Who pays for sustainability? An analysis of sustainability-linked bonds

Julian F. Kölbel* Adrien-Paul Lambillon†

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Abstract

We examine the novel phenomenon of sustainability-linked bonds (SLBs). These bonds' coupon is linked to the issuer achieving a predetermined sustainability performance target. We estimate the yield differential between SLBs and non-sustainable counterfactuals by matching bonds from the same issuer. Our results show that in most cases investors pay for the improvement in sustainability, while issuers benefit from a sustainability premium. Our analysis suggests that the sustainability premium is larger for bonds with a higher coupon step-up and for callable bonds. We also show that there is a 'free lunch' for some SLB issuers, as their financial savings are higher than the potential penalty, and they have a call option to reduce this penalty. While our findings suggest that most SLBs incentivize sustainability improvements by offering a lower cost of capital, some companies that do not benefit from a sustainability premium seem to issue SLBs to signal their commitment to sustainability targets. The 'free lunch' however suggests that SLBs can also be a form of greenwashing, when they are issued purely for financial optimization without a real commitment to carry out sustainability improvements.

Keywords : Sustainable investing, ESG, sustainability-linked bonds, impact, greenwashing

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*MIT Sloan; University of Zurich, Department of Banking and Finance

†University of Zurich, Department of Banking and Finance

1 Introduction

As companies worldwide pledge to net-zero emissions and more sustainable activities in order to contribute to a low carbon economy, a fundamental question arises: who pays for this shift to sustainability? A recent development in the field of corporate finance is the issuance of sustainability-linked bonds (SLBs).[1] These are any type of bond instruments incentivizing the issuer's achievement of predetermined sustainability performance objectives (ICMA, 2020). Certain sustainability targets related to ESG ratings or GHG emissions, for example, are thus included in the bond documentation and margin ratchet. The margin ratchet is a mechanism whereby the coupon of the bond is adjusted during the bond's lifetime depending on whether the company achieves the predetermined and externally verified sustainability objectives. In November 2020, for example, the European cement company Holcim Group issued a EUR 850 million callable SLB with a coupon of 50 bps maturing in 2031, which will however increase by 75 bps, if the company fails to achieve its sustainability target of 475 kg net CO2 per ton of cementitious material by 2030 (Holcim, 2020).

SLBs are distinct from green bonds. Green bonds have a 'use of proceeds' clause stating that the financing will be used for green corporate investments. The impact of green bonds on firms' sustainability profile is not straightforward. While a green bond can lead to additional corporate investment into green projects, it can also replace regular financing from existing green projects. As a result, a firm could potentially issue a green bond while increasing its investment in brown projects. SLBs, in contrast, seem to offer a relatively straightforward impact mechanism. SLBs do not determine the use of proceeds, the financing can be used for general corporate purposes. Instead, they create a clear financial incentive for issuers to achieve a certain sustainability target.

[1] SLBs are publicly listed bonds. There also exist sustainability-linked loans (SLLs) which are mostly non-listed loans provided by banks or other financial institutions. While the mechanism is identical for SLLs, the market dynamics and implications may vary.

Importantly, this target concerns the entire firm, not a subset of its investments. If the issuer achieves the target, investors renounce on a potential coupon step-up, or in some cases accept a coupon step-down. That means, investors can use SLBs to incentivize firms to adopt a wide range of sustainability improvements. Investors pay for these improvements only if they are achieved. Thus, from the perspective of impact investing, SLBs are an important and promising mechanism.

SLBs seem to emerge as a major sustainable capital financing instrument for corporates. While the volume of SLBs is still relatively small, it has been growing strongly. The first SLB was issued in December 2018. Since then, the market size of issued bonds has grown to over USD 140 billion (as of 31 December 2021). Currently, little is known about this new financial instrument, and we are not aware of any study focusing on SLBs. Several empirical studies have analyzed the existence of a 'greenium' (green bond premium) comparing the pricing of green and non-green bonds, with mixed evidence (Ehlers and Packer, 2017; Baker, Bergstresser, Serafeim, and Wurgler, 2018; Hachenberg and Schiereck, 2018; Karpf and Mandel, 2018; Zerbib, 2019; Larcker and Watts, 2020; Flammer, 2021). Some research highlights that green bonds sell for a moderate premium, meaning that companies benefit from lower cost of capital on green bonds, while more recent papers based on tighter matching procedures find no such greenium, and suggest that firms may issue green bonds even if it is costly to signal their commitment to sustainability (Larcker and Watts, 2020; Flammer, 2021)

In this paper, we try to understand who pays for the sustainability improvement in the case of SLBs. If the investor pays for the improvement in sustainability, then SLBs are a mechanism for investors to have impact. If the company pays, SLBs are a costly signaling tool for companies to signal their commitment to sustainability. To address this question, we analyze how SLBs are priced at issue in comparison to their non-sustainable counterpart and investigate how the sustainability target agreement affects the issuance price. A priori, one might expect that investors pay for the impact of an SLB. In this case, an SLB that specifies a coupon step-up for failing to reach the sustainability target should have a lower yield at issue compared to a conventional bond. However, it is also possible that companies pay, using SLBs to signal that they are serious about reaching a sustainability target. In this case, an SLB with a coupon step-up could trade in line with or higher than conventional bonds.

Our paper addresses this question empirically in a three-step approach. In the first step, we match a sample of 102 bond pairs. Each bond pair consists of an SLB and a non-sustainable counterfactual bond from the same issuer. The minimum matching requirements are the issuer, bond seniority, maturity type, coupon type and currency. Provided that these characteristics are identical, we then select the bond counterfactual with the closest issue date, bond maturity and issue size. We then analyze whether the difference of yield at issue for the 102 bond pairs is statistically significant with a nonparametric Wilcoxon rank sum as well as with a parametric, paired t-test. The second step tests the robustness of the results in an OLS framework, when controlling for matching, issuer and bond parameters, as well as changes in the risk-free rate. Furthermore, we aim to determine the effect of the coupon step-up, the sustainability performance target and the callable feature on the yield differential. Finally, in the third step, we perform a cost-benefit analysis of the SLB issuance.

Our results provide three main findings. First, we show that there is a statistically significant sustainability premium. The yield differential between SLBs and non-sustainable counterfactuals at issue is on average -29.2 bps. SLB Issuers benefit from lower cost of capital, while investors pay for the sustainability improvement. Since the average coupon step-up is lower than the sustainability premium (26.6 bps) and there is a time lag until the coupon step-up applies, issuers also benefit from a lower cost of capital when they fail on their sustainability performance target. Thus, SLBs do not align to the benchmark pricing when the sustainability target is not achieved. Second, we perform OLS regressions as a robustness check. The results confirm that the pricing dynamics are different for at maturity and callable SLBs. Issuers of callable SLBs benefit from a significantly higher sustainability premium. Third, our cost-benefit analysis suggests that SLB issuers benefit from financial savings which are larger than the potential penalty, resulting in an estimated net benefit of USD 3.5 million on average. This suggests that there might be a 'free lunch' for SLB issuers where the profit significantly outweighs the potential downside, regardless of whether the sustainability target is reached. This is even more pronounced for callable SLBs, because the call option can further reduce the penalty.

Our paper contributes to the sustainable finance literature in three ways. First, we provide the first overview of the SLB market. While SLBs are still a novel phenomenon and currently lack consistency and alignment in terms of sustainability targets and coupon pricing, these instruments provide the potential to drive impact through financial incentives for issuers to achieve their sustainability objectives. Second, our paper addresses the question of who pays the price of sustainability by analyzing the pricing of SLBs on the primary market. Our results suggest that investors pay for the sustainability improvement, while companies benefit from a lower cost of capital. In other words, SLBs are issued at a substantial 'sustainability premium' for issuers. Third, we show that there is a 'free lunch' for many SLB issuers. The average coupon step-up is lower than the sustainability premium, resulting in financial savings over the SLB lifetime which are on average more than 60% higher than the potential penalty. Thus, SLBs offer a profitable arbitrage strategy, where the safe gain outweighs the potential loss, independently of whether the issuer reaches the sustainability performance target. Furthermore, the potential penalty can be reduced due to the call option, which is included in 66% of the total SLB market volume.

Our findings have important implications for the SLB market and provide relevant insights into the potential motivations of companies issuing SLBs. Due to the existence of a sustainability premium, issuers benefit from a lower cost of capital by issuing SLBs, and could thus be driven by financial motivations. Our results however show that approximately a third of the companies do not benefit from a lower cost of capital and commit to a high potential penalty in case of failure of achievement of their sustainability performance targets. Thus, such issuers seem to use SLBs as a costly signaling tool for their commitment to more sustainable operations, or as a business case motive to set a company-internal price for sustainability. We further argue that the two features of SLBs, the sustainability target and the coupon step-up, offer two potential greenwashing channels. In this paper we do not analyze the first channel, namely the ambitiousness of the sustainability targets. Instead, we focus on the financial features of SLBs and argue that the high share of callable bonds in the SLB market and the possibility to reduce the potential penalty limits many companies' commitment to the sustainability performance targets. While the callable feature is nothing unusual in the corporate bond market, for some companies the SLB issue represented the first time they launched a callable bond. Callable SLBs can reduce the penalty and thus the issuer's sustainability commitment, implying potential greenwashing motivations. The upshot is that SLBs are a promising instrument for sustainable finance, but they are also complex, so it is important that they are designed properly.

