Sustainability-Linked Bonds

*A study comparing the yields of sustainability-linked bonds and green bonds.*

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Abstract

This paper analyzes the difference in yield to maturity between two types of ESG-fixed income instruments, and aims to answer the research question "Is there a yield difference between sustainable-linked bonds and green bonds issued in Europe?". The sample consists of a total of 1499 bonds, issued between the time period 2019-2023, where the databases Bloomberg and Refinitive Eikon have been used to collect and filter the data. The null hypothesis is that there is no significant difference between the two bond types, the alternative hypothesis states that one of them has a premium towards the other. For the methodology, the sustainability-linked bonds (SLBs) are matched with green bonds, creating pairs based on similar characteristics. This procedure, which corresponds to previous work by Kölbl & Lambillon (2022), alongside an OLS regression, are used to answer the research question. The results show that there is no significant yield difference between the bond types. This conclusion is drawn from using a Wilcoxon test on the paired bond sample. The result from the regression implies that the yield on green bonds is explained by the defined independent variables to a greater extent than the yield on SLBs.

There are amble number of prior studies which have found a present premium on the ESG instruments green bonds (Fatica et al., 2019; Baker et al., 2018; MacAskill et al. 2021; Kapraun, 2021; Löffler et al., 2021; and Zerbib, 2018) and SLBs (Kölbl & Lambillon, 2022; Feldhütter et al., 2023). This essay aspires to use previous research findings as reference for comparing bond types against each other rather than their performance against conventional bonds. Additionally, the SLB instrument is still considered relatively novel and hence this essay aims to contribute to existing knowledge with new inputs and findings.

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Keywords: Sustainability-Linked Bond, Green Bond, ESG, Premium, Sustainable Investing
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Keywords: Sustainability-Linked Bond, Green Bond, ESG, Premium, Sustainable Investing
1. Introduction

1.1 Background

Sustainable finance refers to how financial markets incorporate economic, social and governance (ESG) factors into investment decision-making processes (European Commission, 2023). Various stakeholders such as shareholders, society and regulatory systems express a high demand for ESG-related business, consequent from aiming to reach common sustainable goals (ibid). This has led to companies exploiting customer preferences to create a competitive edge in connection with allocating capital to sustainable practices. ESG has also been used in capital markets by companies trying to lower their cost of capital by issuing sustainability-related instruments. In this practice, companies create bonds of green, social, sustainable and sustainability-linked character, and investors are drawn to these instruments as they offer benefits of generating financial returns and contributing to positive environmental and social outcomes (Kölbel & Lambillon, 2022). Investors also argue that these instruments are less risky due to their sustainable nature and are reflected in an “ESG premium” where investors are willing to give up returns in exchange for an ESG-positive asset. In parallel to this, for issuers this means having a lower cost of debt (Delevingne et al., 2020).

The bonds under the GSSS label (Green-, Social, Sustainable- and Sustainability-linked bonds) include a range of fixed-income securities where most are designed to finance projects with specific environmental and social benefits (Mishra et al., 2023). Each bond here has a distinct focus, and due to demand and from existing different lengths of time, their market shares differ. Green bonds have been on the market since 2007, and has been researched broadly since where a premium, sometimes referred to as a “greenium”, has been found in various studies when comparing against conventional bonds (Fatica et al., 2019; Baker et al., 2018; MacAskill et al. 2021; Kapraun, 2021; Löffler et al., 2021; and Zerbib, 2018).

Sustainability-Linked Bonds (SLBs) were first introduced in 2019 by the Italian utility company Enel (OECD, 2021). Its structure is different compared to other GSSS instruments, including step-up rates for the issuers who do not meet defined sustainability goals, hence increasing their cost of debt. SLBs have similarly been studied in comparison to regular bonds, however to a lesser extent than green bonds. The research on SLBs as with green bonds, indicate that there is a premium investors are willing to pay for sustainable investments options (Kölbel & Lambillon, 2022; Feldhütter et al., 2023). The potential yield difference between SLBs and green bonds has however not been investigated, as SLBs are a relatively novel instrument, despite the findings being of value to various stakeholders.
1.2 Problem discussion

Green bonds and SLBs are both instruments under the GSSS bond label, but have existed for different lengths of time and thus their potential premium has not been confirmed equivalently. Green bonds make up the largest part of GSSS bonds, while SLBs account for the smallest share. Both of the bond types have been evaluated compared to conventional bonds, investigating the existence of a lower yield to maturity, indicating a premium. For green bonds, large sample research has repeatedly found a lower yield, hence confirming a “greenium” (Fatica et al., 2019; Baker et al., 2018; MacAskill et al. 2021; Kapraun, 2021; Löffler et al., 2021; and Zerbib, 2018). With the first SLB issued in 2019, a limited amount of research has been conducted. Nevertheless, the research that does exist also shows a premium, when comparing against conventional bonds (Kölbel & Lambillon, 2022; Feldhütter et al., 2023).

This paper aims to investigate the yield on SLBs against green bonds, in contrast to comparing a GSSS bond against a conventional bond. Reasoning follows that through examining instruments that belong to the same category of bonds, but have been adopted by the market to different extents, we can evaluate whether SLBs follow similar behavior as green bonds in terms of yield. In addition to this, if SLBs have a smaller yield (a premium), this may be explained through the principles of supply and demand. Our research aims to investigate the yield on the respective bond types, the incentive structure and the mechanical differences with regard to the compensation and use of proceeds for the respective bond type. This study is thus relevant not only for firms looking to raise capital but also for investors who seek a sufficient risk-adjusted return on the bond market.

With the underlying stated background, this essay aims to answer the research question:

RQ: “Is there a yield difference between Sustainable-Linked Bonds and green bonds issued in Europe?”

Further, with help from descriptive statistics we discuss what factors contribute to explaining the yields of sustainable-linked bonds and green bonds.

1.3 Research design

The research design can be described as an ontological and deductive approach, with an epistemological consideration. The sample consists of all European issued bonds in the estimation window September 2019 until December 2023, that are either considered green or sustainability-linked and meet defined sampling criteria. For filtering the data of the bond types
respectively, the variables sector, amount issued, duration, bond type, maturity type, currency and country of issuance are considered. The data bases used to source the bonds are Bloomberg and Refinitive Eikon, and the total initial sample includes 1499 bonds. Two main methods are used to answer the research question. The first is OLS regression inspired primarily by previous research by Fatica et al. (2019). The second method is a matching approach inspired by Kölbel & Lambillon (2022), where SLBs are paired with green bonds based on similar criteria, creating sets of pairs. The latter significantly reduces the sample to 32 bond pairs, and this sub-sample is further used in order to perform a Wilcoxon test.

1.4 Aim and knowledge contribution

This study replicates and takes inspiration from studies previously done by Fatica et al. (2019) on green bonds, and Kölbel & Lambillon (2022) on SLBs. In the studies mentioned, both SLBs and green bonds yield have been compared to conventional bonds. The traditional (non-ESG) bond sample works as a control group while the GSSS bond is the one performing exceptional in theory. We argue that the market for green bonds is more mature than SLBs, having already been in implementation for over 12 years. Hence, this essay intends to apply what has already been contributed in terms of green bonds yield premium, and compare the yield of the novel instrument, SLB, against this.

1.5 Results

No yield difference between European issued SLBs and green bonds is detected in the paired sample when performing an Wilcoxon test. This result from the methodology means that we cannot reject the null hypothesis. When analyzing the OLS regression, we find that the green bond yield is explained by the variables in the model to a greater extent than SLB yield is. This implies that despite not being able to significantly differentiate the two bond types yield, the underlying factors determining the yields variate.

1.6 Limitations

The data includes bonds obtainable from Bloomberg and Refinitive Eikon which have been able to provide information on predefined variables. Due to this method of collecting data, and filtering out a large proportion of available bonds, the conclusions drawn from the research of this essay may not be applicable for other bonds which do not follow these defined characteristics. Bonds that potentially could indicate a different result than what is demonstrated in the conclusion of this study have hence been excluded. Reasons behind this decision have been limited research time and that we considered that the sample size (of almost 1500 bonds) to be large enough to be able to provide a quantitative
result.

Bonds which have been studied are ones issued from September 2019 until December 2023, with the underlying argument that SLBs have only existed in this time frame and hence no historical data prior to this exist. The same does though not apply for green bonds, where data can be obtained before 2019. Consequently, the SLBs sample is highly representative of its entire market data, whereas green bonds data is rather a proportion of the population at a segmented timeframe. As this essay aims to evaluate a young instrument against an older one, the nature of this essay could not be formed differently in this aspect, although it needs to be acknowledged. This is also the collection method that has been used in prior studies which compare fixed-instruments with different life-spans.

Lastly, this study has been limited to the European market with the motive that a majority of European-issued bonds follow the same regulatory framework, as a majority of countries of issuance are European Union (EU) members. However, there are exceptions to this, being Switzerland, Norway and Great Britain which are not members of the EU and hence do not necessarily follow identical legislation for bonds.

1.7 Outline

This essay is composed of six main sections, where the first section introduces the thesis' background, problem discussion, research design, aim and knowledge distribution, results and limitations. The second section examines the literature review and theoretical framework, consolidates information on sustainable finance and bonds, and highlights previous research and conclusions on SLBs and green bonds. The third section covers the methodology and logic behind the choice of analytical tools used. The empirical results of the research are presented in the fourth section, while the fifth section delves into the analysis of these findings and makes comparisons with existing literature and theories. Lastly, section six provides a summary of these findings, leading to conclusions, implications and suggestions for future research.

