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MASTER THESIS

THE GREENIUM EFFECT IN GREEN BOND FINANCING	ŽALUMO PREMIJOS EFEKTAS ŽALIŲJŲ OBLIGACIJŲ FINANSAVIME

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INTRODUCTION

In recent times, the global focus on corporate environmental governance and social responsibility by market participants, policymakers and regulators has significantly increased. The fields of Environmental, Social, and Governance (ESG), Socially Responsible Investing (SRI), Impact Investing and other themes of sustainability have emerged as a prominent area of research. Specifically, the influence of ESG performance on corporate value has received considerable attention. Some stakeholder models are introduced that demonstrates how focusing on maximizing the overall value of a firm, rather than solely on shareholder value, leads to a more sustainable equilibrium (Magill et al., 2015). Although there remains a gap in empirical evidence regarding the benefits to firms from enhancing non-financial facets of their corporate operations, such as ESG aspects, use of classic financing instruments, adjusted towards sustainable development of the company, are gaining increased pace of popularity. Such instruments - green bond - over the last decade has clearly established its role as an instrument of the future.

Climate change stands as one of the most critical challenges at a global scale in our times. The Paris Agreement, adopted in December 2015 and effective from November 2016 following ratification by 196 parties, recognizes the essential role of innovation in tackling climate change. The primary objective of this agreement is to keep the global temperature rise to 1.5°C above pre-industrial levels. Achieving this goal is crucial for substantially minimizing the risks and adverse effects associated with climate change (Paris Agreement, 2015).

Relevance of the Topic

In the current financial landscape, the integration of ESG criteria into investment decisions is not just a trend but a fundamental shift in investor expectations and corporate accountability. Green bonds, representing a tangible commitment to environmental sustainability, have seen a meteoric rise in popularity and acceptance. This surge is further amplified by global commitments like the Paris Agreement, which underscores the urgency of addressing climate change and its far-reaching impacts. The exploration of green bonds within the framework of sustainable finance is not only academically enriching but also crucial for stakeholders including policymakers, investors, and corporate leaders.

This thesis delves into an intriguing and increasingly relevant field within the domain of sustainable finance. This area has gained significant momentum in the wake of growing environmental concerns and the pressing need for corporate accountability in environmental governance. At the heart of this evolution is the concept of green bonds, a novel financial instrument designed to fund projects with

environmental benefits, which has witnessed a meteoric rise in popularity since the European Investment Bank issued the first green bond in 2007.

Green bonds are a type of fixed-income security, issued by entities seeking to raise capital specifically for projects that are environmentally beneficial. These projects can include renewable energy, sustainable water management, pollution prevention, climate change adaptation, and other similar initiatives. As the world grapples with climate change and environmental degradation, the role of green bonds has become more pivotal. This surge in interest is partly due to global agreements like the Paris Agreement. These international commitments, coupled with a variety of regulatory frameworks across countries, have significantly shaped the green bond market, influencing financing practices in corporate, municipal and governmental towards a more sustainable path.

The relationship between green bonds and sustainable finance is particularly fascinating. Green bonds represent a tangible manifestation of ESG criteria that are increasingly guiding investment decisions. They offer a pathway for investors to contribute to environmental sustainability while potentially reaping financial rewards. However, assessing and certifying green bonds present unique challenges, including the need for reliable methodologies and the establishment of universally accepted standards. This aspect is crucial in ensuring the integrity and effectiveness of green bonds as tools for sustainable development.

Level of Exploration of the Topic

Despite the growing importance of green bonds, there remains an evident gap in empirical research, particularly concerning their impact on the cost of capital both for corporates and governments. Numerous contemporary research studies provide a spectrum of findings regarding the green bond premium. Some studies report obvious greenium in the yields of green bonds compared to their conventional counterparts, reflecting a lower cost of borrowing for issuers (Ehlers & Packer, 2017; Febi et al., 2018; Kapraun et al., 2019; Karpf & Mandel, 2018; Li et al., 2022; Wu, 2022). These investigations have adopted methodologies such as matched pair analysis and have considered the intricacies of both primary and secondary markets. Nevertheless, the presence of a greenium has not been universally substantiated, with some studies (Hachenberg & Schiereck, 2018; C. Y. Huang et al., 2023; Larcker & Watts, 2019; Partridge & Medda, 2020a; Zerbib, 2018) suggesting it is either nominal or non-existent, particularly in the primary market where the bond issuance occurs.

This thesis intends to delve into the complex dynamics of the green bond market by scrutinizing the empirical evidence of greenium specifically at the time of issuance, quantifying it and observing its dynamics through time. In essence, while the theoretical underpinnings of green bonds as instruments

of sustainable finance are well-established, this thesis identifies a gap in the empirical assessment of their direct impact on company valuation.

Novelty of the Master Thesis

The novelty of this research lies in its empirical approach to examining the impact of green bond issuance on the cost of capital. By combining theoretical insights with practical case studies, this thesis introduces new dimensions to the understanding of green bonds in sustainable finance. The focus on "greenium" – the potential for a lower cost of capital for green bond issuers – and its implications on a company's Weighted Average Cost of Capital (WACC) and overall market valuation, marks a significant contribution to the field. The exploration of how green bonds affect cost of capital not only contributes to the academic discourse but also provides valuable insights for corporate decision-makers and investors. Incorporating case studies and empirical evidence on companies that have issued green bonds will enrich the thesis, offering a practical lens through which to view the theoretical concepts discussed. This approach will illustrate the real-world impact of green bonds on financial performance and market valuation, providing a clearer understanding of their role in the contemporary financial landscape.

The research conducted in this Master Thesis served as the foundation for the presentation titled "Cost of Capital Dynamics: The Role of Green Bonds in Corporate Financing" (Peciukevičius T., 2024) at the International Conference on Accounting, Audit and Analysis, themed "The Modern Economic, Technological, and Societal Trends: New Challenges or Opportunities".

Problem of the Master Thesis

The central question this thesis addresses is whether the issuance of green bonds has effect on cost of capital through lower borrowing costs compared to traditional bonds. This inquiry is pivotal in understanding the tangible benefits of green bonds for issuers and their position in the financial market.

Purpose and Objectives

The main aim of the Master thesis is to determine whether issuance of green bond bring value to company through lower borrowing cost compared to issuance of regular bonds.

To achieve this aim, the following objectives are set:

1. Review the literature about the growing importance of sustainable finance and market development of green bonds and discuss its relevance to cost of capital to corporates and governments.
2. Construct a methodology to investigate the relationship between green bond issuance and cost of capital.
3. Relying on built methodology, conduct a study to analyse and describe results and discuss limitations, suggest improvements for future work.

Methodology

The research adopts a yield curve analysis approach to evaluate the impact of green bonds on cost of capital. This methodology involves constructing yield curves for conventional and green bonds, analysing differences in yields to identify the presence of a green premium. The yield curve analysis provides a comprehensive overview of the bond's performance relative to prevailing market conditions and enables the assessment of green bond yield dynamics over time. Additionally, an extensive review of relevant literature and data collection on green bond issuances will be conducted to provide context and support for the analysis.

Structure of the Master Thesis

The thesis is structured to systematically explore the topic. Following this introduction, the literature review provides a detailed background on sustainable finance and green bonds. The methodology section outlines the research approach, followed by an analysis of the data and case studies. The thesis concludes with a discussion of the findings, implications for various stakeholders, and suggestions for future research.

1. THEORETICAL CONCEPTS OF SUSTAINABLE FINANCES AND ITS EFFECT TO COST OF CAPITAL

In this section existing literature is explored, which relates to sustainable finances and green bonds, how it potentially affects cost of capital, and "greenwashing" as a negative outcome of overpromise to the market.

1.1. Concept of the Sustainable Finance

The concept of sustainable finance has evolved significantly over recent years, gaining traction within both academic and financial circles. Sustainable finance could be described as the integration of environmental, social, and governance issues into financial decisions (Edmans & Kacperczyk, 2022), reflecting an increased awareness of the long-term impacts of financial activities on society and the environment. Unlike conventional finance, sustainable finance seeks to integrate all parts of ESG and climate change variables into financial institutions' business strategies (Kashi & Shah, 2023). (Migliorelli, 2021) defines sustainable finance as finance that seeks to deploy financial capital to economic sectors or activities that are more likely to generate and/or reinforce positive economic, environmental, and/or social impacts. The issue regarding how economic activities affect nature and social structures has been a topic of discussion for many decades (Migliorelli & Dessertine, 2019). The relevance of the topic increases at an exponential pace. The concept of sustainable finance is predominantly utilized by those involved in the political oversight, regulation, and macro-management of the financial sector (Kuhn, 2022). The fundamental idea driving this concept is the recognition that transitioning to sustainability demands substantial investments. To shift investments, for instance, from fossil fuel industries to clean technology sectors, political direction is required, along with the implementation of new laws and regulations, and a range of incentives and support.

From the broader society perspective *responsible finance* and *responsible investment*, *green finance*, *ethical investment*, and *impact investment* terms are usually used to define investment impact. The term *responsible investment* is more popular among investors and companies (M. Zhou, 2022).

Another critical aspect of sustainable finance is the role of ESG ratings. (Berg et al., 2022) raise concerns about the divergence of ESG ratings, pointing out inconsistencies in how these ratings are determined and their subsequent impact on investment decisions. Such discrepancies can lead to challenges in accurately assessing the sustainability of financial products and instruments. This highlights a need for standardized, transparent criteria in ESG evaluations, as discussed by Marquis,

Toffel, & Zhou (2016), who explore the global phenomenon of "greenwashing" – misleading claims about the environmental benefits of a product or service.

The growth of sustainable finance has led to the development of various policy and regulatory frameworks aimed at guiding and encouraging the issuance of sustainable financial products. The Green Bond Principles (ICMA, 2018) serve as voluntary process guidelines for issuing green bonds, emphasizing transparency and disclosure. Similarly, (Zetzsche & Anker-Sørensen, 2022) discuss the regulatory landscape surrounding sustainable finance, underscoring the importance of regulatory clarity in fostering the growth of sustainable financial markets.

One critical dimension of sustainable finance is the growing interest in sustainability-linked bonds (SLBs). Unlike green bonds, which are dedicated to specific environmental projects, SLBs are more flexible, allowing companies to commit to overall sustainability performance targets. These instruments, as discussed by (Schumacher, 2020), link the financial terms of the bond to the achievement of predetermined sustainability objectives, thus integrating a company's overall sustainability performance into its financing strategy (Ahmed et al., 2024).

Furthermore, the rise of sustainable finance has prompted a significant shift in investor behavior. Investors are increasingly considering the long-term sustainability of their investments and are showing a heightened interest in companies that demonstrate strong ESG performance. This trend is highlighted by studies like those of (Friede et al., 2015), which found a positive correlation between ESG performance and financial performance, suggesting that integrating ESG criteria into investment analysis can potentially lead to better investment returns.

Another emerging aspect in sustainable finance is the role of financial technology (FinTech). FinTech innovations are playing a crucial role in enhancing transparency and efficiency in sustainable finance, and sector development can significantly boost green bond issuance (J. Huang et al., 2024). Technologies like blockchain and AI are being leveraged to track and verify the impact of sustainable investments. These technologies provide new ways to measure, monitor, and report on the social and environmental impact of investments, which is critical for the credibility and growth of sustainable finance.

A pivotal component of sustainable finance is the issuance of green bonds. (Baker et al., 2018) and (Bhutta et al., 2022) emphasize that green bonds are designed to finance or refinance projects that yield environmental benefits, such as renewable energy, energy efficiency, sustainable water management, and clean transportation. Green bonds offer environmental advantages to market

participants (stakeholders), allowing them to make a direct contribution to the global environmental efforts through the purchase or issuance of these bonds (Bhutta et al., 2022).

1.2. Green Bonds

International Capital Market Association defines green bonds as any type of bond instrument where the proceeds will be exclusively applied to finance or refinance, in part or in full, new and/or existing eligible Green Projects and which are aligned with the four core components of the Green Bond Principles (ICMA, 2018). The difference between green and conventional bonds rests in the issuer's commitment to dedicating the proceeds from the bond to investments that yield environmental or climate benefits (Löffler et al., 2021). However, the bondholder typically does not take on the risk associated with the environmental project; instead, they usually have full recourse to the issuer's balance sheet. As a result, the fundamental risk factors for conventional and green bonds from the same issuer are presumed to be similar, including the issuer's default risk or a liquidity premium. In the context of bond issuance, issuing green bonds requires issuers to conduct standardized screening of green projects to determine whether the proposed project qualifies under the green bond framework and meets certain identification criteria (Shi et al., 2023).

The inaugural green bond, termed a "climate awareness bond," was issued by the European Investment Bank (EIB) in 2007. Since then, the green bond market has seen significant growth, not only in terms of the total amount issued, but also in its diversity and reach. The geographical scope of the green bond market has been expanding, along with a broadening range of bond types.

Back in December 2016 Poland was the first to issue the world's first green sovereign bond, a milestone soon followed by France in January 2017. In the same year, the United States government agency Fannie Mae issued a record-breaking $24.9 billion USD in green mortgage-backed securities (MBS), the largest to date. June 2017 marked another milestone with Malaysia introducing the world's first green Islamic bond, or "green Sukuk", aimed at financing climate-resilient growth.

The variety of issuers in the green bond market has also significantly increased. This includes supranational organizations like the World Bank and the International Finance Corporation (IFC), development banks such as the Asian Development Bank (ADB) and the African Development Bank (AfDB), commercial banks including Bank of America and HSBC, non-bank financial institutions like Real Estate Investment Trusts (REITs) and corporations such as Apple, Inc., and Tesla. This expansion in issuer types reflects the ever-growing interest and commitment across different sectors and geographies to finance environmentally sustainable projects.

Below is a statistical review of green bond issuance since 2014. It is based on Climate Bonds Standard v4 methodology, developed by Climate Bonds Initiative (CBI), an international organization working to mobilize global capital for climate action.

Focus on sustainable finance and high demand for such products helped to create exponential growth not only in green bonds, but also newly developed financing solutions. As depicted in Figure 1, despite the recent sudden increase in base interest rates, the global green bond market avoided a decline in the issued amount.

Figure 1

Green bond issuance globally by year
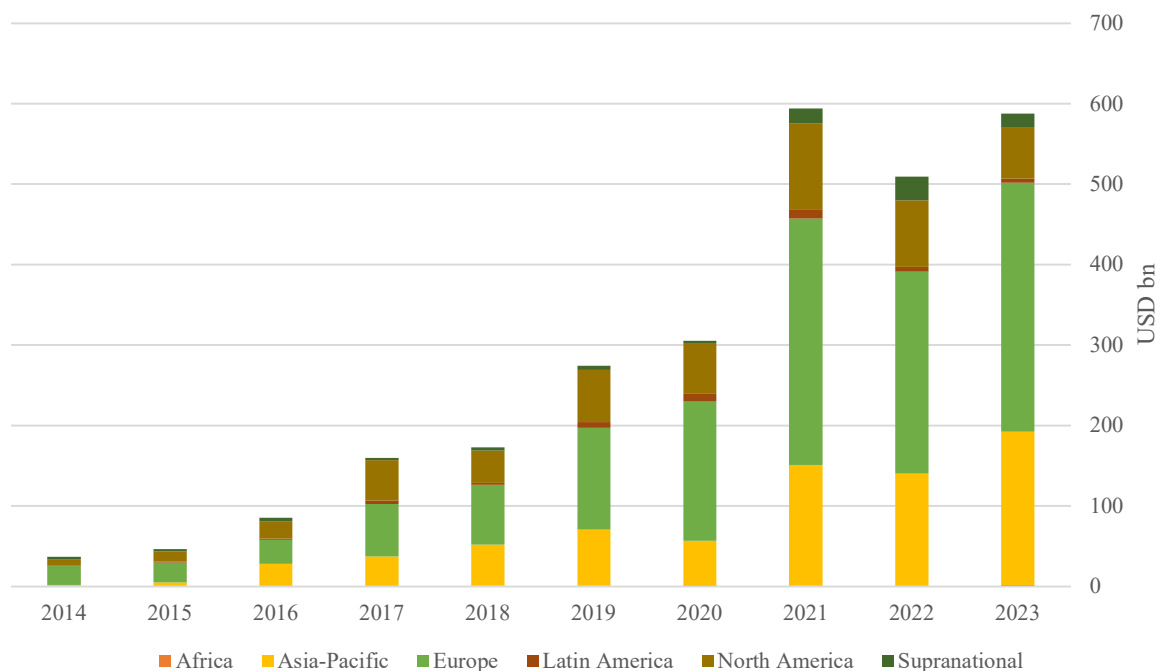
Source: Climate Bonds Initiative, data extracted 2024.03.15

In 2023, the issuance volume reached USD 587.6 billion, marking a 15% increase from 2022. This growth is indicative of heightened awareness and investment in projects aimed at mitigating climate change. Europe's dominance in this market can be attributed to strong regulatory frameworks and ambitious climate policies, which correlates with the increasing adoption of green finance practices and policies such as the EU Green Deal.

Asia-Pacific has shown remarkable growth, particularly from 2016 onwards. This rapid increase is driven by major economies like China, which have heavily invested in green bonds to support their

extensive infrastructure and renewable energy projects. The chart underscores Asia-Pacific's crucial role in the global green bond market, reflecting its transition towards sustainable development.

North America's green bond market experienced growth but has been more volatile compared to Europe and Asia-Pacific. This volatility can be partially explained by differing political and regulatory environments across the United States and Canada, affecting the consistency of green finance initiatives.

Figure 2

Green bond issuance by market
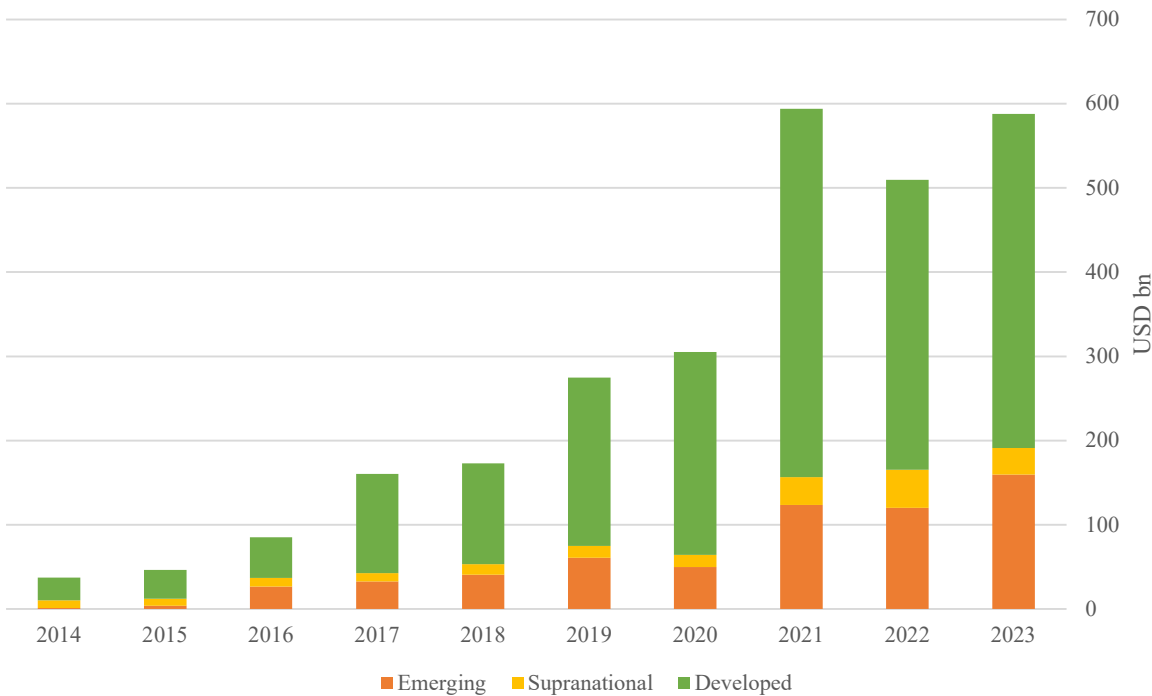
Source: Climate Bonds Initiative, data extracted 2024.03.15

Latin America and Africa, while showing growth, remain smaller players in the green bond market. Their issuance volumes have increased, indicating a growing recognition of sustainable finance's importance. However, the lower volumes compared to other regions suggest that there are still significant barriers to entry, such as economic instability and less developed financial markets. This well corresponds to data in Figure 2. Dominance of developed markets is likely due to established financial markets and regulatory environments that are conducive to green bond issuance. Developed markets also have the financial resources and investor demand necessary to support large-scale green bond initiatives.

Emerging markets have shown impressive growth in green bond issuance, particularly from 2016 onwards. This growth reflects increasing awareness and commitment to sustainability within these markets. It also suggests that emerging markets are starting to leverage green bonds as a tool to finance sustainable development projects, which is critical given their significant infrastructure needs and vulnerability to climate change. Supranational issuers, which include entities like the World Bank and the European Investment Bank, play a crucial role in the green bond market. These issuances are vital for supporting large-scale, cross-border green projects and providing a benchmark for other issuers.

