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Sustainability-Linked Bonds

An Examination of Yield Differences Between Sustainability-Linked and Conventional Bonds

Master's thesis spring 2023

Oslo Business School

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MSc in economics and business administration

Abstract

This thesis explores sustainability-linked bonds (SLBs), a financial instrument that directly link coupon payments to a predefined sustainability performance target, resulting in a potential penalty if the target is not met. This thesis explores the existence, magnitude and determinants of sustainability premium. Furthermore, we examine the determinants of the yield differential between by matching bonds from the same issuer. Finally, we investigate the effect of the callable feature on the yield differential between SLBs and their counterfactuals. We find a positive sustainability premium of 22.71 basis points, which challenges previous research. We find that callable SLBs on average have a higher yield differential than at-maturity bond pairs, implying a penalty for issuers of callable SLBs. The thesis provides a comprehensive overview of the rapid growing SLB marked, highlighting key features.

Keywords: Sustainability-linked bonds, Sustainability premium, ESG, Yield differential, CSR, Socially Responsible Investing (SRI)

Preface

This thesis was written to fulfil the graduation requirements of the Master of Science program in Business Administration at Oslo Metropolitan University. We have taken on the project of writing this thesis from January 2023 until May 2023.

We would like to express our deepest appreciation to our supervisor Danielle Zhang. Input and guidance from you have been indispensable in this process.

We would also like to express our deepest appreciation to Olivier David Zerbib for providing valuable advice.

Oslo, May 26, 2023

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1. INTRODUCTION

Investments in green and sustainable finance are increasingly popular, capturing the attention of investors due to their potential to deliver financial returns and alignment with climate objectives. The Paris Agreement (2016) has established ambitious goals for reducing greenhouse gas emissions, and the financial market is expected to play a crucial role in achieving these goals. Within this context, financial products like sustainability-linked bonds have emerged as promising tools to incentivise companies to adopt environmentally responsible practices. This thesis aims to explore the concept of sustainability-linked bonds as an instrument with a key role in promoting sustainability and driving environmental change. Specifically, we address three questions on the existence, magnitude, and determinants of the yield differential between sustainability-linked bonds and conventional bonds.

Firstly, our objective is to investigate whether issuers of Sustainability-Linked Bonds (SLBs) benefit from a lower issuance price when linking a bond to a sustainability target, compared to issuing a Conventional Bond (CB). This examination directly addresses the research question: Do issuers benefit from a lower price at issue when linking a bond to a sustainability target, compared to issuing a conventional bond? By exploring this question, we also aim to assess the financial performance of SLBs and examine whether they offer competitive returns for investors. To achieve this, we employ a paired t-test and a non-parametric t-test and test for robustness by performing an Ordinary Least Squares (OLS) regression. Our findings reveal that, on average, the issuance of SLBs is more costly for issuers than non-sustainable bonds, resulting in a positive yield differential between the bond pairs. The unconditional mean differential between SLBs and their counterfactual conventional bond at issue is, on average, 22.71 basis points and is statistically significant, however, when testing for robustness it appears to be non-significant.

Secondly, we investigate the determinants of yield differential and examine various factors by performing an OLS regression on matching bond pairs. Our second research question is: What are the determinants of yield differential between sustainability-linked bonds and conventional bonds? Previous studies have demonstrated that the bond premium varies based on several factors, including issuer rating, coupon step-up, callable feature, and the financial sector, among others (Zerbib, 2019; Kölbel & Lambillon, 2022). Employing the OLS regressions, we discover that factors such as a coupon step-up, callable feature, targets linked to renewable energy and companies in the utility sector have a statistically significant effect on the yield differential between SLBs and CBs. Specifically, callable and bonds with a coupon step-up exhibit a larger positive premium for SLBs, leading to increased costs for issuers. On the other hand, targets linked to renewable energy, and bonds issued in the utility sector are significant drivers for a lower yield differential, indicating a negative premium.

Thirdly, we investigate the impact of the callable feature on the yield differential between the SLBs and matched conventional bonds. Our specific research question is: How does a callable feature affect the yield differential between SLBs and CBs? Previous research conducted by Kölbel & Lambillon (2022) suggests that callable bonds exhibit a substantially larger negative premium, compared to at-maturity bonds. However, our analysis yields conflicting results. We find that, on average, callable bonds exhibit a larger positive premium, implying additional costs for issuers and higher returns for investors as compensation for increased risk.

Sustainability-linked bonds are defined as bond instruments in which financial or structural characteristics depend on the issuer's achievement of a sustainability goal (ICMA, 2020). These instruments share similarities with use-of-proceed bonds, where sustainability is the primary financing objective. The achievement of these objectives is measured through two channels, namely Sustainability Performance Targets (SPTs) and predefined Key Performance Indicators (KPIs), typically verified by an independent external third party. However, SLBs have a distinct structure, particularly a coupon that is contingent on the issuer's achievement of sustainable objectives (Figure A.1 in the Appendix). The issuer commits to improving its sustainability performance by meeting the predetermined SPTs within the target date to avoid a penalty, in a form of an increased coupon. In the event of failing to meet the sustainability targets, the issuer pays a larger coupon to bondholders. Alternatively, it avoids the penalty in a form of a coupon increase, and more rarely, pays a reduced coupon to its investors (Liberadzki, Jaworski, & Liberadzki, 2021). Table A.1 in the Appendix supports this by reporting that only 1.8% of the SLBs in the global market as of

March 2023 report having a step-down feature. Another distinguishing aspect of SLBs compared to use-of-proceeds instruments like green bonds is the issuer's full discretion over capital usage. This discretionary nature of SLBs reduces investor control and potentially increases the risk of greenwashing (Vulturius et al., 2022).

Furthermore, SLBs can incorporate various features, such as a callable or putable option, which introduce additional considerations regarding the penalty paid by the issuer. A callable option grants the issuer the right to repurchase and cancel the debt before its maturity, effectively enabling bond issuers to avoid penalties associated with the remaining interest payments (Ul Haq and Doumbia, 2022). By exercising the call option prior to the target date, the issuer ensures that a coupon step-up is never imposed, effectively allowing them to bypass penalties entirely. While the callable option provides flexibility for the issuer, it also raises concerns about the issuer's commitment to its sustainability targets. The presence of a callable option may undermine the strength of the issuer's sustainability pledge and introduce uncertainty regarding their long-term dedication to sustainable practices.

Our findings make several important contributions to the literature on SLBs for market participants, policymakers, and researchers. There has only been one overview and analysis of SLBs to our knowledge, which amplifies the need for further research. This thesis contributes to the literature in three folds. Firstly, we find contradictive results compared to previous literature leveraging the largest sample size to date. We observe a positive sustainability premium and the drivers behind it, which challenges previous literature. Secondly, it provides a comprehensive overview of the rapidly growing SLB market. Thirdly, we observe that bond pairs' callable feature has on average a substantially higher yield differential than at-maturity bond pairs.

This thesis is structured into six distinct sections. Section 1 provides an introduction to the research questions under investigation. Following this, Section 2 provides relevant literature on the topic of sustainable finance, SLBs and previous investigations of bond premia. In section 3 we describe the data collection process and a comprehensive overview of the SLB global universe. Section 4 outlines the methodology used to analyse our research question. We explain the data collection process, matching techniques used to create bond pairs, and the statistical analysis and tests. Section 5 provides empirical findings of our research, including the existence of premium, its determinants and further investigation of the callable feature. Section 6 discusses these empirical findings and compares them to the existing literature on SLBs. Lastly, Section 7 summarizes the key findings related to our research questions.

2. LITERATURE REVIEW

This section provides a theoretical background to answer the research questions in this study. First, we provide historical context for the emergence of sustainability-linked bonds, which highlight the growing need for this financial product, and the factors contributing to its development. Then, we present literature on the contribution SLBs have on driving environmental change, and which benefits it provides to its issuers and investors. Lastly, we explore the potential issues with greenwashing. Due to the scarcity of existing literature and academic research addressing the topic of sustainability-linked bonds and the similarity of financial debt instruments, this section reviews the literature on green bonds relevant to our research.

2.1 Sustainable Finance

To comprehend the role, development, and mechanisms of sustainability-linked bonds as an instrument promoting sustainability, it is essential to highlight the underlying factors that have led to the emergence of this financial instrument. The inception of sustainable finance can be traced back to the late 20th century, marked by the establishment of the United Nations Environment Program Finance Initiative (UNEP FI, 2017). Sustainable finance has evolved as a response to the growing recognition of the imperative to incorporate Environmental, Social and Governance (ESG) considerations into corporate decision-making processes. The adoption and implementation of ESG investing strategies have witnessed a significant upsurge, aligning financial goals with positive environmental outcomes.

Global initiatives, such as the United Nations-supported Principles of Responsible Investment (PRI) launched in 2006, aim to encourage companies to integrate ESG factors into their investment processes (Hoepner et al., 2019). The introduction of the Sustainable Development Goals (SDGs) by the United Nations in 2015 provides a comprehensive framework for aligning sustainable objectives with financial activities (UNDP, 2022). Regulatory developments have further encouraged this development, as governments and regulatory bodies have acknowledged the crucial role of sustainability integration in the financial markets. Examples of such regulations and guidelines include the European Union's Sustainable Finance Disclosure Regulation (SFDR) and the Green Bond Principles, which promote transparency, accountability, and risk management concerning sustainability issues (Spinaci, 2020).