2. Literature review

This section will begin with clarifying notions that underlie this essay's relevance, such as sustainability concepts, bond definitions and additional framework. Furthermore, theories are explained in the literature survey, which are the basis for assumptions made throughout the essay. Finally, the section ends with previous studies' contributions to the subject, including the conclusions that have been drawn from these.
2.1 Background

2.1.1 Sustainable Development Goals

Sustainable development is the practice of meeting present needs without compromising the chances of future generations to meet theirs (United Nations, 1987). In 2015, the United Nations (UN) outlined 17 sustainable development goals (the SDGs), aiming for economic, social and environmental improvement and development (United Nations, n.d.a). Each goal includes targets, accumulating to 169 in total, adopted by 193 UN member states (ibid). Synergies of these goals are health, aware consumption and production, clean energy, urbanization and oceans. In order to maintain societal and environmental survival, social inclusion, economic growth and environmental protection must be realized (United Nations, 2023). Contrary to this is pursuing immediate or short-term rewards without considering the potential damage exposed to others or the planet. Despite 2015 being the landmark for the SDGs, the plan is built upon Agenda 21, established in 1992 (United Nations, 1992). This agenda’s motives were to improve human as well as environment conditions globally, hence preparing the world for challenges of the next century (ibid).

2.1.2 Environmental, Social and Governance

Environmental, Social and Governance (ESG) is a sustainable development concept with underlying criterias sectioned into three components (Ahmad et al., 2023). The criteria of Environment, “E”, covers emission policies, net zero movements and other climate actions. The Social criteria, “S”, includes improving working conditions, equality, diversity and further fields regarding human rights. Lastly, “G”, for Governance, includes how corporate governance uses implementations of regulation and frameworks to incorporate sustainability (Van Duuren et al., 2016). Examples of governance implementations in ESG are sustainability reporting, due diligence, business models, strategies, transformations, regulatory compliance and whistleblowing systems (ibid). Practicing ESG means raising awareness regarding companies' role in the movement of a sustainable shift, where investments, business operations and corporate actions are main objectives (Hoang, 2018). These standpoints are closely related to the SDGs, and hence the concepts are often evaluated together. What differentiates the two is that ESG centralizes organizations and companies' influence and impact while the SDG refers to the world as a whole (Fallah Shaya et al., 2022). ESG has become a lead object in the corporate universe as more external pressure is put on companies to integrate ESG measures into its operations (ibid). It is also used frequently in financial markets as more and more investors have believed that companies without ESG in operations have a lower probability of running a successful business (Van Duuren et al., 2016).
2.1.3 Sustainable finance

Sustainable finance relates how financial markets incorporate ESG factors into the investment decision process, incentivising investors towards sustainable economic activities by promoting long-term investments and (Schoenmaker, 2017). By this, the competitive environment enables firms to increase return and hence benefiting from choosing sustainability. Promoting transparency regarding risks associated with ESG factors that could impact the financial system is heavily advocated (European Commission, 2023). ESG risks include adopting effective governance structures, responsible business practices, and adapting to evolving ESG expectations and regulations (Hübel & Scholz, 2020). By proactively addressing these risks, corporate resilience can be enhanced and furthermore protect their reputation. Despite the concept of sustainable finance underlining the social and governance aspect in ESG, financial institutions include the aspect of environment through adapting investments to be towards sustainable projects and being long-term (Fatemi & Fooladi, 2013). Environmental adaptations include projects of preventing pollution, addressing climate change, preserving biodiversity, and promoting a circular economy (European Commission, 2023).

Sustainable finance plays a crucial role in directing private investment towards the shift to a climate-neutral, climate-resilient, resource-efficient, and equitable economy. The goal of sustainable finance is to guarantee that investments contribute to building a robust economy, including fostering a productive recovery from the repercussions of the Covid-19 pandemic (European Commission, 2023). In the EU, sustainable finance aligns with supporting economic growth while alleviating environmental pressures, in line with the climate and environmental initiatives (ibid).

2.1.4 GSSS bond labels

GSSS bonds consist of green, social and sustainable bonds, as well as sustainability-linked bonds and as of 2023 make up between 14-16% of the global bond market (Cochelin et al., 2023). Green bonds have funding which is allocated for projects with a positive environmental impact and dominate GSSS representing 59% of issuance. Social bonds have allocated funding towards improving human life and supporting socioeconomic advancement, and account for 18%. Sustainability bonds are a combination of green- and social bonds, enabling a broader inclusion of project categories and represent 17% of issuance. Lastly, sustainability-linked bonds (SLBs) account for 6% of GSSS amount issued, and compared to the earlier mentioned segments this bond type is not directed towards a specific project (Cochelin et al., 2023). The focus for SLBs is that companies should meet a predefined Sustainability Performance Target (SPT) or else the consequence will be an increased yield on the issuance (OECD, 2021). For further details, see section 3.
Figure 1.1 shows global GSSS bond issues in billions of USD. A positive trend between 2016 to 2021 can be seen, with the increase between 2020 and 2021 being the largest observed (going from 623 to 1,183 billion USD). Green bonds consistently dominate the GSSS market share. From 2019, social and sustainable bonds start to be observed more and more, and further in 2021 SLBs market share can also visually be observed. From 2021, the trend shifts from positively increasing to downshifting, and for the latest figures from January to June of 2023, annual issuance amounts to 602 billion USD. The bond categories appear to be equally affected by the reduction of issuance between 2021 and 2023.

Background for the trends observed includes challenging macroeconomic factors in the market for the years studied. Challenges include increasing inflation, leading to central banks increasing interest rates (Brazil et al., 2022). Consequently, this results in higher borrowing costs which decrease the incentives for corporations to issue bonds (ibid).

2.1.4.1 Green bonds

The first green bond was initiated in 2007 by a Swedish pension group, and in late 2008 the instrument was embraced by the World Bank in collaboration with SEB, who became the first institutions to issue this type of bond (Ferlin & Fryxell, 2020). The World Bank started raising funds from fixed income investors to support lending for projects with focus on sustainability for the climate (ibid). The structure of green bonds are similar to conventional bonds, however financing procedures are aimed towards the environmentally sustainable sector. Common examples are financing amongst renewable energy, energy efficiency, clean transportation, green buildings, wastewater management and climate change adaptation (World Bank, 2023). Contextualizing green bonds with the ESG
framework, the “E”, environment, is the main related sector (European Environment Agency, 2023). In 2014, green bonds accounted for 0.6% of all bonds issued in the EU, and as of 2022 this figure rose to 8.9% (ibid).

2.1.4.2 Sustainable-Linked Bonds

First introduced in 2019, sustainability-linked bonds (SLBs) are financial instruments that, similar to green bonds, encourage sustainable investments (OECD, 2020). The aim of the instrument is to involve performance based financing solutions for institutions and corporations that can create a bigger incentive to improve sustainability in operations rather than specified projects (ibid). SLBs feature a new structure where the compensation to investors is tied to predefined Key Performance Indicators (KPIs), called Sustainable Performance Targets (SPTs) (Ghosh, 2021). The SPTs aim is to improve the green business transition, involve performance based financing solutions for institutions and corporations, and create a bigger incentive to improve sustainability in operations rather than financing specific green projects (ibid). The International Capital Market Association (ICMA) defines SLBs as “any type of bond instrument for which the financial and/or structural characteristics can vary depending on whether the issuer achieves predefined sustainability/ESG objectives” (ICMA, 2020). If the issuer of a SLB is unable to achieve its SPT within the given timeframe, this will result in a penalty taking form through a step-up coupon rate, meaning that the issuer must pay a higher rate of interest to the bondholder (ibid).

ICMA has specified in the Sustainability-Linked Bond Principles (SLBPs) that the SPTs should be: (1) relevant, core and material to the issuers overall business, (2) measurable and quantifiable, (3) externally verifiable and (4) benchmarkable using an external point of reference or definitions to verify the SPTs level of ambition (ICMA, 2023). To ensure the verifiability of the targets, the SLBP recommends that the issuer should seek independent and external verification of the performance against the targeted achievements (ibid). The structure of the SLB ensures that the proceeds of the bond is used to invest in a sustainable transition of the issuers operations. This results in a different incentive structure for the issuer as the SLB is not regarded as a use-of-proceeds bond as the invested amount is for overall business use rather than towards a specific project (Köbel & Lambillon, 2022).

2.1.5 EU regulations

Through actively enacting legislation and frameworks focused on sustainable investments, the EU has emerged as an important driver in facilitating the operations of GSSS bonds (Alexandraki, 2021). The Union has been proactive in introducing legislation aligned with the SDGs, exemplified by initiatives such as the 2018 Action Plan (European Commission, 2018) as well as the 2019 EU Green Deal (European Commission, 2019). This commitment has experienced visible progress in sustainable
finance, fostering a surge in demand for these instruments and enhancing transparency (Alexandraki, 2021).