Figure 3

Green bond issuance by issuer type
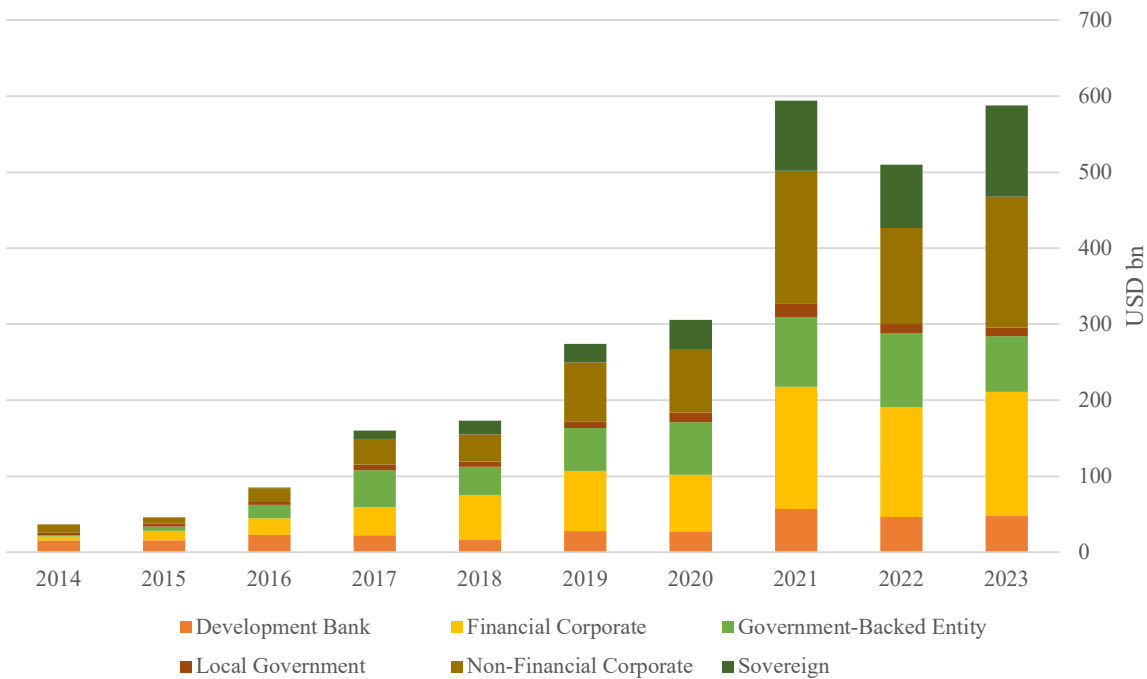
Source: Climate Bonds Initiative, data extracted 2024.03.15

The data in Figure 3 reveals significant growth across various issuer categories, highlighting the broadening adoption of green finance. Development banks and government-backed entities have consistently supported large-scale sustainable projects, with financial and non-financial corporates showing dramatic increases in issuance, reflecting heightened commitment to sustainability driven by regulatory pressures and investor demand. Sovereign issuers, starting significantly in 2016, have become crucial in setting market benchmarks and mobilizing large-scale funds, particularly notable during the post-pandemic recovery period. Local governments, although growing steadily, still face barriers like limited financial capacity. Furthermore, the private sector's robust participation,

especially from non-financial corporates, underscores a broadening engagement in sustainable development initiatives. Overall, the diverse and increasing participation across all issuer types underscores a maturing market essential for addressing global sustainability challenges comprehensively.

Figure 4

Green bond issuance by use of proceeds
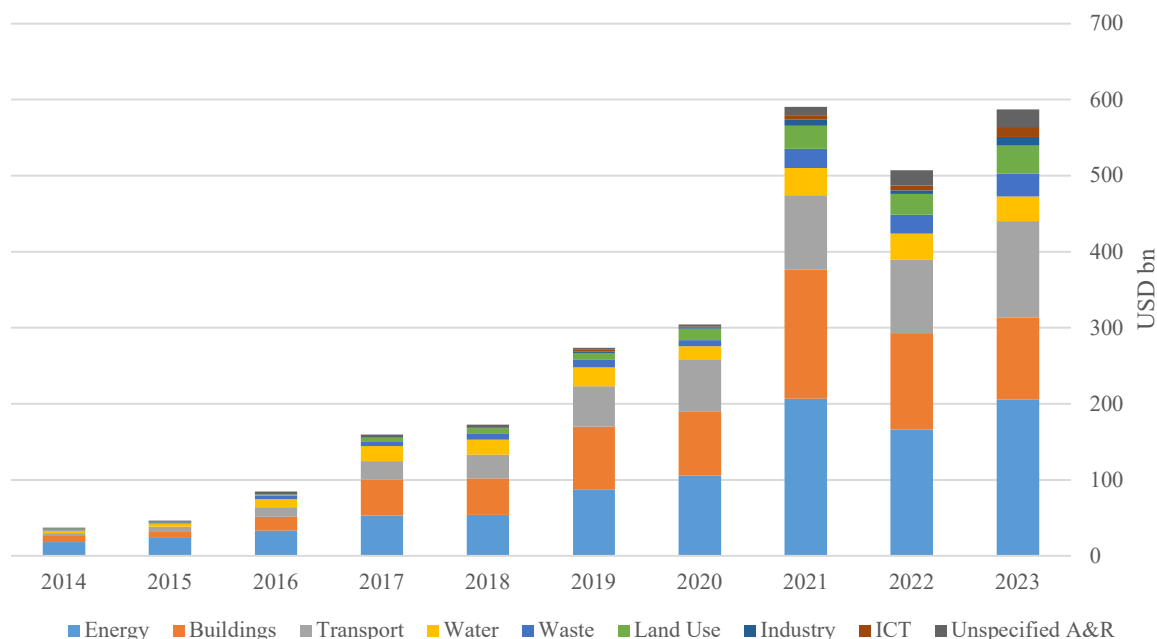
Source: Climate Bonds Initiative, data extracted 2024.03.15

The data on the use of proceeds (Figure 4) highlights the fact that the energy sector consistently leads in green bond allocations, reflecting global priorities in transitioning to renewable energy sources, with a notable peak at USD 206.7 billion in 2021, which was almost repeated in 2023 with USD 205.7 billion. The buildings sector also shows substantial growth, peaking at USD 169.6 billion in 2021, driven by investments in energy-efficient constructions and retrofitting. Transport sector investments have steadily increased, reaching USD 126.8 billion in 2023, indicating a robust commitment to sustainable mobility solutions. Water-related projects have seen moderate but consistent funding, peaking at USD 35.9 billion in 2021, underscoring the importance of sustainable water management. Waste management and land use sectors have shown significant growth, particularly in recent years, with land use peaking at USD 37.1 billion in 2023, highlighting the increasing focus on sustainable agriculture and forestry. The industry and ICT sectors, although smaller, have also started to receive more attention, reflecting broader efforts to integrate sustainability across all sectors. The category of

unspecified adaptation and resilience (A&R) projects has seen notable growth, especially from 2021 onwards, indicating a rising awareness and need for climate adaptation measures. This diversified allocation of proceeds illustrates the comprehensive approach needed to address various facets of sustainability and climate resilience through targeted green investments.

The Euro (EUR) and US Dollar (USD) are the leading currencies for green bond issuance. The predominance of the Euro can be attributed to the European Union's strong regulatory support for green finance and its role as a global leader in climate action. The significant volume in USD reflects the global reach of the US financial market and its attractiveness to international investors. Chinese Yuan (CNY) issuance has also seen significant growth, particularly from 2016 onwards (Figure 5). This trend underscores China's commitment to green finance as part of its broader environmental and economic policies.

Figure 5

Green bond issuance by currency
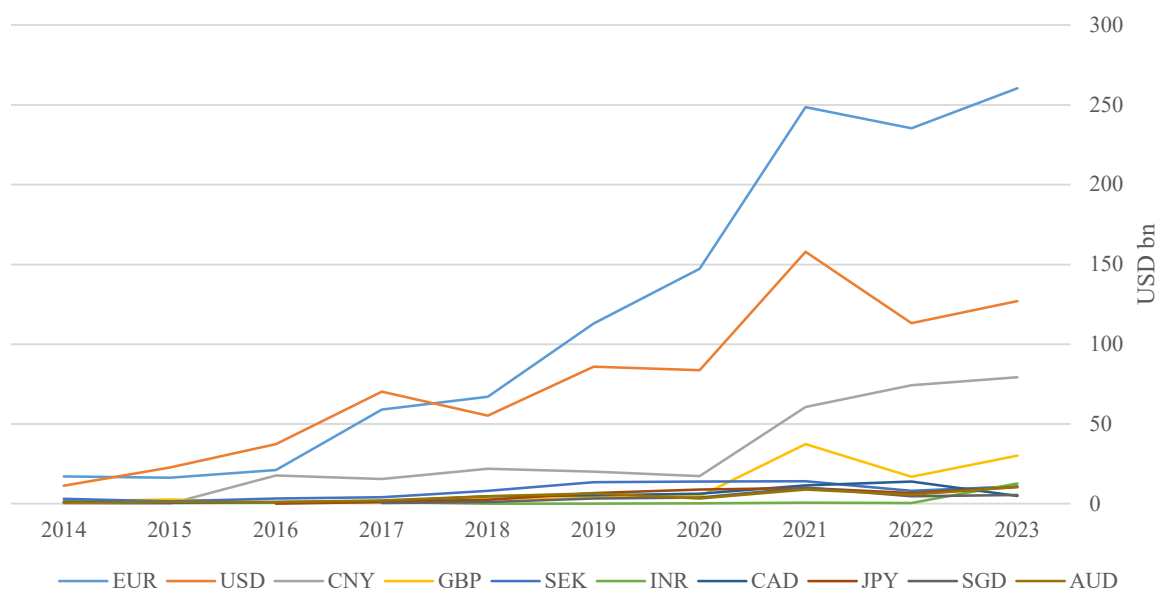
Source: Climate Bonds Initiative, data extracted 2024.03.15

The data in Figure 6 shows a clear trend towards larger deal sizes over time. This shift indicates increasing confidence and investment in green projects. Large deals (over USD 1 billion) have become more common, suggesting that significant capital is being mobilized for substantial projects such as large-scale renewable energy installations and sustainable infrastructure developments. Smaller deals (under USD 100 million) have been stable in nominal terms, but indicating that green bonds are being utilized for a variety of projects, including those at a smaller scale. This

diversification in deal size is essential for ensuring that green finance can support a wide range of initiatives, from local community projects to major international developments.

Figure 6

Green bond issuance distribution by deal size
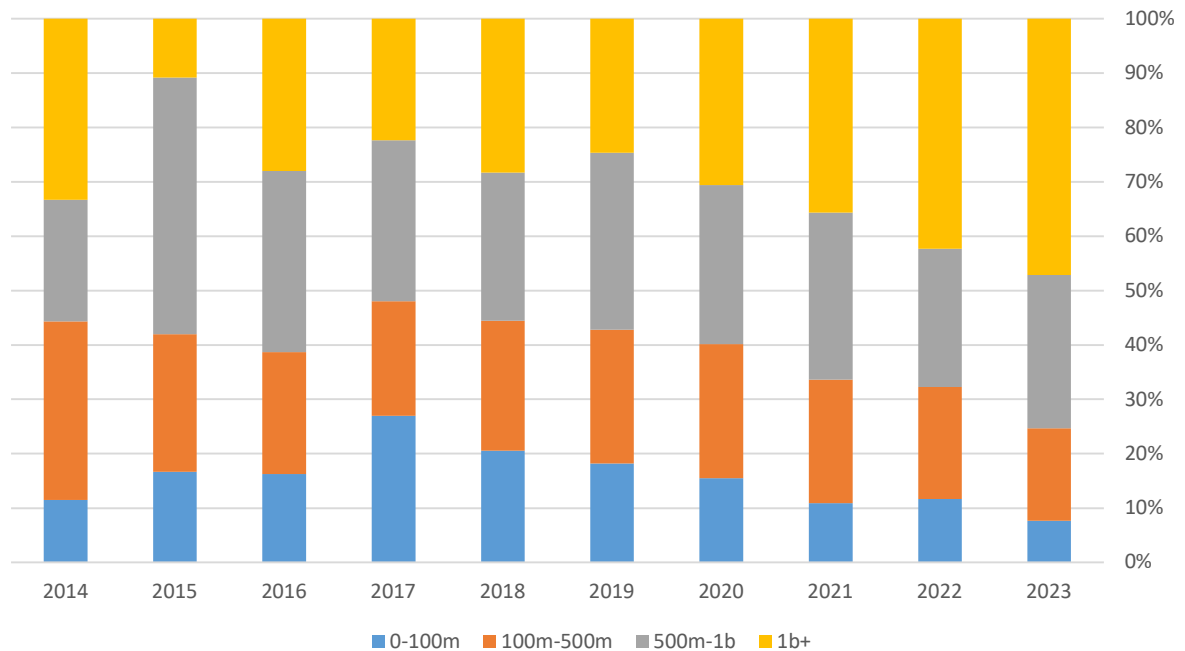
Source: Climate Bonds Initiative, data extracted 2024.03.15

The increasing adoption of corporate green bonds as a financial tool is notable, yet there remains a limited understanding of this relatively new instrument. On the surface, the preference for issuing green bonds over conventional bonds might seem counterintuitive, given that green bonds require the proceeds to be allocated specifically to environmentally beneficial projects, thereby limiting the range of investment options for the issuing company. Additionally, obtaining the status of a "certified" green bond involves third-party verification to ensure the funds are used for environmentally impactful projects, leading to extra administrative and compliance expenses (Flammer, 2021). Considering these restrictions, one might argue that it would be more advantageous for companies to issue conventional bonds and then choose to invest in green projects only if they offer greater financial returns compared to other investment opportunities.

Green bonds typically involve extra transaction expenses due to the requirements for tracking, monitoring, and reporting on the allocation of funds. However, these initial costs are frequently balanced out by the benefits of showcasing their environmentally friendly assets or operations

(Cusano et al., 2024). This can create favourable marketing narratives, expand the diversity of their investor pool, and facilitate partnerships with other companies.

From the perspective of the issuers, green bonds offer several advantages. Firstly, they can broaden the range of ownership, allowing issuers to tap into a wider and more diverse investor base. This expansion is particularly relevant as global awareness of environmental issues grows, attracting investors who are keen to support sustainable initiatives (Lin & Su, 2022). Additionally, issuing green bonds might enable entities to secure capital at a lower cost compared to conventional corporate bonds. This cost benefit is often attributed to the growing demand for sustainable investment options among investors. Furthermore, green bonds can sometimes offer a longer tenor, providing issuers with more extended periods for repayment, which can be particularly beneficial for long-term environmental projects (Tang & Zhang, 2020).

For investors, green bonds represent an opportunity to align their investments with their environmental values and objectives. These bonds can be an essential part of fulfilling a green mandate, where investment strategies are geared towards sustainability and environmental responsibility. Investing in green bonds also assists investors in boosting their ESG score, a metric increasingly used to evaluate an organization's ethical impact and sustainability practices (Zaghini, 2024). This aspect is particularly appealing to institutional investors, who are often under pressure to demonstrate their commitment to responsible investment practices.

While the ICMA Green Bond Principles have emerged as the primary framework for issuing Green bonds, and the European Commission has proposed EU Green Bond Standards, adhering to these guidelines remains optional. Additionally, a unified framework for choosing eligible projects or for reporting has not been established.

1.3. Greenium as a Product to the Lower Financing Cost

Most of the research examining the link between corporate environmental performance and financial performance indicates a positive correlation. Most studies posit that by enhancing their environmental performance, companies can boost their image and attain greater social recognition (G. Zhou et al., 2022). The exploration of the relationship between environmental performance and financial performance has a lengthy history. The correlation between the two has been derived through empirical studies utilizing various perspectives, models, and indicators to measure both environmental and financial performance.

The value of a company is a multifaceted concept influenced by a range of internal and external factors. It's determined not just by financial performance and assets, but also by more intangible

aspects such as reputation, investor sentiment, and ESG practices. In recent years, there has been a growing recognition of the impact of ESG criteria on company value. ESG considerations, which include a company's efforts to address climate change, improve social conditions, and uphold high standards of corporate governance, are increasingly influencing investment decisions. The shift towards sustainable finance is evident in the rise of green bonds, which are designed to fund projects that have positive environmental and social outcomes. The positive impact of green bond issuance on a company's green total factor productivity may differ depending on the level of financing constraints (Liu & Li, 2024). If a company can reduce its financing costs by issuing green bonds, it can increase its net present value (NPV) and, by extension, its overall value. Caramichael and Rapp argue that on average, firms capable of issuing larger bonds — indicative of better access to debt capital markets — tend to capture a larger greenium (2024).

According to Tang et al. (2020), there are three main sources of positive effect of lower financing cost due to green bond announcement:

1. The "reduced financing cost" channel: green bonds can attract socially responsible investment funds or investors prioritizing ESG considerations. Their demand for green bonds may elevate bond prices, enabling issuers to benefit from decreased debt costs. This, in turn, should elicit lower cost of capital and a favourable response from the stock market.

2. The "enhanced investor awareness" channel: issuing green bonds can heighten media coverage, drawing investor interest. This increased visibility of the issuing companies may lead to heightened demand not only for their bonds, but shares as well, and expand their investor base.

3. The "corporate sustainability" channel: by issuing green bonds, companies showcase their commitment to sustainable practices. Investing in such projects can offer long-term benefits, including improved resilience in challenging situations.

Transition, from a tangible as well as intangible benefits of a lower financing cost, embodies the growing importance of sustainable finance and its favorable impact on a company's financial and environmental objectives. This is where the concept of green premium (Greenium) plays a pivotal role.

A green premium occurs when a green bond is priced higher and, consequently, offers a lower yield than equivalent conventional vanilla bonds. The greenium is crucial for certain market participants, as it allows issuers to benefit from higher prices and lower yields at the time of issuance. This results in reduced capital costs, which can compensate for the extra costs associated with disclosure

requirements (Partridge & Medda, 2020a). This is particularly true when there is high demand for green bonds (Zerbib, 2018). For investors, while a greenium might diminish the yields on their bonds, the increase in prices in the secondary market enables them to potentially sell the green bonds at a higher profit. However, the Climate Bonds Initiative (hereafter, (Climate Bonds Initiative, 2022) pricing report explains that "there is no reason why a bond being green should impact its price, since green bonds rank pari-passu (on equal footing) with bonds of the same payment rank and issuer. There is no credit enhancement to explain pricing differences and issuers of green bonds often incur costs such as Second Party Opinions and Certification, although these are typically negligible". Although there are opposite research based opinions (Ballester et al., 2024). The existence of a greenium in the secondary market may exert pressure on primary market prices, as the secondary market prices serve as a gauge for what the market is willing to tolerate. As stated in a CBI pricing report (2022), "when green bond curves have a handful of maturity points, they could be used as a reference for pricing new green bonds. If green bonds were trading tighter than vanilla bonds, we would reasonably expect to see a consistent greenium emerging," however, "a secondary green curve does not guarantee a greenium". In addition, "the secondary market structure seems to have the potential for increasing the green bond issuance and offering a primary yield which is slightly lower than that observed on the conventional bond curve" (Zerbib, 2016). In addition, based on other academic research (Mitchell et al., 2024) "nearly all interviewees also mentioned some level of greenium, but most admitted it was difficult to measure".

There are multiple components which work as pieces of the puzzle of the overall conceptual framework for understanding the incentives and premiums associated with green bonds in the context of sustainable finance. Each component plays a critical role in shaping the market for green bonds, reflecting the intersection of finance, environmental policy, and investor behavior. These components do not operate in isolation; rather, they represent a network of incentives and premiums that combine to shape the valuation and desirability of green bonds. From regulatory incentives to enhanced transparency, each factor is a critical part in the construction of sustainable finance, driving the market towards an equilibrium where ecological mindfulness and economic gain are not mutually exclusive but are harmoniously aligned.

At the core is the greenium itself, symbolizing the additional value or reduced yield that investors are willing to accept in exchange for contributing to environmentally beneficial projects. Table 1 provides descriptions of key components that drive the existence and magnitude of greenium:

Table 1

Listed description of greenium sources

Source of Greenium	Description
Investor Demand	The level of interest and demand from investors for green bonds, driven by a desire to invest in environmentally and socially responsible projects.
Regulatory Support	Government policies, regulations, and incentives that encourage or mandate investment in green projects, thus boosting the appeal of green bonds.
ESG Criteria	The emphasis investors place on environmental, social, and governance factors when making investment decisions, which can lead to a preference for green bonds.
Risk Perception	The perceived risk associated with green bonds, which may be considered lower than traditional bonds due to their focus on sustainable projects, potentially affecting their yield.
Reputational Benefits	The positive reputation and image associated with investing in green bonds, both for issuers and investors, as it demonstrates a commitment to environmental stewardship.
Market Liquidity	The level of liquidity in the green bond market, which can affect the pricing and yield of these bonds. As the market matures, it may influence the greenium.
Reporting and Transparency Requirements	The obligations for issuers of green bonds to provide detailed reports on the use of proceeds and the environmental impact of the financed projects, which can increase investor confidence and affect the bond's yield.

Source: made by author

While an increasing number of contemporary studies provide estimates for the green bond premium, the results of these prior studies are somewhat mixed. In recent years the search for greenium began with an analysis of the yield differences between corporate green bonds and their non-green counterparts. Table 2 consists of selected recent research studies, which explored this pricing dynamic starting by (Ehlers & Packer, 2017), (Hachenberg & Schiereck, 2018), (Febi et al., 2018), (Zerbib, 2018), and (Kapraun et al., 2019). These studies primarily employed a matched pair analysis method to compare the yields of green bonds with their nearest non-green equivalents, including some synthetic matches. This approach is also central to the CBI pricing reports from 2017 to 2019. The research encompasses a variety of analyses across primary, but mostly secondary markets.

(Ehlers & Packer, 2017) examined 21 green bonds issued from 2014 to 2017, discovering that issuers of green bonds typically borrowed at lower spreads compared to conventional bonds, with an average difference of about 18 basis points. (Hachenberg & Schiereck, 2018) focused on secondary market

spreads, noting that 63 green bonds traded slightly tighter than non-green bonds from the same issuers between October 2015 and March 2016. (Kapraun et al., 2019) analyzed 2,000 green bonds in both markets, finding a significant negative premium of 20-30 basis points for green bonds in the primary market. Although with a small selection of 64 green bonds issued in 2014-2016, (Febi et al., 2018) identified a greenium of nearly 70 bps in the secondary market in 2016, also observing greater liquidity in green bonds compared to conventional ones. (Zerbib, 2018) reported a greenium of 2 bps in green bonds issued between July 2013 and December 2017.

