because when you consume electricity, you don't pollute. On the other hand, you pollute from the gas plant that burned coal to generate electricity. Then, scope 3, it's all indirect, like your purchases of goods, etc. In short, Total Energy wanted to reduce by 30% compared to 2015, these scope 1 and 2 emissions, by 2025, and they are in transition. Anyway, all that to say that we accompany the best-in-class, the best students, in this transition towards a decarbonized economy. And so, to answer your question, not investing in this transition and in this economy, it's a risk. And doing it is a way to de-risk your business a bit.

Interviewer: (15:26) Do you think that sustainable investments are great ways to diversify portfolios ?

Wealth Management Actor at Rothschild: (15:38) It's a way to diversify your portfolio too, even if the return on investment is less interesting than others...

We, today, have chosen to have a classic mandate and a mandate for change. On the other hand, in the mandate for change, we are active in the most polluting sectors and we accompany them towards a transition. If you take for example the year 2022, if you didn't invest in energy, you took a scud between -10% and -15% on your portfolio. Compared to our competitors, our ESG mandate outperformed the market because we were invested in the energy sector. It's true that today there is a tendency to say that ESG mandates and ESG investment have lower performances, which is true. In fact, that's where you have to set the cursor as an investor to know that yes, I want to invest in ESG, but to what extent do I want to go in this philosophy. I think that the further you push the cursor, the less attention you pay to financial returns, but you pay more attention to social, environmental, and governance returns.

That's where we have discussions with our clients. We want to know if the client's primary objective is financial performance or energy, social, or governance performance. We have clients who say, for me, it's 50-50. In that case, indeed, we make decisions that may be less financially interesting, but which are more interesting from an environmental point of view. We are also able to provide ESG reports. We will take a portfolio for one of our clients. We will look at the portfolio temperature. When we talk about the environment, the most important thing, the critical factor, is greenhouse gas emissions that cause global warming. I'm simplifying, but that's how it is.

Portfolio temperature is the critical factor for someone who wants to improve the environment today. So the portfolio temperature, following Paris Agreement, it must, by 2050, be aligned with the fact that the increase in the average global temperature remains below 2% compared to the pre-industrial era, slash 1850, and optimally 1.5°C. So we are able to provide reports that say that your portfolio is at 1.4°C, in parentheses, in relation to the Paris Agreement. And clients appreciate it. We have two reports. We have the financial report with all the ROI, etc. And we have the ESG report. Some clients look at the ESG report as a priority. So to answer your question, it serves as diversification, but not for the same thing, not for finance. It serves as diversification for the cause of investment, in fact.

Interviewer: (22:45)What main criticism would you have for the current state of sustainable finance? — Or what potential improvements do you see?

If we take the CSRD, it evolves in the right direction because the spectrum is getting bigger and bigger. Before, it was mega-caps on the repayment side that were obliged to do so. Today, it's more and more companies, even SMEs, that are also on the repayment side. So I find that it's evolving well. When we look at ESG reports from certain companies, we see that they are making real efforts. And it's not greenwashing. However, there are some who do greenwashing. I won't mention any names, that's for sure.

On the other hand, my criticism today is that indeed, you have companies that use these extra-financial issues and may think they have a big impact on the E, on the S, or on the G level, but they don't. But it shows. The problem is that it shows. So my criticism would be more at the level of the companies themselves that invest, that say they invest in renewable energies. But in fact, they don't do anything. That's my criticism at the level of companies. On the other hand, I think that at the level of intermediary actors, everyone realizes who is a big actor and who isn't. So that means that as a private bank, for example, if you come to your client saying, I won't mention the name, but such a company is great in terms of G, you can't defend these people, it's impossible. So I think at the financial intermediary level, I wouldn't have any criticism to make, quite simply.

Interviewer: (25:28) Thank you so much for your time and valuable insights.

Annex 2: Interview with a Senior Research and Advocacy Officer at Finance Watch

Interview Date: 17 July 2024
Interviewer: Amina Abene
Interviewee: Senior Research and Advocacy Officer at Finance Watch
Duration: 22 minutes and 31 seconds

[00:00:14.560] - **Interviewer**

Thank you so much for giving a bit of your time for this interview. I will start with the first question on additionality. Could you tell me what is your definition of additionality and how it can be measured in regards to the green bonds ?

[00:00:17.850] - **Senior Research and Advocacy Officer at Finance Watch**

I think there are different definitions of additionality and how you can measure it. It will depend on what you want or how you define it as a broad term, because you could say either additionality is going to be, I want to have an impact with my investment, or I want to have an impact that would not have happened if I had used more traditional sources of funding. I think that will be the question, did my green bonds really change anything?