The 2018 Action Plan had the aim to enhance transparency by directing capital toward sustainable investments and mitigating financial risks arising from sustainability issues (Alexandraki, 2021). Subsequently, the EU Green Deal, introduced at the close of 2019, aimed to position Europe as the first climate-neutral continent by 2050 (European Commission, 2019). Also introduced in 2019 (enforced in 2021), the Sustainable Finance Disclosure Regulation (SFDR) became a central element of both the Action Plan and the EU Green Deal (Regulation 2019/2088). The primary objective of SFDR is to mandate reporting, thereby reducing greenwashing practices (ibid).

The EU Taxonomy (2020), an integral part of the Green Deal (Regulation 2020/852), provides definitions for environmentally sustainable business activities, covering a vast majority of economic activities contributing to EU emissions (Schütze & Stede, 2021; European Commission, n.d.b). This regulation ensures that financial market participants cannot make unsubstantiated claims of environmental commitment (Flammer, 2021; Becker et al., 2022). Aligned with EU Taxonomy guidelines, the European Green Bond Standard (GBS) serves as a voluntary framework for green bonds, evolving from ICMA's Green Bond Principles (European Commission, n.d.b; Alexandraki, 2021). Its purpose is to increase third-party verifications and ensure precise disclosure of bond proceeds (European Commission, n.d.b).

In conclusion, the EU's legislative efforts in sustainable finance aim to reduce information asymmetries, increase transparency, and create a common framework for assessing financial and sustainability performance, guiding capital toward activities that promote sustainability.

2.2 Theoretical framework

2.2.1 Stakeholder theory

The stakeholder theory is descriptive, prescriptive and instrumental, and further captures how different stakeholders' values become affected by actions of other stakeholders as well as managers (Freeman, 1984). The concept of a stakeholder first arose in literature in 1963, originally consisting of shareholders, employees, customers, suppliers, lenders and society (ibid). These parties were believed to have valuable viewpoints of the business performance, consequent from themselves being affected by the state of the organization (Schoenmaker, 2017). If the value creation of a company would increase, it would be highly likely that the residual gains stakeholders were entitled to would merge simultaneously (ibid). However, as the sub-groups which make up the stakeholders have different
roles, motives and targets, this gives rise to a conflict of interest (Parmar et al., 2010). Despite aiming for efficiency and overall profitability, how this is done is not necessarily a universal belief shared by the range of parties (ibid). Thus, included in the theory is the idea of firms being able to balance the conflicting claims of various managers, stockholders, suppliers and more (Schoenmaker, 2017). Despite difficulty, if executives fail to take account of the opinions of stakeholders, they would not survive in the market due to lack of support (ibid).

According to Pearce (1982), besides stockholders having justifiable reasons to expect appropriate returns on investments, there is a simultaneous presence of local communities wanting companies that are responsible citizens and the general public demanding improved life quality as a result of the company's presence (Parmar et al., 2010). These are only a few of many angles, but the general idea Pearce suggests follows that as stakeholders include more than profit-driven individuals, the actions needed to be taken go further than ensuring economic wealth. In concurrence with this, Corporate Social Responsibility (CSR) has bloomed in the context of stakeholder theory (ibid). CSR includes reassessing businesses activity with regards to civil rights, anti-war efforts, consumerism, environmentalism and women rights (Du et al., 2010).

2.2.2 Risk and reward analysis

Risk aversion is defined as unwillingness to expose oneself to risk. In financial contexts, risk aversion means demanding higher compensation for engaging in risky investments (Konjunktursintitutet, 2015). This characteristic is usually most evident for investors or market participants who prefer investments with lower returns and relatively known risks over investments with potentially higher returns but also with higher uncertainty and more risk (CFI, n.d.a). Bonds belong to the category of financial instruments with lower risk, suitable for risk-averse investors (ibid). The logic behind the instruments being classified as less prone to risk is due to absolute priority in situations such as the company experiencing bankruptcy or similar event of dissolution (Guiso et al., 2018). There is a defined legal order on repayment to the company's creditors and investors, where bonds and other debt instruments are paid off before preference shareholders and common shareholders (equity investors) (ibid).

2.2.3 Conclusion of theoretical framework

This essay investigates yield to maturity as the dependent variable, and understanding the underlying mechanisms of this variable is crucial. A lower yield implies a lower cost of capital for the issuer, while for the investor, lower yield equals lower return. While a lower return is generally not seen as beneficial, stakeholder theory suggests that this may be overlooked due to external pressure increasing the demand for ESG fixed-income instruments. Additionally, sustainable investments align with modern regulatory frameworks for bonds, potentially reducing perceived risk. Thus, stakeholder
theory and CSR is the basis used to develop the hypotheses of this thesis. Risk and reward analysis additionally helps explain investors' willingness for risk exposure, providing possible reasons for lower yields of sustainable instruments in the first place.

2.3 Literature survey

Previous research on the yield of SLBs compared to conventional bonds has been done mainly in recent years, consequent from the instrument entering the market in 2019. “Sustainability Linked Bond premium” reaches 57,400 results on Google Scholar, which is approximately one third of the research provided by searching for “Green Bond premium” on the same platform (search results for January 2024). Previous research done on both SLBs and green bonds respectively will be included in the following section, and the methodology of this essay (chapter 3) follows a similar one to Fatica et al. (2019) as well as Köbel & Lambillon (2022). No previous research specifically on SLBs yield to maturity in comparison to green bonds is provided in this section as this has not been conducted previously.

2.3.1 Previous research on the premium on green bonds

Fatica et al. (2019) find that green bonds have a premium over conventional bonds, shown through a negative yield when investigating the pricing at issuance. The empirical research includes analyzing the primary bond market worldwide, sampling 1,397 green- and conventional bonds issued in the period 2007-2018. The method of investigating the data consists of an econometric equation model including the yield at issuance as the dependent variable, as well as a dummy variable “green bond” (0=no, 1=yes) as the main dependent variable. Besides from the green dummy variable, independent variables are set bond characteristics possibly affecting the yield (both dummy and continuous ones). Variables being dummy are the bond being callable, puttable, collateralized, and further currency, maturity, use of proceeds, size and rating are included (categorical and continuous variables). A conservative approach accounts for twists in the yield curve, this being maturity × rating × time and lastly an error term is included to finalize the regression model. This result is significant for evaluating the full sample. However when segmenting the data based on the types of issuers, the premium varies markedly across issuers. Green bonds issuers being supranational institutions and non-financial corporations being the only ones found to sell for a premium. Contrasting to this, the existence of a “greenium” is not confirmed for issuers of financial institutions, where no statistically significant yield difference could be found for green bonds (Fatica et al., 2019).

Baker et al. (2018) investigate green bonds, focusing on the American corporate and municipal markets. The methodology includes testing the prediction that green bonds sell for a premium by regressing after-tax yields on green bond indicators and various controls. Factors such as maturity,
rating, month fixed effects, size decile categories, insurance presence, tax features, bank rating, new money, collateralization, use of proceeds, and other considerations are accounted for in the filtering. Certain specifications involve additional fixed effects, such as maturity×rating×month interaction fixed effects and issuer fixed effects, to account for variations in yields. The study finds that certified green municipal bonds are issued at a premium of around five to seven basis point lower compared to similar conventional bonds, indicating a moderate premium for green bonds. Additionally, smaller or low-risk green bonds tend to have more concentrated ownership compared to ordinary bonds. These trends are particularly pronounced for bonds with external green certification (Baker et al., 2018).

MacAskill et al. (2021) evaluate the existence of a “greenium” in the secondary and primary bond market through a systematic literature review. The literature reviewed consists of 15 prior articles with 30 observations in total, that analyze and identify price differentials for green versus comparable conventional bonds with similar characteristics. For articles regarding green bonds and conventional bonds in the secondary markets, OLS or generalized least squares (GLS) regression using fixed effects is applied to samples, alternatively dynamic conditional correlations method. The time frame for sampling was 2007-2019 and commonly included variables used in the article's regressions are bond yield, maturity, issued amount, rating, group, and currency (similar variables and time frame as Faticia et al., 2019). Findings include a confirmed existence of a “greenium” being -1 to -9 basis points in the secondary market, whilst the primary market experiences a wider variety (MacAskill et al., 2021).

There are various studies which apply a pairing and matching procedure for comparing green bonds to conventional bonds (Kapraun, 2021; Löffler et al., 2021; Zerbib, 2018). For the matching of bonds, a green bond is paired with a conventional bond based on having the same issuer, credit rating, issuance currency and bond type. Kapraun et al. find, when using a sample of 431 pairs, that denominated EUR bonds issued by supranational entities or governance, or corporate bonds with very large issue sizes, where the type of green bonds exhibited to a lower yield. Löffler et al. (2021) finds the “greenium” on average being 15-20 basis points (bps) lower than for regular bonds when using a sample of 836 bonds, a finding applicable for both the primary and secondary bond market. Zerbib uses 110 pairs on green and conventional bonds and through this concludes a small albeit significant negative green bond premium of minus two basis points, and embedded in this finds that sector and rating have a compelling effect on the premium. The yield is found to be more negative for financial bonds as well as low-rated bonds.