The emergence of Corporate Social Responsibility (CSR) constitutes a crucial aspect in the evolution of sustainable finance. CSR refers to the incorporation of ESG considerations into business operations and has become an integral activity for firms (Liang & Renneboog, 2020). Socially responsible firms are expected to voluntarily engage in environmental protection, workforce diversity and financing welfare. Historically, this perspective contrasts with the neoclassical economic paradigm, which regards CSR as unnecessary and inconsistent with the firm's sole purpose of generating profits (Liang & Renneboog, 2020; Friedman, 1970). Friedman (1970) stated that "the social responsibility of business is to increase its profits" implying that companies fulfil their social responsibility by providing safe workspaces, financing welfare, and contributing to economic growth. This raises the question of whether a company's exclusive commitment to maximising shareholder results in ethically responsible outcomes for society, thus eliminating the need for further commitments beyond profit maximisation. Instances of unethical corporate behaviour, environmental scandals and labour exploitation have fuelled public mistrust in corporations and highlighted the necessity for companies to act in a more responsible and accountable manner. The concept of CSR emerged as a response to these societal concerns.

2.2 Why do companies issue SLBs?

Having emphasised the significance of companies taking action on sustainability by integrating ESG criteria, and its broader social benefits it is crucial to recognize that such efforts also yield advantages for the companies themselves. These advantages include enhanced reputation, risk mitigation, access to capital, operation efficiency and cost savings. Numerous studies have demonstrated positive correlation between environmental performance and corporate profitability (Kempf and Osthoff, 2007; Murphy, 2002). The research conducted by Kempf and Osthoff examined the relationship between Socially Responsible Investing (SRI) and portfolio performance by comparing the performance of SRI portfolios with conventional investment portfolios. Their findings indicate a positive impact of environmental performance on a company's stock returns. Additionally, Murphy (2002) presents evidence of a positive association between environmental performance and corporate profitability, particularly for firms that score well on independently evaluated environmental criteria.

Demonstrating a strong commitment to sustainability can also serve as a competitive advantage in attracting customers, investors and other stakeholders who share these values (Demetriou et al., 2009). These findings are further supported by research conducted by Flammer (2021), which finds that issuers experience an improvement in their environmental performance after issuing green bonds, along with increased ownership by long-term and green investors. The findings align with the signalling argument, suggesting that issuing green bonds serves as a credible signal from the issuer's dedication to environmental concerns. Companies with robust ESG performance are more likely to attract investment capital as sustainable investing gains prominence. Moreover, firms that issue ESG instruments can potentially reduce their operational costs through sustainable performance targets, which can lead to energy consumption reduction and other efficiency measures. Lastly, in terms of risk mitigation, Sun and Cui (2014) assert that integrating CSR into business strategy can lead to increased economic benefits and a subsequent decrease in the risk of default. Taken together, the studies mentioned above indicate that sustainability efforts are rewarded with improved financial and operational performance.

2.3 Why do investors choose SLBs?

Market demand and investor preferences play a significant role in driving the development of sustainable finance. The growing concern about the environment among investors has led to increased demand for sustainable investments and instruments like use-of-proceed bonds and sustainability-linked bonds, enabling investors to contribute to positive environmental change. Previous studies have provided evidence of the existence of a green premium, indicating a negative yield difference between green and regular bonds, and demonstrating that investors are willing to sacrifice some return for sustainable improvements (Flammer, 2020). Moreover, Kölbel & Lambillon (2022) identify a sustainability premium for SLBs, suggesting that investors are willing to pay a premium when issuers achieve their sustainability targets, reflecting the investors' prosocial motives. This aspect is of particular interest to our study as we aim to investigate the existence of a sustainability premium.

Within this context, debt instruments such as green, social, sustainability and sustainability-linked bonds have gained popularity as financial products that align investments with climate objectives.

2.4 Green bonds

Green bonds are financial instruments with similarities to SLBs. Given these similarities, it is reasonable to provide a concise overview of the features and evolution of green bonds, thereby offering a comprehensive overview of sustainability-linked bonds. The International Capital Markets Association defines green bonds as debt instruments that are designed to finance or refinance new or existing eligible green projects and are aligned with the four core principles of the Green Bond Principles (ICMA, 2018). Examples of green projects include renewable energy, sustainable agriculture, energy efficiency, and waste management. Green bonds are commonly issued by governments, financial institutions, municipalities, and corporations (Flammer, 2019). Key features of green bonds include (i) Use of Proceeds, (ii) Process for Project Evaluation and Selection (iii) Management of Proceeds and (iv) Reporting. The principles for sustainability-linked bonds are derived from the green principles mentioned above and serve to aid investors by promoting accountability. These include KPIs, Calibration of Sustainability Performance Targets (SPTs) and Bond characteristics in addition to the Reporting and Verification principles (ICMA, 2020).

2.5 Existence of premium

The market of green bonds has experienced substantial growth since its introduction to investors attracting investors who are motivated by both prosocial reasons and the anticipation of superior financial performance compared to traditional bonds. The concept of green premium refers to a lower return associated with investing in environmentally friendly projects and can be observed if investors accept lower returns in exchange for supporting environmentally friendly initiatives (Flammer, 2020). This phenomenon implies that issuers can access debt financing at a more favourable cost i.e., lower coupon payments due to the perceived attractiveness of green investments.

With the emergence of green bonds, the green premium is a subject actively researched in numerous studies. However, the existence and magnitude of the green premium is mixed and contingent upon various factors, including market conditions and perceived higher risk. Studies performed by Larcker and Watts (2019) and Flammer (2020) found that, in a significant majority of matched bonds, the median difference in yield was exactly zero when comparing green bonds to otherwise identical non-green securities. In fact, in 85% of matched cases, the yield differential was exactly zero (Larcker and Watts, 2020). This evidence is supported by Chiang (2017) who concluded from qualitative surveys that investors would not be willing to invest in green bonds if the returns were not competitive. Chiang (2017) suggests that the growth of the market will eventually reduce the pricing premium. However, other empirical studies have provided evidence of a negative yield differential, suggesting the presence of a green premium. (Baker et. al, 2018; Ehlers and Packer, 2017; Hachenberg and Schiereck, 2018). The studies reported evidence of a negative yield differential of respectively 7, 18 and 1 basis points. These papers are based on the comparison between green bonds and their non-green counterparts, analysing secondary (Hachenberg and Schiereck, 2018) and primary (Ehlers and Packer, 2017) markets. Likewise, market data suggests that issuers of sustainable debt on average benefit from slightly lower borrowing costs compared to regular bonds (Vulturius et al., 2022).

Various approaches are applied when it comes to matching techniques. Zerbib (2019) employs a model-free or direct approach, which involves matching bonds with the same properties apart from the aspect we want to investigate. Zerbib (2019) utilise the following matching criteria: identical rating, currency, bond structure, seniority, collateral, and coupon type for the pairs. In addition to that, the maximum difference in maturity between bonds is two years. Furthermore, the amount issued, and the issue date are used as a proxy for liquidity. As stated by Zerbib (2019), liquidity can have a substantial effect on yield level and therefore needs to be limited. Comparable bonds in his analysis need to have a maximum of four times the green bond’s amount issued and a minimum of one-fourth of this amount. The issue date for the eligible conventional bond is limited to six years difference from a matching green bond. The rationale behind this double restriction is to better control for any residual liquidity when estimating a green premium. Lastly, Zerbib (2019) eliminates the maturity bias by constructing a panel of synthetic bonds with exact maturity as green bonds, using interpolation and extrapolation techniques on bond triplets consisting of one green bond and two conventional bonds.

Flammer (2021) uses a matching method to obtain plausible counterfactuals to the green bonds by matching green bonds to non-green bonds with the same credit rating, issued in the same country, industry, and year. She follows the methodology used by Larcker and Watts (2020) where brown bonds must be issued by the same company, which ensures the similarity and comparability of bond pairs. Flammer (2021) further selects the nearest neighbour based on a set of covariates, including issue amount, maturity, coupon and number of days between the issuance of a green and a brown bond.

Kölbel & Lambillon (2022) require matching bonds to have an identical issuer, seniority, currency, maturity type and coupon type. Additionally, they require that callable SLBs and callable CBs both have a "make-whole" call option. Another constraint in their matching process applies to the issue date, maturity date and amount issued - the difference between the CB to SLB is a maximum of five years, three years and four times the SLB's issue amount, respectively.

Zerbib (2019) finds a negative green premium of -2 basis points between green and synthetic conventional bonds, by applying a direct matching method followed by a two-step OLS regression. These findings emphasise the impact of investors' pro-environmental preferences on bond prices. Despite the limited research conducted on SLBs, a recent study by Kölbel & Lambillon (2022) on 102 bond pairs observed a sustainability premium of 29.2 basis points. In this paper, we aim to investigate whether the sustainability premium is present in a more extensive and updated bond sample.