Some of the researchers have focused their analysis on the US green municipal bond market, where smaller green bonds are issued more frequently, which enables more direct comparisons. (Karpf & Mandel, 2018) were among the first to analyze municipal green bond market, examining 1,880 bonds labeled as green by Bloomberg and comparing them to 36,000 conventional bonds from the same issuers over 2010–2016. They did not observe a distinct greenium in the secondary market until 2016, at which point they noted an average spread of 23 basis points. Building on this, (Baker et al., 2018) conducted a study on 2,083 municipal bonds also defined as green by Bloomberg, comparing them against 643,299 conventional municipal bonds from the same period (2010–2016). Their analysis, focused on the primary market, identified an average greenium at issuance of 6 basis points. Unlike Karpf and Mandel, Baker and colleagues adjusted the equivalent yields of various bond types, including taxable and tax credit municipal bonds along with tax-exempt bonds, for their regression analysis. (Larcker & Watts, 2019) narrowed the focus further by examining 640 matched pairs of green and non-green municipal bonds issued between 2013 and July 2018. They discovered a nominal green discount of 0.45 basis points, with 85% of the matched pairs showing no price difference at issuance. When they expanded their analysis to include bonds from the same issuers but issued at different times, they found an insignificant greenium. They also observed no significant difference in liquidity or institutional ownership, nor any pricing difference for certified green bonds. Conclusively, they stated that their results suggest municipalities might actually increase borrowing costs by issuing green bonds. Similarly to Larcker & Watts, study conducted by (Partridge & Medda, 2020b) could hardly identify any sign of greenium. Observed a greenium grew to nearly 5 bps in the secondary market by 2018, and no statistically significant differences in greenium were observed in the primary market.

However, some cases in 2017 and 2018 were observed where paired bonds were issued with lower green yields than their vanilla counterparts. It is worth mentioning very recent studies by (Wu, 2022) and (Li et al., 2022) on green bonds with a strong emphasis towards Chinese bond market.

Table 2

A summary of selected greenium studies, with their data scopes, methodologies, and findings

Study	(Ehlers & Packer, 2017)	(Hachenberg & Schiereck, 2018)	(Febi et al., 2018)	(Zerbib, 2018)
Dataset	Corporate	Corporate	Corporate	Bloomberg Green Labeled
Market	Primary	Secondary	Secondary	Secondary
Sample Size	21	63	64	1065
Timeframe	2014–2017	2015–2016	2014–2016	2013–2017
Method	Nearest Neighbors	Nearest Neighbors + Panel Regression	Nearest Neighbors + OLS with Fixed Effects	Synthetic Pairs + OLS with Fixed Effects
Greenium	–18 bps	–1 bp	–5 to –30 bp	–2 bp
Study	**(Karpf & Mandel, 2018)**	**(Baker et al., 2018)**	**(Larcker & Watts, 2019)**	**(Kapraun et al., 2019)**
Dataset	Bloomberg Green Muni	Bloomberg Green Muni	Bloomberg Green Muni	Green Labeled
Market	Secondary	Primary	Primary	Primary and Secondary
Sample Size	1880	2083	640	2257
Timeframe	2010–2016	2010–2016	2013–2017	2010–2018
Method	OLS Regression + Decomposition Oaxaca Blinder	OLS Regression + Fixed Effects	Matched Pairs	Nearest Fixed Effects Neighbors +
Greenium	–18 bps	–7 bps	Negligible	–20 to –30 bps
Study	**(Partridge & Medda, 2020b)**	**(Wu, 2022)**	**(Li et al., 2022)**	**(C. Y. Huang et al., 2023)**
Dataset	Green-Labeled Muni	Corporate and Government	Corporate (China)	Corporate
Market	Primary and Secondary	Secondary	Primary	Secondary
Sample Size	453	811	296	964
Timeframe	2013–2018	2016-2019	2016-2020	2014-2022
Method	Matched Pairs + Fixed Effects	Matched Pairs Two-layer regression	Propensity Score Matching (PSM) Logistic Regression Kernel matching method	Matched Pairs Regression
Greenium	Negligible Primary, –5 bps Secondary	-12,5 bps	-8 to -12 bps	Inconclusive

Source: based on findings of (Partridge & Medda, 2020b), updated and extended by the author

However, some cases in 2017 and 2018 were observed where paired bonds were issued with lower green yields than their vanilla counterparts. It is worth mentioning very recent studies by (Wu, 2022) and (Li et al., 2022) on green bonds with a strong emphasis towards Chinese bond market. Due to this country focus both studies managed to find greenium of 8 to 12 bps in both secondary and primary markets. Finally, a fresh and broad study by (C. Y. Huang et al., 2023) with "classical" secondary

market and corporate bonds characteristics again was not able to prove conclusive greenium existence. The presence of a greenium was confirmed, however it vanishes within specific limits (greenium was noticed to be larger in financial and low-rated bonds only).

Study "Searching for 'Greenium'" by Meyer and Henide ((2020), released by IHS Markit, investigates the premium linked to corporate green bonds. It scrutinizes the secondary market for Euro-denominated, investment-grade corporate bonds, with data up to August 31, 2020, to assess the presence of a green pricing premium. The methodology used slightly deviates from standard studies on green premiums by focusing on the iBoxx Global Green Social and Sustainability Bond index. The greenium is identified as the disparity in the Z-spread between a green bond and an equivalent non-green bond, factoring in various characteristics. The findings revealed a greenium of -1.84 basis points, weighted by market value. The greenium was particularly pronounced in high-emission sectors such as oil and gas, utilities, and industrials. Meyer and Henide emphasize that the greenium is not fixed and evolves over time. They propose that as the scale and frequency of bond issues expand, both the evidence of greenium and its limitations may become more apparent. The empirical results of very recent study demonstrate a positive relationship between the use of green bond proceeds and the premium on green bonds. A green premium of, on average, 1–5 basis points is observed across both government and corporate issuers (Okafor et al., 2024).

While greenium could be found in secondary bond market, it could be easily challenged for not providing positive effect to the issuer anymore. Primary market is a point in time where issuer could gain from greenium through lower weighted average cost of capital (WACC) in practical terms. It begs the question as to why greenium has been observed in the secondary market but is much harder to detect in the primary market.

When bonds are issued, they aren't introduced via an open outcry system but through a more controlled new issue period using one of three methods: competitive, negotiated, or private placement (Pozdena et al., 2007). During this process, the initial offering prices of the bonds are predetermined by the underwriters. Although the underwriters engage in initial price discussions to set these prices, once the bonds are released to the market, no further adjustments are made until they are resold in the secondary market. Effectively, purchasing a bond at issuance is typically not available to retail or smaller investors due to high entry barriers (Pearlman, 2021). Although bonds are perceived as relatively accessible to retail investors, this is less the case for the primary markets, especially in the European Union. In contrast, the secondary market can attract a significantly broader base of retail investors, which has implications for both pricing and liquidity.

Under certain circumstances, the expense associated with obtaining green certification can result in higher costs for green bonds compared to traditional bonds. Consequently, issuers might opt for conventional bonds to fund projects that meet green criteria, which could hinder the expansion of the green bond market. This is particularly problematic for projects aimed at carbon neutrality, as it could lead to insufficient disclosure about carbon offsets and usage of funds, complicating regulatory oversight of the project's carbon offset impact. To remedy this, governments could offer subsidies for green certification to issuers of green bonds, as well as there should be an effort to establish a multi-tiered green bond market system to promote growth and enhance the impact of the green bond sector (Wei Su et al., 2024). Additionally, providers of green certification might consider implementing a sliding scale for pricing based on the amount issued, encouraging participation from issuers of smaller amounts. Regarding information disclosure, collaboration between policymakers and industry experts is needed to establish clear, universally accepted metrics for reporting the emissions reduction achieved by projects financed through green bonds. The paper also recommends considering tax-based incentives as a key policy tool. To support the investor side, policymakers could introduce tax exemptions for green bond earnings, enabling investors to earn interest from green bonds without incurring income tax.

Portfolios composed of stocks from green bond-issuing companies demonstrate superior environmental performance, particularly through reduced CO_2 emissions over the medium to long term, and outperform their non-green counterparts over a 12-month investment horizon. Overall, investing in stocks of green bond issuers appears to provide competitive risk-adjusted returns (Badía et al., 2024).

1.4. Greenwashing – Motives, Regulation, Certification

Green bonds encourage firms to redirect financial resources towards research and development, helping to mitigate the financial challenges of green innovation. Positive impact of corporate green bonds on green innovation is stronger in regions with weaker climate regulations, industries with higher environmental performance, and firms with more concentrated ownership. Additionally, green innovation provides dual benefits by enhancing both financial performance and environmental sustainability (Dong et al., 2024).

(Zetzsche & Anker-Sørensen (2022) provide provocative conclusion that regulators, aiming at securing the sustainable transformation of the EU economy, effectively regulate in the dark. Regulators are, and should continue to be, concerned with the problems created by asymmetric information, such as moral hazard and adverse selection, which can potentially result in resource misallocation and heightened risk-taking. These issues are critical as they can threaten investor

protection and the overall stability of the financial system. For regulators to effectively address these challenges, it's crucial that they have a thorough understanding of the effects what sustainability focused financial legislation has on financial intermediation and investment services. Without this deep insight, regulators would be making decisions in the dark, hindering their ability to fulfil their mission effectively (Wang & Liu, 2024).

The critical issue, however, is whether the issuance of green bonds genuinely prompts companies to invest in green projects, or if companies engage in greenwashing, misrepresenting the extent of their green investments. This is a significant concern for both academics and practitioners. Traditionally, 'greenwashing' is defined as the practice where companies make deceptive or overstated claims about their environmental responsibilities, often through selective disclosure of information or presenting misleading narratives (Lyon & Maxwell, 2011; Marquis et al., 2016).

The research paper "Green Bond Pricing and Greenwashing under Asymmetric Information" (Chang et al., 2023) explores the rapidly expanding green bond market, emphasizing the importance of green bonds in funding green initiatives and pricing climate risks. The authors develop a model that explains the green bond premium (greenium) without assuming investors have a green preference, focusing instead on asymmetric information and transition risks from potential carbon taxation. The model shows that green bonds can signal a firm's green credentials but at a cost, particularly for brown firms, which face higher greenwashing expenses. The paper contrasts perfect and asymmetric information scenarios, showing that under perfect information, firms would only issue conventional bonds. In contrast, under asymmetric information, firms choose bond types to maximize profits, and investors adjust prices to equalize expected returns on green and brown bonds. Green firms always prefer issuing green bonds, while brown firms' decisions depend on their emission intensity and the transition risk. The study reveals that a greenium exists when there are transition risks, green bond issuing costs, and greenwashing costs. The existence of a greenium aligns with mixed empirical evidence. Policy implications include the need for swift implementation of carbon pricing to reduce greenwashing and create a small greenium, and the necessity of strong information disclosure requirements and regulations to ensure market integrity. The model highlights the importance of quick action on carbon pricing and robust regulatory frameworks to ensure the effectiveness of the green bond market.

One of the key challenges in sustainable finance is how to evaluate the sustainability of a company. In study done by (Berg et al., 2022) researchers investigated the divergence of ESG ratings based on data from six prominent ESG rating agencies: Kinder, Lydenberg, and Domini (KLD), Sustainalytics, Moody's ESG (Vigeo-Eiris), S&P Global (RobecoSAM), Refinitiv (Asset4), and MSCI. Researchers

put emphasis on important implications for a range of stakeholders including academics, investors, businesses, rating agencies, and regulatory bodies. Academics should be meticulous in selecting data for future studies on ESG issues. Study found that average pairwise correlation between rating agencies of 38-71% is substantially lower than the 99% for credit ratings. It is crucial to recognize that results derived using the ESG ratings from one agency may not be consistent with those obtained using ratings from a different agency.

As (Gregory, 2023) suggests, firms with lower stock volatility are more inclined towards greenwashing, as the consequences they face when exposed are relatively milder. These companies, characterized by less volatile stocks, experience a smaller increase in market value from misleading the market, and consequently, they risk less in terms of potential stock price decline if their greenwashing practices are revealed. In contrast, firms with higher stock volatility, possessing riskier assets, stand to lose more. Additionally, companies with a higher WACC are more likely to engage in greenwashing. Due to their riskier assets, the future penalties of being caught in greenwashing practices are more heavily discounted, making it a seemingly more viable option. Furthermore, firms with greater information asymmetry may be more prone to greenwashing, as they can more effectively conceal their deceptive practices for an extended period, thereby enhancing the perceived benefits of greenwashing. Finally, firms with significant pricing power may also be inclined towards greenwashing, as the immediate returns they gain can potentially offset the future discounted costs associated with being caught.

A perfect example of stated above is widespread scandal named Dieselgate. On September 18, 2015, the United States Environmental Protection Agency issued a Notice of Violation to Volkswagen AG, Audi AG, and Volkswagen Group of America (collectively referred to as Volkswagen). The notice revealed that Volkswagen had equipped certain diesel vehicles from model years 2009–2015 with defeat devices. These devices were designed to circumvent and disable key elements of the vehicles' emission control systems, which were in place to meet emission standards. This disclosure led to a significant drop in Volkswagen's stock value, with cumulative abnormal returns plummeting by −18.02% on the day of the announcement and further declining by −23.43% over the following three days (Bouzzine & Lueg, 2020). On a non-risk adjusted basis, Volkswagen's shares experienced a 32% decline in value a year after the announcement, marking a substantial setback for the company's market valuation. The situation escalated when, on January 4, 2016, the United States announced its intention to file a lawsuit against Volkswagen. This move was later followed by a class-action lawsuit in Germany in December 2016 and a lawsuit by the European Union in 2018. Moreover, Volkswagen faced financial repercussions, with over $16 billion in penalty fees. While damage due to the scandal

seems to be very high, Volkswagen managed to collect a number of rewarding incentives while engaged in wrongdoing. This example demonstrates that corporate management often acts rationally in response to heightened risk, choosing to steer clear of riskier strategic endeavors such as greenwashing, particularly when faced with considerable idiosyncratic risk.

While green bonds offer several advantages, issuers face specific challenges and costs. More extensive information disclosure is required, along with the upfront costs associated with certification and the need for specialized personnel. There's also a significant reputation risk; if a project financed by a green bond is perceived as not genuinely environmentally friendly, the issuer's reputation could suffer.

A study by Tang and Zhang (Tang & Zhang, 2020) argue that a major issue in the green bond market is the lack of unified standards. There's no universally accepted definition of what qualifies as a green bond, and the enforcement mechanisms for maintaining green integrity are limited. This lack of standardization can make it difficult for corporations to decide whether to issue green bonds. Critics argue that this fragmentation in standards and labeling creates uncertainty for investors, potentially impeding the market's future growth. Furthermore, the potential reputational risk for issuers of green bonds cannot be overstated. If a project financed by a green bond fails to deliver on its environmental promises, the issuer could suffer a significant loss of reputation, which could have a long-term negative impact on the company's value. Therefore, the due diligence conducted by investors and the transparency of reporting by issuers are critical components in sustaining the green bond market's integrity.

In addressing these issues, regulatory bodies must balance the need for comprehensive and accurate sustainability reporting with the costs and complexities faced by companies in complying with such regulations. Companies that issue green bonds are already subject to additional costs related to certification, specialized personnel, and extensive disclosure requirements. While these measures are essential for maintaining market integrity, they also present significant barriers to entry, particularly for smaller companies.

Implementing a uniform standard to assess the "greenness" of bonds is challenging. A universally accepted criterion to evaluate green bonds is difficult to establish due to the diverse nature of environmental projects and regional variations in environmental priorities and regulations.

Another critical aspect is due diligence on the environmental impacts of funded projects. Investors often have limited knowledge about the actual environmental impact of green loans and bonds. The information they can access typically comes from voluntary disclosures by the issuing entities or

through third-party verification, which may not always provide a complete picture of the project's environmental benefits.

The integrity of green bonds is crucial to maintaining the "greenium" and the associated lower Weighted Average Cost of Capital (WACC). To address greenwashing concerns, firms are increasingly opting for voluntary external reviews of their green bond issuances. However, some of the studies do not find evidence that external reviews lower the financing cost of green bonds compared to conventional bonds (Allman & Lock, 2024). As regulators strive to ensure that the sustainable transformation of the economy is genuine, they face the significant challenge of accurately verifying the environmental impact of funded projects. The information asymmetry that arises from voluntary disclosures and third-party verifications can lead to skepticism among investors about the true environmental benefits of these projects.

As the green bond market continues to mature, the development of more sophisticated and standardized reporting tools may help alleviate these challenges. Such tools could provide more accurate and comprehensive assessments of the environmental impact of green bond-funded projects, reducing the risk of greenwashing and enhancing investor confidence. This, in turn, could lead to a more robust and transparent market, encouraging more companies to issue green bonds and capitalize on the associated greenium. Investors, for their part, must exercise due diligence by critically assessing the environmental claims made by green bond issuers. This includes a deeper examination of voluntary disclosures and third-party verifications, as well as a consideration of the issuer's overall commitment to sustainability beyond individual projects. In doing so, investors will be better equipped to distinguish between genuine green initiatives and greenwashing attempts.

In conclusion, while green bonds offer a promising avenue for companies to potentially reduce their financing cost and enhance their value, the challenge of establishing a reliable and universally accepted standard for sustainability remains. Overcoming this challenge requires concerted efforts from regulators, issuers, investors, and other market participants to foster a green bond market that not only contributes to sustainable economic transformation but also accurately reflects the environmental stewardship of the companies involved. Only with such collaborative efforts can the full potential of green bonds to contribute to company value and the broader sustainable finance landscape be realized.

2. METHODOLOGY FOR RESEARCHING THE GREEN BOND IMPACT ON THE COST OF CAPITAL

The methodology of this research is meticulously designed to delve into the specific impact of green bonds on the cost of capital, emphasizing the delivery of practically valuable findings. This section details a structured, selective approach tailored to explore this complex relationship, which is vital due to the innovative and dynamic characteristics of green bonds. Recognizing the evolving nature of these financial instruments, the methodology of this research is engineered to selectively capture the subtleties and nuances effectively. Our approach integrates a variety of research methods aimed at yielding a deep, empirical understanding of the green bond market. These methods include hypothesis testing to validate initial assumptions about green bonds' impacts, comparative reviews to contextualize findings within the specific issues and bond issues, and detailed statistical and regression analyses to quantify relationships and trends precisely. Through this combination, the aim is not only to explore theoretical constructs but also to provide concrete, actionable insights.

This tailored methodology is designed to filter out the noise often associated with broader market analyses and to focus sharply on the most relevant factors that influence the value addition of green bonds to companies. By doing so, practitioners can utilize the research to make informed decisions, apply findings in actual scenarios, and ultimately drive more sustainable financial practices. The research is anchored on three primary hypotheses.

1) **H1**: Yield of green bonds at issue date is lower than seasoned bonds yield curve of the same issuer.

    To investigate this, the research compares yield of new issue green bond at issue date and non-green bond yield curve on the same exact date. This comparison is critical to understanding the financial attractiveness of green bonds from an issuer's perspective, as all (or the majority) of the yield curve (maturities) is taken into consideration.

2) **H2**: Presence of greenium in the secondary market persists over time.

    This analysis will explore market and interest rate dynamics across the yield curve, comparing the yields of new green bonds at issuance as well as 7- and 30-days post-issuance. Such an analysis aims to provide insights into how investors value these bonds over time.

3) **H3**: Greenium is consistently present in both corporate and government bond sectors.

To conduct a research analysis on the performance of newly issued green bonds compared to the conventional yield curve of the same issuer, a structured approach integrating both qualitative and quantitative data will be adopted. This methodology is designed to assess whether green bonds command a premium or exhibit different risk characteristics compared to conventional bonds from the same issuer.

2.1. Definition of Scope and Data Collection of Green Bonds

Data on all newly issued green bonds in 2023.01.01-2023.12.31 by a set of issuers will be collected. Corresponding data on conventional bonds issued by the same issuer will also be gathered. Key data points include issuance date, maturity date, coupon rate, yield at issuance, and any other relevant terms. For the research to be consistent, bonds with same characteristics (i. e. same payment rank, credit rating, etc.) except green bond label will be compared.

Table 3

Data selection variables

Issue date range	2023.01.01 – 2023.12.31
Green Bond Indicator	Yes
Geography	Europe
Currency	EUR
Asset Class	Corporates and Government bonds
Exclusion	Banks and Financial Services

Bonds of banks and financial institutions are often excluded from general bond analyses due to their unique regulatory environments and complex capital structures, which can differ significantly from non-financial entities (Table 3). These institutions are highly sensitive to macroeconomic conditions and receive varying degrees of government support, which can distort risk assessments and bond valuation. Their bonds often serve different purposes, such as meeting liquidity requirements rather than funding capital projects, which affects their market behavior and investment attractiveness. Financial institutions' bonds also have a distinct risk profile, with a higher and more volatile exposure to various financial risks compared to other sectors. Excluding these bonds from analyses helps avoid skewing data and provides clearer insights into sector-specific trends and risk factors.

Table 4 summarizes the data on all European green bonds issued in 2023, providing detailed insights into the number, value, and types of bonds issued across different countries.

Table 4

Summary of Green Bonds Issued in 2023 in Europe, EUR

Description	Value
Total Number of Bonds	193
Total Amount Issued (EUR billion)	145.4
Average Amount Issued (EUR million)	753
Min Amount Issued (EUR million)	2
Max Amount Issued (EUR billion)	11.25
Average Coupon Rate (%)	4.02
Average Yield at Issue (%)	4.27
Number of Countries	18
Number of Corporate Bonds	152
Number of Government Bonds	41

Source: Bloomberg, data extracted 2024.04.04

The table provides the selection of European corporate and government green bonds from the total sample. The bonds included in this study were chosen for several reasons. Each selected green bond has corresponding conventional bonds issued by the same company, enabling accurate yield curve analysis and the identification of green premiums. For some issuers, yield curves were created not only for their conventional bonds but also for their green bonds, providing a more detailed understanding of the yield dynamics and the market's perception of green bonds versus non-green bonds. In several cases, companies issued two bonds on the same date, allowing for a direct comparison of new green and non-green bond issuances against the existing yield curves, thus offering insights into market reception and yield changes over time.

To assess the impact of green bonds on the cost of capital, the research will compare the yields of newly issued green bonds with the existing yield curves of both conventional and green bonds from the same issuers. This comparison will be carried out at the time of issuance and subsequently at 7 and 30 days post-issuance to observe any changes over time.

Initially, the yield of each newly issued green bond at the issuance date will be compared with the corresponding yield curve of the issuer's conventional and, where applicable, green bonds. This initial comparison will help identify the presence of a green premium. Additionally, the yields will be analyzed at 7 and 30 days post-issuance to observe how the market adjusts to the new green bonds,

providing insights into the persistence of the green premium and the market's evolving perception of green bonds.