2.3.2 The supply and demand affecting yield to maturity

A bond’s price and yield has an inverse relationship, where the yield increases as the price decreases (European Central Bank, n.d.). The supply and demand for bonds with different maturities affects
their prices and consequently their yields. When there is an increased demand for a particular maturity of bonds, the price tends to rise, therefore leading to lower yields. Conversely, a higher yield can be a consequence of less demand. The yield curve reflects this dynamic, showing the relationship between interest rates and bond maturities. Changes in supply and demand not only affect prices but also provide important indications of investor expectations and conditions of the market. This makes the analysis of bond supply and demand essential for investors and policy makers to understand market dynamics and make informed investment decisions. Hence, investors demand is affected by preferences for different asset classes, influenced by expectations of future monetary policy and risk perceptions. During times of economic uncertainty, investors may demand higher returns to compensate for perceived higher risks. This complex interaction between supply and demand, along with external factors that influence investor judgments, shape the overall interest rate environment and yield levels in the bond market.

Ben Slimane et al. (2020) examine how the potential mismatch of supply and demand can trigger scarcities and a larger negative yield premium on green bonds (Ben Slimane et al., 2020). Results show that a premium can arise from a discrepancy of supply and demand. If the demand for green investments is growing independently from the supply, a premia can arise by investors paying a higher price for green bonds compared to conventional bonds, thus creating a negative yield. Figure 2.1 demonstrated this relationship graphically.

![Figure 2.1](source.png)

Source: Reserve Bank of Australia (n.d.)

Figure 2.1 *Yield curves affected by increase in supply of bonds*
2.3.3 Previous research on the premium on SLBs

Kölbel & Lambillon (2022) examine the yield difference on SLBs in comparison to conventional bonds by a matching process similar to Zerbib (2018). Bond seniority, issuer, maturity- and coupon type and currency are variables considered to the pairing procedure. However due to the novelty of SLBs, rating is not a significant matching criteria. The study’s sample includes 145 bond pairs from 115 issuers, and in the methodology an OLS regression is used. Findings are that issuing an SLB gives an average premium of -9 basis points on the current yield compared to the comparative party, although this premium decreased over time. The premium examined on SLBs has also been volatile between years, as the premium in 2021 is found to be -31 bps while no significant premium can be found in 2022. The study additionally finds that there is no clear empirical relationship between the yield at issue and the coupon step-up agreement of SLBs as well as that an issuer’s first SLB appears to command a significantly larger premium. The latter suggests that according to investors, specifically the first SLB is seen as a heavily weighted indication of a company's commitment to sustainability (Kölbel & Lambillon, 2022).

Feldhütter et al. (2023) have carried out research on a sample of 36 SLBs and 44 associated options, where the price difference is calculated in order to validate a potential premium. The findings are similar to Kölbel & Lambillon (2022), concluding that investors accept a lower return on bonds due to ESG labels, specifically 4-7 bps lower. The study examines how cash flows are affected by commitments to meet one or more ESG goals, and there is significant evidence that the potential penalty is significant for SLBs prices. Regarding pricing, Feldhütter et al. argue that despite an efficient SLB market, there is strong evidence of incorrect pricing of SLBs (Feldhütter et al., 2023).

2.3.4 Conclusion of previous studies

Summarizing this section, the findings from studies above on the premium on SLBs (by Kölbel & Lambillon, 2022 and Feldhütter et al. 2023) follow similar conclusions as on the premium on the green bond market (Fatica et al., 2019; Baker et al., 2018; MacAskill et al. 2021; Kapraun, 2021; Löffler et al., 2021; and Zerbib, 2018). Common research approaches for comparing both the GSSS bonds are regression and using a pairing procedure. The sample sizes and research carried out on green bonds is more robust in comparison to the corresponding research done on SLBs, a consequence from the novelty of the latter.

2.4 Chapter summary

Stakeholder theory and CSR contributions as well as risk and rewards analysis, are used to justify underlying factors that explain the potential premium of SLBs and green bonds. The long-term
characteristics of both SLBs and green bonds would in theory indicate less risk in the market, hence imply experiencing a smaller yield. This potential premium has been confirmed by various green bond studies (Kapraun, 2021; Löffler et al., 2021 and Zerbib, 2018) and studies on SLBs, however to a lesser extent (Kölbel & Lambillon, 2022; and Feldhütter et al., 2023). In contrast to previous studies mentioned, this thesis aims to evaluate which instrument, SLBs or green bonds, has a premium in relation to the other. SLBs relatively late introduction to the market, this means that the supply of this instrument is not as developed or broad as green bond, is the underlying motive for conducting the hypotheses this essay tests for. A smaller supply of bonds, not concurring with the higher demand, would in theory cause investors to accept a lower yield. (See section 3.4.2.1 Yield to Maturity for further details.) The higher demand of SLBs, disrupting yield equilibrium, is motivated by SLBs structure of penalties in the form of step-up rates. Thus, there is an incentive for companies to maintain, or aim for a lower cost of debt. This reasoning confirms profit driven motives of companies, as well as stakeholder theory in terms of increasing profits while adapting after societal ambitions regarding sustainable development.

3. Methodology and research design

3.1 Problem, purpose and contribution

The aim of this thesis is to contribute to existing literature and research on SLBs and green bonds, which will lead to a deeper understanding of these instruments. Furthermore, it attempts to unravel if the structural differences have an impact on pricing mechanisms and use cases. Though there has been extensive research comparing conventional bonds to green bonds and also noteworthy research on SLBs, the extent to which these instruments have been directly compared remains uncharted. This thesis aims to offer a comprehensive comparison of the two instruments, highlighting to what extent they differ or in what matter they perform in concordance. The main focus is on SLBs and their market behavior, using green bonds as the comparison, and the control instrument.

A null- and alternative hypothesis have been conducted to capture the research results possible outcomes.

*NH1: There is no significant yield difference between SLBs and green bonds in Europe.*

*AH1: There is a significant yield difference between SLBs and green bonds in Europe.*
In order to test the null hypothesis of a difference in yield between SLBs and green bonds, a variety of statistical frameworks can be applied for this purpose. Previous research has used the Wilcoxon signed rank test that can be employed when a random sample of matched pairs of observations is available (Newbold, Carlson & Thorne, 2013). In this study the Wilcoxon test will be deployed in order to test for a yield difference between matched bonds of green bonds and SLBs. Since the yield premium is defined as the difference in yield between two identical bonds of different types, the bonds in our sample have to be paired in order to test for a difference in yield. The Wilcoxon test is a non-parametric test, meaning it does not assume a normal distribution. It is also suitable for small samples and robust to outliers.

3.2 Research approach

This study follows an ontological, deductive research approach with an epistemological consideration, followed by an epistemological as well as quantitative approach. The deductive approach of the research carried out involved using theories and previous research done on the area of SLBs and green bonds. Past findings and method components are carefully desiccated in order to test hypotheses and be able to answer the research question. The approach consists of identifying relevant literature and theory to (1) establish concepts and theories that are of particular interest. (2) This is then used to generate hypotheses that are later tested by (3) collecting data and tested empirically. (4) The results are then presented and analyzed in a (5) detailed discussion where the results are discussed and any implications and contradictions to the theory interpreted (6) (Bryman & Bell, 2011).

The research is considered as epistemological, referring to the philosophical objective that only the observable phenomena can be considered as knowledge (Bryman & Bell, 2011). This approach embodies the principle of abductive reasoning, where theories are employed to formulate testable hypotheses that, upon empirical validation, augment the explanatory power of the underlying theoretical framework. The epistemological approach in this study refers to the generations of hypotheses that are then tested empirically to determine the observability and existence of a premium on SLBs which is generated through theory (Bryman & Bell, 2011).

The method is shaped by a quantitative approach which essentially means measurable data is retrieved, enabling statistical inferences to be made using empirical methods and models. The quantitative approach follows the deductive method described previously, thus the procedure of generating and testing hypotheses, with the objective of determining the difference in yield between green bonds and SLBs. Additionally, the quantification of this indicator enables the development of findings that support existing literature and theory. The following model of the yield is used in the OLS regression:
3.3 Research design

The empirical design is characterized by using cross-sectional secondary data through a quantitative method. Cross-sectionality refers to observational studies that collect data from a population at a particular point in time. As the existence of SLBs is relatively novel and hence there is limited availability of historical data, conducting a cross-sectional study allows a large collection to be studied and variables can be observed without influencing them (Thomas, 2023). Further, despite omitting historical fluctuations and movements of unobserved data, there are benefits of being able to draw concrete conclusions (Ellram & Tate, 2016).

3.4 Methodology

3.4.1 Data collection method

<table>
<thead>
<tr>
<th>Variable</th>
<th>Criteria</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue date (year)</td>
<td>2019-2023</td>
<td>Eliminate difference in yield due to maturity</td>
</tr>
<tr>
<td>Maturity</td>
<td>2032</td>
<td>Eliminate difference in yield due to maturity (time aspect)</td>
</tr>
<tr>
<td>Region</td>
<td>Europe</td>
<td>EU framework enables set regulations and legislation, except for Norway, Great Britain and Switzerland.</td>
</tr>
</tbody>
</table>

Data on green bonds and SLBs have been collected respectively. Bloomberg and Refinitive Eikon both have filtering functions which are used for a more effective data retrieving and cleaning process. The data is primarily filtered based on issue date, maturity and region, shown in Table 3.1. As the focus of this study is on the European bond market, the data is filtered on the European region including the EU, Norway, Great Britain and Switzerland. Exceptions to this filtering are Russia and Ukraine with the rationale being that these two countries have ongoing conflict as of when this research is performed, affecting their local financial markets (Sehn et al., 2022). Further, bonds are filtered based on issue- and maturity date. This due to the main dependent variable of this essay, yield to maturity, being heavily impacted by the remaining time to maturity. Hence, the sample of green bonds is shortened to match the SLB sample for this aspect. Neither of the bond types include any
bond maturing after the year 2032. As first SLBs were issued in 2019 we choose this year as our starting period for both green bonds and SLBs. This follows similar reasoning for prior green bond studies, which use the instrument's year of implementation (2007) as the starting time frame (see section 2.3.1 Previous research on green bonds).