The remainder of this paper is organized as follows. Section 2 provides a review of the most relevant literature on sustainability considerations in the debt space. Section 3 describes the mechanism of SLBs and the market growth. Section 4 summarizes the matching approach and the resulting sample of bond pairs, as well as the empirical approach. Section 5 presents the results of the empirical analysis. Section 6 discusses the results and its implications. Finally, section 7 provides future research opportunities.

2 Literature Review

Since the early 2000s there has been an interest in studying the relationship between firms' sustainability performance, especially environmental factors, and their respective credit instruments, as well as the associated bank lending behavior. Early research in the field highlighted that banks and bond investors integrate at best environmental risk in their credit risk assessment, but not in the further credit management process, such as the pricing of loans (Weber, Scholz, and Michalik, 2010). There has been a literature showing that better corporate social responsibility (CSR) performance is associated with lower yield spreads of bonds, but that some of the effect is absorbed by credit ratings Menz (2010); Ge and Liu (2015); Hasan, Hoi, Wu, and Zhang (2017); Magnanelli and Izzo (2017). Furthermore, CSR performance can also increase the investor base size.

With the emergence of green bonds, numerous studies analyze the pricing of green bonds to identify the potential presence of a green bond premium or so-called 'greenium'. Early studies pursue a multitude of approaches to analyze the greenium. Ehlers and Packer (2017) perform a simple comparison of 21 euro and USD bonds on the primary market and find a negative premium (-18 bps). Karpf and Mandel (2018) perform an Oaxaca-Blinder decomposition to analyze 1880 US municipal bonds[2] on the secondary market. This approach separates the bond spread into an explained part (due to fundamental characteristics) and an unexplained part, which would potentially signal the existence of a greenium. When controlling for the bonds' liquidity based on the number of transactions within the past 30 days, Karpf and Mandel (2018) find a positive premium (8 bps). Finally, Baker, Bergstresser, Serafeim, and Wurgler (2018) construct a framework featuring a subset of investors whose objective function includes nonpecuniary sources of utility, such as social responsibility from holding green bonds. They analyze 2083 municipal and corporate bonds on the primary bond market, using the issue amount as a proxy of the liquidity, and find a negative premium (-6 bps).

More recent studies base their analysis on matching procedures and a statistical analysis of the yield differential between green bonds and non-green counterfactuals. Hachenberg and Schiereck (2018) use a matching procedure and a panel regression to analyze 63 bonds aligned with the Green Bond

[2] Note that some studies base their analysis on a less restrictive data framework than the alignment with the Green Bond Principles, and focus on bonds with a Bloomberg green flag, especially on the US municipal bond market.

Principles on the secondary market and find a minor negative premium (-1 bps). Gianfrate and Peri (2019) conduct a propensity score matching analysis with 121 European green bonds on the primary and secondary market, comparing the returns of these green bonds with conventional peers. Their results also indicate a statistically significant greenium of -18 bps. Similarly, Zerbib (2019) performs a direct matching method followed by a two-step regression procedure to estimate the yield differential between 1065 European and US green bonds and their counterfactual conventional bonds, and finds a small negative premium (-2 bps). Larcker and Watts (2020) focus on the municipal bond market comparing green bonds with conventional counterfactuals issued the same day by the same issuer. In contrast to previous work, their study based on 640 bond pairs indicates that the greenium is equal to zero. Larcker and Watts (2020) argue that the mixed evidence from prior studies result from misspecifications in the methodological matching design which produce biased estimates. Applying Larcker and Watts (2020) methodology and in line with their results, Flammer (2021) finds no greenium for her sample of 152 corporate bond pairs. Thus, so far the empirical evidence for a greenium is mixed. Some studies seem to indicate the existence of a small greenium, especially in the municipal bond market. The more recent papers with tighter matching approaches however find no green bond premium (Larcker and Watts, 2020; Flammer, 2021)

Recent research also analyzes the motivation of investors and issuers of green bonds. Flammer (2021) explains that there are three categories of motivations for companies to issue green bonds: signaling, greenwashing and financial arguments. The first motivation to issue green bonds is that they can function as a signal to demonstrate a firm's commitment to sustainability. The second motivation is to use green bonds as a greenwashing tool, i.e. to merely pretend that the firm is committed to sustainability. The last motivation is to obtain a lower cost of capital. As Flammer (2021) results suggest the absence of a greenium, her findings are consistent with the signaling rationale, meaning that companies signal their commitment toward the environment by issuing green bonds. Our research extends the literature on sustainable debt instruments by analyzing the new phenomenon of SLBs. Our paper addresses the question of how SLBs are priced in comparison to their non-sustainable counterpart, and who pays for the sustainability (i.e. positive or negative premium).

3 Sustainability-Linked Bonds

3.1 Definition & mechanism

As defined by the Sustainability-Linked Bond Principles (ICMA, 2020), an SLB is any type of bond instrument which incentivizes the issuer's achievement of predetermined sustainability performance objectives. The financial and/or structural characteristics of the bond can vary depending on the achievement of these objectives. Predefined sustainability performance targets (SPTs) are set for these objectives, measured using predefined key performance indicators (KPIs) and externally verified by an independent third party. These KPIs may include external ratings (ESG ratings) or metrics, a company's GHG emissions, or the number of female board members, for example. SLBs are fundamentally different from green bonds, as there is no 'use of proceeds' clause for the categorization of SLBs, and the funds are used for general corporate purposes in most cases.[3] The purpose of SLBs is therefore not the specific use of proceeds, but rather to improve the issuer's sustainability profile by aligning bond terms to the achievement of predetermined SPTs. The Sustainability-Linked Bond Principles (ICMA, 2020) further encourage issuers to select ambitious SPTs, and KPIs that are measurable and transparently defined. Furthermore, issuers should disclose the relevant information and appoint an external review to confirm the bond's alignment with the Sustainability-Linked Bond Principles (ICMA, 2020). The sustainability KPIs are thus

[3] Note that in some instances a bond may be structured as both a green bond (aligned with the Green Bond Principles) and a sustainability-linked bond (ICMA, 2020).

included in the bond structuring documentation, tested on a regular basis, and used for coupon redetermination over the life of the SLB. The coupon adjustment typically works as follows: If the company fails to achieve the predetermined criteria, then the coupon increases by 25 bps. The SLB may in some cases be tied to several SPTs, and thus have several coupon step-ups (e.g. 5 bps per SPT). As described in Section 3.2, the typical coupon step-up is 25 bps, but can be lower or higher for certain firms. In some cases, the coupon may also decrease by 25 bps in case of KPI attainment. Figure 1 below illustrates the typical mechanism of an SLB. The coupon step-down in Figure 1 is represented as a light-grey dashed line, since the most common case is to only include a penalty for failing to achieve the SPT (see Section 3.2).

Thus, SLBs can have impact through two channels. First, SLBs create a clear financial incentive for firms to address their sustainability. If the firm does not meet the SPT, it leaves money on the table. Thus, unless the SPTs would have been reached anyways, SLBs give companies an incentive to change. Second, SLB issuers must commit to explicit sustainability goals, for which they will be held accountable and financially liable in the future. SLBs could therefore constitute a public commitment to sustainability that is costly to walk back beyond the financial penalty for reputational reasons.

The impact of SLBs is therefore much more explicit than many other mechanisms in sustainable investing. For example, while an increasing volume of funds is managed according to ESG ratings, it is uncertain for firms in what metrics they should improve and how substantial the market's reward will be. SLBs effectively put a price on specific improvements, giving firms a clear signal what they need to do, and what the reward will be.

Figure 1. Typical mechanism of an SLB.

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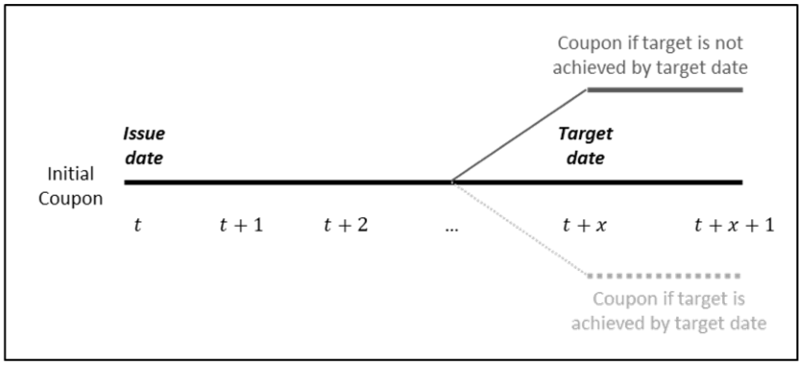

3.2 Data

Our sample of (corporate) SLBs is extracted from Bloomberg's fixed income database, covering all bonds labeled as 'sustainability-linked bonds' as of December 31, 2021. Given the extent of the coverage of Bloomberg's fixed income database, we assume that the resulting data is likely to map closely the full universe of SLBs issued until December 31, 2021. The extraction results in a total of 329 SLBs issued by a total of 189 companies. For each bond, Bloomberg provides the standard bond characteristics (issue size, maturity, coupon, seniority, etc.) and a security description with information on the sustainability components. Bloomberg's security description contains details on the SPT, the target date and coupon adjustment for most SLBs. However, in some cases the security description does not provide complete information on the coupon step-up or the SPT. In these cases, we manually complete the data based on company press releases, publicly available investor relations materials or by contacting the investor relations of the respective company.

Table 1 SLBs over time.