Table 5

Selected bonds for research

	Issuer	Sector	Country	Date	GB [1]	Duration	Yield	Rating	Comp non-GB [2]	Comp GB [3]
Corporate	Engie SA	Utilities	France	2023.01.04	Yes	7Y	3.709	BBB+	10	10
				2023.01.04	Yes	12Y	4.106	BBB+	10	10
				2023.11.29	Yes	3Y	3.657	BBB+	12	13
				2023.11.29	No	10Y	3.973	BBB+	12	13
	VW Int. Finance	Consumer Discretionary	Germany	2023.03.23	Yes	3Y	3.963	BBB+	8	7
				2023.03.23	Yes	6Y		BBB+		
	E.ON SE	Utilities	Germany	2023.08.22	Yes	5.5Y	3.825	BBB+	11	10
				2023.08.22	Yes	10Y	4.113	BBB+	11	10
Government		Ireland		2023.01.04	Yes	20Y	3.106	AA-	15	1
		Austria		2023.04.17	Yes	6Y	2.952	AA+	23	1
		Netherlands		2023.10.13	Yes	20Y	3.345	NR	22	1

[1] – Green bond, [2] – Number of comparable non-green bonds at issue, [3] - Number of comparable green bonds at issue

Source: Bloomberg, data extracted 2024.04.04

The selected bonds for this research (Table 5) include issuances from companies such as Engie SA, VW International Finance, E.ON SE, and government bonds from Ireland, Austria, and the Netherlands. These bonds were issued in 2023 and were chosen due to their comparability with existing bonds from the same issuers. This selection enables a thorough and balanced analysis of the impact of green bonds on the cost of capital, capturing both the immediate and longer-term market responses to these financial instruments.

Additionally, the inclusion of government bonds serves several critical purposes. It allows for comparing greenium presence and dynamics between government and corporate bonds, helping to reveal whether the premium is consistent across different types of issuers. Government bonds, often considered lower-risk investments, provide an essential benchmark for understanding the greenium and offer insights into market confidence and stability. Their inclusion helps assess the influence of regulatory environments and policy support for green finance, highlighting the effectiveness of governmental policies in promoting green investments. Moreover, government bonds attract a diverse

investor base, allowing for a comprehensive view of market behaviour across various investor profiles. Evidence suggests that green bonds generally provide higher yields compared to conventional sovereign bonds when the returns on conventional bonds decline. This may indicate that investors view green bonds as offering superior returns or better risk-adjusted returns during times of market downturns or falling interest rates (Tomczak, 2024). Finally, they help benchmark corporate bond performance, providing deeper insights into the additional risk premiums demanded by investors for corporate issuances and the true cost benefits of issuing green bonds for companies.

To ensure robust results, polynomial regression will be used to construct the yield curves for conventional bonds. This method allows for a detailed and accurate estimation of the yield curve by accounting for various maturities and market conditions.

2.2. Yield Curve Analysis vs Matching Method

This thesis is dedicated to isolating the green premium that arises from investor preferences, specifically by distinguishing it from the influences of other external factors on bond prices. Typically, the price of a bond is influenced by a combination of factors, including the credit risk of the issuer, prevailing risk-free rates, market liquidity, and specific characteristics of the bond itself. To effectively analyze these influences the empirical methodology that is most frequently employed involves conducting detailed regression analyses. This analytical approach requires that all potential determinants of a bond's yield are accounted for, which helps to explain any observed fluctuations in bond prices accurately. If these factors are not adequately controlled for in the dataset, the analysis may fail to reveal the actual impact of the green bond premium, thereby significantly diminishing the insights that can be drawn from the research. By ensuring that these elements are included in our analysis, we can more precisely assess the true contribution of green premiums to bond valuations.

Hence, the matching method is a commonly employed technique for analyzing the greenium, known also as a model-free or direct approach. This method enjoys widespread use in studies of the green premium because it enables the pairing of two comparable bonds from the same issuer, ensuring that all yield-explaining factors are consistent. Such a strategy helps in avoiding biases due to omitted variables. The matching can be executed by comparing a green bond with one or two traditional bonds. Helwege and others (Helwege et al., 2014) adopted this methodology to quantify liquidity costs by pairing bonds from the same company. Similar tactics have been applied in the evaluation of the excess returns of ethical funds by contrasting them with their conventional counterparts (Kreander et al., 2005; Renneboog et al., 2008; Bauer et al., 2005). However, Zerbib (2018) noted a

slight maturity mismatch in this method and opted to pair a green bond with the two nearest conventional bonds. By doing so, he created a synthetic bond matching the exact maturity of the green bond through interpolation and extrapolation, effectively neutralizing the maturity bias.

Although the matching method is well recognized, in this thesis yield curve analysis will be applied. Yield analysis is favoured over the matching method due to its the broader scope of assessment it provides. It facilitates a rapid evaluation of a bond's yield relative to the prevailing market or a particular issuer's yield curve, thereby offering a macroeconomic perspective that can be crucial for comprehensive financial analysis and real-world applicability. As summarised in Table 6, this approach is particularly advantageous when the dataset lacks sufficient comparable bonds, which is a common limitation in the application of the matching method. Furthermore, yield analysis does not necessitate the extensive data manipulation and statistical matching processes required by its counterpart, thereby enhancing efficiency in terms of resource allocation.

Yield analysis also boasts greater methodological flexibility, allowing for nuanced interpretations at varying levels of the yield curve, which can provide valuable insights into the market's implicit risk assessments and interest rate expectations. Consequently, it is an effective way for issuers and investors to assess market evaluations timely.

Analysing specific bond issue to comparable yield curve can illustrate where the bond lies in relation to the overall term structure of interest rates for that issuer. It might show if the bond is yielding higher or lower than would be expected given the general pattern of yields across different maturities.

Moreover, if the bond's yield significantly deviates from the curve, it might indicate an anomaly that warrants further investigation, such as an unexpected credit risk, liquidity issue, or other factor unique to that bond.

These, of course, are not the only methods to compare: a very recent article examines greenium using the mean difference Welch t-test (Singh et al., 2024), yet again it is based on linear regression, which somewhat contradicts with the effort to smooth yield curve along all duration of the issuer.

Table 6

Comparison of Matching Method and Yield Curve Analysis

Aspect	Matching Method	Yield Curve Analysis
Objective	To isolate the effect of a single variable by comparing pairs of similar securities.	To assess a bond's performance relative to the broader market or issuer's yield curve.
Approach	Comparative, controlling for confounding factors by matching characteristics.	Analytical, examining the bond's yield within the context of the yield curve.
Complexity	Can be complex, requires statistical methods to ensure accurate matching.	Relatively simpler; involves analyzing yield positions on a curve.
Data Requirements	High; needs a robust dataset to find comparable pairs.	Lower; requires access to the yield curve but not necessarily individual bond pairings.
Focus	Narrow, concentrates on specific bonds and their closest matches.	Broad, considers the entire (or extensive) spectrum of maturities on the yield curve.
Suitability	Best for research and scenarios where detailed comparison is needed.	Useful for investors and issuers looking for quick assessments.
Market View	Limited to the bonds being compared.	Provides a macro view of the market or issuer's range of bonds.
Resource Efficiency	Less efficient, data preparation and analysis can be resource intensive.	More efficient. Generally, requires fewer resources for analysis.
Risk Assessment	Controlled, aims to compare bonds with similar risk profiles.	Comprehensive, reflects market's risk assessment across different maturities.
Flexibility	Limited, dependent on the availability of comparable bonds.	High, can be adapted to various levels of analysis.

Source: made by author

2.3. Yield Curve Construction and Regression Analysis

For each issuer, a yield curve using the yields of their conventional bonds will be constructed. This involves plotting bond yields against their respective maturities at a given point in time. Polynomial regression will be employed to estimate the conventional yield curve $Y_c(t)$ for each maturity t:

$$Y_c(t) = \beta_0 + \beta_1 t + \beta_2 t^2 + ... + \beta_n t^n \tag{1}$$

where $\beta_0, \beta_1, ..., \beta_n$ are coefficients determined through polynomial regression of the bond data.

Polynomial regression is often preferred for modelling bond yield curves for several reasons, particularly its flexibility in fitting the typical shape of these curves. Bond yield curves are known for their non-linear shapes, such as inverted, humped, or sigmoidal curves. Polynomial regression, unlike linear regression, can effectively model these complex, non-linear relationships between maturity and yield. By adjusting the degree of the polynomial, one can fit a curve that closely follows the intricate patterns observed in bond yields.

Polynomial regression can approximate a wide variety of shapes through the adjustment of coefficients for different powers of the independent variable (in this case, time to maturity). This flexibility allows for a more accurate representation of the yield curve compared to simpler linear or logistic models.

To determine the optimal degree of the polynomial regression models in this research, the Bayesian Information Criterion (BIC) will be employed. The BIC is particularly effective for model selection as it incorporates both the goodness of fit and the complexity of the model. This criterion is based on the likelihood of the model and penalizes models with a higher number of parameters to avoid overfitting, which is crucial given the potentially complex nature of the relationships within financial data.

Each polynomial regression model, from a simple linear model to higher-degree polynomials, will be assessed using the BIC. The process involves calculating the residual sum of squares (*RSS*) for each model fitted to the data and applying the BIC formula:

$$BIC = n \cdot ln(RSS/n) + k \cdot ln(n) \qquad (2)$$

where n is the number of observations (bonds consisting of the yield curve), *RSS* is the residual sum of squares, and k is the number of parameters in the model. The model with the lowest BIC score will be selected as it indicates the best balance between accuracy and simplicity, ensuring that the chosen model is robust enough to capture the essential dynamics of the data. This methodical approach will aid in minimizing the risk of model overfitting while maximizing the explanatory power of the models used in analyzing the impact of green bonds on company's cost of debt. Through the careful selection of the polynomial degree, this research aims to provide precise and reliable insights into the financial implications of green bond investments.

For each green bond, its yield at issuance will be compared with the interpolated yield on the conventional yield curve at the same maturity. This comparison will quantify the green premium (or

discount) as the difference between the green bond yield Y_g and the interpolated yield Y_c of the conventional bond at the same maturity:

$$Green\ Premium = Y_g - Y_c(t) \tag{3}$$

Following this initial assessment, as depicted below, the model facilitates the longitudinal monitoring of both the yield dynamics of the new issue and the fluctuations within the broader yield curve. This continuous observation is critical for observing and explaining the interactions between market-driven changes and the specific characteristics of the green bond. By examining these dynamics over time (Figure 7), one can derive insights into the relative performance of the green bond against general market trends. Such analysis is instrumental for stakeholders aiming to make informed decisions regarding portfolio adjustments and investment strategies in the context of evolving economic and environmental considerations.

Figure 7

Chronology of event study
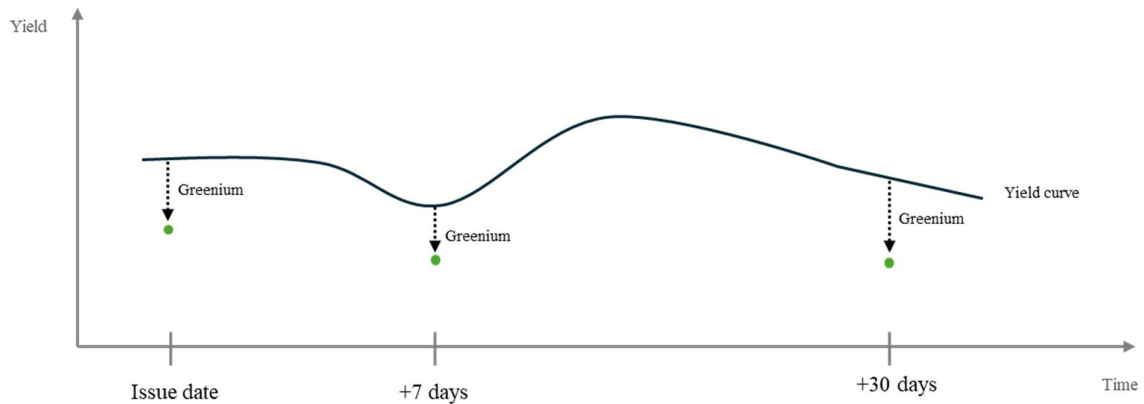
Source: figure constructed by author.

2.4. Limitations of the Research

This research encountered challenges related to data availability and comparability (particularly between green bond and regular bonds yields in time), as well as in measuring the direct impact of green bond issuance on the cost of capital. Additionally, the evolving nature of the green bond market and varied regulatory frameworks present limitations in standardizing the assessment criteria for green bonds across different jurisdictions.

Each bond issuance is unique, influenced by factors such as the issuer's financial health, the bond's maturity, underlying assets, and specific terms of the bond issuance. These variations necessitate a

highly detailed approach to comparison, ideally examining the bonds on an issuer-by-issuer basis. This level of granularity ensures that differences in yields are attributable to the bond's green status rather than other extraneous factors.

A further limitation is the influence of changing market conditions and environmental factors on bond pricing which is present twofold. First, the green bond market is relatively new yet rapidly evolving, with fluctuations in supply and demand, investor sentiment, and regulatory frameworks potentially clouding the true impact of green bonds. Economic and environmental contexts also shift, further complicating the analysis. These dynamic conditions require sophisticated modeling techniques that can separate the specific effects of being a green bond from broader market movements. Secondly, during

Moreover, the heterogeneity of green bonds complicates the analysis. The definition of what qualifies as a "green" project can vary significantly between issuances and over time, adding another layer of complexity to the classification and comparison of bonds. This variability can make it challenging to develop a clear, consistent categorization, essential for analysing pricing differences accurately (He et al., 2024).

Another critical point is that relying on broad datasets might be misleading due to the potential for aggregation to mask important nuances. Broad datasets often combine bonds with varying characteristics, potentially diluting individual distinctions that are crucial for understanding the greenium. This underscores the need for careful data selection and a focused analytical approach that considers the specific characteristics of each bond.

Finally, in recent years interest rate environment has undergone significant changes compared to the past decade, creating challenges for the comparability of green bonds. Interest rates across developed economies were very accommodative for a long period, maintaining low levels to stimulate economic growth and stability.

From 2022 onwards, three major central banks – European Central Bank, Federal Reserve, and Bank of England – embarked on aggressive and very steep rate hikes to combat surging inflation. The ECB rates rose from zero to above 4%, while FED and BOE also saw steep increases, with the FED's rate climbing above 5%, the highest in many years (Figure 8). These changes in interest rates present several challenges for the comparability of green bonds. As central banks adjust rates, not only do the yields on green bonds fluctuate, but they are also impacted by changing spreads.

Figure 8

Base interest rate dynamics in Eurozone, US and UK, %
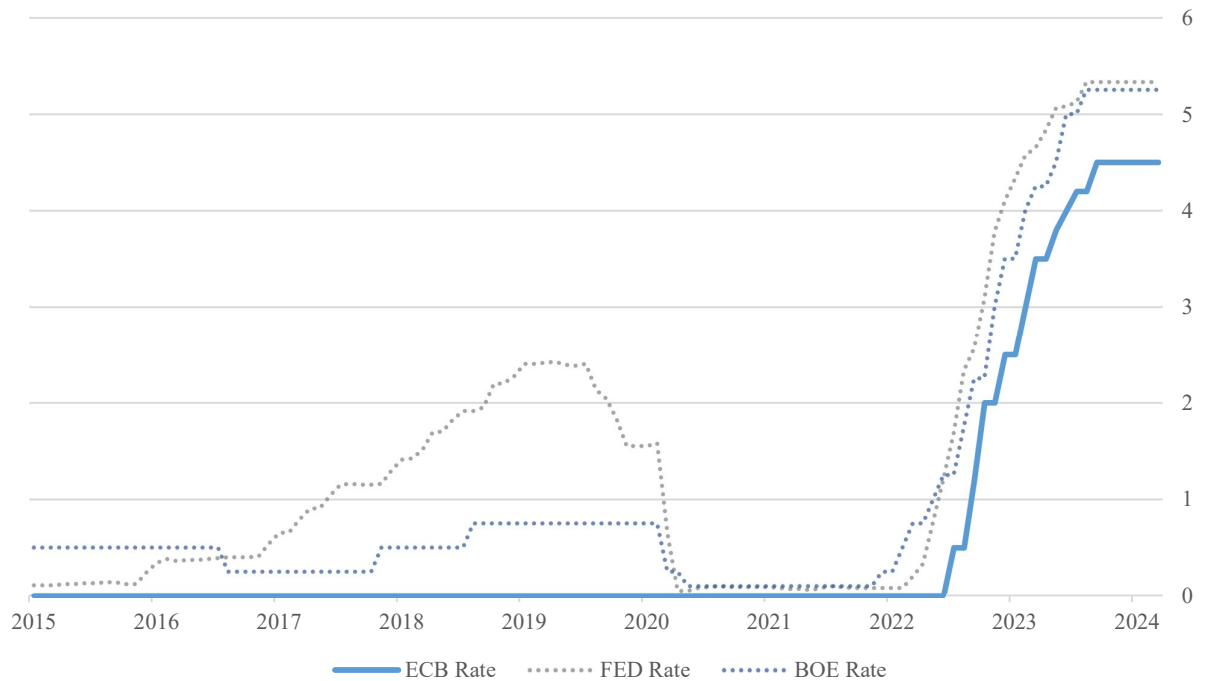
Source: Refinitiv Workspace data, , data extracted 2024.03.31

Interest rate changes also influence market dynamics and the risk perception of green bonds. In a rising rate environment, investors might demand higher yields to compensate for the increased risk, altering the perceived value of previously issued bonds. Shifts in interest rates can lead to changes in investment strategies, with investors potentially moving away from green bonds if higher returns are available elsewhere. Some studies indicate that there were periods of high correlation between green and brown bonds, especially from late 2015 to early 2023. During this period, green bonds became increasingly attractive investments, particularly as sustainability efforts gained momentum. However, from 2022 onward, the trend started to shift back towards traditional bonds (Caramichael & Rapp, 2024). Monetary policies of central banks' directly impact financial markets, influencing the demand and supply of green bonds. Regulatory changes aimed at promoting green finance must adapt to the prevailing interest rate environment to remain effective.

3. EMPIRICAL RESEARCH OF GREEN BOND PREMIUM DYNAMICS

3.1. Scope Review of Selected Data

The dataset was created by filtering out the bonds labeled as "green bonds" from the Bloomberg database for corporate and government bonds. In recent years, numerous studies have explored the concept of greenium. Therefore, this thesis aims to conduct research using the most recent data available, specifically by identifying all European corporate and government green bonds issued in 2023. Initially, the selection of the dataset for green bonds was broad in scope, employing a top-down approach to identify trends within the green bond market. Subsequently, the process became highly selective, focusing on specific issues and issuers to enhance comparability.

Figure 9

Distribution of Corporate and Government green bonds by maturity
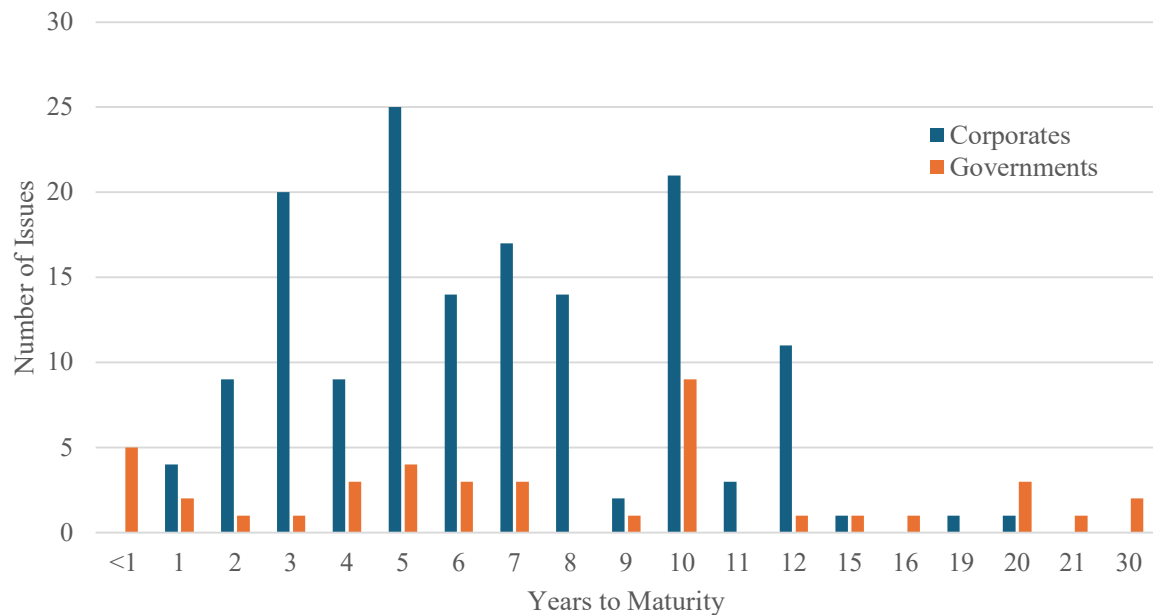
Source: Bloomberg, data extracted 2024.04.04

The data (Figure 9) shows the distribution of bonds across various maturities, ranging from short-term (less than 1 year) to long-term (over 30 years). The chart likely highlights distinct trends in the maturity preferences of corporate versus government issuers. Corporate issuers may tend to concentrate around mid-term maturities, aligning their green bond issuance with medium-term project timelines. Government bonds, on the other hand, may be more evenly distributed across both short

and long-term maturities, reflecting diverse public financing strategies. The variance in maturity distribution underscores the differing financial objectives and constraints between corporate and government entities, with corporate bonds potentially aligning more closely with specific project lifecycles and governments leveraging longer-term bonds for broader fiscal sustainability initiatives.