Table 3.2 Regression variable descriptions

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Data type</th>
<th>Rationale, independent variables potential effect on the dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issuer sector</td>
<td>Dichotomous</td>
<td>Sectors follow different cycles in the market and are volatile to different extents.</td>
</tr>
<tr>
<td>Principal currency</td>
<td>Dichotomous</td>
<td>Can affect yield through exchange rate movements, interest rate differentials, credit risk, and inflation differentials. The related risks affect investors' willingness to invest in various currencies.</td>
</tr>
<tr>
<td>Country of issue</td>
<td>Dichotomous</td>
<td>Similar rationale as “Principal Currency”. Political and economic stability affect risk, being one of the reasons some countries in Europe have been removed from the sample (Ukraine, Russia). The country of issuance plays a key role in determining the risk profile of a bond, and this risk directly influences the yield.</td>
</tr>
<tr>
<td>Amount issued</td>
<td>Ordinal</td>
<td>Used for descriptive statistics rather than directly affecting yield. It however demonstrates market dynamics, investor perceptions, and supply and demand, all of which can affect the bond's market price and, consequently, indirectly its yield.</td>
</tr>
<tr>
<td>Years long (duration)</td>
<td>Ordinal</td>
<td>The length of the bond affects interest rate sensitivity and represents the weighted average time it takes for the bond's cash flows (coupon payments and return on capital at maturity) to be repaid.</td>
</tr>
<tr>
<td>Issue date</td>
<td>Ordinal</td>
<td>The issue date indirectly affects the yield through its impact on the bond's remaining maturity, interest rate sensitivity and market conditions. Additionally, 2019-2023 have been volatile years in the stock and bond market, hence year of issuance can affect results.</td>
</tr>
<tr>
<td>Maturity date</td>
<td>Ordinal</td>
<td>Same rationale as “Issue date”.</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>---------------------------------</td>
</tr>
</tbody>
</table>

After adjusting both samples for geographical location and issue- and maturity date, descriptive statistics are conducted with the variables sample size, amount issued, sector, principal currency, duration (in years), bond type and country of issue. These independent variables are either dichotomous or ordinal and are listed in Table 3.2. Here, the relevance and motivation for various independent variables is included and summarized.

3.4.2 Data analysis and empirical methods

3.4.2.1 Yield to maturity

This study will use the yield to maturity (YTM) to quantify the difference in yield. The YTM reflects the rate of return (or interest rate) on a bond or other fixed-rate security at any given time. An investor receives this level of compound return given the underlying assumption that he or she purchases the security at the current market price and is maintained by the investor until the maturity date when the instrument has reached its full value. All interest and coupon payments are made as planned and have the potential to be reinvested at the same rate of return as the bond (CFI, n.d.b). The YTM is limited in the matter of not accounting for bond taxes that an investor pays, nor does it account for purchasing or selling costs. The formula follows using the bond’s maturity value (or par value), which below is referred to as the Face Value, and the Current Price is equal to the bond's price today.

\[
YTM = \sqrt{\frac{FaceValue}{Current Price}} - 1
\]

Further the YTM can be used to calculate the bond price, which is beyond what this essay is aiming to focus and investigate on. However, including and identifying the relationship between the YTM and bond price is relevant in terms of why YTM is an important objective for this analysis as they may vary between bond types. Additionally, understanding the mechanisms of a bond’s price and yield is essential for explaining the yield curve through supply and demand later in this section. In the formula below, the term \(n\) represents the number of periods to maturity.

\[
Bond \ price = \left(\text{Coupon} \times \frac{1}{(1+YTM)^n}\right) + \left(\text{Face Value} \times \frac{1}{(1+YTM)^n}\right)
\]
3.4.2.2 Wilcoxon test

Berson, Levine, and Szabat (2014) states a number of statistical methods for comparing two samples of numerical variables, including the Wilcoxon test and paired t-test. These tests are used by Köbel and Lambillon (2022) and hence we use the Wilcoxon test to return Köbel and Lambillon's (2022) method. The choice of this test is due to its non-parametric nature, which means that it does not require normal distribution within the population (Wilcoxon et al., 1963). The matched dimension is of relevance to our study, where we pair obligations (Berson, Levine & Szabat, 2014). The Wilcoxon signed rank test becomes valuable when the sample sizes are small and it is difficult to assume that the population is normally distributed. This is the case here when the sub-sample consists of 32 bonds. This is of particular importance because it can be difficult to maintain normal distribution with such a sample size. Compared to Köbel and Lambillon's (2022) study, which includes approximately one third of the entire SLB universe and a greater focus on Asia and Oceania, our study focuses only on the Europe market.

3.5 Reliability and validity

Bryman & Bell (2011) characterize validity as if the concept in question is measured by the chosen measure in fact. Reliability on the other hand is defined as the level of consistency of the measure (Bryman & Bell, 2011). Validity in this research is provided through the SLBs being compared to green bonds based on a set of variables such as sector, bond type, maturity type and more. Further, the aspect of legal and regulatory factors affecting results is managed through using a sample of bonds issued in Europe, hence EU regulations apply to a majority of bonds studied. The study of SLBs observed YTM against green bonds has, as mentioned in section 1.2 Problem discussion, has not prior been investigated.

Reliability is ensured by using a similar research design as previous studies which have been able to contribute with findings. Consistent measurement methods enhance the likelihood that the results accurately reflect the true characteristics of the variables. The methodology used by Fatica et al. (2019) and Köbel & Lambillon (2022) has been the approach followed in this research. This research also uses historical secondary source data which further increases its reliability and additionally, enables it to be replicated.

3.6 Source critical considerations

The study uses historical bond data from the widely used sources Bloomberg (primarily) and Refinitive Eikon (as a complementary source). Bloomberg is used by a variety of professionals in the
financial sector, and offers more robust information on the variable "sector" compared to Refinitive Eikon. Refinitive Eikon provides complementary information about other relevant variables which are evaluated in this study.

The data underlying the research is considered secondary. By using secondary data and through this not sorting and cleaning out raw material, time instead has been able to be allocated towards other research priorities. It is nevertheless acknowledged that there are some benefits lost from not using primary data notably that self gathered data is considered as more exact with regards the specific research aim than secondary data, and researchers have greater control over variables (Maione, 2023).

3.7 Research ethical reflection

The research conducted has the absence of direct involvement of individuals, thus potential ethical problems such as confidentiality, anonymity and respondents' rights do not arise. The quantitative data utilized is available on the databases Bloomberg and Refinitive Eikon, which eliminates concerns about sharing private or sensitive information. Consequently, ethical questions related to general data protection regulations (GDPR) are not applicable. The data employed is objective and intended for statistical use and research purposes only.

4. Empirics, analysis and results

In the following section, a comprehensive report on descriptive statistics, empirical results and the summary of the essay's hypothesis is presented. For the descriptive statistics, the sample on SLBs and green bonds are presented respectively in terms of geographical spread, amount issued and yield. Further, respective OLS regressions are performed where the $R^2$ suggests how much of the YTM is explained by the model. After this the matching approach, where the two samples of bonds are paired, is used in order to conduct a Wilcoxon test. Finally, the obtained results are presented.
4.1 Descriptive Statistics of Sustainability-Linked Bonds

Cumulative amount issued on SLBs is displayed over a four year period, from 17 October 2019 until 11 December 2023, in Figure 4.1. The figure provides an insight of the SLB issuance demand in Europe, where the observed trend is positive and increasing over time, specifically growing at the end of 2020. The latest figures from late 2023 conclude an aggregated issuance of 147 300 million USD.

Table 4.1 SLB issuance by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
<th>Amount issued (USD)</th>
<th>% of Amount issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>5</td>
<td>1 086 334 200</td>
<td>0.74%</td>
</tr>
<tr>
<td>CH</td>
<td>9</td>
<td>4 858 394 750</td>
<td>3.30%</td>
</tr>
<tr>
<td>CZ</td>
<td>2</td>
<td>1 452 639 000</td>
<td>0.99%</td>
</tr>
<tr>
<td>DE</td>
<td>19</td>
<td>11 072 396 900</td>
<td>7.52%</td>
</tr>
<tr>
<td>DK</td>
<td>9</td>
<td>4 859 405 000</td>
<td>3.30%</td>
</tr>
<tr>
<td>ES</td>
<td>6</td>
<td>2 202 241 830</td>
<td>1.50%</td>
</tr>
</tbody>
</table>
Table 4.1 shows the distribution of the amount issued in billions of USD in Europe, where 21 countries are featured in the sample. Italian issued bonds are superior as these make up 40.44% of market share for amount issued as well as dominate in quantity with 66 bonds. France is the second largest issuing country, representing 19.65% of the amount issued, and likewise is the country making up the second most quantities of bonds (51 bonds). For the remaining countries, the proportion of amount issued follows a similar spread, all being under 7%. However, in terms of quantity, Sweden that has 33 bonds in the sample is the third most represented (after Italy and France).