Moreover, we aim to examine the impact of a callable feature on the yield differential between bond pairs. In the study by Kölbel & Lambillon (2022), the yield differential for the callable bonds was even more profound, with -48.7 basis points. This suggests that companies issuing callable SLBs benefit from an even lower cost of capital.

2.6 Signalling and Greenwashing

Signalling in the context of ESG bonds refers to the use of these financial instruments as means for issuers to communicate their commitment to sustainability and their willingness to align their financial activities with environmental and social objectives (Flammer 2021). On the topic of the signalling effect when issuing green bonds Flammer (2021) identifies two reasons for its credibility which is also applicable for SLBs. Firstly, the issue size of the bond, indicating the commitment by the company. The potential penalty of not meeting the target reinforces the commitment.

Secondly, the entry cost and resources needed for monitoring, due to the unique features of the SLBs. The process of issuing an SLB can be considered costly due to the comprehensive nature of the prospectus. The International Capital Markets Association (ICMA) provides guidelines through their Sustainability-Linked Bonds Principles (ICMA, 2020) on structuring features, disclosure, and reporting which adds additional expenses for the issuer. Furthermore, Flammer (2021) argues that issuers have demonstrated improvements related to their environmental performance post-issuance, observing lower CO_2 emissions and higher environmental ratings, which might be another supporting argument for the credibility of the issuer's commitment to environmental objectives.

Greenwashing refers to the practice of making misleading claims about an issuer's environmental commitment which can be motivated by companies aiming to portray themselves as environmentally responsible or obtaining cheaper cost of capital (Flammer, 2021). SLBs could, despite the costly reasons mentioned on signalling, potentially be a tool to be used to greenwash the image of the issuer. The framework for SLBs and the linked KPIs are made up of recommendations by ICMA. The greenwashing risk can therefore be attributed to the lack of public regulation, especially since there are no minimum requirements towards the issuers' ESG performance (ICMA, 2022).

3. DATA AND SAMPLE

This chapter provides a description of the data collection process and statistics on sustainability-linked bonds in the global universe, to give a comprehensive overview of the market as of March 2023. By doing so, we explore the development, dynamics and patterns of the SLB market which support the discussion section later in our study.

3.1 Data collection

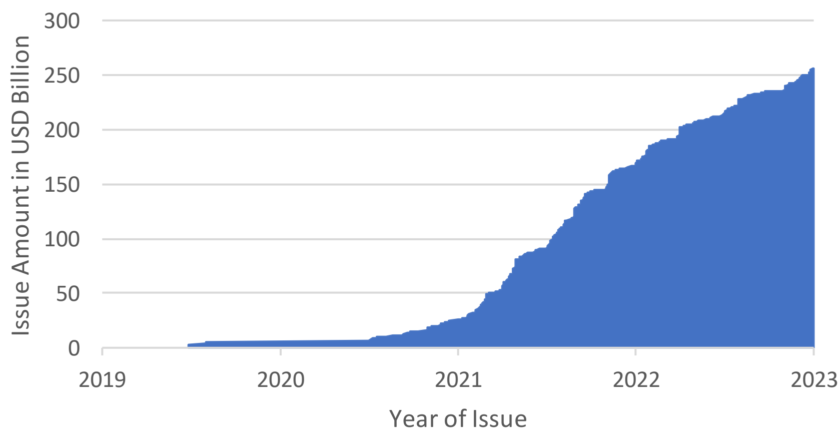
The initial phase of our analysis involves the collection of relevant information about bonds. To form our sample of sustainability-linked bonds and comparable conventional bonds, we utilise Eikon Refinitiv's fixed-income database. We assume a bond sample retrieved from this database is representative of the entire universe of sustainability-linked bonds as of March 2023. The sample of SLBs is determined by the data availability in the database and the matching possibility to a conventional bond. The extraction resulted in a total of 558 SLBs, issued by 301 companies in the period of 2019-2023. The database provides an overview of bond characteristics and standard components (coupon, maturity, issue size etc.), which will later be applied to address the research question regarding the determinants of sustainability premium.

3.2 Market Overview

Figure 1 provides an overview of the current sustainability-linked bonds market as of March 2023, retrieved from Eikon Refinitiv.

Figure 1. Cumulative issuance of SLBs

Illustration of the cumulative issuance of sustainability-linked bonds in USD billion from 2013 until March 21st, based on data collected from Refinitiv Eikon.



The first SLB issue found a place in 2019, issued by the Italian utility group Enel with a value of 1.5 billion USD. The bond's KPIs are related to renewable energy, more precisely reduction of greenhouse emissions, and reported a coupon step-up of 25 basis points (Refinitiv, 2023). The market for sustainability-linked bonds is growing strongly and we observe the issue size to double from 2019 to 2020 and increase by as much as 13.6 times the following year, reaching the 100 billion USD mark. Since the first issuance of sustainability-linked bonds, the market has faced several setbacks that have impacted its growth and development. Such factors include the Covid-19 pandemic, which disrupted global financial markets: increased market volatility and economic uncertainty diverted attention and resources from sustainable finance (London et al., 2022). The energy crisis, which began in the aftermath of the pandemic and the invasion of Ukraine, could additionally contribute to a weaker issuance trend for SLBs and ESG-related instruments. Lastly, the SLB issuance may be affected by higher operating and financing costs.

Table 1

This table reports the regional distribution of SLB market issuances, highlighting the total issued amounts in billions of dollars ($bn).

Region	#SLBs	Issued (USD billion)
Europe	281	154.0
Asia	128	20.6
North America	116	77.6
Other	33	3.9
Total	**558**	**256**

Table 1 shows that the majority of issuance came from the European market (154.0 billion USD) with North America (77.6 billion USD) following in terms of issue size. Other regions account for a smaller market share in the SLB market. We observe that the industrials and utilities sectors have the highest number of SLB issuances in the market, with 113 and 89 issuances, respectively. The largest sector in terms of the amount issued is the utility sector with 56 billion USD. This sector includes energy companies, which are known for their capital-intensive operations.

Table 2

This table reports the number of sustainability-linked bonds as well as the total issuance amount (USD billion) for each sector. We use the Primary Refinitiv Business Classification (TRBC) Economic Sector Description for the sector breakdown procedure.

Sector	#SLBs	Amount Issued (USD billion)
Educational Services	1	0.5
Basic Materials	76	32.0
Consumer cyclicals	29	13.1
Consumer Non-cyclicals	51	24.4
Energy	37	18.7
Financials	79	38.3
Government Activity	8	3.7
Healthcare	20	11.6
Industrials	113	37.4
Real Estate	30	7.5
Technology	25	13.0
Utilities	89	56.0
Total	**558**	**256.0**

Information on the different maturity types of the SLB market is presented in Table 3. It shows that SLBs with a callable feature dominate the market with a 60% share of the total number of issued SLBs and over 80% of the issue amount. At-maturity bonds is the second largest group with 34% of the total number of issuances, corresponding to 15% of the total amount issued.

Table 3

Distribution of sustainability-linked bonds based on their maturity type along with the corresponding issued amounts in USD billion.

Maturity type	#SLBs	Amount Issued (USD billion)
At Maturity	192	39.8
Callable	337	209.1
Callable/Perpetual	4	0.7
Convertible	2	1.1
Putable	9	1.3
Sinkable	14	4.1
Total	**558**	**256.0**

A company can issue an SLB that is linked to several SPTs. An example is a sustainability-linked bond issued by L'Oréal in March 2022 which is linked to 3 different SPTs (i) Reach zero absolute scopes 1 and 2 GHG emissions at companies operated sites by 2025 (ii) Achieve 14% reduction of cradle-to-shelf scopes 1, 2 and 3 GHG emissions per unit of sold product by 2025 from 2021 baseline and (iii) Achieve 50% of recycled or biobased plastics used in packaging by 2025. The company specified the additional coupons (step-ups) of respectively 0.375, 0.25, and 0.125 per cent for each SPT. Table 4 shows the different types of sustainability performance targets in the global SLB universe, as well as the SPTs of the bonds in our sample. We observe that a significant majority of SLBs are addressing environmental targets.

Table 4

Overview of Sustainability linked bonds categorised by the type of Key Performance Indicator and amount issued for each KPI category.

KPI Type	#SLBs	Amount Issued (USD billion)
Environmental	470	226.5
Social	33	15.0
Governance	27	5.1
Missing	28	9.4
Total	**558**	**256**

Overall, the market for sustainability-linked bonds as of March 2023 is still in the early stages. The vast majority of issuances of this fixed-income financial instrument are mainly issued by European companies, dominated by the industrials and utilities sectors. Additionally, a substantial portion of SLBs has a callable option.

4. METHODOLOGY

The methodology chapter outlines the chosen research design to answer the research questions for this thesis. The exploration of the sustainability premium in this study is measured using historical secondary data, hypothesis testing with statistical significance and multivariate analysis. The research follows a quantitative research strategy based on previous studies and theories within sustainable finance. Due to the similar research design, our approach relies on the methodology used to examine the existence and determinants of the green premium to address the questions of the existence, magnitude, and determinants of the sustainability premium.