Figure 10

Distribution of green bonds by credit rating

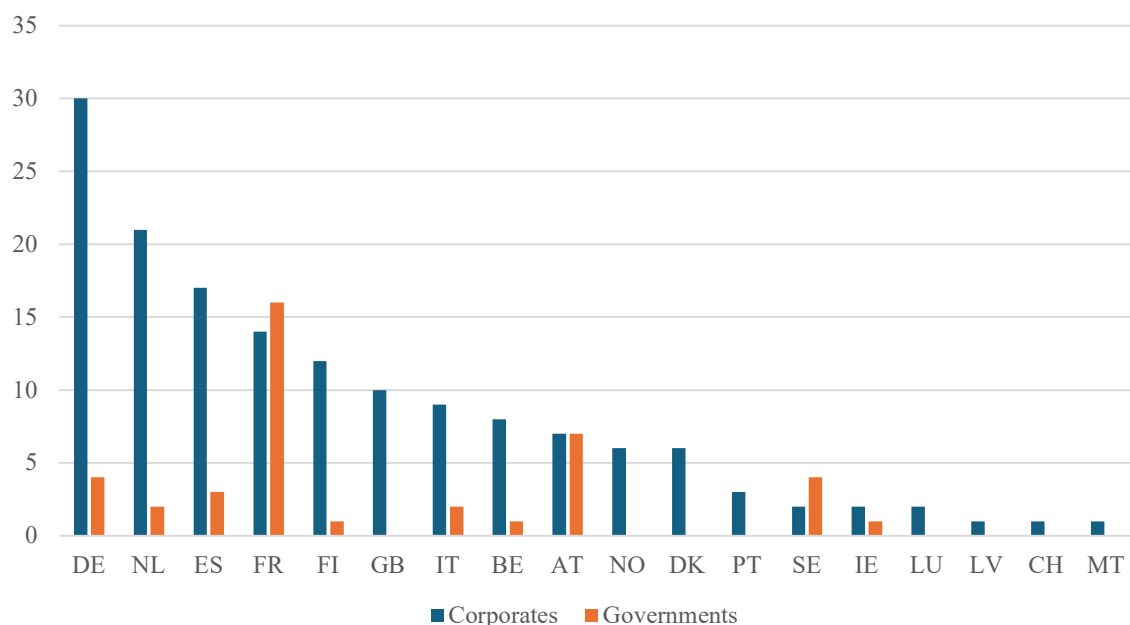*Source*: Bloomberg, data extracted 2024.04.04

The presence of a large proportion of bonds rated BBB and BBB- (Figure 10) suggests that the majority of green bonds fall into the lower investment-grade category, which indicates moderate risk and solid financial standing of the issuers. The presence of AAA-rated bonds at the highest end of the spectrum reflects a smaller number of highly secure investments, often associated with government-backed or large institutional issuers. Interestingly, the chart also shows a significant number of unrated bonds, which may indicate newer market entrants or issuers that do not seek ratings from traditional credit agencies. The inclusion of lower-rated bonds (BB and below) indicates that some issuers are taking on higher-risk green projects, or that investors are willing to accept greater risk in return for the environmental benefits of these bonds. Nonetheless, the large proportion of unrated green bonds reflects the market's growing inclusivity, with newer or smaller issuers entering the space who may not pursue formal credit ratings due to cost or investor preferences. This trend suggests that investors, particularly those focused on sustainability, may prioritize the environmental impact of

projects over traditional credit risk assessments, although this could introduce higher financial uncertainty. As a result, unrated bonds highlight both the opportunities for growth and the potential risks in the evolving green bond market.

The geographical distribution of green bonds (Figure 11) is showing clear leadership by Germany (DE) in corporate green bond issuance, which is indicative of the country's strong industrial base and commitment to sustainable financing. This leadership position is reflective of Germany's proactive role in promoting green finance within its corporate sector. France (FR), on the other hand, stands out in terms of government-issued green bonds, likely due to the French government's aggressive stance on green energy and sustainability projects. Other notable countries with significant issuance include the Netherlands (NL), Spain (ES), and Italy (IT), which have developed robust green bond markets in both the public and private sectors. This distribution underscores the growing importance of green bonds across a wide range of European economies, with both advanced and emerging markets playing a role in financing environmental initiatives.

Figure 11

Distribution of Corporate and Government green bonds by country

Source: Bloomberg, data extracted 2024.04.04

After collecting samples of green bonds, corresponding conventional bonds were identified in the same Bloomberg database. This identification was accomplished by filtering both corporate and government bonds based on specific matching criteria, which are detailed in a subsequent section.

These criteria were implemented to mitigate bias, ensuring that the bonds compared held equivalent characteristics to assess the green premium more accurately. Only issuers that had issued both green and conventional bonds were considered. Given the challenge of finding conventional bonds with identical maturities to green bonds, yield curves for both types of bonds were constructed. Yield was employed as a primary variable for comparison. However, for more detailed and risk-sensitive analyses, particularly across various markets or currencies, the spread to midswap generally provides more comprehensive insights. Nonetheless, gathering data for the mid-swap rate on the issue date proved challenging, as this figure was often unreported for many issues. It was ensured that green bond yields were compared only to actual yield curves, not extrapolated ones, to maintain a practical rather than theoretical approach. These limitations were imposed to make it easier to estimate the somewhat synthetic conventional bond yield more accurately.

3.2. Data Analysis and Descriptive Statistics

Engie, as a company, serves as a perfect example for greenium research because it has solidly established itself as a prominent issuer of green bonds in the market. This positioning allows for in-depth analysis of how green credentials can affect bond yields over time. Engie's consistent issuance of green bonds provides a rich dataset that helps researchers and investors understand the pricing dynamics and investor sentiment towards environmentally friendly investments.

The yield curve graph for Engie bonds in Figure 12, dated 2023-01-04, provides a clear visual representation of the differentials between non-green, green, and newly issued green bonds across various maturities.

The yield curve for non-green bonds, depicted with gray dots and a dotted line, displays a consistent upward trajectory. This reflects typical market behaviour where longer maturities command higher yields due to increased risk and longer exposure periods. The green dots and the dashed green line represent the existing green bonds. The curve lies consistently below the non-green bond curve for most maturities but shows a similar upward trend. This suggests that while green bonds are generally considered more in demand (thus the lower yields), they still follow the same market principles as non-green bonds. The new green bonds 7 and 12 year maturity are marked with larger green dots. Notably, these are positioned higher on the yield curve compared to existing green bonds at similar maturities. This placement suggests an initial higher yield requirement by the market, possibly reflecting a premium for new issuance or an adjustment period as the market evaluates these new entries.

Figure 12

*Engie yield curves, 2023-01-04, date of new issues*
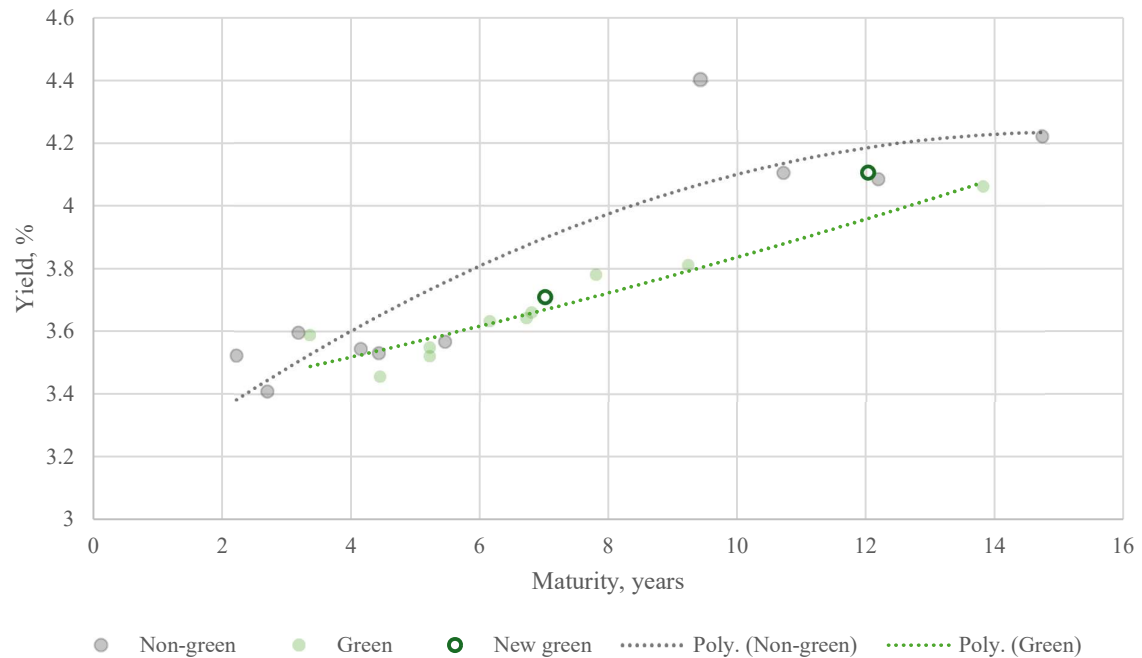
Source: Bloomberg, data extracted 2024.04.04

The new green bonds are marked with larger green circles. Notably, these are positioned higher on the yield curve compared to existing green bonds at similar maturities. This placement suggests an initial higher yield requirement by the market, possibly reflecting a premium for new issuance or an adjustment period as the market evaluates these new entries. However, the focus of this research is to compare newly issued green bonds to non-green bonds yield curve, which is derived from polynomial regression (2nd degree order). Both bonds demonstrated greenium by 19 and 8 bps accordingly.

This "market picture" reflects immediate market reactions that can be speculative or based on incomplete information, which might not accurately represent the bond's long-term value. Observing market and yield dynamics over time, such as at 7 and 30 days after bond issuance, is crucial for accurately assessing market sentiment and the stabilization of bond prices. This period allows for the observation of liquidity improvements, as initial trading volumes increase and the bonds integrate into the market, typically resulting in yield adjustments. Additionally, monitoring yields over time helps isolate the impacts of broader market movements and macroeconomic factors that can influence bond pricing beyond the specifics of the issuance itself.

Figure 13

*Engie yield curves, 7 days after new issues*
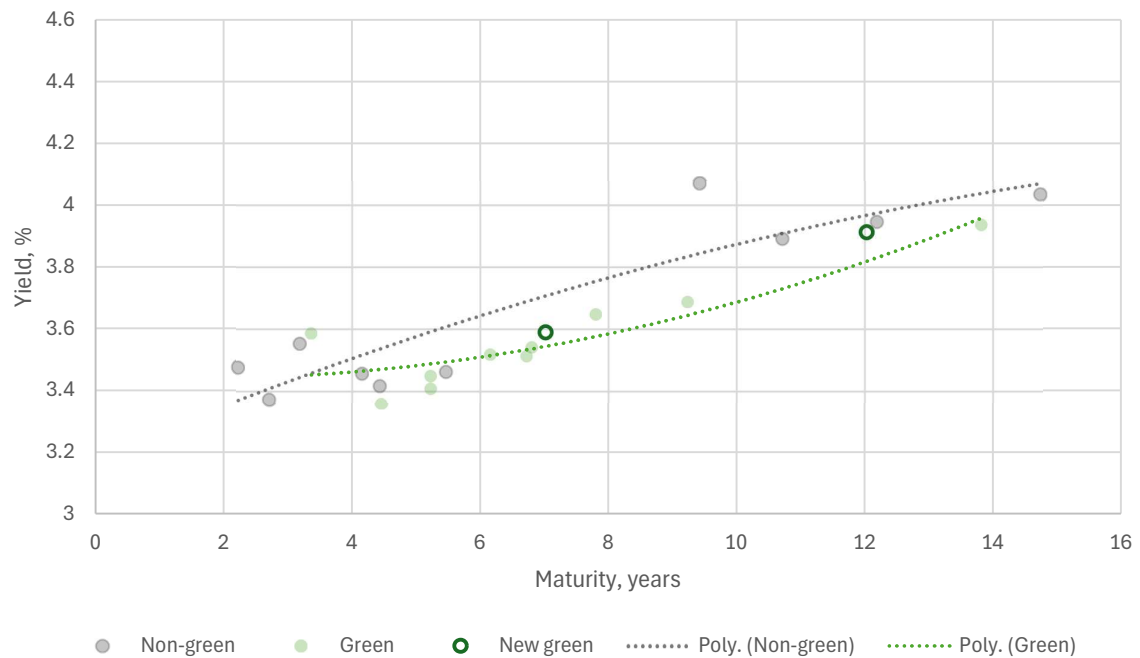
Source: Bloomberg, data extracted 2024.04.04

The dynamics observed in the Figure 13 and Figure 14, along with the table data for Engie's new green bond issues, show that the yields for the new green bonds decrease significantly from the issuance date to 30 days later. For example, the yield on the 7-year bond drops from 3.71% to 3.50%, and the yield on the 12-year bond decreases from 4.11% to 3.82%. This trend of reducing yields is more pronounced in new green bonds than in the overall market yield curves, suggesting an initial premium due to perceived risks or novelty that diminishes as the market adjusts. The greenium, or the yield difference between green and non-green bonds, also narrows over this period, starting negatively and shifting closer to zero, showing a decrease in the yield advantage of green bonds over non-green bonds. Additionally, the yield curve itself shows more negative changes over time, reflecting a downward adjustment in yields that might also be influenced by broader economic factors and a growing market acceptance of green bonds. These yield and curve changes might be influenced by broader market conditions, including interest rate movements and macroeconomic trends, affecting investor sentiment and bond valuations.

Figure 14

Engie yield curves, 30 days after new issues, data extracted 2024.04.04
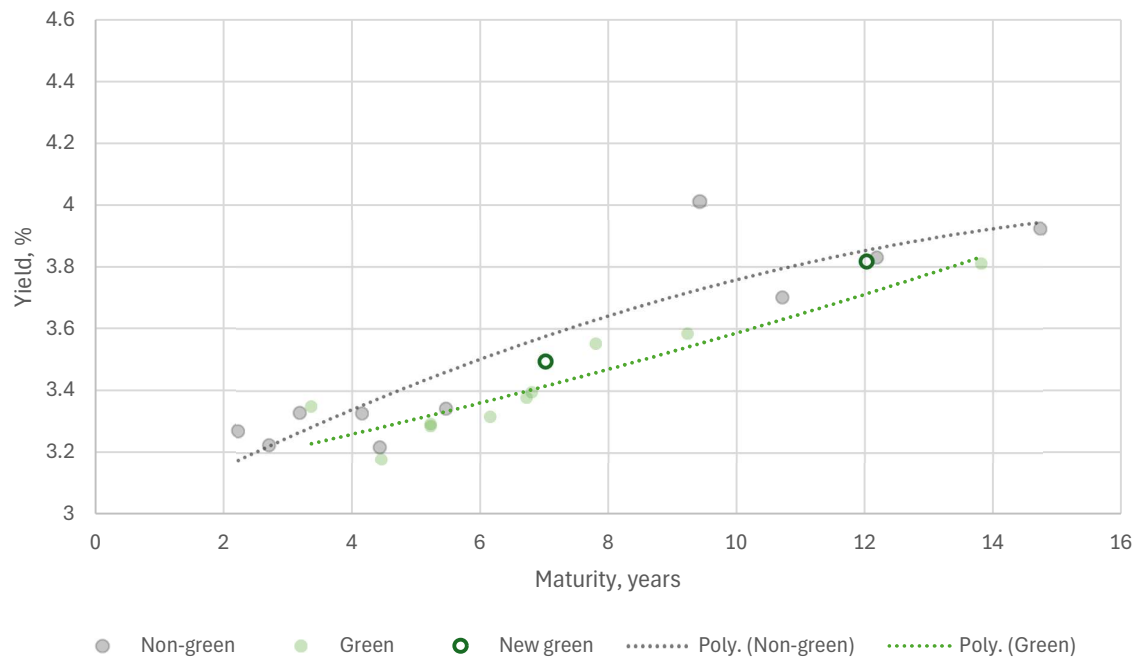
Source: Bloomberg, data extracted 2024.04.04

By closely monitoring these yield dynamics over time, rather than just at issuance, investors and analysts can gain a deeper understanding of how new green bonds are perceived and assimilated into the market, which assists in informed investment decision-making and risk assessment. For the company, on the other hand, this dynamic is less relevant, because the only real time window to catch greenium effect is during the issuance. Described dynamics summarized in the table.

Table 7

Yield dynamics of Engie (2023-01-04)

		Bond yield	Curve Value	**Greenium**	Bond yield change	Curve change
	Issue date	3.71	3.90	**-0.19**		
7Y	+7 days	3.59	3.71	**-0.12**	-0.12	-0.19
	+30 days	3.50	3.58	**-0.08**	-0.21	-0.32
	Issue date	4.11	4.19	**-0.08**		
12Y	+7 days	3.91	3.97	**-0.05**	-0.19	-0.22
	+30 days	3.82	3.85	**-0.04**	-0.29	-0.33

Source: Bloomberg, data extracted 2024.04.04

Continuing with Engie, on November 29, 2023, nearly a year later (Figure 15), the company issued two new bonds—one green (3Y) and one conventional (10Y).

Figure 15

Engie yield curves, 2023-11-29, date of new issues
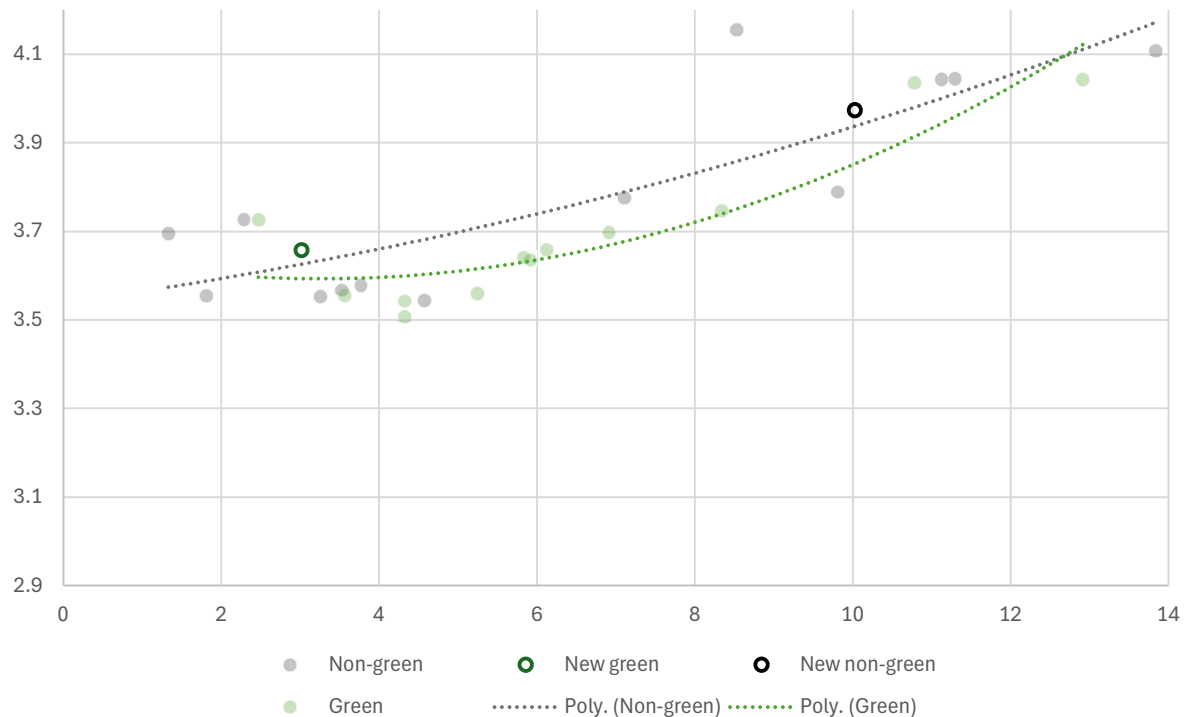
Source: Bloomberg, data extracted 2024.04.04

This simultaneous issuance presents a unique opportunity for analysis, particularly because although they were issued on the same day, they have different maturities. Engie's well-established yield curves for both types of bonds simplify the comparison, allowing for a clear assessment of the differences in market reception and yield dynamics between the green and conventional bonds. This scenario provides valuable insights into how the same issuer's bonds are valued under varying environmental credentials and terms, and how these factors influence investor decisions.

Both the new green and new non-green bonds are plotted above non-green yield curve, indicating that they were issued with a yield premium. This premium suggests cautious investor reception, possibly due to the perceived additional risks associated with new issuances or specific terms related to these bonds. All in all, it could be attributed as New Issue Premium (NIP), which is a common factor in the primary market.