Table 4.2 Descriptive statistics for SLBs
<table>
<thead>
<tr>
<th>Sector</th>
<th>Count</th>
<th>Amount Issued (USD)</th>
<th>Avg. Amount Issued (USD)</th>
<th>% of amount issued</th>
<th>YTM (%)</th>
<th>Stdev YTM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>11</td>
<td>6 345 328 670</td>
<td>576 848 061</td>
<td>4.3%</td>
<td>6.74%</td>
<td>4.74%</td>
</tr>
<tr>
<td>Consumer Discretionary</td>
<td>34</td>
<td>15 134 535 925</td>
<td>435 263 520</td>
<td>10.3%</td>
<td>5.70%</td>
<td>3.11%</td>
</tr>
<tr>
<td>Consumer Staples</td>
<td>26</td>
<td>16 858 629 350</td>
<td>648 408 821</td>
<td>11.4%</td>
<td>4.59%</td>
<td>2.87%</td>
</tr>
<tr>
<td>Energy</td>
<td>15</td>
<td>10 162 178 900</td>
<td>677 478 593</td>
<td>6.9%</td>
<td>7.76%</td>
<td>9.47%</td>
</tr>
<tr>
<td>Financials</td>
<td>17</td>
<td>7 025 670 400</td>
<td>413 274 729</td>
<td>4.8%</td>
<td>5.18%</td>
<td>2.03%</td>
</tr>
<tr>
<td>Government</td>
<td>9</td>
<td>321 466 200</td>
<td>35 718 467</td>
<td>0.2%</td>
<td>3.80%</td>
<td>0.70%</td>
</tr>
<tr>
<td>Healthcare</td>
<td>7</td>
<td>2 774 340 040</td>
<td>396 334 291</td>
<td>1.9%</td>
<td>10.97%</td>
<td>12.71%</td>
</tr>
<tr>
<td>Industrials</td>
<td>43</td>
<td>19 670 876 720</td>
<td>457 462 249</td>
<td>13.3%</td>
<td>5.49%</td>
<td>2.17%</td>
</tr>
<tr>
<td>Materials</td>
<td>33</td>
<td>14 388 303 000</td>
<td>436 009 182</td>
<td>9.7%</td>
<td>6.78%</td>
<td>4.82%</td>
</tr>
<tr>
<td>Technology</td>
<td>7</td>
<td>2 405 381 860</td>
<td>343 625 980</td>
<td>1.6%</td>
<td>11.80%</td>
<td>9.97%</td>
</tr>
<tr>
<td>Utilities</td>
<td>67</td>
<td>52 548 562 700</td>
<td>784 306 906</td>
<td>35.6%</td>
<td>5.19%</td>
<td>5.23%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>269</strong></td>
<td><strong>147 635 273 765</strong></td>
<td><strong>547 582 519</strong></td>
<td><strong>100%</strong></td>
<td><strong>5.92%</strong></td>
<td><strong>5.12%</strong></td>
</tr>
</tbody>
</table>

The five first columns of Table 4.2 provide information about the sector’s bond count spread, amount issued, average amount issued and how much this amount issued accounts for relative to the total sample. The aggregated amount issued is approximately 147.3 billion USD and the average amount issued per bond is almost 547.6 million USD. Utilities, industrials and consumer discretionary are the most appearing bonds in terms of count, with 67, 43 and 34 bonds respectively. Utilities is also the sector with the largest proportion of amount issued with 35.6%. Government, technology and healthcare are the bonds which appear least, and also have the smallest percentage of amount issued.

The two columns on the right side of Table 4.2 show the sectors YTM and standard deviation YTM. The average YTM is 5.92% while the average standard deviation YTM is 5.12%. The technology sector has the highest YTM with 11.80% and is followed by healthcare with 10.97% Both of these account for a rather small proportion of the sample with seven bonds and amount issued accounting
for less than two percent (respectively). The government sector accounts for the smallest average yield and the smallest standard deviation, as well as the smallest percent of amount issued.

4.2 Descriptive statistics of green bonds

Table 4.3 *Green bonds issuance by country*

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
<th>Amount issued</th>
<th>% of Amount issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>20</td>
<td>12 573 229 050</td>
<td>4.00%</td>
</tr>
<tr>
<td>CH</td>
<td>117</td>
<td>23 261 183 343</td>
<td>7.39%</td>
</tr>
<tr>
<td>CZ</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>DE</td>
<td>427</td>
<td>123 303 154 461</td>
<td>39.18%</td>
</tr>
<tr>
<td>DK</td>
<td>19</td>
<td>18 157 632 105</td>
<td>5.77%</td>
</tr>
<tr>
<td>ES</td>
<td>18</td>
<td>10 414 305 903</td>
<td>3.31%</td>
</tr>
<tr>
<td>FI</td>
<td>5</td>
<td>696 085 729</td>
<td>0.22%</td>
</tr>
<tr>
<td>FR</td>
<td>79</td>
<td>64 134 533 315</td>
<td>20.38%</td>
</tr>
<tr>
<td>GB</td>
<td>24</td>
<td>4 332 998 772</td>
<td>1.38%</td>
</tr>
<tr>
<td>GR</td>
<td>4</td>
<td>863 362 146</td>
<td>0.27%</td>
</tr>
<tr>
<td>HR</td>
<td>9</td>
<td>1 571 240 828</td>
<td>0.50%</td>
</tr>
<tr>
<td>IE</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>IT</td>
<td>2</td>
<td>11 331 628 192</td>
<td>3.60%</td>
</tr>
<tr>
<td>LT</td>
<td>1</td>
<td>21 584 053</td>
<td>0.01%</td>
</tr>
<tr>
<td>LU</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>NL</td>
<td>2</td>
<td>1 349 003 355</td>
<td>0.43%</td>
</tr>
<tr>
<td>NO</td>
<td>203</td>
<td>20 805 677 304</td>
<td>6.61%</td>
</tr>
<tr>
<td>PL</td>
<td>7</td>
<td>695 346 046</td>
<td>0.22%</td>
</tr>
</tbody>
</table>
The distribution of the amount issued in billions of USD, featuring 16 countries for green, is shown in Table 4.3. Five issuing countries observed in the SLB sample could not be found in this sample, and these countries are noted with “NA”. Denmark and France have the biggest market share, where the amount issued stands for 38.96% and 20.26% respectively. Besides these, there are no big outliers, as the rest of the sample account for less than 8% individually. Regarding bond count, Scandinavian countries account for the biggest quantity, with Denmark (408 bonds), Sweden (309 bonds) and Norway (203 bonds) being on the top pillar.

Table 4.4 *Descriptive statistics for green bonds*

<table>
<thead>
<tr>
<th>Sector</th>
<th>Count</th>
<th>Amount Issued</th>
<th>Avg. Amount Issued</th>
<th>% of amount issued</th>
<th>YTM (%)</th>
<th>Stdev YTM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>28</td>
<td>12 042 766 228</td>
<td>430 098 794</td>
<td>2.3%</td>
<td>4.24%</td>
<td>1.38%</td>
</tr>
<tr>
<td>Consumer Discretionary</td>
<td>67</td>
<td>20 850 076 767</td>
<td>311 195 176</td>
<td>5.5%</td>
<td>5.05%</td>
<td>2.14%</td>
</tr>
<tr>
<td>Consumer Staples</td>
<td>32</td>
<td>9 130 656 508</td>
<td>285 333 016</td>
<td>2.6%</td>
<td>4.02%</td>
<td>1.56%</td>
</tr>
<tr>
<td>Energy</td>
<td>53</td>
<td>5 496 856 886</td>
<td>103 714 281</td>
<td>4.3%</td>
<td>5.72%</td>
<td>2.49%</td>
</tr>
<tr>
<td>Financials</td>
<td>821</td>
<td>163 554 481 408</td>
<td>199 213 741</td>
<td>66.8%</td>
<td>4.57%</td>
<td>1.80%</td>
</tr>
<tr>
<td>Government</td>
<td>84</td>
<td>72 259 540 559</td>
<td>860 232 626</td>
<td>6.8%</td>
<td>3.43%</td>
<td>1.13%</td>
</tr>
<tr>
<td>Healthcare</td>
<td>3</td>
<td>254 570 379</td>
<td>84 856 793</td>
<td>0.2%</td>
<td>5.40%</td>
<td>3.48%</td>
</tr>
<tr>
<td>Industrials</td>
<td>32</td>
<td>5 914 376 875</td>
<td>184 824 277</td>
<td>2.6%</td>
<td>6.13%</td>
<td>3.11%</td>
</tr>
<tr>
<td>Materials</td>
<td>26</td>
<td>3 731 184 453</td>
<td>143 507 094</td>
<td>2.1%</td>
<td>6.01%</td>
<td>2.87%</td>
</tr>
<tr>
<td>Technology</td>
<td>12</td>
<td>2 419 705 769</td>
<td>201 642 147</td>
<td>1.0%</td>
<td>4.93%</td>
<td>3.46%</td>
</tr>
</tbody>
</table>
Likewise the representation for SLBs, the first five columns of Table 4.4 show the sector’s distribution in terms of bond count, amount issued, average amount issued and how much this amount issued accounts for relative to the total sample. The aggregate amount issued is almost 315.9 billion USD and the average amount issued per bond is just over 257 million USD. The three most represented sectors in terms of count are financials; government and utilities. These also have a percentage of amount issued following the same trend. Financial is the dominant sector for count (821 bonds) and sample market share (66.8%), government and utilities have the second and third most (84 and 71 bonds) with 6.8% and 5.8% respectively. Healthcare with only 3 bonds represented, and technology (12 bonds), are the least appearing bonds. These also have the smallest percentage of amount issued (0.2% and 1% respectively). This follows a similar trend as the SLBs sample (with the exception of the government sector).