4.1 Matching procedure

To examine the existence of a sustainability premium, we perform a matching procedure on a comprehensive sample of sustainability-linked bonds and conventional bonds issued by the same company. The purpose of this step is to select and investigate SLBs and CBs that have minimal differences. This step ensures that the bonds are exposed to the same financial risk and increases the likelihood that the remaining difference in yield at issue is due to the sustainability feature.

Based on the different approaches described in Section 2.5, we perform the matching procedure in two steps, making restrictions based on data availability. First, we require that issuer, seniority, bond structure, coupon type, and currency are identical for the sustainability-linked bonds and their conventional counterparts. Following Kölbel & Lambillon (2022), we exclude convertible and putable bonds due to structural differences. Convertible bonds allow the bondholder to convert their bonds into a predetermined number of common stock or equity shares (Brennan and Schwartz, 1980). Putable bonds, on the other hand, allow the bondholder to sell the bonds back to the issuer prior to the maturity date (Ge and Liu, 2015). Putable and convertible bonds would introduce factors that have an impact on the bond's risk profile, an implication that makes it challenging to isolate the impact of the features on yield differences. As this creates a challenge for the comparability of the bonds, we choose to focus on the bonds with as similar characteristics as possible and therefore exclude these bond types from the analysis. Kölbel & Lambillon (2022) problematise the aspect of availability of credit ratings for sustainability-linked bonds due to the early stage of the market, an issue that still is relevant for our analysis. We assume that bonds are still comparable despite missing ratings for some observations.

In the second step, we select a comparable non-sustainability linked bond with the closest maturity- and issue date, and amount issued. This approach is similar to the nearest neighbour method Flammer (2021) use to analyse green bonds. Table 5 provides an overview of the criteria in both steps of the matching procedure.

Table 5

Matching Criteria used to choose conventional bonds that are eligible to be matched with the respective sustainability-linked bond.

Bond Characteristic	Matching Criteria
Maturity date	± 3 years
Issue Date	± 6 years
Amount Issued	± 25% - 400%
Issuer	Same
Seniority	Same
Bond structure	Same
Coupon type	Same
Currency	Same

Issue date. Following the methodology of Zerbib (2019) and Kölbel & Lambillon (2022) and adapting it in the best possible way to our dataset, we limit the difference between issue date between sustainability-linked bonds and their conventional counterparts to a maximum of six years.

Maturity. We limit the difference in maturity between sustainability-linked bonds and conventional bonds to three years, aligned with Kölbel & Lambillon (2022). Zerbib (2019) applied a limitation of two years for the matching bonds, to ensure the comparability between bonds. This approach seems plausible when analysing the green bonds and comparing them to brown bonds, yet we have to employ a larger difference in maturity to ensure a sufficient number of bonds included in the analysis.

Amount issued. The issue size between SLBs and CBs is limited to a maximum of fewer than four times the sustainability-linked bond's issue amount and greater than one-fourth of this amount, in line with limitations used by Zerbib (2019) and Kölbel & Lambillon (2022).

Table 6

This table provides the means, medians, and standard deviations as well as minimum and maximum values for the differences between the sustainability-linked bonds and their matched counterfactual bonds.

	Mean	Median	SD	Min	Max
Yield difference (bps)	22.71	-42.00	129.15	-298.7	466
Coupon difference (bps)	23.21	-0.41	128.29	-300	466
Maturity difference (years)	0.79	-0.11	1.26	-2.99	3.00
Issue date difference (years)	1.12	-0.00	1.45	-1.37	4.99
Amount issued difference (mn)	41.18	-29.06	194.79	-500	1345.88

Table 6 displays the differences between the matched bond pairs. The first indication of the sustainability premium is apparent as the yield difference in basis points, a value that on average equals 22.71 bps in our sample. However, this differential is positive, unlike the research conducted by Kölbel & Lambillon (2022). The coupon difference between SLBs and comparable CBs is 23.21 bps, slightly larger than the yield differential. Additionally, the table provides the differences in the bond pairs: the average difference in maturity is 0.79 years, the average difference in date of issue is 1.12 years, and the average difference in amount issued is 41.18 mn. We try to minimise the differences to ensure bond similarity and comparability, and the table above indicates that the matching pairs have relatively small differences in these parameters. To facilitate the comparisons, we convert all the amounts to US dollars.

Table 7

This table reports the average Yield at Issue difference for each matched bond pair in our sample. The overview represents the development of sustainability premium over the period of 2019-2023.

Year	#SLBs	Average Yield at Issue difference (bps)
2019	1	-26.4
2020	6	1.6
2021	52	-25.7
2022	68	43.8
2023	9	162.2
Total	**136**	**22.7**

The development of sustainability premium in our sample of matched bonds is presented in Table 7. The average yield differential in our sample varies substantially from year to year. We observe a negative sustainability premium in 2019, followed by a positive yield differential between SLBs and CBs in our sample in 2020. Noticeably the difference is especially significant in 2021 and 2022 which holds most of the observations in the sample. A positive sustainability premium in 2022 increases by as much as 269 per cent the following year, however, with only a few observations showing a strongly positive premium in 2023. The sample is too small to be representative and draw conclusions from on the development of sustainability premium.

In summary, our sample of sustainability-linked bonds seems to be representative of the global SLB universe. Overall, our sample covers 24% (136 of 558) of the total market for sustainability-linked bonds and 38% (115 of 301) of all firms which have issued SLBs as of March 2023. We gather data using the Eikon Refinitiv database and extract 558 SLBs issued in the period of 2019-2023. By performing a matching method based on techniques employed in other studies, we end up with a sample of 136 SLBs, each matched with a conventional bond. To ensure comparability, we limit issue date, issue size and maturity differences between each bond pair. The matching procedure aims to establish a more robust and accurate assessment of the sustainability premium, isolating the effects of sustainability-related characteristics on bond yields while controlling for firm-specific factors. Lastly, we find the first indications of a positive sustainability premium between SLBs and CBs which on average equals to 22.71 basis points.

4.2 Data analysis

In this section, we are presenting the methodology applied in data analysis by systematically explaining and clarifying the technical aspects before the analysis is carried out. Furthermore, we explain the rationale behind the chosen methods. This will be done for all three research questions, as they require different statistical approaches.

4.2.1 Empirical analysis of sustainability premium

First, we identify the effect of linking a bond to a sustainability target through a sustainability premium, defined as a yield differential between a sustainability-linked bond and an otherwise identical conventional bond. We define a variable ΔYield, capturing the sustainability premium:

$$(1)\ \Delta Yield = Yield^{SLB} - Yield^{CB}$$

To address this question, we employ hypothesis tests to investigate the yield differential and see if the bond types compared in the analysis are significantly different from each other. The hypotheses are formulated as follows:

NH1: There is no statistically significant difference in yield at issue between sustainability-linked bonds and conventional bonds.

AH1: There is a statistically significant difference in yield at issue between sustainability-linked bonds and conventional bonds.

We compare two groups, one representing the sustainability-linked bonds, and another representing the regular bonds matching on a set of criteria as described earlier. We employ a parametric paired t-test which is generally used when the observations are not independent of one another as the test accounts for this, as well as a non-parametric Wilcoxon signed-rank test, which is a test used to compare two related samples and tests the equality of matched pairs of observations. The null hypothesis for Wilcoxon signed-rank test is that both distributions are the same. Both tests are employed in our analysis in line with Zerbib (2019) and Kölbel & Lambillon (2022).

Additionally, we test the robustness of our previous results and examine whether the sustainability premium is affected by a range of factors, by performing an OLS regression. The regression takes the following form:

$$(2)\ \text{Yield}_i = \beta_0 + \beta_1 * SLB_i + \sum \beta_k * Control\ variables + u_i$$

The robustness check allows us to examine the stability and consistency of the results by including factors as controls. The control variables we include in this step are the following: SLB denotes a binary variable indicating a sustainability-linked bond. Floating is a binary variable for a floating coupon type. ESG score is a binary variable for a self-proclaimed ESG score equal to or better than A- (lower scores include B+, B, B-, C+, C and C-). We control for the factors mentioned above in addition to control for variables presented in Table A.2 in the Appendix.

4.2.2 Determinants of Yield Differential

To address our second research question examining the determinants of sustainability premium, we apply a cross-sectional, secondary statistical analysis. A cross-sectional analysis refers to studying data from a population at a single point in time (Wang and Cheng, 2020). We select this approach as we collect our data on bonds at a single point in time, however, examining the SLB issuances in the period between 2019 and 2023. This point in time refers to the point when differences in yields and other characteristics between matched bond pairs are captured. The selection of the research design is in line with a previous study of green bond premia (Zerbib, 2019), nonetheless, a range of studies of bond premia apply different approaches, such as a time-series analysis or a panel regression (Flammer, 2021; Liberadzki et al., 2021). Cross-sectional data consist of multiple entities observed at a single time. Variables in cross-sectional analysis describe the values “common” for SLBs and matched CBs, but different between groups, such as Sector and Currency.