Year	# SLBs	Amount (USD billion)
2018	1	0.2
2019	15	7.2
2020	42	14.2
2021	271	122.8
Total	329	144.2

In Table 1, we provide a descriptive overview of the current market for SLBs as of December 31, 2021. For the sake of comparison, we convert all amounts into US dollars. While some media commonly attribute the world's first SLB in September 2019 to the Italian utility company Enel (Financial Times, 2021), Bloomberg data indicates that Beijing Infrastructure Investment Corporation Limited, the Chinese state-owned rail transportation company, issued an SLB in December 2018. The market for SLBs is growing strongly. In 2019, the total issuance of SLBs was USD 7.2 billion, it doubled the year after, and reached USD 122.8 billion in 2021.

Table 2 SLBs across regions.

Region	# SLBs	Amount (USD billion)
Asia-Pacific	61	14.4
Europe	223	106.3
North America	17	12.5
Rest of World	28	11.0
Total	329	144.2

In Tables 2 and 3 we provide a breakdown of SLBs by region and sector. Sectors are partitioned according to the GICS sector classification. The majority of SLB issuance is made up of European companies (USD 106.3 billion), followed by companies in Asia-Pacific (USD 14.4 billion). With less than 10% of total bond issuance in North America by the end of 2021, the phenomenon of SLBs has not yet been established in the US market and among the largest S&P 500 companies.

In terms of sector breakdown, the industrials, consumer discretionary and utilities sector issued the largest amount of SLBs. The leading SLB issuers are mainly from capital-intensive sectors which are most concerned by the transition to a more energy-efficient, low-emission economy. Furthermore, Table 3 also shows that many sectors, beyond capital-intensive companies, such as in healthcare or financials, started to issue SLBs.

Table 3 SLBs across sectors.

GICS Sector	# SLBs	Amount (USD billion)
Communication Services	3	2.3
Consumer Discretionary	49	21.7
Consumer Staples	27	13.2
Energy	12	7.6
Financials	19	4.9
Health Care	12	8.2
Industrials	111	38.6
Information Technology	7	3.2
Materials	49	20.6
Real Estate	13	2.7
Utilities	27	21.2
Total	329	144.2

Table 4 provides a breakdown of the SLB market by maturity type.[4] While 53% of the SLBs issued are at maturity (173 bonds), 66% of the SLB market volume consists of callable bonds (USD 94.9 billion). The use of callable corporate bonds has increased since the Great Financial Crisis to a share of over 60% in advanced economies due to the advantages for financing and liquidity optimization allowing issuers to redeem the bond due to changes in the interest rate or credit environment or for restructuring purposes (Çelik, Demirtaş, and Isaksson, 2019). In the

[4]The plain vanilla maturity type for bonds is 'at maturity', meaning that the issuer must repay the bond at maturity. Callable bonds give the issuer the option redeem the bond before maturity y subject to time constraints or other special constraints (Çelik, Demirtaş, and Isaksson, 2019). Putable bonds offer the bondholders the right to demand early repayment of the principal from the issuer. Convertible bonds offer the possibility to convert the bond into a number of common stock or equity shares at a predetermined date. Sinkable bonds are bonds backed by a fund set aside by the issuer.

specific case of callable SLBs, issuers have the option to redeem the bond before maturity to reduce or avoid the coupon step-up due to a failure on their SPT. The extent to which the call option reduces the penalty related to the SPT depends on the SLB structure. While some issuers within our sample have historically relied heavily on the callable feature for their bond emissions, 12% of issuers in the SLB market have not issued any callable bond prior to the issuance of a callable SLB. Due to the callable feature of the SLB one can question the actual commitment to sustainability targets of issuers and interpret the bond issuance as driven by greenwashing motivations.

Table 4 SLBs by maturity type.

	# SLBs	$ Amount (billion)
At maturity	173	46.3
Callable	145	94.9
Callable / Perpetual	2	0.3
Callable / Sinkable	1	0.4
Convertible	2	1.3
Putable	3	0.3
Sinkable	3	0.7
Total	329	144.2

Despite the Sustainability-Linked Bond Principles and the efforts to create universal guidelines, there is a lot of diversity with respect to the SPTs and the concrete KPIs set by issuers. Table 5 summarizes the SPTs and coupon margin adjustments across the entire sample of 329 SLBs based on the available Bloomberg data, as well as company press releases, investor relations materials, as well as information provided by investor relations contacts. The most common SPTs are linked to a company's GHG emissions or energy efficiency measures followed by a target related to an ESG score or other sustainability rating. Some issuers have their SPT linked to diversity, water or waste management, or some company-specific renewable energy target, which we classified as 'Other'. The coupon step-up, however, is comparable across companies. The most common feature of SLBs is a coupon step-up of 25 bps if the company fails to reach the predetermined SPT at the given date (USD 61.5 billion). Less than 25% of the SLB market volume has a step-down in case of achievement of the SPT or a two-sided coupon adjustment (step-up and step-down).

Table 5 Summary statistics of SPTs and coupon adjustments of SLBs.

	# SLBs	$ Amount (billion)
Sustainability performance target (SPT)		
GHG emissions & energy efficiency	164	91.5
ESG score	63	15.2
Other	77	20.9
No information	25	16.6
Coupon margin adjustment		
Step-up: <25 bps	117	36.8
Step-up: 25 bps	90	61.5
Step-up: >25 bps	66	28.5
No step up or other penalty	14	3.0
No information	19	4.7
Step-down	67	35.0

In summary, the SLB market as of December 2021 is still in the early stages. It is mainly a European phenomenon, dominated by the industrials, consumer and utilities sectors. The prevalence of the callable feature, as well as the divergence in SPTs and coupon adjustment highlight the varying motivations and ambitions of issuers.

4 Matching Methodology and Empirical Approach

4.1 Matching methodology & sample description

To address our research question and test for the existence of a sustainability premium, we perform a matching approach at the bond-level. The aim of our matching procedure is to match bond pairs with an SLB and a non-sustainable bond by the same issuer, which is as similar as possible except for the sustainability features linked to it. This procedure allows us in a second step to compare and analyze the yield differential, as SLBs and conventional bonds of the same company are subject to the same financial risk once all their differences have been controlled for. Our matching procedure is similar to studies analyzing the greenium.[5]

Matching procedure. In a first step, we require that issuer, bond seniority, maturity type, coupon type and currency are identical for both, the SLB and the counterfactual bond. In terms of maturity type, we focus on at maturity and callable bond pairs and exclude putable and convertible bond pairs. Furthermore, for callable SLBs with a 'make-whole' call option[6] we require as a necessary condition that the counterfactual bond also includes a make-whole call option, while we accept differences in the make-whole spread.[7] While studies on green bonds use the bond rating as an additional matching criteria, we only take into consideration the bond seniority. Due to the early stage of the SLB market, many SLBs do not have a rating. Yet, none of the bond pairs differ in the bond rating conditional on ratings being available, and for that subset results are (qualitatively) the same. The bond seniority is therefore a reasonable matching requirement.

[5]Studies analyzing the green bond premium are based on different matching approaches. Gianfrate and Peri (2019) apply three different propensity score matching techniques (nearest neighbours matching, kernel matching and radius matching) to predict the probability of bonds being green, using Logit and Probit functions. Hachenberg and Schiereck (2018) match each green bond with two comparable non-green bonds (one with a shorter and one with a longer maturity) from the same issuer with the closest maturity, same ranking, currency, rate structure (fixed or floating), secured/unsecured, and that are not structured (callable, etc.). Zerbib (2019) uses a matching method known as model-free or direct approach, which consists of matching a pair of instruments with the same properties except for this one green property. He thus matches every green bond with a conventional bond with the same currency, rating, bond structure, seniority, collateral, and coupon type (Zerbib, 2019). Larcker and Watts (2020) base their matching approach on the specific feature of the municipal bond market which consists in the fact that municipal issuers commonly price tranches of securities, including green and non-green bond in their case, on the same day with the similar maturities. Thus, this allows them to match green bonds with quasi-identical non-green bonds. Flammer (2021) applies Larcker and Watts (2020) methodology to the corporate green bond market, matching each green bond to the most comparable brown bond of the same issuer in two steps. Her first step requires the credit ratings to be the same, and the second step then picks the closest neighbor using the Mahalanobis distance based on four characteristics: log(issuance amount), maturity, coupon, and the number of days between the green and brown bond issuance (Flammer, 2021).

[6]Bonds with a 'make-whole' call option have a call price that is above the market price of the bond, making the investors 'whole' and reducing concerns about early redemptions (Çelik, Demirtaş, and Isaksson, 2019).

[7]The difference in make-whole spread of the SLBs and the counterfactuals within our sample is on average 4.1 bps.

In a second step, we select the counterfactual bond with the closest issue date, maturity and issue size.

Issue date. We limit the difference between issue dates for the bond pairs to a maximum of five years. As the SLB market is strongly driven by Europe, the monetary and interest rate environment during the observed period is relevant. The European Central Bank started its quantitative easing program in 2015. Thus, matching SLBs issued in 2020 with non-sustainable counterfactuals prior to 2015 would imply macroeconomic variation and lower comparability. An issue date restriction of five years therefore seems reasonable.

Maturity. We limit the difference in maturity between SLBs and conventional bonds to three years. This maturity difference is marginally higher than in studies on green bonds.[8]

Issue size. We limit the issue size ratio between the SLB and its counterfactual to a factor of 4 (i.e. not larger than four times the SLB's issue amount and not smaller than one-quarter). We do not set a constraint for the minimum issue size, as liquidity considerations do not affect our pricing analysis of the yield differential at issue.[9]

While our sample is reduced by some missing values in the data, as Bloomberg does not provide yield for the complete SLBs sample, we rely in some cases on the Refinitiv database to complete the data on yield at issue for some SLBs and counterfactuals.