That's, I think, a big challenge that will go beyond the question of impact via the green bond, but more, I think, in the definition of impact finance. Because I think it's something that also happens also for the shares. If you're investing into shares, you can use a leverage from your power, let's say, as a shareholder to push the investing companies to take I would say more sustainable decisions/behaviors. By saying that, you could say, Well, if I'm voting in favor as an investor of more sustainable behaviors during the shareholder meetings, you could say, Well, I am having a good impact. The question is, does it really contribute to it? If I know that

when I'm voting in favor of sustainable behaviors, I know that already all the shareholders are going to vote for that. In that sense, you're not really changing anything. It's the game. On the contrary, you're voting in favor of sustainable behaviors because you know that all the other shareholders are going to vote against it. You know that in the end, your vote is not going to change or to contribute to any change.

In the context of bonds, I think there's something that is important to reflect on.

That's going to be, would it be profitable to invest, let's say, into the project through standard bonds. You can think of other ways, let's say, to finance it, like using blended finance or having green bonds that are leveraged, let's say, from blended finance, meaning private investments, but also public investments that can actually create some projects more bankable, more attractive for investors. That's probably one of the ways I would try to phrase it. I'm going in all directions, but now to maybe rationalize my initial idea, that would be to say, Okay, would the investment take place if it wasn't a green bond? Second point would be, was it also a catalyst to it? I will take some concrete examples, which I don't know where they stand at the moment, but I think it's what Proximus wanted to... Did issue, I think, a green bond in the context of the installation of Fiverr. You can wonder, would Proximus have done that investment without having a green bond? Is it just a catalyst?

Or, and that's also going to another extent. Even if they had installed it, maybe they're going to do it now in a greener manner. So maybe it's increasing the extent to which you make the project sustainable because you want to respect certain standards.

I'm going with some more complexity. We have a regulation that was recently approved last year. It's the EU Green Bonds Center regulation, which is leveraging the taxonomy. We will actually look into it because taxonomy is broadened in purely energy. But I I think that's going to be one of the potential drivers to say at the same time, it's not just that you want to invest into the green, but maybe you're going to increase your standards. In that sense, when we're talking of impact or additionality, maybe it can be additionality not into the type of investment, but to the standards that will be respected.

[00:05:54.040] - **Interviewer**

Thank you for the answer. I have the second question, but you mostly already responded to it. It's, in your opinion, how effective have green bonds been in driving sustainable investment and achieving environmental outcomes compared to traditional financing methods and conventional bonds.

[00:06:34.510] - **Senior Research and Advocacy Officer at Finance Watch**

The issue is that the EU Green Bonds Standard Regulation will not apply to all the green bonds. It's only one specific, let's say, I would say top standards. We can call it that way.

The framework is very specific. It's also limited, I will say, to some extent to the EU only, which to me is also not a big issue because it's maybe not where the funding is the most difficult for the green projects because it's relying on taxonomy, and we can come to that a bit later. At the same time, the framework as it existed before the EU Green Bon Standard regulation, there was no minimum requirements. Some of them may decide to be reviewed externally, so you may have a reviewer, like a big four, for example, who's going to check whether the initial commitments are respected. But there are very limited standards, let's say, that have to be respected. And somehow a green bond may not be so green if it's not a new green bond, let's say and that new standard does not apply yet. We need to check the date of application.

[00:07:40.830] - **Interviewer**

It's in December 2024.

[00:07:43.240] - **Senior Research and Advocacy Officer at Finance Watch**

It's coming soon. And I think in that context, it makes it very difficult now to assess what is really the final impact as of today. The question will be probably how many green bonds are switching into an EU green bond, let's say, by that time.

[00:08:01.330] - **Interviewer**

Then what do you think about the green bond principles?

[00:08:26.210] - **Senior Research and Advocacy Officer at Finance Watch**

I will not position on it because I don't know in detail the different standards that exist already. If you look, for example, for the, we'll call it the Chinese taxonomy. This is not the right word, but it's true. I mean, this is how we call it, let's say that. Usually, for example, in China, and not only in China, I think it also applies in Hong Kong, if I'm not wrong, they developed standards themselves for green bonds. That is already different. I think there are very different frameworks. I think it's good to have, let's say, some voluntary frameworks that are being developed. I think it's voluntary. It will certainly help to increase the transparency But certainly the question will always be, where do you put the bar? Do you put it really high as we did for the EU Green Bonds Standard Regulation? Or do you put rather low and you put some minimal minimum requirements for all the green bonds. I think they should be probably two of them to some extent. And that's actually something that we are missing in the EU

Green Bonds Standard Regulation. Because even in terms of transparency, and that's probably another limit, you have very diverse ways, let's say, to report on the impact of your EU Green Bonds.

In the EU Green Bonds Standard Regulation they mandated, it's the Commission who will issue guidelines for templates. Templates because it's not really requirements, but indicative templates, let's call it that way, for non-EU green bonds that are green bonds. In that sense, they're promoting, let's say, transparency, but not making it comparable. I think it's still quite difficult today in most of the standards to have a good understanding of what will be the additionality of the green bonds because they don't all respect the same standards. Maybe they can be based on different transparency requirements, but I think in most cases, they are more voluntary. So that will be an issue.

[00:12:25.460] - **Interviewer**

Okay. And in your opinion, what are the different ways in Europe that are used by corporations in order to market and brand their bonds as green?