In addition to the cross-sectional analysis described above, our approach provides insights into within-group factors. These are observed through the differences between SLBs and CBs in each of the 136 bond pairs, such as differences in the Issue Date and Maturity Date. Doing so allows us to investigate whether the differences between matched SLBs and CBs affect the yield differential. Thus, we apply both factors that vary *across* the bond pairs and the factors that vary *within* the bond pairs. Table A.2 in the appendix provides a full overview of the explanatory variables in the OLS regression.

Zerbib (2019) investigates the determinants of green bond premium as it may not be stable across bonds. Bond characteristics that differ for bonds across the sample, determine where, and to what extent the premium applies (Zerbib, 2019). Bond characteristics applied in our analysis are Currency, Sector, Maturity and Amount issued. The Eikon Refinitiv database provides a range of bond characteristics which, according to Kölbel & Lambillon (2022), can have explanatory power for sustainability premium. We select our explanatory variables based on these research papers and provide a detailed explanation in Table A.2 in the appendix.

The independent variables employed in our multivariate analysis are divided into six groups. The first group, Matching differences, is related to the differences between an SLB and a comparable CB and includes differences in Issue date, Maturity date and Amount issued ratio. The second group, KPI characteristics, include the independent variables GHG target and Renewable related to the sustainability performance targets, where the former describes the target related to the reduction of greenhouse gas emissions, and the latter describes if the target is linked to renewable energy. Bond pair characteristics aim to control for the factors common for SLBs and CBs in each bond pair, such as the maturity type of the bond (callable feature) and bond seniority. SLB characteristics include variables related to the SLB features of the bond, such as coupon step-up and an interaction term between a callable feature and a coupon step-up. The Issuer characteristics variable group aims to control for factors related to the issuer, such as sector and currency. The last group includes the yearly time-fixed effects based on the findings presented in Table 7 which shows that the Yield Differential varies substantially from year to year. The OLS regression takes the following form:

$$(3)\ \Delta \text{Yield}_i = \beta_0 + \sum \beta_j * Matching\ differences_{ji} + \sum \beta_k * KPI\ characteristics_{ki} + \sum \beta_l * Bond\ pair\ characteristics_{li} + \sum \beta_m * SLB\ characteristics_{mi} + \sum \beta_n * Issuer\ characteristics_{ni} + \sum \beta_o * Other_{oi} + u_i$$

It should be noted that for the independent variables that contain several categories, such as Sector, we choose the categories to be included in the OLS regression models, instead of including all of them. This is done in order to avoid overfitting our models and avoid other issues, as described in Section 5.4. For instance, we choose the Financial and Utility sector and interpret them compared to other sectors. This decision is based on the theoretical rationale and these sectors being the most represented in the total market and our sample (Table A.4). The financial sector has unique characteristics including the nature of financial institutions and regulatory frameworks (policies that incentivise sustainability initiatives). Moreover, the financial sector plays a critical role in sustainable investing practices. When it comes to the Utility sector, it includes companies operating with the generation, transmission, and distribution of energy, including renewable energy sources. Similar to the Financial market, governments and regulatory bodies often implement policies and regulations to promote sustainability and incentivize renewable energy adoption within the Utility sector.

4.2.3 Callable feature

To address the last research question in our study, we investigate the effect of the callable feature on the Yield Differential between SLBs and CBs. We perform a separate regression on the Callable bonds in our sample. Furthermore, we highlight the callable option by performing hypothesis (paired t-test and Wilcoxon signed-rank test) and normality tests separately for Callable and At-Maturity bonds in the empirical analysis of sustainability premium. The motivation behind the investigation of this feature is due to its distinctive nature, as discussed in the literature review section. We examine whether our results align with the findings of Kölbel & Lambillon (2022), where the pricing dynamics are different for bonds with these maturity types (issuers of callable SLBs benefit from a significantly higher sustainability premium). For the OLS regression for Callable bonds, we apply the same independent variables as those included in the full-sample regression on 136 bond pairs, see Eq.(3).

5. EMPIRICAL FINDINGS

5.1 Sustainability premium

In the first step of the analysis, we aim to estimate the direction, magnitude, and significance of the yield differential. Prior to performing a paired t-test, we tested out data for normality in alignment with Zerbib (2019) using Shapiro-Wilk and Skewness and Kurtosis tests. We perform the normality tests separately for callable CBs, callable SLBs, at maturity CBs, and at maturity SLBs to test all the 272 bonds. We test the callable bonds separately to further investigate the effect of the option and address the last research question. Through these tests, we reject the normality hypothesis for all the samples except the callable conventional bonds, which appear to be normally distributed at a 5% significance level. Table A.2 in the appendix provides the Prob>z statistics (Shapiro-Wilks test) and the Prob>chi2 statistics (Skewness and kurtosis test) for the Callable and At Maturity bonds, to investigate the normality of the distribution of the subsamples. Given a small sample size of 272 bonds, it is reasonable to not expect the data to be normally distributed.

Table 8

The table shows the distribution of Yields at Issue by maturity type for SLBs and CBs in the sample using a Shapiro-Wilk test and a Skewness and Kurtosis test.

	Callable CBs	Callable SLBs	At Maturity CBs	At Maturity SLBs
N	58	58	78	78
Shapiro-Wilk test	0.0001	0.0001	0.0000	0.0000
Skewness and kurtosis test	0.0051	0.0001	0.0004	0.0001

Based on the results of the normality tests above, we assume that the assumption of normality for the data may not hold. This means that we must be cautious when interpreting the p-values obtained from t-tests that assume normality. Departure from normality may lead to inaccurate p-values and affect the reliability of the test results. Therefore, we apply a non-parametric test on two related samples, a Wilcoxon signed-rank test, as per Zerbib (2019) and Larcker & Watts (2020). Doing so allows us to run an equality test on matched data. The null hypothesis for the test is that both distributions are the same.

Table 9

The table presents the following values for (i) The whole sample (ii) Callable bonds and (iii) At-Maturity bonds, separately: Yield at Issue (SLBs), Yield at Issue (CBs), Yield Differential, test statistics for Wilcoxon signed-rank test and a paired t-test. Yield values are displayed in basis points.

	All	Callable	At Maturity
N	136	58	78
Yield SLB (bps)	367.28	367.04	367.46
Yield CB (bps)	344.57	315.12	366.47
Yield diff (bps)	22.71	51.92	0.99
Wilcoxon signed-rank test (p-value)	0.4995	0.1640	0.7597
Paired t-test (p-value)	0.0422	0.0217	0.9193

The results of a paired t-test show that a yield differential of 22.71 appears to be statistically significant at the 5% level. However, the results of a non-parametric Wilcoxon signed-rank test provide a substantially insignificant p-value. There is no evidence of a statistically significant difference between Yield SLB and Yield CB. Thus, we fail to reject the null hypothesis:

NH1: there is no difference between the paired observations being compared.

AH1: there is a difference between the paired observations being compared.

With a p-value of 0.4995, which is greater than the conventional significance level of 0.05, we do not have sufficient evidence to reject the null hypothesis. This suggests that there is no statistically significant difference between the paired observations.

To assess the robustness of the results and examine whether the sustainability premium is affected by various factors, we perform an OLS regression using Eq. (2). Table 10 displays the variable of interest, the SLB variable, representing the yield differential.

Table 10

Results of an OLS regression of yield at issue for a sample of matched bonds. We determine whether the sustainability premium is affected by different factors presented below.

	Yield at Issue				
	Model 1	Model 2	Table 67	Model 4	Model 5
SLB (true)	22.71 (0.463)	-6.47 (0.848)	4.30 (0.899)	19.34 (0.429)	19.06 (0.470)
Callable		-1.34 (0.969)	51.64 (0.177)	42.86 (0.123)	43.07 (0.114)
Step up		2.86*** (0.000)	-0.002*** (0.001)	-0.01 (0.994)	0.01 (0.994)
Step up x Callable		-2.83*** (0.007)	-3.16** (0.012)	-0.33 (0.763)	-0.33 (0.763)
ESG score			-113.90*** (0.002)	-82.37*** (0.008)	-82.37*** (0.008)
Seniority			-183.08** (0.014)	-37.86 (0.329)	-37.86 (0.329)
Floating				620.22*** (0.000)	620.21*** (0.000)
Risk-Free Rate				36.27*** (0.003)	36.27 *** (0.003)
Year of Issue					Y
Constant	344.57	345.15	503.68	249.83	-329.09
N	272	272	272	272	272
R2	0.0020	0.0366	0.1243	0.5100	0.5100
Adj. R2	-0.0017	0.0222	0.1045	0.4951	0.4932
Residual Std. Error	253.13	251.80	240.98	180.94	181.29

**p <0.10, **p <0.05, ***p <0.01. The OLS regressions are performed using robust standard errors.*

The results of a paired t-test show that a yield differential of 22.71 appears to be statistically significant at the 5% level. However, the results of a non-parametric Wilcoxon signed-rank test provide a substantially insignificant p-value, which points in the direction of rejecting the NH1 that the groups (SLBs and CBs) are significantly different from each other. The robustness test finds no statistically significant sustainability premium.