During next 7 days following their issuance (Figure 16), yield curves went lower in parallel, but the yield of newly issued green bond went lower even more.
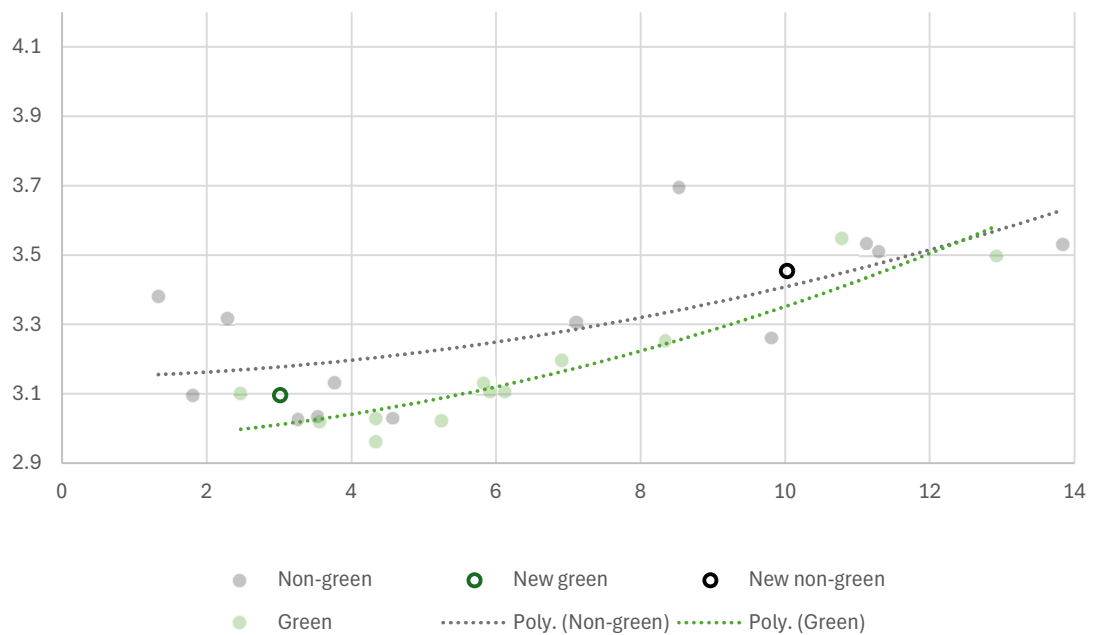
Figure 16

Engie yield curves, 7 days after new issues
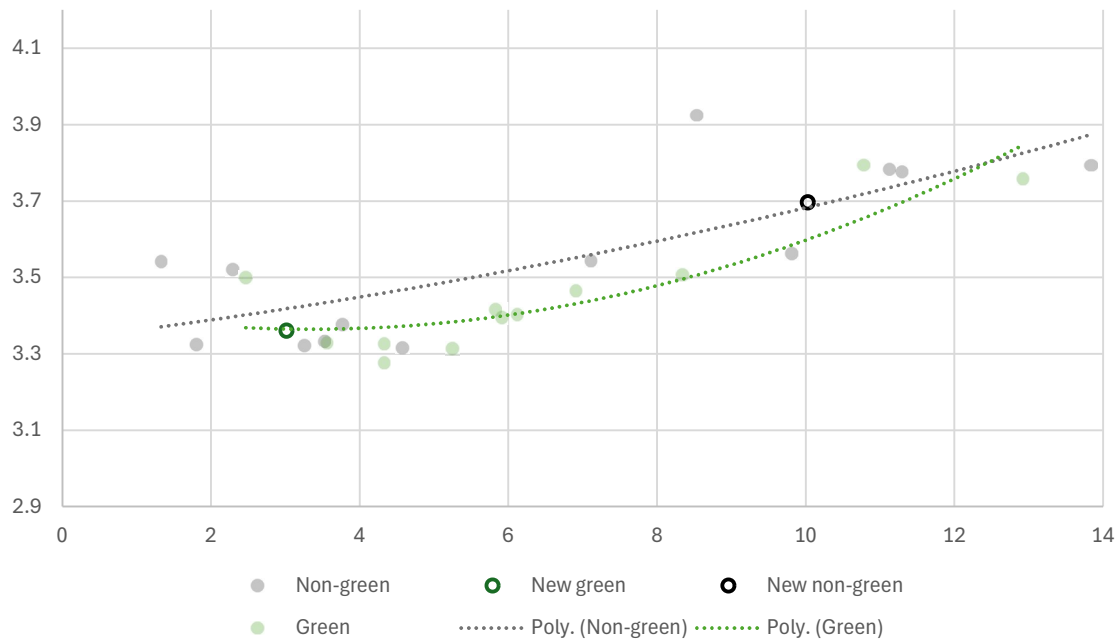
Source: Bloomberg, data extracted 2024.04.04

Figure 17

Engie yield curves, 30 days after new issues

Source: Bloomberg, data extracted 2024.04.04

In the month following their issuance (Figure 17), both the overall yield curves and the yields of the newly issued bonds experienced a decline. Notably, the green bond exhibited a more substantial decrease in yield compared to its conventional counterpart, ultimately achieving a greenium of 8 basis points. Summary of yield dynamics is represented in Table 8. This performance highlights the green bond's enhanced market reception over time, reflecting an increasing investor preference for environmentally sustainable investment options.

Table 8

Yield dynamics of Engie (2023-11-29)

		Bond yield	Curve Value	Greenium	Bond yield change	Curve change
3Y green	Issue date	3.657	3.636	0.02		
	+7 days	3.36	3.418	-0.06	-0.30	-0.22
	+30 days	3.095	3.178	-0.08	-0.56	-0.46
10Y non-green	Issue date	3.973	3.938	0.03		
	+7 days	3.696	3.683	0.01	-0.28	-0.26
	+30 days	3.453	3.360	0.09	-0.52	-0.58

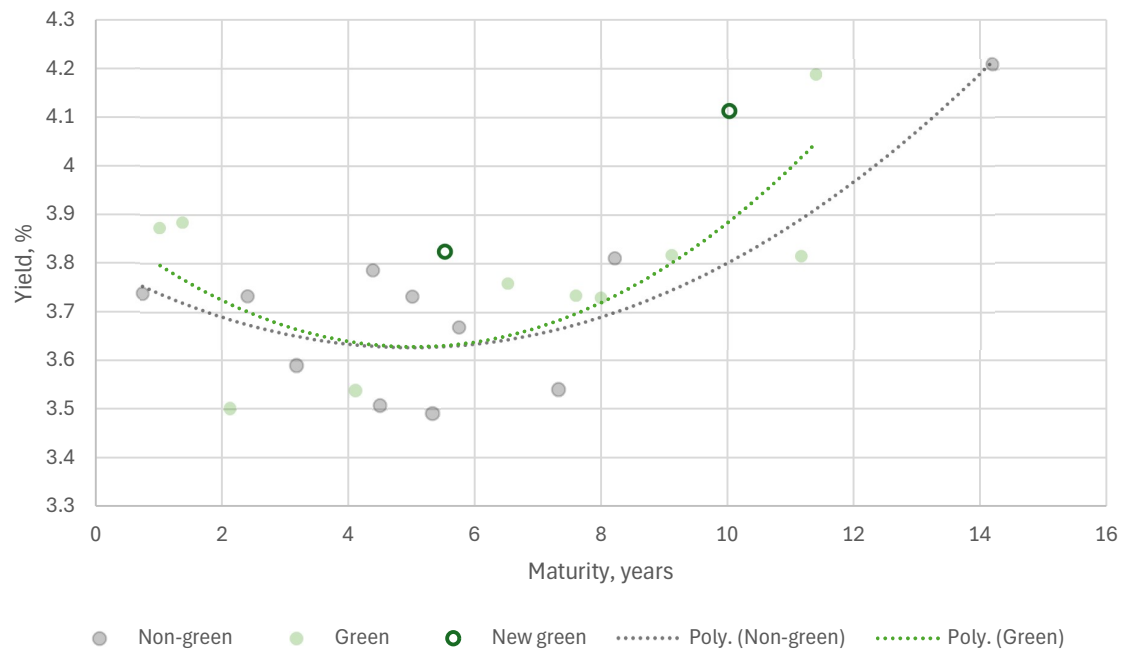*Source*: Bloomberg, data extracted 2024.04.04

E.ON has emerged as a key player in the green bond market, following a similar path to other major energy companies aiming to bolster their sustainability credentials. The company's issuance of green bonds allows for comprehensive analysis of how the market values green investments relative to traditional bonds. E.ON's consistent engagement in issuing green bonds provides a solid basis for examining investor sentiment, market pricing, and yield dynamics over time.

E.ON issued new green bonds alongside existing ones, and these new green bonds were initially priced at a higher yield compared to existing green bonds of similar maturities. This reflects an issuance premium, where the market demands higher yields for newly issued green bonds, perhaps reflecting initial uncertainties or perceived risks. In this case there are 2 clear facts: a) no Greenium was found; b) green bond yield curve is mostly above non-green bond yield curve (Figure 18).

In the 7 and 30 days following the issuance of new bonds (Figure 19 and Figure 20), E.ON's green bonds experienced a notable decrease in yields, much like the trend observed with Engie. For example, E.ON's newly issued green bond with a maturity of 7 years saw a yield drop from 3.825% at issuance to 3.716% after 7 days, and further to 3.952% after 30 days. These dynamics suggest that as liquidity in the green bond market improves and investor confidence solidifies, the initial risk premium diminishes, leading to a reduction in yields. However, yields of newly issued green bonds dropped in parallel to lower yield curves, therefore yield differential was intact.
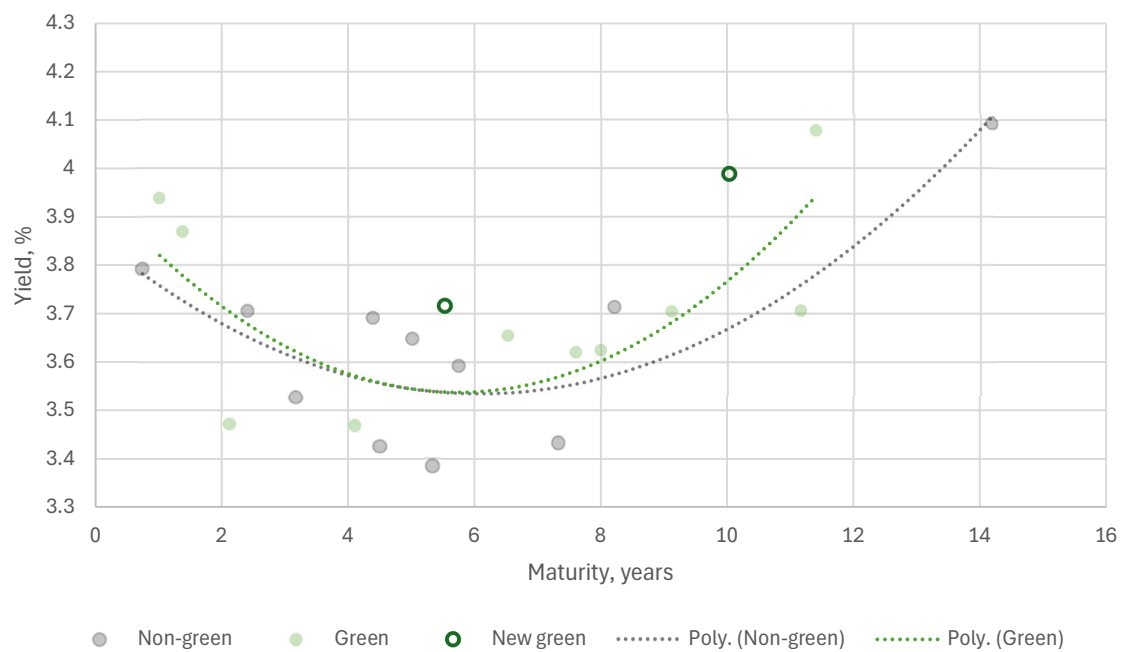
Figure 18

E.ON yield curves, 2023-08-22, date of new issues

Source: Bloomberg, data extracted 2024.04.04

Figure 19

E.ON yield curves, 7 days after new issues

Source: Bloomberg, data extracted 2024.04.04

Despite observing the yield dynamics no significant changes in the greenium were detected. In fact, the Greenium was largely absent throughout the monitoring period. Contrary to expectations, E.ON's newly issued green bonds were consistently priced at a discount compared to the non-green yield curve, signalling that the market did not assign any notable green premium to these bonds.

Figure 20

E.ON yield curves, 30 days after new issues
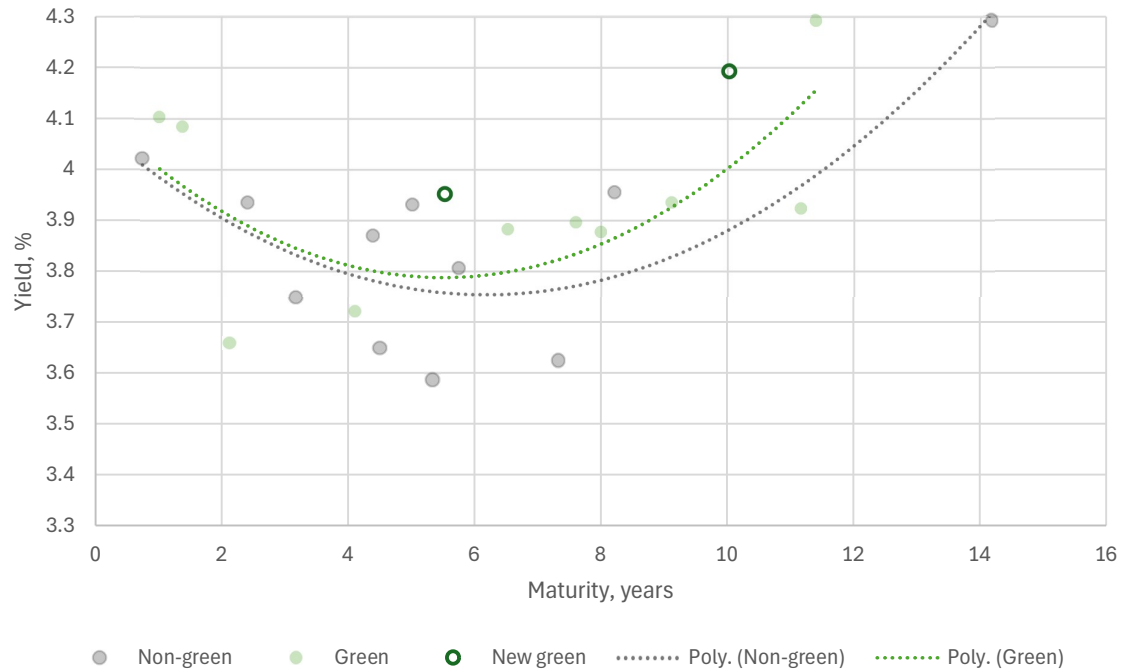
Source: Bloomberg, data extracted 2024.04.04

Even after 7 and 30 days, when markets often adjust to initial issuance conditions, the yield differentials between green and non-green bonds remained negligible (Table 9). The yield curves revealed that the new green bonds were persistently priced below the yellow curves (representing non-green bonds), indicating that greenium was not present. This suggests that investor sentiment did not favor green bonds significantly over conventional bonds during this period, and that the market did not ascribe additional value based on the green credentials of these bonds.

Table 9

Yield dynamics of E.ON (2023-08-22)

		Bond yield	Curve Value	Greenium	Bond yield change	Curve change
5.5Y	Issue date	3.825	3.63	0.20		
	+7 days	3.716	3.538	0.18	-0.11	-0.09
	+30 days	3.952	3.758	0.19	0.13	0.13
10Y	Issue date	4.113	3.801	0.31		
	+7 days	3.988	3.667	0.32	-0.13	-0.13
	+30 days	4.193	3.879	0.31	0.08	0.08

Source: Bloomberg, data extracted 2024.04.04

Further follows a study case on Volkswagen (VW) bonds. As presented in Figure 21, in 2023-03-23 VW issued 2 new green bonds, and yields of both bonds were above non-green bond yield curve, concluding that there was no greenium in both cases. Moreover, green bond yield curve was slightly higher that non-green bond yield curve.
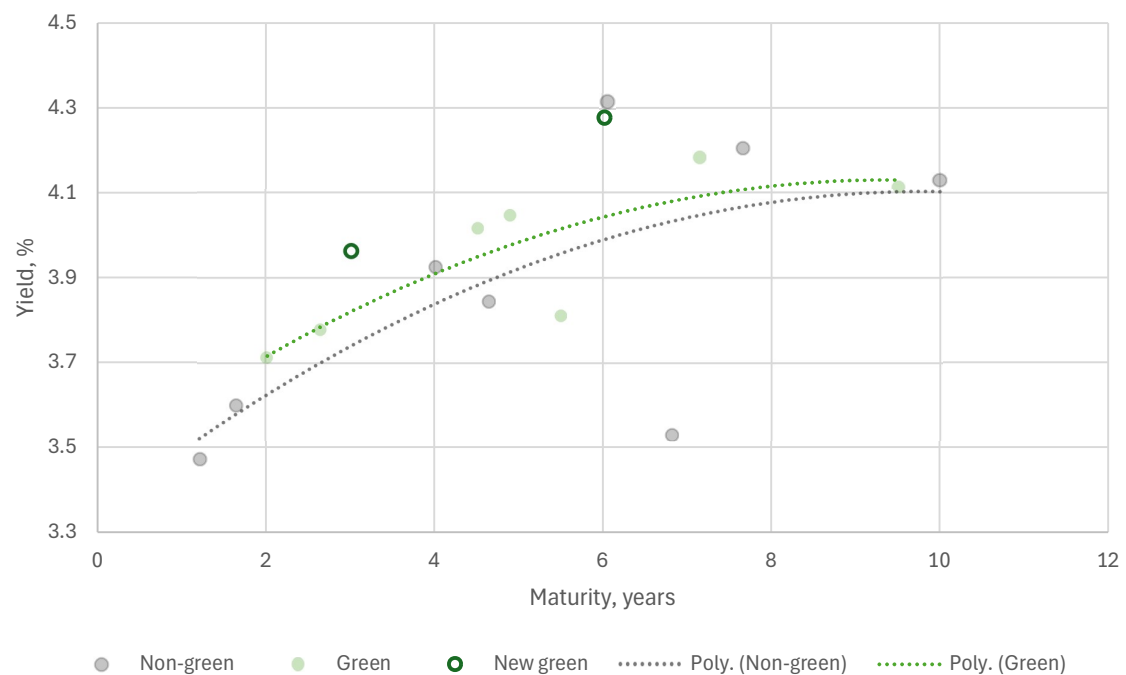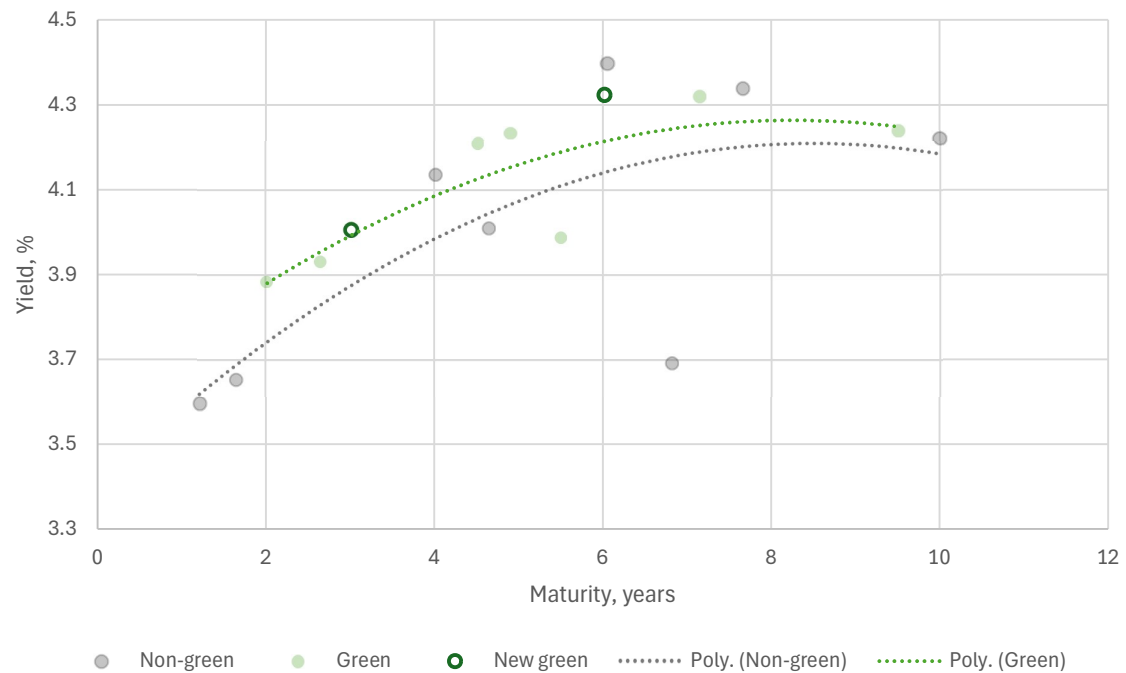
Figure 21

Volkswagen yield curves, 2023-03-23, date of new issues

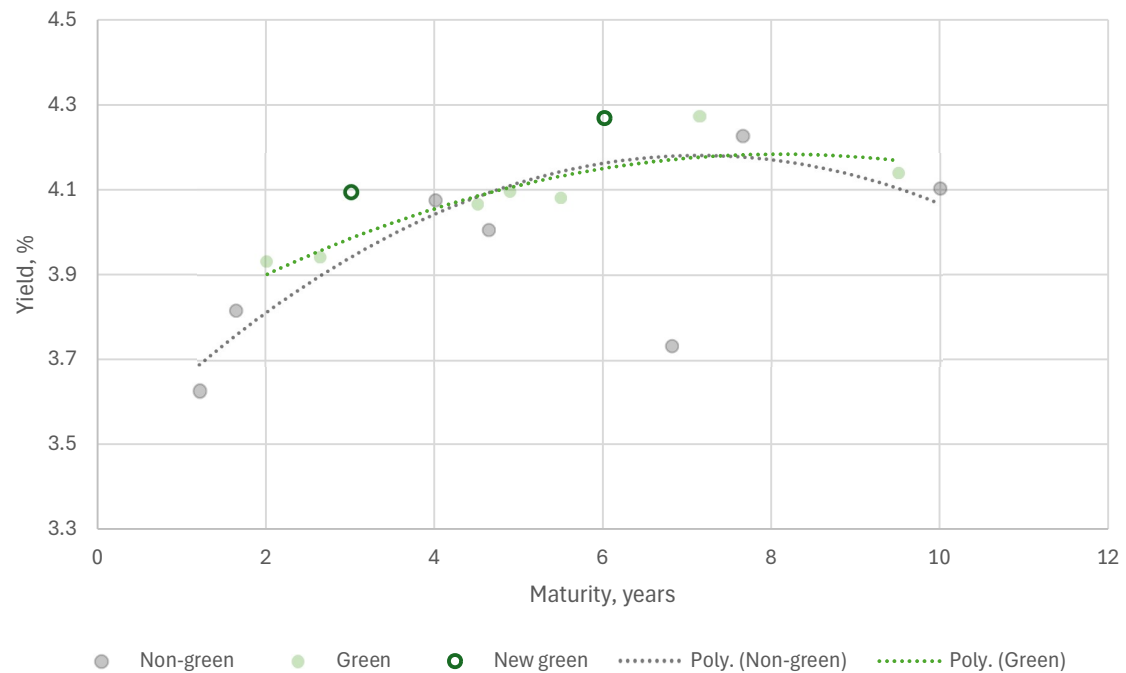*Source*: Bloomberg, data extracted 2024.04.04

Figure 22

Volkswagen yield curves, 7 days after new issues

Source: Bloomberg, data extracted 2024.04.04

Same pattern was present 7 and 30 days after new green bond issuance (Figure 22 and Figure 23). Although green bond yield curve almost aligned with non-green bond curve, 2 newly issued green bonds showed no progress in yield differential to the curve. This could point to market conditions or investor demand that has led to this pricing discrepancy, where investors are not valuing these green bonds as favourably in terms of yield reduction.

The Volkswagen case study serves as an illustrative example within the broader context of this research, which applied polynomial regression analysis across all cases. VW was specifically selected to provide a detailed walkthrough of the statistical methodology, demonstrating how green bond yields were compared with conventional bonds. This example highlights the analytical approach used consistently throughout the study, offering a clearer understanding of the methods and insights obtained from the regression analysis in each case.