[8]Larcker and Watts (2020) limit the maturity differential to be within one year, as they argue that this restriction maximizes the number of securities for which they can obtain matches, while also minimizing the differences in the slope of the credit spread. Zerbib (2019) limits the maturity of the counterfactual bond to two years shorter or longer than the green bond's maturity.

[9]For liquidity reasons, some studies on green bonds have set constraints on the issue size. Hachenberg and Schiereck (2018) focus on bonds with a minimum issue size of USD 150 million, while Gianfrate and Peri (2019) set a minimum of EUR 200 million. Zerbib (2019) imposes the restriction of factor four on the issue size ratio between the green bond and the counterfactual.

Finally, our matching process results in 102 bond pairs from 85 issuers. There are 14 issuers with more than one bond pair (11 issuers with 2 bond pairs and 3 issuers with 3 bond pairs). Table 6 provides summary statistics for the sample of bond pairs of SLBs and counterfactual bonds.

Table 6 Summary statistics of bond pairs.

Variable	Bond group	Min	1. Quart.	Median	Mean	3. Quart.	Max
Maturity (years)	*SLBs*	1	5	7	7	10	15
	Counterfactuals	2	5	7	7.03	10	12.25
Maturity diff. (years)	*Both*	-3.05	0	0	0.03	0.05	3
Issue size (USD bn)	*SLBs*	28	150	383	479	750	2'146
	Counterfactuals	14	142	465	478	728	1'748
Issue size (ratio)	*Both*	0.3	0.8	1	1.14	1.25	4
Issue date diff. (years)	*Both*	-0.48	0.55	1.33	1.48	2.2	4.81
Coupon (bps)	*SLBs*	0	88	250	249	340	971
	Counterfactuals	20	125	294	284	397	1'069
Yield (bps)	*SLBs*	8	98	258	252	340	971
	Counterfactuals	20	125	292	282	395	1'069
Yield diff. (bps)	*Both*	-275	-63	-21	-29	13	107

Our matching procedure results in a sample of bond pairs with a maturity difference of close to zero, and a similar issue size (average ratio of 1.1). The issue date difference within our bond pairs is on average 1.5 years, with the minimum difference being zero (both bonds issued on the same date representing perfect comparables), and the maximum difference being 4.8 years. Table 6 does not include information on the bond seniority, as this was a necessary matching requirement, and thus identical for all bonds. In terms of bond seniority, most bonds are Senior Unsecured bonds (79 out of 102), while a minority are of higher seniority (4 out of 102) and lower seniority

(19 out of 102).[10] Table 6 also provides the average coupon, excluding any potential step-up, and the yield at issue for the bond pairs. We observe that the average coupon of SLBs is 34 bps lower than for counterfactual bonds, and the yield at issue 29 bps lower. Thus, at first glance, SLBs within our sample benefit from a sustainability premium.

Overall, our sample reflects the general SLB market in several dimensions (see Table A.1 in the Appendix). First, our sample covers 31% of the total SLB market (102 out of 329 SLBs), 34% of the total SLB market volume (USD 49 billion) and 45% of all issuers in the SLB market (85 out of 189). Second, in terms of maturity type, our sample has similar proportions of at maturity and callable SLBs as the overall market (55 at maturity and 47 callable). Third, the sector breakdown within our sample is comparable to the overall market. However, our sample of bond pairs has a higher share of SLBs from Asia-Pacific and a lower share from Europe, as compared to the overall SLB market.

4.2 Empirical analysis

In a first step, we test whether the yield differential between the SLBs and the counterfactuals is significant. We analyze the difference with a nonparametric Wilcoxon rank sum as well as with a parametric, paired t-test.

In a second step, we estimate an OLS regression to test the robustness of the results, when controlling for matching, issuer and bond parameters, as well as changes in the risk-free rate. Furthermore, we aim to determine the effect of the coupon step-up, the SPT and the callable feature on the yield differential. The dependent variable is therefore the yield differential at issue (in bps) between the SLB and its non-sustainable counterfactual $\Delta\ Yield_i$ for every bond pair i. The OLS regression takes the following form:

[10] Among the bonds with higher seniority the breakdown is 1 First Lien, 1 Senior preferred and 2 Secured bonds. Among the bonds with lower seniority there are 19 Unsecured bonds.

$$\Delta \mathit{Yield}_{\mathrm{i}} = \beta_0 + \sum \beta_{\mathrm{j}} \cdot \mathit{SLB\ Characteristics}_{\mathrm{ji}} + \sum \beta_{\mathrm{k}} \cdot \mathit{Matching\ differences}_{\mathrm{ki}}$$
$$+ \sum \beta_{\mathrm{l}} \cdot \mathit{Bond\ pair\ characteristics}_{\mathrm{li}} + \sum \beta_{\mathrm{m}} \cdot \mathit{Issuer\ characteristics}_{\mathrm{mi}} + \sum \beta_{\mathrm{n}} \cdot \mathit{Other}_{\mathrm{ni}} + u_i$$

The independent variables are divided into five types. The first type of variables is linked to the SLB characteristics: the $\mathit{Step\text{-}up}_{\mathrm{i}}$ and a binary variable whether the SPT is related to the reduction of GHG emissions $\mathit{GHG\ target}_{\mathrm{i}}$. These variables thus indicate whether the sustainability features (coupon step-up and SPT) have an impact on the bond yield differential. The second type of explanatory variables, $\mathit{Matching\ differences}_{\mathrm{ki}}$, is intended to capture the differences between the SLB and the counterfactual bond due to our matching approach. This includes the difference in issue date, maturity, as well as the ratio in issue sizes. The third type of variables $\mathit{Bond\ pair\ characteristics}_{\mathrm{li}}$ aims to control for the common bond pair characteristics, such as the maturity type (at maturity or callable), the coupon type (fixed or floating), the bond seniority and the maturity. We also include a binary variable to control for the first SLB issue as compared to later SLB issues. The fourth type of explanatory variables, $\mathit{Issuer\ characteristics}_{\mathrm{mi}}$, relates to firm control variables, such as the ESG profile, the issuer's credit rating, the region and sector. For the ESG profile of issuers, we test our model with two different variables.[11] $\mathit{DJSI}_{\mathrm{i}}$ captures in a binary form whether the issuer is included in the Dow Jones Sustainability Indices and thus allows us to distinguish between ESG leaders and laggards. Furthermore, the advantage of using this variable is that this data is available for our entire sample of 85 issuers. The second ESG variable we use is the S&P global ESG score ($\mathit{ESG\ rating}_{\mathrm{i}}$). Using this variable however reduces our sample size, as not all issuers have an S&P global ESG rating. Finally, the fifth variable type includes quarterly time fixed effects to control for the growing momentum in the SLB market,

[11]The DJSI constituents are available on the S&P website, while the S&P global ESG scores are downloaded from Bloomberg.

and the change in the respective risk-free rate between the issue dates of the counterfactual bond and the SLB.[12] Table 7 provides an overview and description of all variables.

Table 7 Overview and description of dependent and independent regression variables.

Variable	Description	Type	Unit
$\Delta Yield$	Yield differential at issue between the sustainability-linked bond and the non-sustainable counterfactual.	Quantitative	Basis points
SLB characteristics			
Step-up	Coupon step-up determined in the margin ratchet of the SLB structure.	Quantitative	Basis points
GHG target	Binary variable equal to 1 if the SPT of the bond includes targets related to GHG emission reduction.	Qualitative	Binary (0 or 1)
Matching differences			
Issue date diff.	Difference between issue dates of the sustainability-linked bond and the counterfactual bond.	Quantitative	Years
Maturity diff.	Difference between maturity of the sustainability-linked bond and the counterfactual bond.	Quantitative	Years
Issue size ratio	Ratio between the sustainability-linked bond and the counterfactual bond.	Quantitative	Ratio (0.25-4)
Bond pair characteristics			
Callable	Bond pair has a callable maturity type.	Qualitative	Binary (0 or 1)
Floating	Binary variable for floating coupon type.	Qualitative	Binary (0 or 1)
Seniority	Binary variables for seniority higher than Senior Unsecured (First Lien, Senior Preferred, Secured) and for seniority lower than Senior Unsecured.	Qualitative	Binary (0 or 1)
Maturity	Binary variable for maturity shorter than 5 years.	Qualitative	Binary (0 or 1)
First SLB issue	Binary variable for first SLB issued by this company.	Qualitative	Binary (0 or 1)
Issuer characteristics			
DJSI	Issuer was included in one of the Dow Jones Sustainability Indices at the issue of the SLB.	Qualitative	Binary (0 or 1)
ESG rating	The bond issuer's S&P global ESG score in 2020.	Quantitative	Score (0-100)
Credit rating change	Change in one of the issuer's credit ratings during the interval of the counterfactual and SLB issuance.	Qualitative	Binary (0 or 1)
Region	Binary variables for issuer region.	Qualitative	Binary (0 or 1)
Sector	Binary variables for issuer sector.	Qualitative	Binary (0 or 1)
Other			
Risk-free rate change	Change in the risk-free rate between the issue dates of the counterfactual and the SLB.	Quantitative	Basis points
Time fixed effects	Binary variables for all quarters (Q3 2020 - Q4 2021)	Qualitative	Binary (0 or 1)

[12]To control for the interest rate change between the issuance of the counterfactual and the SLB, we use the change in the 5-year risk-free rate for bond pairs with a maturity below 7.5 years and the 10-year risk-free rate for bond pairs with a maturity above 7.5 years of the respective bond region, except for EUR-denominated bonds where we use the 10-year EURIBOR swap rate.