5.2 Determinants of Yield Differential

In this section, we present the findings relating to our second research question: What are the determinants of yield differential between SLBs and CBs? To address this question, we employ Eq. (3) as outlined in the methodology section and perform an OLS regression on the bond pairs, as shown in Table 11. Furthermore, we perform a two-sample t-test to compare the yield differential between SLBs and CBs within groups to gain deeper insights into the variation in pricing. The focus of this section is to analyse the factors that contribute to the variation in yield differential observed in section 5.1 on sustainability premium.

Table 11

OLS regression for 136 bond pairs, on a dependent variable Δ Yield denoting the sustainability premium. The purpose of this analysis is to investigate how the explanatory variables affect the premium.

	Δ Yield					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Step-up	0.61* (0.056)	0.43 (0.219)	0.54* (0.075)	0.47 (0.148)	-0.06 (0.871)	0.38 (0.465)
GHG target	24.98 (0.328)					
Renewable	-41.30* (0.051)					
Callable		45.01* (0.086)	31.25 (0.239)	-1.55 (0.972)	-46.58 (0.352)	-12.64 (0.782)
Seniority		-8.62 (0.790)				
Sector Financials		-11.71 (0.759)				
Sector Utilities		-43.43** (0.047)				
Maturity diff			6.25 (0.540)			
Issue Date diff			11.33 (0.342)			
Amount issued ratio			-15.23 (0.483)			
Euro				77.31 (0.178)	79.22 (0.162)	43.99 (0.382)
US Dollar				-48.47 (0.265)	-50.81 (0.225)	-46.35 (0.244)
Chinese Yuan				-32.43* (0.100)	-34.24* (0.071)	-35.95* (0.071)
Step-up x Callable					1.71** (0.019)	0.97 (0.161)
Risk-Free Rate change						36.90*** (0.001)
2020						-25.37 (0.616)
2021						-40.32 (0.263)
2022						-12.75 (0.733)
2023						90.74** (0.033)
Constant	-4.15 (0.842)	8.18 (0.773)	-1.54 (0.951)	10.39 (0.564)	20.67 (0.212)	23.48 (0.550)
N	136	136	136	136	136	136
R-squared	0.0344	0.0616	0.0736	0.1495	0.1749	0.3673
Adj. R-squared	0.0125	0.0255	0.0380	0.1168	0.1365	0.3111
Residual Std. Error	128.34	127.49	126.67	121.37	120.01	107.19

**p* <0.10, ***p* <0.05, ****p* <0.01. *The OLS regressions are performed using robust standard errors.*

Table 10 represents an OLS regression that tests the robustness of the results and whether the response variable, yield differential, is impacted by the independent variables included in a series of regression models. Following the approach of a recent research study on sustainability-linked bonds by Kölbel & Lambillon (2022), we discover the following:

Step-up represents a penalty for the issuer and appears to have a statistically significant impact on yield differential. The coefficient is positive, implying an increase in yield differential (positive sustainability premium) when the variable increases with one basis point, holding other variables constant.

We observe a similar outcome for the *Callable feature*. We started investigating the effect of callable feature by comparing the means of yield differential in Table 9 which presented the means for yield differential for the whole sample (22.71 basis points) with the means of yield differential for callable bonds (51.92). This implies that it is on average more costly for an issuer to issue callable SLBs. When including controls, the coefficient becomes negative, reflecting a relationship we initially expected, yet not statistically significant. The interaction term, *Step-up x Callable* describes the effect of an increase in basis points for coupon step-up on the bonds with a callable feature. This variable is statistically significant, and the inclusion of the interaction term affects the magnitude of the coefficient for the callable variable, which becomes substantially negative while decreasing the coefficient of the step-up.

GHG target and Renewable reflect the nature of SLB's targets and show that the GHG target has no statistically significant impact on the yield differential. As for the binary variable for renewable energy, a negative coefficient of -41.30 is observed demonstrating that bonds linked to renewable energy have a more negative yield differential compared to non-renewable bonds, implying they on average experience a more negative sustainability premium, holding other factors constant.

Seniority is a binary variable indicating bonds with seniority higher than senior unsecured and refers to the ranking of the capital structure of a company. Theoretically, senior bonds have a higher priority of repayment in the event of bankruptcy or default compared to junior or subordinated bonds and are expected to have less risk associated with them, hence lower yield. From the two-sample t-test we observe that bond pairs with higher seniority have an SLB that on average is 15.41 bps lower than CBs. A negative coefficient in Table 10 indicates a negative effect on the yield differential yet does not appear to be statistically significant.

Additionally, we include the *Financial and Utility sectors* in Model 2. Table 12 shows that SLBs in the financial sector have a yield at issue that on average is 10.97 bps higher than CB within the same pair. The financial sector, however, does not have a significant impact on the yield differential in the regression above. SLBs in the utility sector have a yield at issue that on average is 20.02 bps lower than CBs within the same pair. Regression results show a statistically significant coefficient for the Utility sector, indicating that it is a driver for sustainability premium. Thus, the utility sector is a significant driver for sustainability premium.

In Model 3, we control for the *Differences* between SLBs and matching CBs. The model shows no indication of statistically significant evidence that the differences between sustainability-linked bonds and their matching conventional counterparts explain the variation in yield differential. This was expected, as these criteria were restricted in the matching procedure by setting the maximum differences between comparable bonds.

In the last three models, we include the following currencies: Euro, US dollar and Chinese Yuan, with the reference modality being other currencies. Throughout these models, only the Chinese Yuan appears to have a statistically significant at the 10% level, which points in the direction that the bonds with this principal currency on average have a lower yield differential, compared to the other currencies category in our sample. Euro and US dollar are consistently non-significant.

The risk-free rate change is controlled for in model 6 to control for the underlying credit environment and shows the change in risk-free rate between the issue date of the conventional bond and the SLB. The control for the risk-free rate has a positive effect on the yield differential and is highly significant.

Time-fixed effects are included as Table 7 indicates that the yield differential varies across different time periods. Notably, the yield differential for bonds issued in 2023 is found to be significantly higher than the reference year of 2019, on average. However, since the sample size for 2023 is relatively small, potential bias may exist.

Overall, based on the regression model above, we observe that many explanatory factors have a theoretical power to explain and drive the sustainability premium, yet some of them appear to be non-significant in our analysis. Control variables like renewable energy, Chinese

Yuan and sector utility have a statistically significant impact on the yield differential. Chinese Yuan (which in our sample indicates China as the country of issue), Renewable target and the Utility sector can are hence considered to be drivers for sustainability premium. The variable indicating the Callable feature is however difficult to interpret due to changing signs but does show to be a statistically significant driver for sustainability penalty in model 2. Lastly, we discover interesting findings in 2023 as a year of issue, as bonds issued that year have yields substantially higher compared to the reference value, 2019. Step-up has a low impact on the sustainability premium, due to its small values and inconsistent significance throughout the regression – only statistically significant in Model 1 and 3.

Table 12

Two-sample t-test with equal variances. Mean comparison of yield differential within groups.

136 bond pairs	Obs.	Mean value of Yield Differential within groups (in bps)
At Maturity	78	0.99
Callable	58	51.92
Less Secure	130	24.46
Seniority	6	-15.42
Non-financial	121	24.16
Financial	15	10.97
Non-Utility	119	28.81
Utility	17	-20.02
Not YUAN	96	39.11
YUAN	40	-16.65
Not USD	114	31.73
USD	22	-24.04
Not EUR	101	-3.95
EUR	35	99.64
Not 2023	127	12.83
2023	9	162.17

5.3 Determinants of yield differential for callable bond pairs

In this section, we present the findings relating to our third research question focused on the impact of the callable feature on the yield differential between SLBs and CBs. Our specific research question is: How does a callable feature affect the yield differential between SLBs and CBs? The results in Table 9 show that the callable feature has a substantially larger impact on yield differential (51.92 basis points) compared to the at-maturity bonds with a much smaller yield differential (0.99 basis points). To address this research question, we perform an OLS regression to further investigate the effect of the callable feature, the results of which are presented in Table 13.

In contrast to the bonds with a callable feature, the At-Maturity bond pairs have a much smaller yield differential between SLBs and CBs, which underlines the importance of further investigation of the callable feature. The results below show a statistically significant positive coefficient for coupon Step-up, indicating a positive effect on yield differential for callable bonds, meaning this factor has a larger effect on yield differential for callable bonds. These findings align with the interpretation of callable, step-up and the interaction term between them in full-sample regression in Table 10.

The sustainability targets linked to the reduction of greenhouse emissions have no significant effect on yield differential throughout the models, as previously shown in Table 11. These findings are, therefore, in line with expectations from earlier analysis. The matching-differences variables: issue date, maturity and amount issued, has a bigger impact on the yield differential for callable than for the complete sample, but it does not have a statistically significant impact on the yield differential. As discussed earlier, this is expected due to these factors being limited in the matching procedure.

Table 13

OLS regression for 58 Callable bond pairs, on a dependent variable Δ Yield denoting the sustainability premium. The purpose of this analysis is to investigate whether certain relationships are more pronounced due to the Callable feature.