[00:12:54.630] - **Senior Research and Advocacy Officer at Finance Watch**

When you say marketing, you mean how they manufacture the green bond or how they promote it?

[00:13:02.800] - **Interviewer**

How do they label it as a green bond?

[00:13:08.480] - **Senior Research and Advocacy Officer at Finance Watch**

In all honesty, I haven't done a real market review of it, so I will probably just give some, I will say, ideas. I would rather say it that way. Usually, I think they're going to try to set, let's say, some internal minimum standards that they're just going to include, let's say, in their own policies, let's say. Usually, they will already have quite concrete projects for it. I'm thinking I was mentioning Proximus. Proximus knew that the green bonds that they were going to issue were going to be to finance the fiber, the move to the fiber. Certainly, it will depend on the activities, and also it will probably depend on what type of institution is issuing the bonds. Is it, for example, Argentina? I think it was back in 2022, they issued green bonds. I don't know what was going to be the use of the proceeds. I suppose that was probably going to be related to mortgage loans, I suppose, but I am not sure. But probably for them, it was maybe more difficult to really know exactly where they were going to invest. So some corporates who have very specific needs and who know in what projects they want to invest the proceeds of

the green bonds, will most probably make it being aligned with what they know they want to achieve.

The taxonomy is certainly one of the big criteria that is going to be used, I think, within the EU. But at the same time, some may also decide to be more related to the “do not harm” principle, I would say, and that they will just, let's say, with the green bonds, try to be more general, let's say more generic, without knowing yet exactly what they're going to invest. Maybe that would be the case for financial institutions who will not be certain yet into what they're going to invest.

[00:15:29.710] - **Interviewer**

And what will be the impacts of the European Green Bond standard when it will come into play?

[00:15:48.830] - **Senior Research and Advocacy Officer at Finance Watch**

I think it's still difficult to know. I think there will be different challenges when it will be implemented. The first one is the access to the data. The problem is that the taxonomy is not yet fully applicable at the moment. It applies since this year to both financial institutions and non-financial institutions, if I'm not wrong. They had to publish it, but they had to publish it based on only two objectives: climate change mitigation, climate change adaptation. There are four other objectives into the taxonomy. We have a circular economy, we have pollution, water, and biodiversity. So the more the scope is going to be extended, the easier it will be, let's say, to use the green bonds. At the same time, you also are going to have more and more companies that will be reporting under the taxonomy. At the moment, it's companies that are reporting under NFRD, so Non-Financial Reporting Directive. As from next year, it will be CSRD, the Corporate Sustainability Reporting Directive. CSRD will itself extend the scope. It means that more and more companies are going to report under it.

In that context, I would say today it has limitations due to the fact that it only finance the bigger institutions. Meaning the moment we're talking of 500 employees and 50 million of revenue, I think, and 25 million on the balance sheet. Or the contrary, I always mix the two of them. I think the value in that sense can be limited because you are going to finance bigger companies that may have less struggle to already obtain the funding to move to the transition

The second point I was mentioning, the EU Green Bonds Standard Regulation, or the taxonomy applies to the EU companies, at least to a certain extent. What does that mean? It means that African companies, companies in South America, for example, or the Americas, are going to not be so much helped to find financing with green bonds that are following the

EU green bond standard because they are not reporting under the EU. It may not serve that purpose also of financing the transition for non-EU companies. And once again, it may be those companies that may struggle the most to find the financing

Third one is, of course, the question of to what extent there is not going to be, I would say, a bit of greenwashing. For example if you say: I'm just going to take, let's say, the investments I had planned. I will package them as a green bond, and I will then just promote the fact that I have issued green bonds, even if on the side, I'm using my standard bonds, let's say, for financing all the crap that I'm still doing. That's certainly going to be a question mark and that requires also revision of the impact of the EU Green Bonds Standard at certain points.

The difficulty when you want to assess that impact, as I mentioned, is that you cannot really see... It's very difficult to assess the impact that you are going to have because you will anyway expect that on the one hand, the companies will increase their reporting, let's say, under the taxonomy. Somehow you will say, well, taxonomy alignment is increasing. It's good, but it may not be because of the green bonds, that's the first point. The second point, they may also effectively increase, not just under the reporting, but they may effectively increase the part of taxonomy-aligned activities. But it may also be due to the fact that there are other regulations that will apply. For example, construction of new buildings. There are some requirements that are now as stringent as the taxonomy is in terms of energy performance. In that context, you could also say Well, then maybe it's not the green bond that really helped it, but this is just a normal transitioning.

To finish, and I should also have mentioned that earlier, you may also decide to issue green bonds to benefit from what we call the greenium. The greenium is the lower interest rate that issuer have to pay, because you have more attractivity, so sustainable investors may be more attracted by green bonds, and so you can lower the percentage of interest rate. So that's another element that I think would have to be considered.

[00:22:31.040] - **Interviewer**

Perfect. Thank you so much for your time and valuable insights.