In a third step, we conduct a cost-benefit analysis to consider the time dimension. We compare the effect of the yield differential over the SLB lifetime to the maximum potential penalty an issuer could face in case the SPT is not achieved.

5 Results

5.1 Is there a sustainability premium?

In the first step of the empirical analysis, we aim to estimate the sign, magnitude, and significance of the yield differential between SLBs and their non-sustainable counterfactuals within our sample. Table 8 provides an overview of the average yield across bond pairs, the average yield differential, as well as the p-values of the Wilcoxon rank sum and the paired difference t-test.

Table 8 Wilcoxon rank sum and paired t-test for bond pairs.

	All	At maturity	Callable
N	102	55	47
Yield SLB (bps)	252.4	264.5	238.2
Yield CF (bps)	281.6	277.0	286.9
Yield diff. (bps)	-29.2	-12.5	-48.7
Wilcoxon rank sum test	0.0001	0.0480	0.0003
Paired t-test	0.0000	0.0548	0.0002

The results show that there is a statistically significant yield differential of -29.2 bps between SLBs and the counterfactuals. The yield differential is larger for callable bond pairs compared to at maturity bonds. The negative yield differential implies that the yield for SLBs is on average lower than for non-sustainable counterfactuals, thus resulting in a sustainability premium for SLB issuers. Therefore, companies benefit from a lower cost of capital, while investors receive a lower return on SLBs. This suggests that investors pay for the sustainability improvements. Since this yield is based on a coupon pricing prior to any step-up, the investor's yield increases if the issuer fails to achieve the predetermined SPT. The SLB coupon step-up however only occurs after several years and is conditional on the issuer failing to achieve the SPT (or several SPTs in some cases). The SLB issuer therefore pays a lower coupon and benefits from a lower cost of capital.

5.2 What drives the sustainability premium?

In the second step, we test the robustness of our results and determine whether the sustainability premium is affected by the coupon step-up, the SPT and the callable structure. We perform a series of linear OLS regressions on the yield differential with different sets of control variables. The results of the different regression specifications are summarized in Tables 9, 10 and 11.

Callable feature and coupon step-up. The OLS regression results confirm our findings from the previous section on the differences between at maturity and callable SLBs. Issuers of callable SLBs benefit from a significantly higher sustainability premium, as reflected by the significantly negative and in most cases statistically significant regression coefficient. The effect of the coupon step-up on the yield differential however seems to diverge between at maturity and callable bonds. As we include an interaction term for the coupon step-up and the callable feature, the results of some regressions suggest a statistically significant effect of the coupon step-up on the sustainability premium. For at maturity SLBs, the results suggest that a higher coupon step-up further reduces the yield differential (i.e. increases the sustainability premium). For callable SLBs, however, the regression coefficients are less straightforward to interpret due to the sign and magnitude of the interaction term. The interaction term is statistically significant and in most cases strongly positive, thus countering the negative effect of the regression coefficients for callable and step-up.

Table 9 OLS regression for all bond pairs.

	$\Delta Yield$						
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
SLB characteristics							
Step-up	-0.08	-0.61**	-0.71***	-0.69***	-0.44	-0.47	-0.54
Step-up x Callable		2.05***	1.82***	1.78***	0.96*	0.95*	0.28
Step-up x DJSI						0.34	
GHG target	-12.31	-11.32	-8.06	-8.26	7.06	8.02	16.24
Matching differences							
Issue date diff.				Y	Y	Y	Y
Maturity diff.				Y	Y	Y	Y
Issue size ratio				Y	Y	Y	Y
Bond pair characteristics							
Callable	-30.13*	-91.39***	-79.38***	-75.34***	-33.39	-33.09	-55.67
Floating					Y	Y	Y
Seniority					Y	Y	Y
Maturity					Y	Y	Y
First SLB issue					Y	Y	Y
Issuer characteristics							
DJSI					8.88	1.59	
ESG rating							0.36
Credit rating change					Y	Y	Y
Region					Y	Y	Y
Sector					Y	Y	Y
Other							
Risk-free rate			-0.48***	-0.46***	-0.28**	-0.29**	-0.16
Time fixed effects					Y	Y	Y
Constant	-5.17	5.70	6.34	-5.05	-35.33	-36.57	-40.72
N	102	102	102	102	102	102	68
R-squared	0.0785	0.1880	0.3309	0.3559	0.6709	0.6716	0.7787

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

Due to these remarkable differences between at maturity and callable bond pairs, we perform separate OLS regressions for at maturity and callable bonds, illustrated in Tables 10 and 11. The regression coefficients from Table 10 confirm that the coupon step-up increases the sustainability premium for at maturity SLBs. The step-up regression coefficient is statistically significant in some regression specifications. The magnitude of the negative constant term in Table 11 shows that the sustainability premium is higher for callable SLBs as compared to at maturity SLBs. Furthermore, the positive regression coefficient for the coupon step-up variable confirms the observation from Table 9 on the different dynamics for callable SLBs.

Risk-free rate. Model (3) adds the variable $\textit{Risk-free rate}_i$ for robustness to control for changes in the underlying risk-free rate affecting the yield differential. The variable is statistically significant across all models. The inclusion of the risk-free rate change marginally affects the magnitude of the callable coefficient and interaction term, while increasing the size and statistical significance of the step-up variable.

GHG target. Whether the predetermined SPT of the SLB is linked to the reduction of the issuer's GHG emissions does not seem to impact the sustainability premium, as the coefficient of the binary variable $\textit{GHG target}_{\mathrm{i}}$ is consistently statistically insignificant.

ESG profile. Model (5) of Table 9 and Model (4) of Tables 10 and 11 include a binary variable $\textit{DJSI}_{\mathrm{i}}$ to capture whether the issuer was included in the Dow Jones Sustainability Indices at the SLB issue date. The coefficient on the $\textit{DJS}_{\mathrm{i}}$ variable is statistically insignificant across all models, and for the separate regressions of at maturity and callable SLBs. The addition of an interaction term for step-up and DJSI does not change the coefficients. In Model (7) of Table 9 and Model (6) of Tables 10 and 11, we replace $\textit{DJSI}_{\mathrm{i}}$ by $\textit{ESG rating}_{\mathrm{i}}$ to have a more granular distinction of the ESG profile across our sample. While the $\textit{ESG rating}_{\mathrm{i}}$ variable is statistically insignificant, the R-squared increases significantly. The inclusion does not affect the $\textit{Step-up}_{\mathrm{i}}$ regression coefficient for the overall model (Table 9) and at maturity bond pairs (Table 10), while changing the sign for callable bond pairs but remaining statistically insignificant (Table 11). This result might however be biased due to the smaller sample (68 bond pairs) for which the issuers have a S&P global ESG score, which might represent companies with better ESG profiles.

Table 10 OLS regression results for at maturity bond pairs.

	$\Delta Yield$					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
SLB characteristics						
Step-up	-0.62***	-0.56***	-0.67***	-0.48	-0.55	-0.53
Step-up x DJSI					0.86	
GHG target	-7.25	-5.28	-9.97	11.40	9.41	90.44
Matching differences						
Issue date diff.			Y	Y	Y	Y
Maturity diff.			Y	Y	Y	Y
Issue size ratio			Y	Y	Y	Y
Bond pair characteristics						
Floating				Y	Y	Y
Seniority				Y	Y	Y
Maturity				Y	Y	Y
First SLB issue				Y	Y	Y
Issuer characteristics						
DJSI				6.19	-0.76	
ESG rating						-0.55
Credit rating change				Y	Y	Y
Region				Y	Y	Y
Sector				Y	Y	Y
Other						
Risk-free rate		-0.16	-0.24	-0.33**	-0.34**	0.03
Time fixed effects				Y	Y	Y
Constant	4.09	3.94	-12.57	-46.92	-43.20	-16.59
N	55	55	55	55	55	31
R-squared	0.1672	0.1989	0.2456	0.6456	0.6479	0.8059

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

Region. The dummy variables related to the issuer's region are included as controls in our regression models, with the base case being European issuers. It must be highlighted that the regression coefficients are positive for all regions (Asia-Pacific, North America, and Rest of World) across all model specifications. When setting another region as a base case and including the dummy variable for Europe, the regression coefficient is negative, and statistically significant in some specifications (see Table A.3 in the Appendix). 66% of callable SLBs (31 out of 47) are from European issuers, while 79% of all European issued SLBs are callable (31 out of 39). Furthermore, all North American bond pairs within our sample (11 in total) are callable. Thus, the higher sustainability premium of callable SLBs might to some extent be driven by regional specifications and multicollinearity due to the high share of European issuers.

Table 11 OLS regression results for callable bond pairs.

	$\Delta Yield$					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
SLB characteristics						
Step-up	1.46***	0.89***	0.89**	0.69	0.76	-0.03
Step-up x DJSI					0.77	
GHG target	-21.80	-28.91	-21.77	10.50	8.12	27.36
Matching differences						
Issue date diff.			Y	Y	Y	Y
Maturity diff.			Y	Y	Y	Y
Issue size ratio			Y	Y	Y	Y
Bond pair characteristics						
Seniority				Y	Y	Y
Maturity				Y	Y	Y
First SLB issue				Y	Y	Y
Issuer characteristics						
DJSI				10.11	34.45	
ESG rating						0.79
Credit rating change				Y	Y	Y
Region				Y	Y	Y
Sector				Y	Y	Y
Other						
Risk-free rate		-0.88***	-0.71**	0.03	0.06	-0.09
Time fixed effects				Y	Y	Y
Constant	-77.23	-43.40	-30.33	-45.77	-53.97	-152.50
N	47	47	47	47	47	37
R-squared	0.1128	0.4385	0.4539	0.7662	0.7672	0.8383

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

5.3 Robustness and limitations

We carry out robustness checks to address potential concerns regarding differences due to our matching approach and changes in issuer credit ratings. Furthermore, due to the early stage of the SLB market our analysis might have a sample bias.