	ΔYield				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Step-up	1.35**	0.90	1.34*	1.11*	0.94
	(0.038)	(0.105)	(0.057)	(0.083)	(0.138)
GHG target	46.57	-19.91	-13.03	-32.20	-20.83
	(0.282)	(0.645)	(0.779)	(0.539)	(0.725)
Maturity diff			27.15	28.36	24.63
			(0.128)	(0.118)	(0.171)
Issue Date diff			13.63	8.32	20.69
			(0.373)	(0.616)	(0.154)
Amount issued ratio			22.40	16.76	18.59
			(0.663)	(0.745)	(0.719)
Euro				2.31	
				(0.970)	
US Dollar				-3.25	
				(0.956)	
Chinese Yuan				-121.58	
				(0.239)	
Industrials					-21.08
					(0.659)
Basic Materials					89.23
					(0.121)
Utilities					1.77
					(0.970)
Financials					-16.08
					(0.797)
Real Estate					-22.80
					(0.655)
2021			-34.17	-33.89	-30.00
			(0.474)	(0.499)	(0.579)
2022			33.39	44.06	30.53
			(0.605)	(0.484)	(0.628)
2023			171.23**	177.92**	184.34*
			(0.034)	(0.026)	(0.054)
Risk-Free Rate		99.45***	83.27***	81.98***	91.42***
		(0.000)	(0.000)	(0.000)	(0.000)
Constant	-21.90	14.11	-94.60	-59.47	-93.13
	(0.527)	(0.718)	(0.428)	(0.634)	(0.505)
N	58	58	58	58	58
R-squared	0.0547	0.4226	0.5671	0.5796	0.6087
Adj. R-squared	0.0204	0.3906	0.4860	0.4675	0.4813
Residual Std. Error	165.77	130.75	120.08	122.22	120.62

**p <0.10, **p <0.05, ***p <0.01. The OLS regressions are performed using robust standard errors.*

The changes in risk-free rate consistently show statistical significance throughout the OLS models and have a positive effect which appears to be stronger for Callable bonds, since the coefficient in Table 13 is substantially larger than the coefficient in the full-sample regression in Table 11. Furthermore, the controls for the sector show that the Industrial, Financial and Real estate sectors have a lower yield differential compared to the reference modality, other sectors. Utility and Basic material sectors, on the other hand, have a larger yield differential than the reference value. These factors, however, appear to be non-significant in our regression. Finally, we control for time-fixed effects, expressed by the year of issue. We observe that callable bonds issued in 2023 on average have a much more positive yield differential than the reference modality 2020, implying a sustainability premium.

5.4 Limitations

The sample of SLBs and CBs is extracted using the Refinitiv Eikon fixed-income database. This sample may not be fully representative of the entire universe, potentially limiting our results. The SLB market is in its early stage, and we acknowledge certain limitations should be taken into consideration when interpreting the results.

Matching. The matching process employed to pair SLBs with CBs involves certain assumptions and criteria aimed to minimise differences not explained by the unique SLB features. This process can have selection bias, which implies the process of selecting data points that influence the availability of data, a process related to the dependent variable, in our case Yield Differential and Yield at Issue (Stock and Watson, 2019). Zerbib (2019) states that choosing the closest bond gives rise to a maturity bias. The selection method can introduce a correlation between the regressors and the error term, e.g., excluding the data points (bonds) which had missing information on the yield at issue.

Furthermore, we applied less strict limitations in the process of selecting the nearest neighbour-match for our sample of SLBs, such as an extended limit for differences in issue date and maturity date. Doing so allowed us to retrieve several comparable bonds, extending our sample. It should however be mentioned that this implies a trade-off between ensuring the comparability of matched bonds and retrieving a sufficient sample for the analysis.

Sample size. To our knowledge, we have created the largest sample used to investigate sustainability-linked bonds as of March 2023. Despite this, we face limitations due to the small sample size such as too few observations per variable, potentially reduced statistical precision of the variables, and a limit in the number of variables that can be included in our multivariate analyses. Hence, we try to include the variables with at least ten observations for each variable to avoid overfitting the models. A relatively small sample size (compared to samples of green bonds, for example), creates limitations such as the generalizability of findings, which implies the possibility of our analysis not being representative of the population we want to study. Another implication is the reduced statistical power of our analysis, which has to do with our data having a lower chance of detecting meaningful effects, potentially leading to inconclusive or non-significant findings. Furthermore, a small sample size can result in uncertain estimates and thus affect the precision and reliability of our findings.

Our studies include various independent variables to control for factors that impact the yield differential between bond pairs. Table A.3 in the exhibit shows how our sample is compared to the overall market. The overall market is dominated by SLBs with a callable feature, representing 60% of the market, while in our sample SLBs, the share is 43%. Bonds issued in Asia have a share of 23% of the market, while it represents 43% in our sample, making it overrepresented compared to the market. We acknowledge that there are other factors that could be unobserved or unavailable that could have an influence on the results.

6. Discussion

The results of our study provide multiple points of discussion. With the limited research on sustainability-linked bonds, there is not a lot of literature on the exploration of a sustainability premium. As we mentioned in the literature review, the only previous paper to our knowledge examining yield differential between SLBs and CBs is Kölbel & Lambillon (2022). This study observes a sustainability premium of -29.2 basis points.

Our findings do not align with the findings in the research performed by Kölbel & Lambillon (2022). The authors observe a negative premium which implies that the yield for SLBs is on average lower than for conventional bonds. Analysing a more recent and extended sample we discover contradicting findings, as the yield differential in our dataset is in fact positive –

on average, the sustainability-linked bonds have a yield at issue of 22.71 basis points larger than the matched counterfactual bond. The fact that our results do not align with earlier research does provide interesting insights and trends that have not been researched yet. Thus, our findings are relevant and interesting for the growing market of sustainability-linked bonds. These findings imply that in fact, it is more costly for issuers to issue SLBs than regular bonds. We discover that 51.47% of the SLB issuers in our sample experience higher costs associated with issuing an SLB (a so-called sustainability penalty), while 48,53% of SLB issuers benefit from a negative sustainability premium, which implies a lower cost of capital for issuers of SLBs.

Table 7 reports the average yield at issue difference between pairs over time and shows that the yield differential is on average substantially higher in 2022 and 2023 with 69,5 and 187,9 basis points, respectfully, compared to 2021. In 2022, as well as the beginning of 2023 the energy crisis, the invasion of Ukraine, and the raising interest rates have affected the market and could additionally contribute to a weaker issuance trend for SLBs and ESG-related instruments. The SLB issuance may also be affected by higher operating and financing costs.

Another distinct difference between the research is the positive yield differential between callable and at-maturity pairs in our sample, indicating a sustainability penalty, contradicting Kölbel & Lambillon (2022) where the results found a substantial negative sustainability premium. These findings are interesting as they highlight the favourable callable feature for the issuer. Nevertheless, this option implies a higher risk for the investors, as it introduces uncertainty for them because they may not receive interest payments for the full duration of the bond in case it is called prior to maturity. Therefore, we would expect callable bonds to have a higher yield at issue compared to at-maturity bonds, to compensate investors for the risk of early redemption.

Our results indicate that issuers of callable SLBs pay a premium to avoid the financial penalty for failing to meet the target. Table 3 shows that 60% of SLB issues feature a callable option which is a notable observation because they can be redeemed before the maturity date if the issuer chooses to. This raises the question about the long-term sustainability of the linked targets, as the callable feature is effectively nullifying the sustainability-linked features of the bond and potentially undermining the confidence of socially responsible investors.

One of the concerns raised regarding SLBs is the potential for greenwashing, where issuers may make misleading claims about their environmental commitment. We did not directly assess this in any analysis, however, the absence of strong regulatory frameworks and minimum requirements towards issuers' ESG performances and SPTs raises concerns. On the other hand, this could hinder the future growth of the SLB market due to increased difficulty and higher costs associated with the issuance. Increased transparency could, nonetheless, play a crucial role in lowering the risk of greenwashing and ensuring the credibility of SLBs.

This research paper can have importance for various stakeholders, including investors, firm managers, researchers, and government regulators.

For firm managers our research highlights the drivers of yield differential and gives them an opportunity to investigate the drivers for sustainability premium in order to get a lower issuing price. Our study shows that among other factors, one of the main drivers for a positive yield differential between SLBs and CBs is the callable feature. This tells firm managers to avoid issuing callable bonds. Contrarily investors should consider SLBs with a callable feature to maximise profit, but still be aware of the increased risk involved.

For a researcher, our findings contribute to gain insight into a novel financial instrument that is gaining traction. With the growth of the market, researcher will be able to build on this thesis with a larger sample size. Thus, being able to include additional conditions. Government regulators will be interested in how our research emphasise the importance of regulatory frameworks and transparency. They can get insight in some of the implications we highlight and provide guidelines and standards. One example is the recent encouragement from ICMA in their Q&A, to set at least one sustainability target date before the call date (ICMA, 2022). Implementation of this as a standard for callable bonds can potentially stop companies from avoid being assessed on their sustainability performance target.