Figure 23

Volkswagen yield curves, 30 days after new issues

Source: Bloomberg, data extracted 2024.04.04

Table 10

Yield dynamics of Volkswagen (2023-03-23)

		Bond yield	Curve Value	Greenium	Bond yield change	Curve change
	Issue date	3.963	3.735	0.23		
3Y	+7 days	4.006	3.869	0.14	0.04	0.13
	+30 days	4.094	3.937	0.16	0.13	0.20
	Issue date	4.277	3.986	0.29		
6Y	+7 days	4.323	4.137	0.19	0.05	0.15
	+30 days	4.268	4.16	0.11	-0.01	0.17

Source: Bloomberg, data extracted 2024.04.04

The statistical results provide an abstract representation of the relationship between Yield and Maturity using a quadratic polynomial model. With an R-squared of 0.777, the model captures around 77.7% of the variance in Yield, indicating a reasonable fit and suggesting that this polynomial form encapsulates significant patterns in the data. The Adjusted R-squared, slightly lower at 0.757, implies that while the model maintains reliability with the inclusion of higher-order terms, it avoids overfitting the given data.

Regression Polynomial: $\text{YIELD} = -0.001 \cdot \text{MATURITY}^2 + 0.09 \cdot \text{MATURITY} + 3.454$
R-squared: $r^2 = 0.777$
Adjusted R-squared: $r^2_{\text{adj}} = 0.757$
Residual Standard Error: 0.283 on 10 degrees of freedom

Coefficient	Estimate	Standard Error	t-statistic	p-value
β_0	3.454	0.239	14.467	0
β_1	0.09	0.056	1.596	0.142
β_2	-0.001	0.003	-0.233	0.82

Analysis of Variance Table

Source	df	SS	MS	F-statistic	p-value
Regression	2	2.789	1.394	17.451	0.001
Residual Error	10	0.799	0.08		
Total	12	3.588	0.299		

The intercept at 3.454 is statistically significant, acting as a foundational point when Maturity is zero, though the practical relevance of zero Maturity depends on the specific financial context, such as bond pricing or duration.

Notably, the model as a whole is statistically significant, with an F-statistic of 17.451 and a p-value of 0.001. This indicates that, collectively, the polynomial terms contribute meaningfully to explaining Yield variations, albeit with an underlying complexity that may not be fully captured by the model in its current form. This points to the potential presence of interdependencies or latent factors influencing the observed outcomes.

The Residual Standard Error of 0.283 indicates an average deviation of observed values from the model's predictions, adjusted for degrees of freedom. Although relatively small, this suggests that unexplained variability persists, likely due to omitted variables or complexities beyond the polynomial framework. The non-significant coefficients for individual terms further suggest that Maturity's linear and quadratic effects may not independently serve as strong predictors of Yield, highlighting the potential influence of other underlying dynamics.

An additional consideration arises from the recent and drastic changes in the yield curve. Given shifts in monetary policy, economic conditions, and global financial volatility, the nature of the yield curve has transformed, challenging the stability of traditional relationships between Yield and Maturity. This adds an element of caution in interpreting these results, as models derived from past data may not fully capture new patterns or inflection points emerging in the current environment.

Moving forward with the data for the Netherlands' government yield curve in Figure 24, both for non-green and green bonds, shows that the 20 year long green bond issued on 2023-10-13 carries a yield

of 3.345%, while the corresponding non-green curve suggests a yield around 3.271%. Interestingly, the green bond yield remains above the non-green bond yield curve, implying that the market has priced in a yield premium for the green bond rather than a discount. This observation is crucial in understanding investor sentiment toward the Netherlands' green bonds, as it contrasts with the theoretical expectation that green bonds often trade at a lower yield due to higher demand driven ESG considerations. Moreover, the yield of previously issued green bond (maturity 16 years) is exactly on non-green bond yield curve.

Figure 24

Netherlands gov. yield curve, 2023-10-13, date of new issue
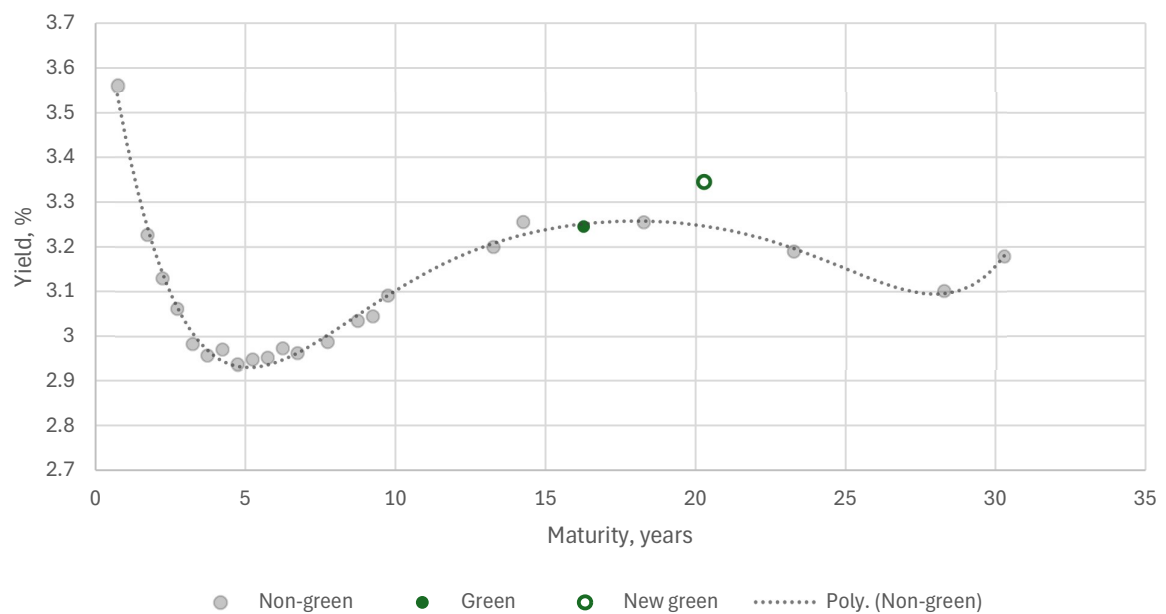
Source: Bloomberg, data extracted 2024.04.04

The dynamics observed in the Netherlands government bonds are noteworthy when analysing the post-issuance performance. For instance, within 7 and 30 days after the new green bond issuance (Figure 25 and Figure 26), there was recorded a narrowing of the gap between green and non-green yields, which transformed into technical greenium. The yield of new issued bond managed to stay below yield curve for the rest of the observation period.

Figure 25

Netherlands gov. yield curve, 7 days after new issues
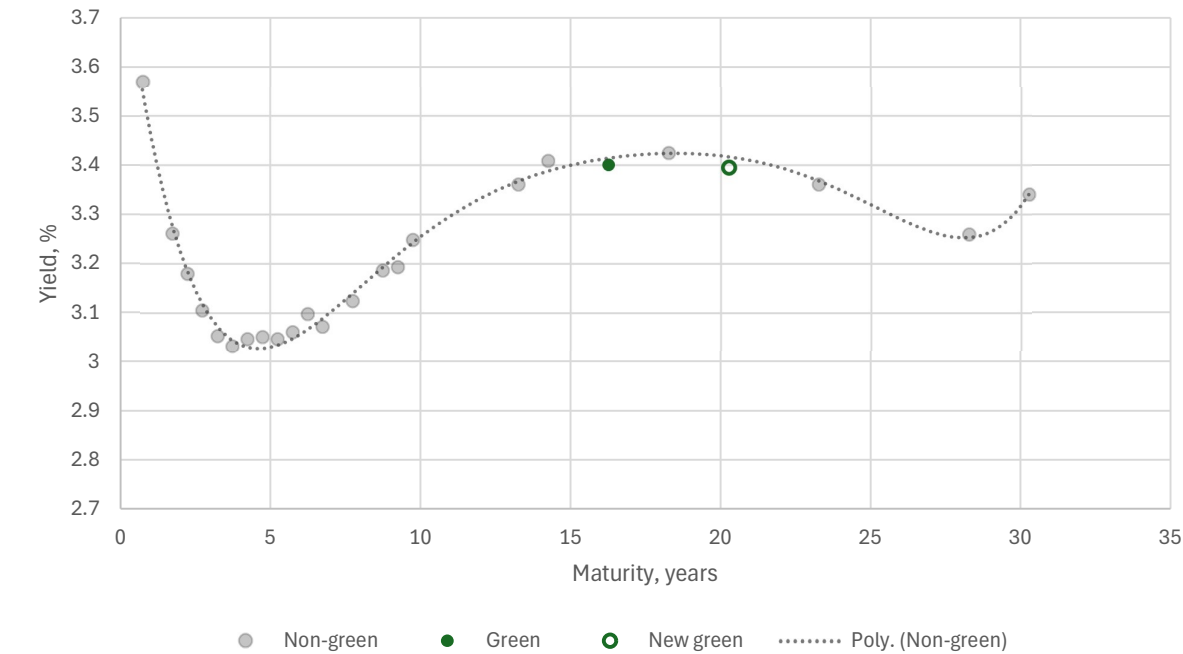
Source: Bloomberg, data extracted 2024.04.04

Figure 26

Netherlands gov. yield curve, 30 days after new issues
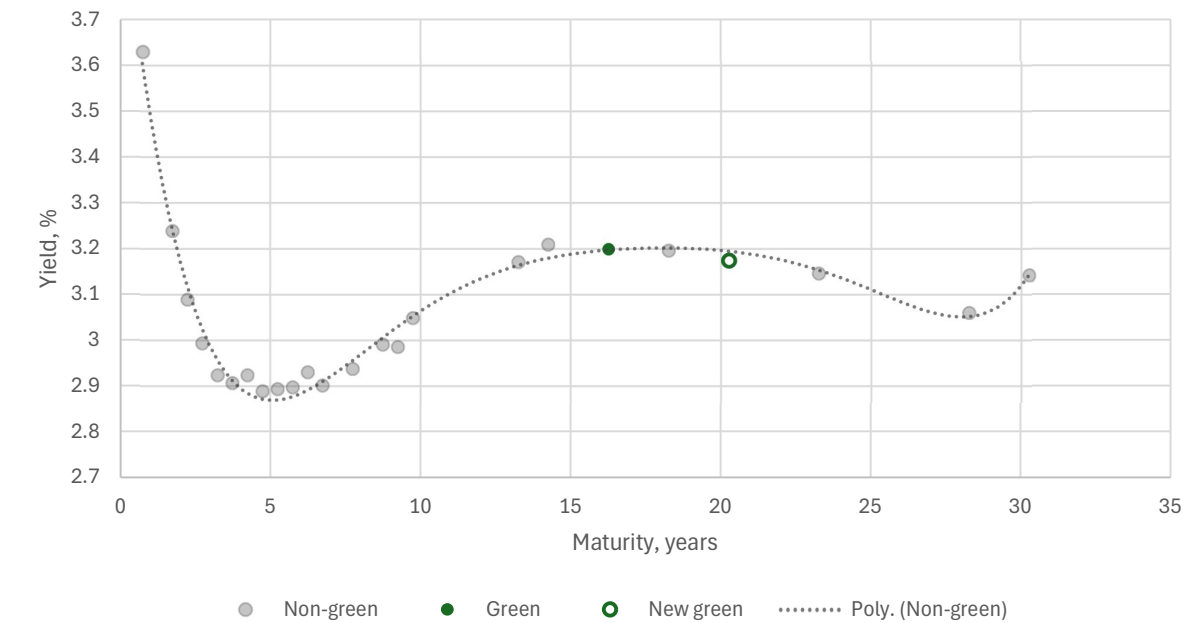
Source: Bloomberg, data extracted 2024.04.04

Table 10

Yield dynamics of Netherlands gov., (2023-10-13)

		Bond yield	Curve Value	Greenium	Bond yield change	Curve change
	Issue date	3.345	3.271	0.07		
20Y	+7 days	3.395	3.438	-0.04	0.05	0.17
	+30 days	3.174	3.23	-0.06	-0.17	-0.04

Source: Bloomberg, data extracted 2024.04.04

These observations highlight the importance of monitoring the yield dynamics over time (Table 10). In the case of the Netherlands, government bond yields behave similarly to corporate bond yields, with green bonds trading at a slight premium, possibly due to issuance risks or other market-specific factors. This behavior challenges the traditional expectation of a greenium, particularly for sovereign issuers, and indicates that the green bond market still has room for maturity and investor confidence to evolve.

Figure 27

Ireland gov. yield curve, 2023-01-04, date of new issue

Source: Bloomberg, data extracted 2024.04.04

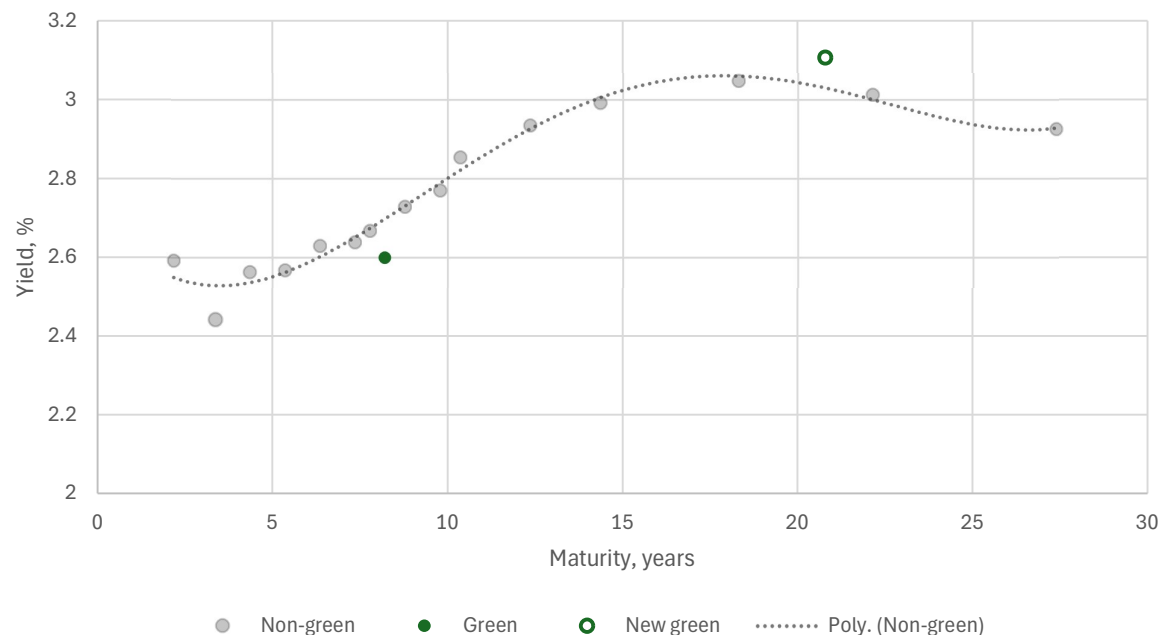Same tendency relates to Irish and Austrian government bonds. Starting with Irish government bonds (Figure 27), at the time of issuance, the Irish government issued a 20-year green bond in January 2023 with a yield of 3.106%, while the corresponding yield for a non-green bond curve stood at 3.028%.

This initial yield difference of 0.08 percentage points suggests lack of greenium at issuance, meaning the market valued the green bond at discount compared to the non-green bonds, likely due to the new issue premium attached to it.

However, after 7 days (Figure 28), the yield for the green bond decreased to 2.922%, while the non-green bond curve value increased to 2.959%. At this point, the green bond yield dropped below the non-green bond curve, creating a technical greenium (-0.04 percentage points). This shift might indicate that investors were more willing to pay a premium for the green bond just one week after issuance, suggesting a rapid adjustment in the market's perception.

Figure 28

Ireland gov. yield curve, 7 days after new issues
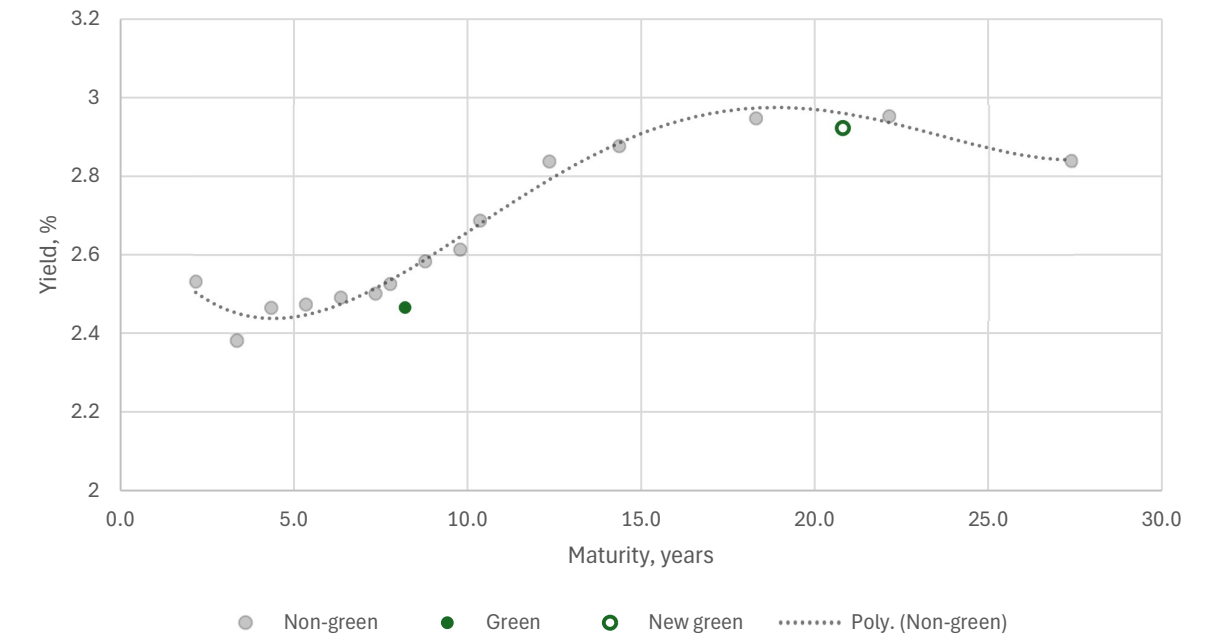
Source: Bloomberg, data extracted 2024.04.04

After 30 days (Figure 29), the green bond yield slightly increased to 2.959%, while the non-green bond curve rose to 3.038%. The greenium persisted (-0.08 percentage points), reflecting that the pricing of newly issued green bond have stabilized in the secondary market (data summarised in Table 11).

Figure 29

Ireland gov. yield curve, 30 days after new issues

Source: Bloomberg, data extracted 2024.04.04

Table 11

Yield dynamics of Ireland gov., (2023-01-04)

		Bond yield	Curve Value	Greenium	Bond yield change	Curve change
	Issue date	3.106	3.028	0.08		
20Y	+7 days	2.922	2.959	-0.04	-0.18	-0.07
	+30 days	2.959	3.038	-0.08	-0.15	0.01

Source: Bloomberg, data extracted 2024.04.04

As showed in Figure 30, in April 2023 the Austrian government issued a 6-year green bond with an initial yield of 2.952%, compared to a corresponding non-green bond curve value of 2.912%. Since the yield of the green bond was higher than the yield curve, no greenium was present at issuance, indicating that the green bond was priced slightly above the non-green bond, contrary to the expectation of a greenium.

After 7 days (Figure 31), the green bond yield increased to 3.011%, while the non-green bond curve value rose to 2.962%. This yield difference of 0.05 percentage points still indicated no greenium, as the green bond continued to trade above the yield curve.