Coupon discount or penalty. Within our bond pairs sample of 102 bonds, there are 9 SLBs that have a coupon step-down, along with a coupon step-up or only a step-down, and 10 SLBs that have a penalty other than a coupon step-up, such as for example the donation to a charity, or a mandatory redemption in case of failing on the SPT. Out of these 19 SLBs 18 are at maturity bonds and 1 is callable. Due to the different penalty or discount mechanisms of these SLBs, the bond pairs might bias our estimations. We therefore perform the same regressions for our overall sample excluding these 19 SLBs (Table A.4 in the Appendix) and for at maturity bond pairs only (Table A.5 in the Appendix). The effect of the callable feature increases marginally, as the reduced sample size has proportionally more callable bonds. The regression coefficients are however similar to the results obtained for the overall sample.

Matching approach. In contrast to studies on green bonds, we allow for a slightly larger maturity difference, and therefore restrict the difference in maturity between SLBs and conventional bonds to three years. Larcker and Watts (2020) limit the maturity differential to be within one year, as they argue that this restriction maximizes the number of securities for which they can obtain matches, while also minimizing the differences in the slope of the credit spread. Zerbib (2019) limits the maturity of the counterfactual bond to two years shorter or longer than the green bond's maturity. We therefore perform the identical OLS regressions for a smaller sample of bond pairs with a maturity difference of less than two years (90 bond pairs). Table A.6 of the Appendix shows that the regression coefficients have the same statistical significance, and higher R-squared values. Thus, our results are robust to bond pairs with smaller differences in bond maturity.

Credit rating. For 36 bond pairs within our sample there was a change in credit rating between the issue date of the counterfactual and the SLB. In some cases, this credit rating change might thus be a significant driver for the yield differential, as also shown in Table A.2 in the Appendix, which focuses on the outliers. We therefore perform the identical OLS regressions for a smaller sample of bond pairs with no credit rating changes (66 bond pairs). Table A.7 in the Appendix shows that the regression coefficients are similar and thus robust.

Sample bias due to regional and firm size characteristics. One limitation of our current study might be the sample of bond pairs. As the market for SLBs is in its early phase, the drivers and motivations of issuers is highly relevant. In line with the research of Flammer (2021), issuers in the SLB market have different motivations, which might affect the representative nature of our sample of bond pairs. Our sample might be biased towards large corporations which issue bonds more regularly, and thus offer counterfactuals. These companies might thus be more driven by the financial incentive (lower cost of capital), than the signaling rationale. Furthermore, our sample includes proportionally less European SLBs (38%) compared to the overall SLB market (68%).

5.4 Cost-benefit analysis

In a third step, we aim to fully understand the financial effects of SLBs on the issuer. To do that, we calculate the explicit dollar value of the yield difference and the value of the potential step-up. Using these figures, we conduct a cost-benefit analysis that provides a comprehensive understanding of the financial implications of SLBs.

Table 12 SLB coupon step-up, potential penalty and savings for bond pairs.

	Averages per bond pair group		
	All	**At maturity**	**Callable**
N	102	55	47
Yield differential (bps)	-29.2	-12.5	-48.7
# SLBs with sustainability premium (yield diff. < 0)	66	34	32
# SLBs with no sustainability premium (yield diff. ≥ 0)	36	21	15
SLB coupon step-up (bps)	26.6	21.5	32.6
SLB maturity (years)	7.1	5.4	9
No coupon step-up until SPT date (years)	4.2	3.1	5.6
Coupon step-up after SPT date (years)	2.8	2.2	3.4
Potential penalty (USD million)	4.1	1	7.8
SLB savings (USD million)	7.6	1.6	14.7
SLB 'free lunch' (savings - penalty)	3.5	0.6	6.9
# SLBs with 'free lunch' (savings $>$ penalty)	55	26	29

In Table 12 we approximate the financial savings and the maximum potential penalty an SLB issuer could face. The average sustainability premium is 29.2 bps, while the average coupon step-up is 26.6 bps, implying that even in the case of failure on the SPT most issuers pay a lower cost of capital on their SLB as compared to a non-sustainable counterfactual. The yield differential however varies across bond pairs (see Figure A.1 in the Appendix).[13] In 34% of our bond pairs (35 out of 102) the SLB issuers do not benefit from a sustainability premium, but instead pay for the sustainability improvement. Furthermore, Table 12 shows that SLB issuers benefit on average during 4.2 years from the sustainability premium, while facing the coupon step-up for the last 2.8 years of the SLB lifetime. This lag in coupon step-up results in significant financial savings for SLB issuers during the lifetime of the SLB, as compared to what they pay for non-sustainable counterfactuals.

The financial savings are calculated as the yield differential multiplied by the number of years until the SPT deadline and the issue size. Similarly, the maximum potential penalty is calculated as the product of the maximum coupon step-up for failing to achieve all the SPTs, the number

[13]Note that there are some bond pairs with a sustainability premium above 150 bps. In Table A.2 in the Appendix we provide an overview and potential explanation for these outliers.

of years between the SPT deadline and the maturity date, as well as the issue size. The potential penalty represents the maximum amount the issuer would face if failing to achieve all its SPTs. On average, SLB issuers save USD 7.6 million due to the negative yield differential, while facing a potential penalty of USD 4.1 million (average of 1.3% of the issue size) in case of a coupon step-up for the final years of the bond. On average, SLB issues result in a benefit of USD 3.5 million for the issuer in our sample. When breaking down the sample according to maturity type, we observe that the potential penalty differs strongly between at maturity and callable SLBs. The average potential penalty for SLBs at maturity is USD 1.0 million (0.3% of issue size), while it is USD 7.8 million for callable SLBs (1.0% of issue size). Figure A.3 in the Appendix, representing the distribution of yield differential and potential penalty according to maturity type, highlights that the majority of SLBs with a high potential penalty are for callable SLBs.

The financial savings due to the sustainability premium vary across our SLB sample, as illustrated by Figure A.4 in the Appendix. The financial savings on callable SLBs are on average significantly higher than for at maturity SLBs (USD 14.7 million vs. USD 1.6 million). Thus, our overall findings suggest that SLB issuers face a significant financial gain with financial savings on average more than 60% higher than the potential penalty in case of a coupon step-up.

There are however divergences among our bond pair sample, as some issuers do not benefit from a sustainability premium and face a potential loss on the SLB issue (see Figures A.1 and A.4 in the appendix). 47 SLBs (out of 102) have no safe gain from the SLB issuance[14], while 55 SLBs benefit from a 'free lunch' as the financial savings are greater than the potential penalty. The average 'free lunch' is USD 14.5 million for these 55 bond pairs. Figure A.2 in the Appendix shows the

[14] 36 SLBs do not benefit from a sustainability premium, while 11 further SLBs benefit from a sustainability premium, but face a potential penalty higher than the financial savings due to the sustainability premium. Thus, these issuers face the risk of having a net loss on the SLB in case of not achieving the SPT. A total of 47 bond pairs therefore have no safe gain from the SLB issuance.

distribution of the potential penalty for SLBs within our bond pair sample. 52% of the SLBs (53 out of 102) have a potential penalty of less than USD 2.0 million (average of 0.3% of the issue size).

Our calculation of a potential 'free lunch' is conservative, because the estimation of the potential penalty for callable SLBs is biased to the upside for two reasons. First, 30% of callable SLBs have several SPTs or SPT dates and on average a longer maturity than at maturity SLBs, implying mechanically a higher maximum potential penalty as the number of years of potential coupon step-up is greater. For the sake of comparison, we consistently estimate the maximum potential penalty (i.e. the scenario where the issuer fails on all SPTs). Second, issuers of callable SLBs have the option to reduce the potential penalty by calling the SLB before maturity. The redemption price and date differ across issuer, but should not affect our analysis, as our matching procedure relies on same issuer bond pairs.[15] Within our sample of 47 callable SLBs, 46 have a make-whole call option with an average make-whole spread of 31.8 bps.[16] Therefore, the potential penalty for callable SLBs with this make-whole option can be reduced up to the make-whole amount, which represents on average 37% of the potential penalty.

In summary, our results provide evidence that SLBs are priced lower than non-sustainable counterfactuals, meaning that SLB issuers benefit from a sustainability premium and investors pay for the sustainability improvements. Furthermore, due to the time lag and sustainability premium being larger than the coupon step-up, our cost-benefit analysis shows that SLB issuers save on average over 60% as compared to their potential penalty. The sustainability premium, as well as the financial savings and potential penalty are higher for callable SLBs.

[15] The redemption dates for callable bonds differ across issuers, as some issuers have specific call dates, while other issuers have the option for redemption at any time in the interval of the SPT date and the maturity date.

[16] The average make-whole spread of 31.8 bps is based on 44 SLBs out of the sample of 46 callable SLBs with a make-whole call option, as Bloomberg does not provide the data for the make-whole spread for two SLBs.