The average YTM is 4.61% while the average standard deviation is 1.96%. The industrials sector has the highest YTM with 6.13% and is followed by materials with 6.01%. These two sector’s count is not in the top nor in lowest represented sectors, hence no trend for number of observations and market share can be observed. Government accounts for the smallest average yield and the smallest standard deviation, a result similar to SLBs sample (see Table 4.2).
4.3 Descriptive statistics for paired bonds

Figure 4.2 Pairs by sector

Figure 4.2 shows the sector distribution for the 32 pairs. Most of the pairs are made up of bonds of the financial sector, consisting of 11 data points. This is followed by consumer discretionary and consumer staples, which each have 6 bond pairs. Further, utilities make up 4 pairs while industrial and materials stand for the least common pairs matched, with 2 pairs respectively.

Table 4.5 Bond pairs descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Avg.</th>
<th>Median</th>
<th>Stdev.</th>
<th>Min</th>
<th>1st Q</th>
<th>3rd Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue date diff (years)</td>
<td>1.3</td>
<td>1.15</td>
<td>1.13</td>
<td>0.03</td>
<td>0.03</td>
<td>1.7</td>
<td>5.15</td>
</tr>
<tr>
<td>Maturity SLB (years)</td>
<td>6.7</td>
<td>7.0</td>
<td>2.52</td>
<td>0.25</td>
<td>0.25</td>
<td>8.26</td>
<td>13.01</td>
</tr>
<tr>
<td>Maturity green bond (years)</td>
<td>6.36</td>
<td>5.7</td>
<td>2.3</td>
<td>3.0</td>
<td>3.0</td>
<td>8.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>
Table 4.5 presents descriptive statistics for 32 bond pairs, this is equivalent to 12% of the SLBs- and 2.6% of the green bonds sample. The average difference in issue dates is 1.3 years, the mean maturity difference is 1.6 years and the pairs have an average issued amount ratio of 1.06. On average, SLBs exhibit a slightly longer maturity and greater issue size. The median and mean differences in yields are 0.24% and 0.48%, respectively.

Table 4.6 Bond pairs average yield to maturity by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Avg. YTM diff (%) (green bond - SLB)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE</td>
<td>0.16</td>
<td>1</td>
</tr>
<tr>
<td>FI</td>
<td>-0.02</td>
<td>1</td>
</tr>
<tr>
<td>FR</td>
<td>-0.46</td>
<td>5</td>
</tr>
<tr>
<td>GE</td>
<td>0.08</td>
<td>6</td>
</tr>
<tr>
<td>GB</td>
<td>0.31</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 4.6 shows the country of issuance of the paired bonds, where 12 countries are included. Most of the bond pairs are issued in Sweden (country code SE), where the average YTM difference is 0.15%. The yield difference is calculated by YTM SLB - YTM green bond, a negative average difference indicates that SLB have a lower YTM than the green bonds and thus a negative premium. The second most common country of issuance is Germany (GE) through 6 bond pairs with an average yield difference of 0.08%. It is important to acknowledge that for a majority of countries, only one SLB could be matched with a green bond.

Table 4.7 Bond pairs, yield to maturity by currency

<table>
<thead>
<tr>
<th>Currency</th>
<th>Avg. YTM diff (%)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUR</td>
<td>-0.07</td>
<td>25</td>
</tr>
<tr>
<td>SEK</td>
<td>0.40</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>0.03</td>
<td>32</td>
</tr>
</tbody>
</table>

The currency spread of the bond pairs is shown in Table 4.7, where almost 80% of bonds are issued in the currency EUR (count 25 of 32 pairs). This is not surprising as most countries in Europe use the euro as currency. The other currency observed is SEK (Swedish Krona). The issuing country and issuing currency do not need to correspond, however Sweden is the country observed in Table 4.6 to individually account for most pairs. The result shows that the average difference between EUR and SEK issued bonds is 0.03%.
### Table 4.8 Bond pairs, yield to maturity by sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Avg. YTM diff (%)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Discretionary</td>
<td>0.20</td>
<td>6</td>
</tr>
<tr>
<td>Consumer Staples</td>
<td>-0.29</td>
<td>6</td>
</tr>
<tr>
<td>Financials</td>
<td>0.15</td>
<td>11</td>
</tr>
<tr>
<td>Industrials</td>
<td>0.18</td>
<td>3</td>
</tr>
<tr>
<td>Materials</td>
<td>0.18</td>
<td>2</td>
</tr>
<tr>
<td>Utilities</td>
<td>-0.26</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.03</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

In **Table 4.8**, the average difference in YTM per sector between the matched bonds can be seen. During the matching process, exact matches could not be obtained across all sectors, hence why healthcare, technology, energy, government and communication are not included. As observed prior in **Table 4.2** and **Table 4.4**, these specific sectors had a limited number of observations, thereby diminishing the likelihood of finding a match.

### 4.4 Wilcoxon test

**Table 4.9 Wilcoxon test statistics**

<table>
<thead>
<tr>
<th>Wilcoxon test statistic</th>
<th>Two sided test ≠ 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>W (W+, W-)</td>
<td>39 (59, 39)</td>
</tr>
<tr>
<td>P-value</td>
<td>0.644</td>
</tr>
<tr>
<td>Significance level</td>
<td>0.05</td>
</tr>
</tbody>
</table>

The results from the Wilcoxon test, provided in **Table 4.9**, indicate that there is a non-significant difference in the YTM between SLBs and green bonds for the 95% confidence level. Furthermore, the high p-value of 0.644 suggests that there is no evidence to conclude that there is a significant difference between SLBs and green bonds and that any observed differences between the two bond
types could likely be due to randomness rather than explanatory relationship. The larger the p-value, the more it supports the null hypothesis.

4.5 OLS regression

Table 4.10 *OLS regression on SLBs and green bonds*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Green Bonds</th>
<th>SLBs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>SE</td>
</tr>
<tr>
<td>Intercept</td>
<td>251,065</td>
<td>28,427</td>
</tr>
<tr>
<td>Amount issued</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>Days until maturity</td>
<td>-0,033</td>
<td>0,005</td>
</tr>
<tr>
<td>Cpn</td>
<td>59,078</td>
<td>1,867</td>
</tr>
<tr>
<td>SEK</td>
<td>39,466</td>
<td>11,166</td>
</tr>
<tr>
<td>EUR</td>
<td>135,496</td>
<td>10,283</td>
</tr>
<tr>
<td>Utilities</td>
<td>-11,470</td>
<td>28,695</td>
</tr>
<tr>
<td>Healthcare</td>
<td>-23,403</td>
<td>78,899</td>
</tr>
<tr>
<td>Consumer Discretionary</td>
<td>9,734</td>
<td>29,337</td>
</tr>
<tr>
<td>Consumer Staples</td>
<td>-57,672</td>
<td>33,452</td>
</tr>
<tr>
<td>Communications</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>Energy</td>
<td>76,898</td>
<td>30,438</td>
</tr>
<tr>
<td>industrials</td>
<td>61,997</td>
<td>33,538</td>
</tr>
<tr>
<td>Materials</td>
<td>47,115</td>
<td>35,265</td>
</tr>
<tr>
<td>Government</td>
<td>-62,776</td>
<td>28,443</td>
</tr>
<tr>
<td>Technology</td>
<td>21,099</td>
<td>44,724</td>
</tr>
<tr>
<td>Financials</td>
<td>31,583</td>
<td>24,819</td>
</tr>
<tr>
<td>R Squared</td>
<td>0,569</td>
<td></td>
</tr>
<tr>
<td>Adjusted R Squared</td>
<td>0,563</td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td>129,679</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1230</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.10 shows the regression on the green bond and SLB data sets. The green bond R squared value is 0.569 while SLBs is 0.297, indicating that the YTM of green bonds is explained through the stated independent variables to a greater extent than SLBs yield is. It is also observed that the difference between the adjusted R squared and the non-adjusted is greater for SLBs than green bonds. A small difference in these values suggest that extra independent variables add little explanatory power to the dependent variable, implying they may not offer significant additional information. The standard error of 439.952 for the SLBs regression is more than three times larger than the green bonds (129.679). This suggests that for SLBs there is a greater uncertainty or variability in the estimated coefficients of the independent variables.