Figure 30

Austria gov. yield curve, 2023-04-17, date of new issue

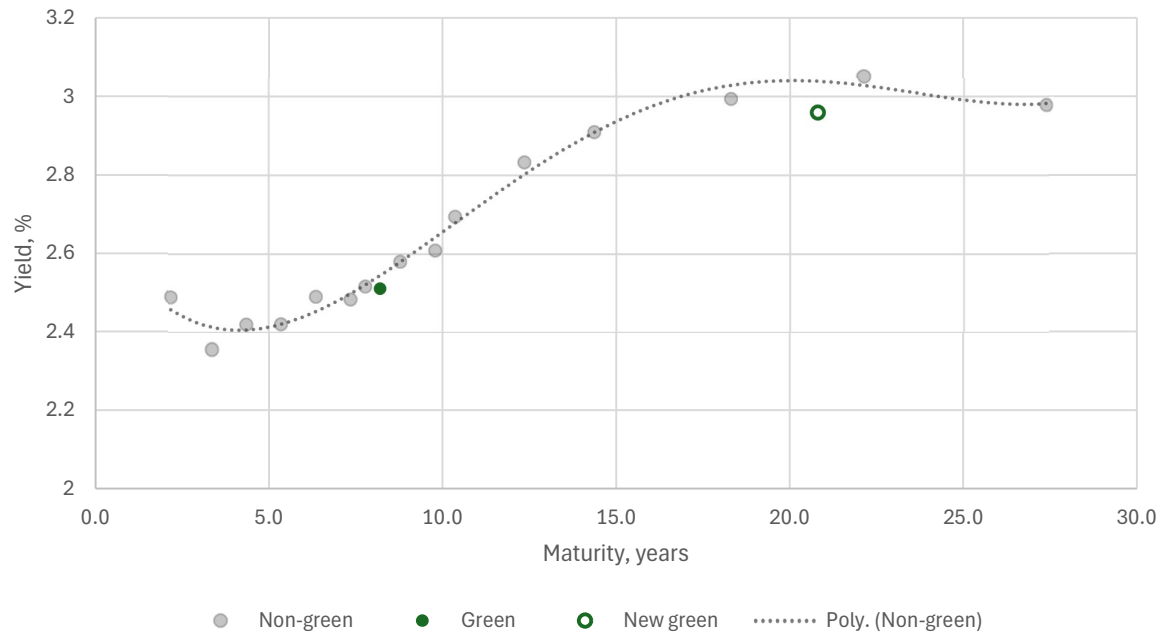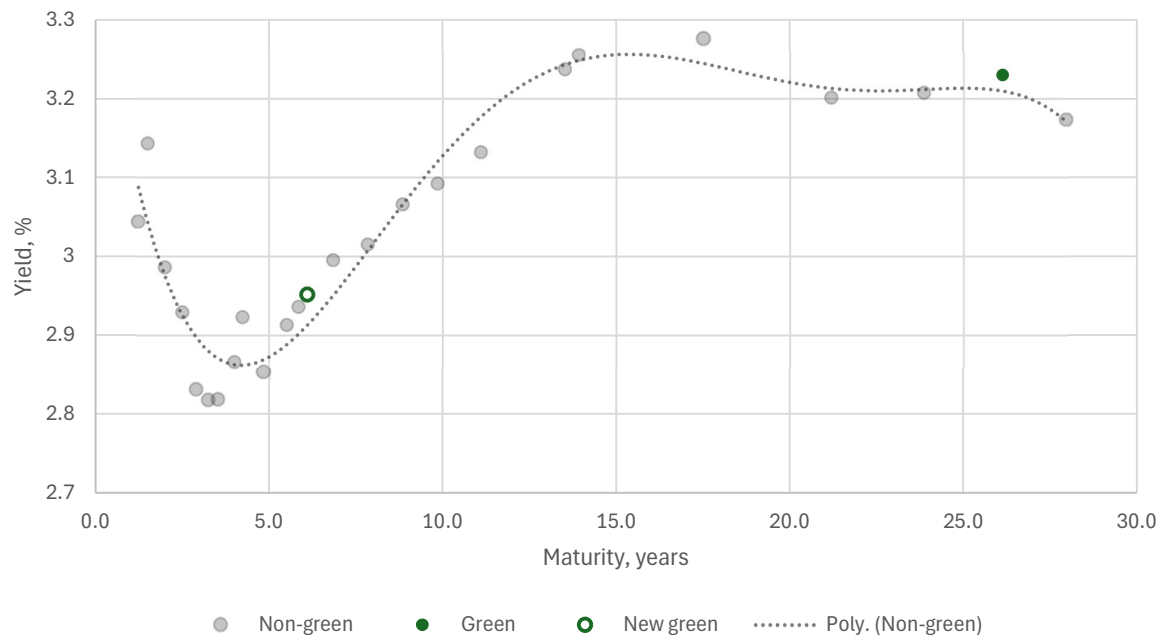*Source*: Bloomberg, data extracted 2024.04.04

Figure 31

Austria gov. yield curve, 7 days after new issues
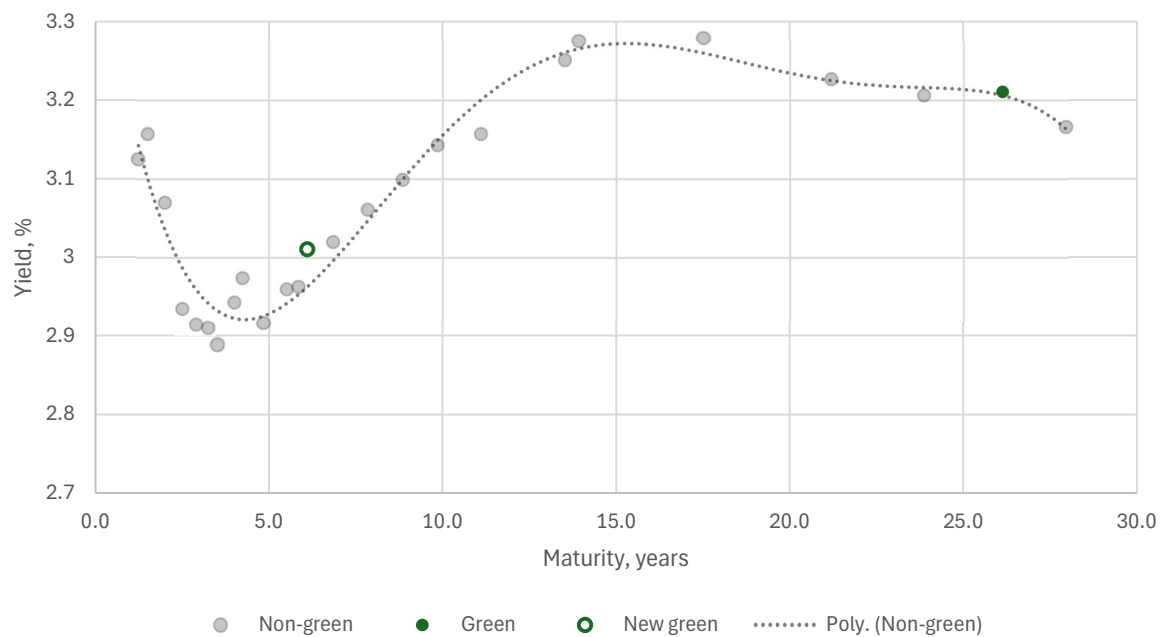
Source: Bloomberg, data extracted 2024.04.04

After 30 days (Figure 32), the green bond yield decreased to 2.797%, while the non-green bond curve decreased to 2.781%. Although the yield difference narrowed to 0.02 percentage points, the green bond remained slightly above the non-green bond curve, further confirming the absence of greenium.

Figure 32

Austria gov. yield curve, 30 days after new issues
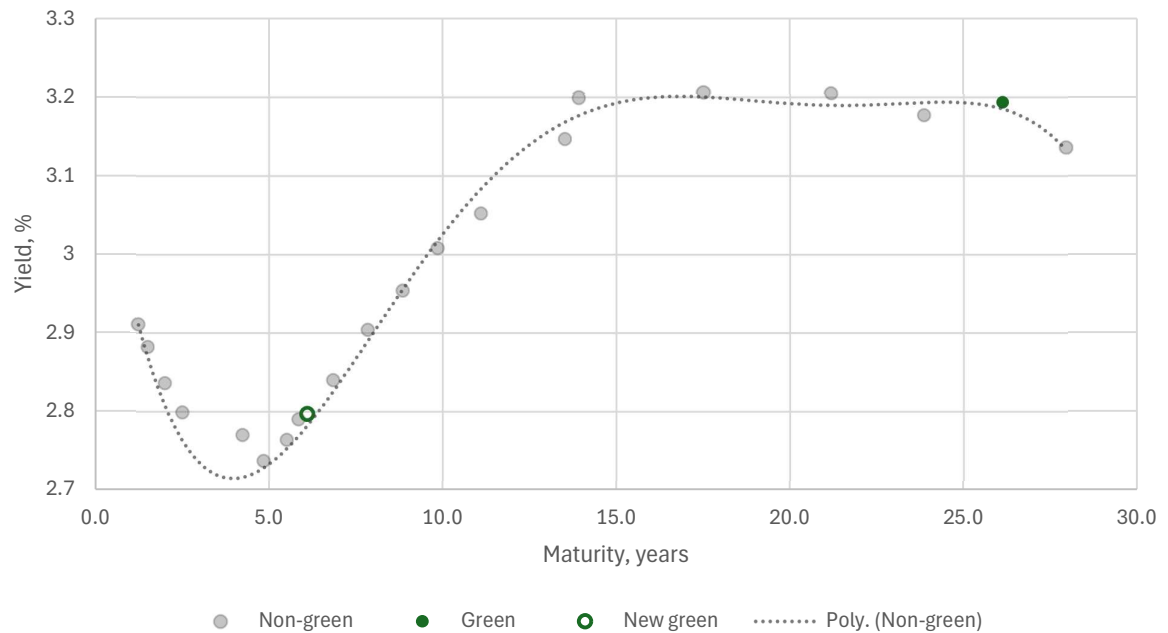
Source: Bloomberg, data extracted 2024.04.04

Table 12

Yield dynamics of Austria gov., (2023-04-17)

|		Bond yield	Curve Value	Greenium	Bond yield change	Curve change
	Issue date	2.952	2.912	0.04		
6Y	+7 days	3.011	2.962	0.05	0.06	0.05
	+30 days	2.797	2.781	0.02	-0.16	-0.13

 Source: Bloomberg, data extracted 2024.04.04

Unlike the Irish bond, the Austrian government green bond consistently traded above the yield curve throughout the first 30 days (Table 12). This indicates that the market did not attribute a greenium to the Austrian green bond, suggesting that investors were not willing to pay a premium for its green credentials during this period.

3.3. Discussion and Future Research Directions

The results of this thesis reinforce the view that greenium—a pricing benefit associated with green bonds—remains a complex and inconsistent phenomenon. The thesis demonstrates that while some issuances show a noticeable greenium at the time of issuance, others do not, highlighting the nuanced nature of the green bond market. This aligns with previous studies by Partridge & Medda (2020) and Larcker & Watts (2019), who found that greenium is not always present, especially in the primary market. These findings suggest that investor sentiment, market conditions, and issuer characteristics play a significant role in determining whether a greenium materializes. The variation in greenium across different bonds emphasizes the importance of market maturity and liquidity, as observed by Zerbib (2018), who found a modest greenium in secondary markets but not necessarily in the primary issuance phase.

Contrasting this thesis with the work of Wu (2022) and Li et al. (2022), which observed a consistent greenium in the Chinese green bond market, suggests regional and market-specific factors could be at play. The thesis findings indicate that the European market's diversity in bond types and issuer profiles may contribute to these mixed results. The inconsistency in greenium detection also challenges earlier studies by Ehlers & Packer (2017), who reported an average greenium in primary markets. This divergence indicates that factors such as regulatory frameworks, investor demand, and the perceived credibility of green certifications influence the existence and size of greenium. It underscores the need for a more refined understanding of how green bond characteristics, investor preferences, and external conditions interact to create or diminish greenium.

The conclusions from the empirical analysis of this thesis reveal that the hypotheses raised are largely inconclusive, with varying levels of confirmation and rejection across the three hypotheses:

The first hypothesis (H1), which posits that the yield of green bonds at issuance is lower than the yield curve of seasoned bonds from the same issuer, is weakly supported. While some cases demonstrated evidence of a greenium at issuance, the results were inconsistent across different issuers and markets. In other instances, green bond yields were even higher than those of comparable conventional bonds. This inconsistency suggests that factors beyond the green label, such as market conditions, issuer credit ratings, and liquidity, may play a significant role in determining bond yields. These findings highlight a need for further academic inquiry to better understand the drivers behind green bond pricing and to refine methodologies for isolating the greenium effect.

The second hypothesis (H2), which suggests that greenium persists in the secondary market over time, is mainly confirmed. The analysis showed that when a greenium exists at issuance, it tends to

remain stable in secondary markets over short timeframes (7 to 30 days post-issuance). This stability indicates that investors continue to value the environmental credentials of green bonds after issuance. However, the persistence of greenium may still be influenced by external factors such as changes in interest rates or shifts in investor sentiment, warranting further investigation into long-term dynamics.

The third hypothesis (H3), which hypothesizes that greenium is consistently present across both corporate and government bond sectors, is largely rejected. The results were mixed, with government bonds generally showing similar instability of greenium compared to corporate bonds. This discrepancy may stem from differences in risk profiles, regulatory support, and investor demand between these two sectors. However, corporate bonds exhibited greater variability in the magnitude of greenium, influenced by issuer-specific factors such as industry type and creditworthiness. These findings suggest that the presence and magnitude of greenium are context-dependent and not uniformly distributed across all types of issuers.

In conclusion, while some evidence supports the existence of a greenium under specific conditions (H2), the overall findings for H1 and H3 remain inconclusive or mixed. These results underscore the complexity of green bond markets and highlight significant opportunities for future research to explore the nuanced factors influencing green bond yields and their implications for sustainable finance.

Several avenues for future research emerge from this study, especially given the evolving nature of the green bond market and the complexities observed in greenium behavior. First, future research could focus on the long-term financial performance of green bonds beyond the immediate post-issuance period. While this thesis examined short-term dynamics, extending the analysis to several years post-issuance could offer more insights into how greenium behaves over the full life cycle of a bond and whether long-term environmental project performance influences market pricing.

Second, there is a need to investigate sector-specific and geographic variations in greenium more thoroughly. While this thesis touched on differences between corporate and government bonds, a more detailed study could analyze how different industries, such as energy, manufacturing, and technology, benefit from green bond issuance and whether regulatory environments in various regions (e.g., Europe vs. Asia-Pacific) impact the size and persistence of greenium. Additionally, examining emerging markets and the role of green bonds in financing infrastructure projects could provide valuable insights into the development of sustainable finance in these regions.

Finally, future research could explore the effects of regulatory changes and green bond certification standards on greenium. As green finance continues to grow, the implementation of more rigorous and

standardized certification processes, such as the EU Green Bond Standard, could have a significant impact on investor confidence and the pricing of green bonds. Investigating how these regulatory changes affect both greenium and the risk of greenwashing would contribute to understanding the future trajectory of green bonds as a reliable tool for sustainable financing. Research on how policy interventions, such as tax incentives or subsidies for green certification, might further enhance the greenium and drive broader adoption of green bonds among corporate and government issuers could also be highly beneficial.

CONCLUSIONS AND RECOMMENDATIONS

Green bonds have become increasingly important as strategic financial instruments. offering companies a way to showcase their commitment to environmental sustainability. This has the potential to attract a broader investor base. especially those interested in sustainable investments. and can lower the cost of capital. However. challenges arise from the lack of standardized criteria for green bonds. necessitating uniform standards and transparent reporting to ensure their integrity and reduce greenwashing risks. It's important to note that, while the issuance of green bonds can lead to a lower WACC, the overall effect on a company's WACC depends on the proportion of green bonds in the company's capital structure and the magnitude of the greenium. If green bonds constitute a small fraction of the company's total capital. the impact on WACC might be limited.

While green bonds' risk and return profiles are similar to conventional bonds, the benefits such as enhanced reputation and investor appeal, can offset the additional costs associated with certification and compliance. Moving forward. it's crucial to focus on long-term performance and the impact of green bonds on the cost of capital. Policymakers should consider incentives for green bond issuance to support a robust market. Investors also need to conduct thorough due diligence scrutinizing the environmental claims and sustainability commitment of issuers. The effectiveness of green bonds in impacting company value and aiding sustainable development hinges on standardized practices. rigorous due diligence. and continued research into their long-term impacts.

The methodology employed in this study is designed to empirically evaluate and quantify the greenium by isolating the effects of green bond issuance from broader market influences. Carefully calibrated yield curve construction using polynomial regression allows for a detailed representation of bond yields across different maturities, accommodating the non-linear shapes typical of yield curves.

Compared to other methods, such as the matching method, which pairs green bonds with comparable non-green bonds to control for external variables, yield curve analysis offers a broader assessment. The matching method, while effective in minimizing biases due to omitted variables, often faces challenges related to the availability of comparable bonds. In contrast, yield curve analysis does not rely on finding perfect matches, thus providing a more comprehensive view of market trends and investor behavior. This method allows for the inclusion of a wider range of bonds, enhancing the robustness and generalizability of the findings. By employing yield curve analysis, this study can

offer more nuanced insights into the dynamics of green bond yields and their implications for the cost of capital, making it a preferred approach for capturing the complexities of the green bond market.

The empirical analysis conducted in study reveals several key insights regarding the dynamics of greenium in the green bond market. The results indicate that, in many cases, green bonds do not exhibit a significant greenium at issuance, meaning that they are often issued at similar yields compared to conventional bonds of the same issuer. This suggests that the hypothesized (H1) cost advantage of green bonds due to their appeal to socially responsible investors may be limited or inconsistent. However, when greenium was observed at issuance, it generally remained stable in secondary markets over short to medium periods (7 to 30 days). That mainly confirms hypothesis (H2), which proposed that greenium persists in secondary markets over time. This stability reflects continued investor interest in green bonds post-issuance, though long-term persistence remains uncertain and requires further study. Hypothesis (H3) of consistent greenium across both corporate and government bond sectors is largely rejected.

The findings further show that the absence of a consistent greenium over time is influenced by market factors such as fluctuating investor demand, overall economic conditions, and the specific characteristics of the bonds issued. The lack of a clear greenium indicates that the market may not consistently attribute additional value to the environmental benefits associated with green bonds, thereby limiting the financial incentives for issuers to adopt sustainable practices. These results are consistent with the conclusions found in other academic studies (Silva et al., 2024), (Hou et al., 2024). On a positive note, from the issuer's perspective, companies are not penalized by the market for the additional costs associated with green bond issuance.

Moreover, the comparative analysis between corporate and government green bonds highlights differences in the presence and variability of greenium. Government-issued green bonds tend to show less variability in yield compared to corporate green bonds, which may be attributed to lower credit risk and greater investor confidence in public sector commitments to sustainability. On the other hand, corporate green bonds demonstrate greater variability, reflecting differences in corporate sustainability practices, issuer-specific risk, and sectoral dynamics. These findings underscore the complexity of the green bond market and suggest that while greenium may be an important concept, its absence in many cases calls into question the consistency of its impact across different types of issuers. This inconsistency should be carefully considered by investors and policymakers seeking to promote green finance as a viable tool for funding sustainable development.

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THE GREENIUM EFFECT IN GREEN BOND FINANCING

Tadas PECIUKEVIČIUS
Master Thesis

Finance and Banking Programme
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SUMMARY

74 pages, 12 tables, 31 figures, 64 references.

The Master Thesis explores the phenomenon of greenium – a premium associated with green bonds that results in lower yields compared to conventional bonds. The study examines its implications for corporate and government financing, analysing whether green bond issuance, in the product of greenium, reduces the cost of capital and enhances market valuation. The thesis consists of three parts: a literature review, empirical analysis, and conclusions with recommendations.

The primary objective is to investigate whether green bonds provide financial advantages by lowering borrowing costs for issuers. The research methodology involves yield curve analysis of green and conventional bonds issued by the same entities in Europe during 2023. Polynomial regression is employed to construct yield curves, and case studies are used to assess yield dynamics at issuance and over time (7 and 30 days post-issuance).

Key findings indicate reveal that the existence and magnitude of greenium are not as straightforward as often perceived. While some evidence suggests green bonds may yield lower costs for issuers compared to conventional bonds, the results vary significantly depending on the issuer type, market conditions, and bond characteristics. These findings challenge the notion of a universal greenium and underscore the complexity of assessing its financial benefits for issuers. The study emphasizes that while green bonds can enhance reputational value and attract ESG-focused investors, their financial advantages are context-dependent and subject to market-specific dynamics.

The thesis contributes to sustainable finance literature by providing empirical evidence on greenium dynamics and highlighting the need for standardized evaluation frameworks for green bonds. It also addresses challenges like greenwashing, emphasizing transparency in reporting.

Recommendations include enhancing regulatory frameworks to support green bond markets, promoting issuer transparency to maintain investor trust, and encouraging further research into regional variations in greenium behavior. This work underscores the growing importance of green bonds as tool for sustainable development while offering actionable insights for policymakers, investors, and corporate leaders.

ŽALUMO PREMIJOS EFEKTAS ŽALIŲJŲ OBLIGACIJŲ FINANSAVIME

Tadas PECIUKEVIČIUS
Magistro darbas

SANTRAUKA

74 puslapiai, 12 lentelės, 31 paveikslai, 64 nuorodos.

Magistro darbe nagrinėjamas „žalumo premijos" (angl. greenium) reiškinys – tai su žaliųjų obligacijų emisija susijusi premija, dėl kurios šios obligacijos pasižymi mažesnėmis pajamingumo normomis nei įprastos obligacijos. Tyrime analizuojama šio reiškinio įtaka įmonių ir vyriausybių finansavimosi kaštams, vertinant, ar žaliosios obligacijos, per žalumo premiją, gali sumažinti kapitalo kainą ir padidina rinkos vertę. Darbas susideda iš trijų dalių: literatūros apžvalgos, empirinės analizės ir išvadų su rekomendacijomis.

Pagrindinis darbo tikslas – ištirti, ar žaliosios obligacijos suteikia finansinių privalumų, sumažindamos emitentų skolinimosi kaštus. Tyrimo metodika apima pajamingumo kreivės analizę, lyginant žaliąsias ir įprastas obligacijas, kurias 2023 m. išleido kruopščiai atrinkti emitentai Europoje. Pajamingumo kreivės sudarytos taikant daugianarės regresijos modelį, o atvejų analizės leido įvertinti pajamingumo dinamiką emisijos išleidimo metu ir po jos (7 bei 30 dienų laikotarpiais).

Pagrindiniai rezultatai rodo, kad žalumo premijos egzistavimas ir dydis nėra vienareikšmiški. Nors kai kurie duomenys rodo, kad žaliosios obligacijos gali sumažinti emitentų skolinimosi kaštus, rezultatai labai priklauso nuo emitento tipo, rinkos sąlygų ir obligacijų charakteristikų. Šie rezultatai, priešingai nei universalūs įsitikinimai, kelia abejonių dėl žalumo premijos egzistavimo ir pabrėžia jos finansinės naudos emitentams vertinimo sudėtingumą. Tyrimas pabrėžia, kad nors žaliosios

obligacijos gali pagerinti reputaciją ir pritraukti investuotojus, orientuotus į tvarumą, jų finansinė nauda priklauso nuo konkrečių rinkos dinamikos veiksnių.

Šis darbas prisideda prie tvaraus finansavimo literatūros, pateikdamas empirinius duomenis apie žalumo premijos dinamiką ir pabrėždamas standartizuotų vertinimo sistemų poreikį žaliųjų obligacijų rinkoje. Taip pat aptariami iššūkiai, tokie kaip "žaliojo plovimo" (angl. „greenwashing") rizika, akcentuojant skaidrumo svarbą.

Rekomendacijose siūloma stiprinti reguliavimo sistemas siekiant paremti žaliųjų obligacijų rinkas, skatinti emitentus užtikrinti ataskaitų skaidrumą bei tęsti tyrimus apie regioninius žalumo premijos skirtumus. Šis darbas pabrėžia augančią žaliųjų obligacijų svarbą kaip tvaraus vystymosi priemonę bei pateikia praktines įžvalgas politikos formuotojams, investuotojams ir įmonių vadovams.

ANNEXES

Annex 1. Certificate of participation at the Internation Conference on Accounting, Audit and Analysis.

ACCOUNTING AUDITING ANALYSIS

Faculty of Economics and Business Administration

Vilnius University

International Scientific Conference

THE MODERN ECONOMIC, TECHNOLOGICAL AND SOCIETAL TRENDS: NEW CHALLENGES OR OPPORTUNITIES

CERTIFICATE

NOVEMBER 27–29, 2024

Tadas Peciukevičius

has participated as presenter and made the presentation

Cost of Capital Dynamics: The Role of Green Bonds in Corporate Financing

at the International Conference on Accounting, Audit and Analysis
The Modern Economic, Technological and Societal Trends: New Challenges or Opportunities

The Conference was held on 27–29 of November 2024, Vilnius, Lithuania

Aida Mačerinskienė

Dean of the Faculty of Economics and Business Administration