6 Discussion

The results of our paper provide several points of discussion. We are aware that due to the early stage of the SLB market and the small size of our bond pair sample, the implications and conclusions drawn from our results need to be considered carefully. As the SLB market grows we intend to add further bonds to our sample. As such, the findings of this article should be viewed as somewhat preliminary evidence. Nevertheless, given the fast growth of SLBs and their significant potential for impact investors, our study offers important insights that may help navigate in the market for SLBs.

Our paper makes three contributions to the sustainable finance literature.

First, our paper provides the first overview and analysis of the SLB market. SLBs are a novel phenomenon, and have gained significant traction since 2020. SLBs have a twofold potential to drive impact: issuers need to set a direct financial incentive to improve their sustainability and set explicit sustainability objectives, for which they are held accountable and financially liable. Due to the early stage of the SLB market, there is currently a lack of consistency and alignment in SPT and coupon step-up, resulting in significant divergences in SLB structuring.

Second, our paper shows that on average investors pay for sustainability improvements, while companies benefit from a sustainability premium. However, our sample also highlights large differences across issuers. While in 65% of our SLB sample the issuers benefit from a sustainability premium, in 35% of our SLB sample the issuers pay for the sustainability improvements due to the absence of a sustainability premium. Part of the yield differential might be driven by changes in the credit rating between the issue dates of the counterfactual and the SLB, as well as changes in the risk-free rates. Our regression analysis and the further robustness checks control for such factors.

Third, we show that SLBs represent a 'free lunch' for many issuers. As the average coupon step-up is lower than the sustainability premium and comes into effect in the last year(s) of an SLB, companies benefit from a lower cost of capital even when they fail to achieve their SPT. Our cost-benefit analysis comparing the magnitude of financial savings and potential penalty suggests that issuers save on average more than 60% on the SLB issue compared to the size of the potential penalty. Furthermore, most SLBs with a high potential penalty have a call option, which allows the issuer to reduce the potential penalty.

As highlighted by Flammer (2021) in the context of green bonds, the existence of a premium provides relevant insights into the potential motivations of companies issuing SLBs, namely signaling, greenwashing, or the cost of capital. Over the past two years, SLB issuance has led to positive media coverage and increased company press releases. Signaling theory however implies that the signal is costly. For SLB issuers benefiting from a sustainability premium, the lower cost of capital thus represents the main motivation. The SLB issuers that do not benefit from a sustainability premium pay for the sustainability improvement and thus seem to be driven by signaling purposes, or use the SLB as a business case motive to set a company-internal price for sustainability or CO2, especially for issuers with GHG emission reduction targets. In order to identify potential greenwashing motivations, a closer examination of the sustainability characteristics (SPTs) and the financial characteristics (coupon step-up and callable feature) is required. While we did not examine the ambitiousness of the SPTs, our paper highlights the divergence in potential penalty, due to a low coupon step-up or limited periods affected, and the fact that the callable feature of many SLBs can significantly reduce the potential penalty. Thus, the sustainability commitment of SLB issuers with unambitious SPTs or small potential penalty can be questioned. Furthermore, the callable feature of a high proportion of SLBs, especially in advanced economies, might further reduce the issuer's future penalty and commitment, thus implying the potential presence of greenwashing motivations from issuers.

Our regression analysis highlights the difference between at maturity and callable SLBs. Callable SLBs are characterized by higher coupon step-up conditions as compared to at maturity SLBs.

Thus, disentangling the effect of the coupon step-up from the callable feature seems to be challenging, as illustrated by the coefficient of the interaction term in our regression results, as well as the separate regressions for callable bonds. Intuitively, one could argue that companies issuing SLBs with a longer maturity and a higher coupon step-up face higher uncertainty regarding the achievement of the SPTs, and therefore opt more often for the callable feature. However, it seems puzzling that issuers of callable SLBs benefit from a significantly higher sustainability premium, or, in other words, that investors are willing to pay more for sustainability improvements.

One driver for the higher sustainability premium for callable bonds might be the regional market dynamics. Two-thirds of the callable SLBs are from European issuers. On the demand side, the trend for ESG and sustainability-linked investment products is larger in Europe, as shown by the investment flows into ESG funds (Bloomberg, 2021). European investors might therefore also be willing to pay more for sustainability. On the supply side, the European corporate bond market has been significantly affected by the ECB's corporate sector purchase program (CSPP) in the past years. The ECB intervention limits the universe of investment grade corporate bonds, which many European institutional investors need to purchase due to regulatory requirements. The SLB market is currently still in its early stages and dominated by European large-cap and investment grade issuers. As the demand for such investment grade bonds from institutional investors is high, these issuers can potentially offer a lower yield, independently of whether the bonds are sustainability-linked. Thus, the high yield differential in favor of issuers might not only be attributable to a sustainability premium, but also to the smaller universe of European investment grade corporate bonds due to the unconventional monetary environment.

Another possible explanation could be related to the SPTs. Investors might be willing to pay a higher price for sustainability improvements of issuers most concerned by the transition to a more energy-efficient, low-emission economy. The fact that 87% of callable SLBs have their SPT related to a reduction of GHG emissions strengthens this argument, as it indicates that climate change is a major concern for investors and a sustainability objective they are willing to pay for. The regression results for the GHG emissions SPT of callable bonds do not confirm this hypothesis, with statistically insignificant regression coefficients and mixed signs depending on the model specification. This result might however be due to multicollinearity between the callable feature and the GHG emissions target. As our sample increases with the growing SLB market, we expect to have more evidence undermining this hypothesis in our regression analysis.

Our paper and the sustainability premium analysis focuses on the issuer perspective, rather than on the investor perspective. We consider the pricing of SLBs on the primary bond market and potential explanations for the existence of a sustainability premium at issue based on bond and issuer characteristics. The aim of our cost-benefit analysis is also to understand the potential decision-making of issuers. Within this analysis, we estimated the maximum potential penalty that issuers could face, and did not treat the 19 SLBs with potential step-down or a penalty other than a coupon step-up (e.g. donation) differently. However, it can be argued that whether a bond has a step-up or a step-down has different implications with regards to investor role and expectation. In the case of a step-up, the investor plays a punitive role, as the SLB issuer faces higher financing costs in case the SPT is not achieved. Some investors might also invest into an SLB with a step-up, expecting to receive the step-up by speculating on the issuer's SPT failure. In the case of a step-down, the investor is more of a philanthropist, as he explicitly accepts to potentially receive a lower coupon in the future. This step-down is therefore an explicit price for sustainability improvement he is willing to pay, while the sustainability premium we have estimated in this paper is implicit, and less transparent. Furthermore, the different dynamics observed for callable and at maturity SLBs might also be due to different investors, as some long-term institutional investors follow a buy-and-hold strategy for bonds and actively avoid callable bonds due to reinvestment risk.

7 Further research

Since our paper is the first study addressing the new phenomenon of SLBs, it offers a multitude of future research opportunities. First, future research could analyze to what extent the sustainability targets set by companies are ambitious, and how the distance from the target impacts the sustainability premium of SLBs. This analysis could provide more insights into the motivation of issuers and allow to distinguish between signaling and greenwashing purposes. Second, market dynamics should be considered. The demand for sustainable investments from institutional investors, especially in Europe, is high. Many company press releases describe the bond emissions as being oversubscribed. Further research could therefore analyze the impact of investor demand on the pricing of these SLBs on the primary and secondary bond market. Third, our paper focuses on the yield differential at bond issuance. Thus, future research could analyze the development of SLBs on the secondary market, and especially price movements as the bond approaches its sustainability target date. Fourth, the actual impact of SLBs on companies' sustainability profile could be analyzed, similarly as it has been done for green bonds (Deng and Lu, 2017; Zhou and Cui, 2019; Flammer, 2020). Finally, we only focused on the issuer perspective and motivations. Future studies could analyze how investor price SLBs based on option theory and expectations regarding the probability of the issuers achieving the SPT. All these future research opportunities could be similarly addressed for (non-publicly listed) sustainability-linked loans. Research in the loan or private markets space could also offer interesting insights allowing to disentangle the signaling and the financial motives, as non-listed companies are less driven by signaling purposes.

A Appendix

Table A.1 Comparison of overall SLB market and our sample of bond pairs.

	SLB Market: # SLBs (% of market)			Matched bond pairs sample: # SLBs (% of sample)		
Total	329			102		
Region	• Asia-Pacific:	61	(19%)	• Asia-Pacific:	40	(39%)
	• Europe	223	(68%)	• Europe	39	(38%)
	• North America	17	(5%)	• North America	11	(11%)
	• Rest of World	28	(9%)	• Rest of World	12	(12%)
GICS Sector	• Communication Services	3	(1%)	• Communication Services	3	(3%)
	• Consumer Discretionary	49	(15%)	• Consumer Discretionary	6	(6%)
	• Consumer Staples	27	(8%)	• Consumer Staples	13	(13%)
	• Energy	12	(4%)	• Energy	6	(6%)
	• Financials	19	(6%)	• Financials	6	(6%)
	• Health Care	12	(4%)	• Health Care	3	(3%)
	• Industrials	111	(34%)	• Industrials	29	(28%)
	• Information Technology	7	(2%)	• Information Technology	2	(2%)
	• Materials:	49	(15%)	• Materials:	19	(19%)
	• Real Estate	13	(4%)	• Real Estate	10	(10%)
	• Utilities:	27	(8%)	• Utilities:	5	(5%)
Maturity type	• At maturity:	173	(53%)	• At maturity:	55	(54%)
	• Callable:	145	(44%)	• Callable:	47	(46%)
	• Callable / Perpetual:	2	(1%)	• Callable / Perpetual:	-	-
	• Callable / Sinkable:	1	(0%)	• Callable / Sinkable:	-	-
	• Convertible:	2	(1%)	• Convertible:	-	-
	• Putable:	3	(1%)	• Putable:	-	-
	• Sinkable:	3	(1%)	• Sinkable:	-	-

Table A.2 Overview of bond pairs with a high sustainability premium (< -150bps).