4.6 Chapter summary

This section on descriptive statistics outlines the European SLB and green bond market, comprising 269 and 1230 bonds respectively. SLBs are mainly issued in Italy, and most bonds belong to the
sectors utilities, industrials and consumer discretionary. The average YTM is found to be 5.92%. Green bonds are mainly issued in Scandinavia, where Danish issued bonds dominate. The most common sectors are financials, utilities and consumer discretionary and for the entire sample, the average YTM is found to be 4.61%. Further, the bond pair section focuses on a matched sample of 32 bond pairs, revealing a mean yield difference of 0.48% at issue. By performing a Wilcoxon test on the paired bonds, the null hypothesis could not be rejected as the test statistic of 39 is less than the critical value. OLS regressions on the total respective samples (269 and 1230 bonds) are provided, highlighting the significance of factors such as country of issuance, sector, currency, coupon and days until maturity in explaining the yield difference at a 95% confidence level. The R squared values of 0.569 for green bonds and 0.297 for SLBs suggest that green bonds YTM is explained by the chosen variables to a greater extent than for SLBs YTM.

5. Analysis and discussion

In this section, empirical results of the SLBs and green bond universe in Europe are analyzed and discussed. The statistical tests performed on the bond pairs are handled against the research question and the hypotheses. The reasons for the observed result are explained, and previous research is used to provide a summary of the implications for SLBs and green bonds issued in Europe.

5.1 SLB and green bond characteristics

Since first introduced in 2019, SLBs have experienced substantial growth at 73% CAGR (%) demonstrated in Figure 4.1. The issuance of SLBs accelerated in mid 2021, when bond markets were fuelled by a low interest rate environment. This upward trend continued with steady growth until recently when the growth has been leveling off, likely due to multiple interest hikes which has increased the cost of debt for corporations and thus decreased the incentive for companies to issue bonds. Despite SLBs growth since introduction, green bonds still dominate the GSSS bond market with a 59% market share within Europe, with SLBs constituting 6% in 2023.

Furthermore, green bonds and SLBs are popular for different sectors, which is evident in the collected data. As observed in Table 4.2, SLBs are popular instruments within manufacturing sectors due to its structure around measurable SPTs. The sectors that issued the greatest amounts are utility (35.6%), consumer staples (11.4%), consumer discretionary (10.3%), industrials (13.3%), and materials (9.7%). These industries can all be categorized as production intensive that can easily structure SPTs around reducing emissions or increasing efficiency. On the other hand, sectors with lower issuance can be characterized as less production intensive such as, government (0.2%), healthcare (1.9%), technology (1.6%) and financials (4.8%). For these sectors, the difficulty arises from identifying measurable SPTs
which is a key feature of the SLB, and therefore find it more difficult to gain from this bond type. This can be compared with the data for the sectors that stood for the greatest amount issued for green bonds. Here, the financial sector stood for two thirds of the total amount issued. When examining the underlying sub-sectors, it can be seen that a large part of the green bonds issuance within the financial sector can be derived from the real estate sector, which is a sub-sector to the Financial sector in the categorization used. In regards to this, since green bonds are a “use of proceeds” bond, meaning that the proceeds are earmarked for environmentally friendly projects, it is well suited for the real estate sector, to for example construct green buildings. The real estate market is also a sector with high capital requirements, meaning that it significantly relies on debt markets and can therefore utilize green bonds in an effort to lower the cost of debt. The rest of the sector's market share of the green bonds market showed to be relatively fragmented, however, the government sector is the second largest with 6.8% of the issued amount. The data indicate that sectors have different preferences for whether green bonds or SLBs characteristics are best suited for various operations and financing objectives.

Regarding geographical spread (both in terms of bond quantity and amount issued), Italy is the country that has issued the majority of the SLB market. When analyzing the source of this issuance, the Italian utility company Enel stands for a considerable amount through having issued more than 40 billion USD. France is the second largest issuer of SLBs accounting for 19.65% of the total amount issued in Europe. For green bonds, Germany accounts for almost 40% of the amount issued in the sample.

5.2 Hypothesis testing

The underlying research question for this thesis is whether a difference in yield could be observed on SLBs as opposed to green bonds. A potential premium would be explained by a lower supply of SLBs due to their recent implementation, not aligning with demand and hence the market not having matured yet. A premium could also be explained by SLBs step-up structure and incentive mechanism, creating a stronger motive for issuers to actively reach SPTs or else experience a higher cost of debt.

According to the Wilcoxon test results, presented in Table 4.9, no significant difference in yield between green bonds and SLBs when using a pairing method could be found, and thus we fail to reject the null hypothesis. The result here is not in line with the supply and demand aspect of yield to maturity, where Figure 2.1 is the underlying explanation for why SLBs should be assumed to have a smaller yield. As indicated by the data, the shift towards sustainable investments has been demonstrated through investors increasingly seeking investment opportunities that align with environmental, social and governance criteria. As indicated also by the Wilcoxon test, the lack of
significant difference in performance between SLBs and green bonds, may reflect the overarching investor preference for GSSS bond label as a category, rather than distinguishing between the specific nuances of the bonds types. This could point to a homogeneous pricing method among investors for SLBs and green bonds. The return of SLBs is dependent on whether the issuer manages to meet the SPTs, this is not the case for green bonds. A potential misalignment between perceived and actual risk due to their structures could therefore lead to mispricing.

5.3 Dependent variable analysis

Following on from the concluding that there is a non-significant difference in yield between SLBs and green bonds, an OLS regression has been deployed to determine the explanatory power of independent variables. The results are shown in Table 4.10 with green bonds to the left and SLBs to the right. Firstly, it is notable that the green bond's $R$ squared value, being 0.569, indicates that the predicting model is better suited than for SLBs, where the $R$ squared is 0.297. In part, this could be explained by the significantly larger sample size of 1230 bonds that was obtained for green bonds, compared to the SLBs sample of 269. By interpreting the respective p-values, the significant effect that the independent variables have on the dependent variable (YTM) can be evaluated. Also from Table 4.10, green bonds p-values are lower than the ones obtained from the SLB sample, indicating that the independent variables have a greater effect on the YTM. The independent variables for the yield on SLBs overall show higher p-values, suggesting that the significant effect on the YTM is lower, thus the variables cannot predict the yield outcome.

On a sector level, the government sector is the only significant predictor affecting the yield on green bonds. On average, this sector has a YTM that is 62.7 basis points lower compared to others, holding all other variables constant. This observation can be attributed to the risk profile provided by governments, as these bonds are backed by national governments, which are generally considered unlikely to default. In contrast, corporate bonds may display greater variability in their YTM, likely due to a wider range of creditworthiness. This is consistent with results from Table 4.2 and Table 4.4, showing that government bonds have the lowest standard deviation for YTM for both SLBs (0.7%) and green bonds (1.13%).

This thesis has intended to investigate whether there is a yield difference between SLBs and green bonds in the European market. The research has been carried out by using an OLS regression as well as Wilcoxon test on respective samples of the bond types from issuance 2019-2023. When comparing the two samples, no significant yield difference has been detected for the OLS regression. As this research is relatively novel, for comparing these specific variables, it is not possible to confirm
previous findings. However, this result can be compared to previous studies done on SLBs and green bonds respectively, comparing against conventional bonds.

6. Conclusion

6.1 Conclusion and knowledge contributions

We set out to fill the knowledge gap of whether there is a yield difference between SLBs and bonds. This is done with help from principles of stakeholder theory, risk and reward analysis, prior studies on SLBs and green bonds as well as the mechanics of supply and demand. Prior research has not examined these bond types against each other, though green bonds and SLBs have respectively been evaluated in terms of a premium. By researching this field, new knowledge on both bonds is contributed. After using a Wilcoxon test and OLS regression, the result shows that there is no significant difference between the two bond types, hence one does not have a higher premium over the other. This suggests that despite SLBs being novel to the market, it will follow similar patterns in terms of yield as the matured instrument, green bonds. Regardless of the bond type's structure and mechanical design, SLBs are perceived and priced similarly in the market as green bonds. A preference between the bond types is observed, where the production intensive sectors are popular for SLB issuance while the financial sector, and real estate more specifically, are more common for green bonds.

6.2 Future research

Variables contrasted in this paper have been studied using OLS regression and by analyzing the samples using descriptive statistics. Due to the new arrival of ESG instruments, specifically SLBs, to the market, there are various possibilities for how the premium on these instruments can be analyzed in the future. Suggestions for future studies include time-series analysis. This requires a certain maturity on the market that SLBs currently does not have due to their introduction only since 2019. It would also be of interest to perform a similar study and analysis on a non-European market. By comparing the results, this would additionally enable a comparison and possible analysis of whether the aspect of regulations and bond laws have a significant influence on YTM as a sub-research question.
7. Limitations of research

This paper has aimed to fill a knowledge gap. Its main limitation is that it has been one of the first in its research field. It has been carried out without the possibility of comparing results to prior research or findings. The approach in this thesis has included methods previously used to compare GSSS instruments with conventional bonds to provide a degree of reliability and validity. However, it cannot be assumed that these procedures are best suitable to compare two GSSS bonds against each other, and/or to leave conventional bonds out of the equation.

The non-symmetry between the sample sizes is a further limitation noted and discussed early in this essay. The sample of SLBs is significantly smaller than that of green bonds. This is something that has affected the data collection and notably the pairing procedure, only providing sufficient groundwork for conducting 32 pairs. This was compensated to an extent by keeping as many bonds from both samples as possible, and by filtering both bonds on the same terms. This however resulted in some asymmetry. As the SLBs market develops and matures, future research may be able to combat this limitation to a greater extent.
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