7. Conclusion

In conclusion, in this thesis we have explored various aspects of the sustainability-linked bond market. The growth in the market of SLBs and growing demand of sustainable finance as a whole

To answer the first question on whether issuers benefit from a lower price at issue with linking a bond to a sustainability target, compared to issuing a conventional bond, we apply a conducted a paired t-test, non-parametric Wilcoxon signed-rank test and a robustness test. The results are mixed. The t-test suggest a statistically significant yield differential of 22.71, indicating a potential penalty for issuers. However, the results from the non-parametric Wilcoxon signed-rank test points in the direction of rejecting the NH1. Our robustness test finds no statistically significant yield differential between SLBs and CB. Thus, our analysis indicates that issuers do not benefit from a lower price at issue, but it is difficult draw a conclusive answer.

The second research question we investigated about factors affecting the yield differential between SLBs and CBs finds several explanatory variables that drives the yield differential. We find that the variables renewable energy, Chinese Yuan and Utility sector all are statistically significant drivers for a negative sustainability premium. On the other hand, the interpretation on callable is challenging to interpret, but in in one model shows to be a statistically significant driver for sustainability premium. Other factors like change in the risk free rate has a positive statistically significant impact on the yield differential.

The changes in risk-free rate consistently show statistical significance throughout the OLS models and have a positive effect which appears to be stronger for Callable bonds, since the coefficient in Table 12 is substantially larger than the coefficient in the full-sample regression. Furthermore, the controls for the sector show that the Industrial, Financial and Real estate sectors have a lower yield differential compared to the reference modality, other sectors. Utility and Basic material sectors, on the other hand, have a larger yield differential than the reference value. These factors, however, appear to be non-significant in our regression. Finally, we control for time-fixed effects, expressed by the year of issue. We observe that callable bonds issued in 2023 on average have a much more positive yield differential than the reference modality 2020, implying a sustainability premium.

Answering the third research question, we look at the impact of a callable feature on yield differential between SLBs and CBs. Our findings indicate that the sectors industrial, financial and real estate shows a lower yield differential compared to the reference group, while utility and basic material sectors have a larger yield differential. We account for time-fixed effects by including year of issue. Callable bonds issued in 2023 exhibit a significantly more positive differential compared to reference year 2020.

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Appendix:

Figure A.1

The mechanism of an SLB. A step-up is a coupon increase applied in case the targets set by the issuer of an SLB are not achieved. A step-down is a coupon decrease applied if the target is achieved.

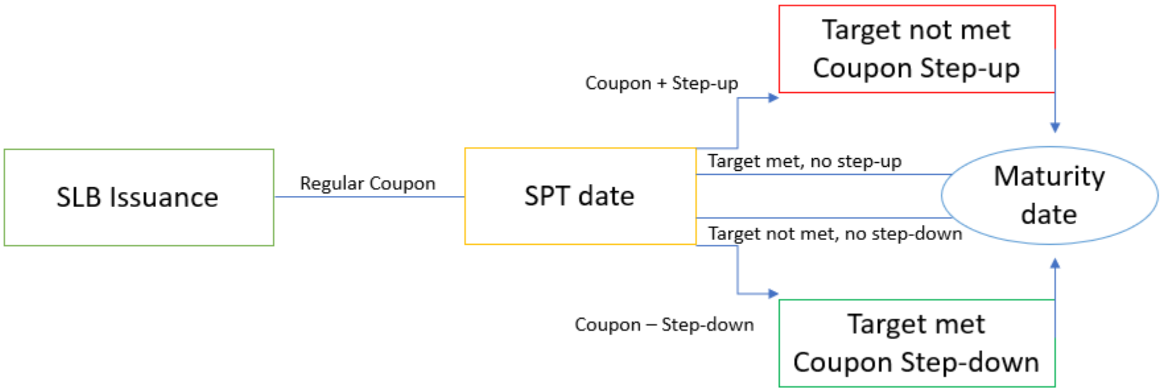

Table A.1

Overview of the coupon adjustment in the SLB market and sample.

Coupon Adjustment	SLB Market	Issued (USD billion)	SLB sample	Issued (USD billion)
Step-up: <25 bps	217	75.9	50	13.6
Step-up: 25 bps	156	103.4	35	22.3
Step-up: >25 bps	120	57.2	24	11.9
No Step-up	2	0.6	-	-
Step-down	10	3.1	2	0.1
Missing	63	15.8	25	4.8
Total	**558**	**256**	**136**	**52.7**

Table A.2

An overview and description of the dependent and independent variables for the regression on 136 bond pairs.

Variable	Type	Unit	Description
Δ Yield	Quantitative	Bps	Dependent variable. The difference in yield at issue between the sustainability-linked bond and the counterfactual conventional bond.
Step-up	Quantitative	Bps	An increase in a coupon rate if the issuer fails to achieve a specific sustainability target.
GHG-target	Qualitative	Binary (0/1)	Binary variable equal to 1 if the sustainability performance target is linked to a reduction of greenhouse gas emissions.
Renewable	Qualitative	Binary (0/1)	Binary variable equal to 1 if the sustainability performance target is linked to renewable energy.
Callable	Qualitative	Binary (0/1)	The bond is callable prior to the maturity date.
Seniority	Qualitative	Binary (0/1)	Seniority higher than Senior Unsecured (First Lien, Senior Secured) and for Seniority lower than Senior Unsecured (Subordinated Secured, Subordinated Unsecured and Unsecured)
Sector	Qualitative	Binary (0/1)	We use the Primary Refinitiv Business Classification (TRBC) Economic Sector Description. TRBC Classifies companies with increasing granularity by Economic Sector. The categories are: (i) Industrials (ii) Basic materials (iii) Utilities (iv) Financials and (v) Real Estate and (vi) Other.
Maturity difference	Quantitative	Years	Difference between the maturity of the sustainability-linked bond and the counterfactual bond. Denoted in years.
Issue date difference	Quantitative	Years	Difference between issue dates of the sustainability-linked bond and the counterfactual bond. Denoted in years.
Amount issued ratio	Quantitative	Ratio (¼ - 4)	The ratio between the amount issued in USD for the sustainability-linked bond and the counterfactual conventional bond.

Currency	Qualitative	Binary (0/1)	The principal currency of the bond issuance. The categories are EUR, USD, Chinese Yuan and Other. The reference value is other currencies.
Risk-Free Rate	Quantitative	Bps	10-year US treasury bond as a measure of a risk-free rate.
Time-fixed effects	Quantitative	Binary (0/1)	Binary variable for years (for the period of 2019-2023). 2019 is the reference modality.

Table A.3

Breakdown of SLB global market and our sample comparing observations on Region, Sector and Maturity type.

	SLB Market			SLB Sample		
Total	558			136		
Region	Europe	281	(50%)	Europe	56	(41%)
	Asia	128	(23%)	Asia	59	(43%)
	North America	116	(21%)	North America	15	(11%)
	Other	33	(6%)	Other	6	(4%)
Sector	Educational	1	(0%)	Educational	0	(0%)
	Services	76	(14%)	Services	19	(14%)
	Basic Materials	29	(5%)	Basic Materials	1	(1%)
	Consumer cyclicals	51	(9%)	Consumer cyclicals	16	(12%)
	Consumer Non-	37	(7%)	Consumer Non-	10	(7%)
	cyclicals	79	(14%)	cyclicals	15	(11%)
	Energy	8	(1%)	Energy	2	(1%)
	Financials	20	(4%)	Financials	2	(1%)
	Government	113	(20%)	Government	33	(24%)
	Activity	30	(5%)	Activity	15	(11%)
	Healthcare	25	(4%)	Healthcare	6	(4%)
	Industrials	89	(16%)	Industrials	17	(13%)
	Real Estate			Real Estate		
	Technology			Technology		
	Utilities			Utilities		
Maturity type	At Maturity	192	(34%)	At Maturity	78	(57%)
	Callable	337	(60%)	Callable	58	(43%)
	Callable/perpetual	4	(1%)	Callable/perpetual	-	-
	Convertible	2	(0%)	Convertible	-	-
	Putable	9	(2%)	Putable	-	-
	Sinkable	14	(3%)	Sinkable	-	-

Table A.4

SLBs by maturity type.

Maturity type	SLB Market	Issued ($ bn)	SLB Sample	SLB Sample	Issued ($ bn)
At Maturity	192	39.8	At Maturity	78	15.0
Callable	337	209.1	Callable	58	37.7
Callable/perpetual	4	0.7	Callable/perpetual	-	-
Convertible	2	1.1	Convertible	-	-
Putable	9	1.3	Putable	-	-
Sinkable	14	4.1	Sinkable	-	-
Total	**558**	**256.0**	**Total**	**136**	**52.7**

Table A.5

SLB Issuer ratings.

Issuer Rating	SLBs
AAA	37
AA	13
A	27
BBB	25
BB	11
B	1
CCC	2
C	1
NR	15
Total	**136**

Table A.6

OLS regression of the yield differential on matched pairs, controlling for a binary variable for SLB and controlling for each bond pair. These variables explain 87,14 per cent of the total variation in yield at issue.

Yield at Issue	
SLB	22.71**
	(0.042)
Bond Pair FE	Y
Constant	194.65
N	272
R-squared	0.9359
Adj. R-squared	0.8714
Residual Std. Error	91.321