Issuer	Yield differential	Region	Sector	SLB issue Date	CF issue date	Credit Rating Change	DJSI / ESG Rating	Comment
Constellium	-275	Materials	Europe	02/06/21	09/11/17	Credit Upgrade	DJSI: No S&P: 20	No
Constellium	-188	Materials	Europe	24/02/21	30/06/20	Credit Upgrade	DJSI: No S&P: 20	
Enel	-155	Utilities	Europe	17/06/21	21/01/19	Credit Upgrade	DJSI: Yes S&P: 99	Benefitted from high media attention ("First issuer")
Klabin	-260	Materials	Europe	12/01/21	03/04/19	-	DJSI: No S&P: 90	High ESG score
Anglian Water Osprey	-192	Utilities	Europe	13/07/21	08/12/17	Credit Upgrade	DJSI: No S&P: N.A	
Surbana Jurong	-163	Industrials	Asia-Pacific	10/02/21	03/10/18	-	DJSI: No S&P: NA	SDG-linked bond; First in Southeast Asia

Table A.3 OLS regressions for callable bond pairs with regional dummy details.

	$\Delta Yield$				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
SLB characteristics					
Step-up	1.27***	0.85***	0.86**	0.63	0.58
Step-up x DJSI					0.35
GHG target	4.34	-13.02	-10.3	-27.1	-26.3
Matching differences					
Issue date diff.			Y	Y	Y
Maturity diff.			Y	Y	Y
Issue size ratio			Y	Y	Y
Bond pair characteristics					
Seniority				Y	Y
Maturity				Y	Y
First SLB issue				Y	Y
Issuer characteristics					
Europe	-66.73***	-38.43*	-33.02*	-56.51	-56.62
North-America			-0.61	-30.4	-31.76
DJSI				-1.3	-12.14
ESG rating					
Credit rating change				Y	Y
Sector				Y	Y
Other					
Risk-free rate		-0.78***	-0.67**	-0.24	-0.26
Time fixed effects				Y	Y
Constant	-49.83	-31.57	-25.2	109.4	111.88
N	47	47	47	47	47
R-squared	0.25	0.4796	0.4912	0.7241	0.7244

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

Table A.4 OLS regressions for bond pairs excluding SLBs with a coupon step-down or a penalty other than a coupon step-up.

	$\Delta Yield$						
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
SLB characteristics							
Step-up	0.02	-0.67**	-0.72***	-0.56**	-0.32	-0.32	-0.08
Step-up x Callable		2.29***	1.85***	1.64***	0.92	0.92	0.23
Step-up x DJSI						-0.02	
GHG target	-12.37	-5.33	-3.23	-3.37	13.23	13.27	35.45
Matching differences							
Issue date diff.				Y	Y	Y	Y
Maturity diff.				Y	Y	Y	Y
Issue size ratio				Y	Y	Y	Y
Bond pair characteristics							
Callable	-27.17	-104.80***	-79.14***	-64.14**	-30.24	-30.20	-63.85
Floating					Y	Y	Y
Seniority					Y	Y	Y
Maturity					Y	Y	Y
First SLB issue					Y	Y	Y
Issuer characteristics							
DJSI					8.25	7.71	
ESG rating							0.64*
Credit rating change					Y	Y	Y
Region					Y	Y	Y
Sector					Y	Y	Y
Other							
Risk-free rate			-0.64***	-0.58***	-0.30*	-0.30*	-0.11
Time fixed effects					Y	Y	Y
Constant	-12.14	5.78	1.84	-15.94	-28.3	-28.35	-46.52
N	83	83	83	83	83	83	54
R-squared	0.0585	0.1962	0.4085	0.4667	0.7228	0.7228	0.8432

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

Table A.5 OLS regressions for at maturity bond pairs excluding SLBs with a coupon step-down or a penalty other than a coupon step-up.

	$\Delta Yield$				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
SLB characteristics					
Step-up	-0.67**	-0.71***	-0.64**	0.05	-0.05
Step-up x DJSI					-6.14
GHG target	-4.73	0.15	-11.94	2.7	2.7
Matching differences					
Issue date diff.			Y	Y	Y
Maturity diff.			Y	Y	Y
Issue size ratio			Y	Y	Y
Bond pair characteristics					
Floating				Y	Y
Seniority				Y	Y
Maturity				Y	Y
First SLB issue				Y	Y
Issuer characteristics					
DJSI				-119.42	3.48
ESG rating					
Credit rating change				Y	Y
Region				Y	Y
Sector				Y	Y
Other					
Risk-free rate		-0.32	-0.40***	-0.49	-0.49
Time fixed effects				Y	Y
Constant	5.6	2.44	-26.10*	-159.86	-190.58
N	37	37	37	37	37
R-squared	0.2335	0.3397	0.5029	0.858	0.858

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

Table A.6 OLS regressions for bond pairs with a maturity difference of ≤ 2 years.

	$\Delta Yield$					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
SLB characteristics						
Step-up	0.03	-0.53**	-0.70***	-0.64***	-0.32	-0.5
Step-up x Callable		1.92***	1.80***	1.82***	0.94*	0.38
GHG target	-7.92	-9.22	-6.38	-8.98	12.96	19.31
Matching differences						
Issue date diff.				Y	Y	Y
Maturity diff.				Y	Y	Y
Issue size ratio				Y	Y	Y
Bond pair characteristics						
Callable	-44.08**	-100.91***	-89.05***	-81.08***	-41.37**	-34.21
Floating					Y	Y
Seniority					Y	Y
Maturity					Y	Y
First SLB issue					Y	Y
Issuer characteristics						
DJSI					15.43	
ESG rating						0.43
Credit rating change					Y	Y
Region					Y	Y
Sector					Y	Y
Other						
Risk-free rate			-0.40**	-0.41**	-0.22*	-0.17
Time fixed effects					Y	Y
Constant	-4.04	7.15	8.19	-5.31	-44.7	-93.06
N	90	90	90	90	90	62
R-squared	0.1293	0.2359	0.3301	0.3454	0.6862	0.7796

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

Table A.7 OLS regressions for bond pairs with no credit rating changes.

	$\Delta Yield$					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
SLB characteristics						
Step-up	-0.22	-0.70**	-0.70**	-0.74***	-0.6	-0.65*
Step-up x Callable		2.13***	1.86***	1.85***	1.5	0.69
GHG target	-3.81	-0.65	-2.71	-6.54	9.4	5.12
Matching differences						
Issue date diff.				Y	Y	Y
Maturity diff.				Y	Y	Y
Issue size ratio				Y	Y	Y
Bond pair characteristics						
Callable	-26.44	-94.27***	-83.85***	-83.91***	-30.59	-58.3
Floating					Y	Y
Seniority					Y	Y
Maturity					Y	Y
First SLB issue					Y	Y
Issuer characteristics						
DJSI					9.84	
ESG rating						-0.12
Credit rating change					Y	Y
Region					Y	Y
Sector					Y	Y
Other						
Risk-free rate			-0.40**	-0.44***	-0.30**	-0.16
Time fixed effects					Y	Y
Constant	-6.56	2.23	2.3	-6.64	-4.76	-70.94
N	66	66	66	66	66	39
R-squared	0.0609	0.2041	0.3259	0.3424	0.7451	0.9086

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

Figure A.1. Distribution of yield differential within our bond pair sample.

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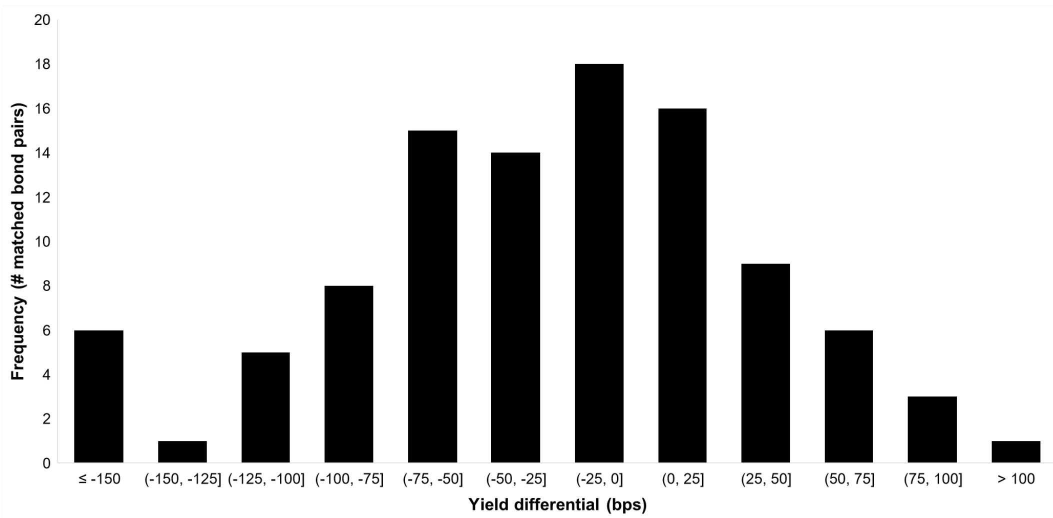

Figure A.2. Distribution of potential penalty for SLBs within our bond pair sample.

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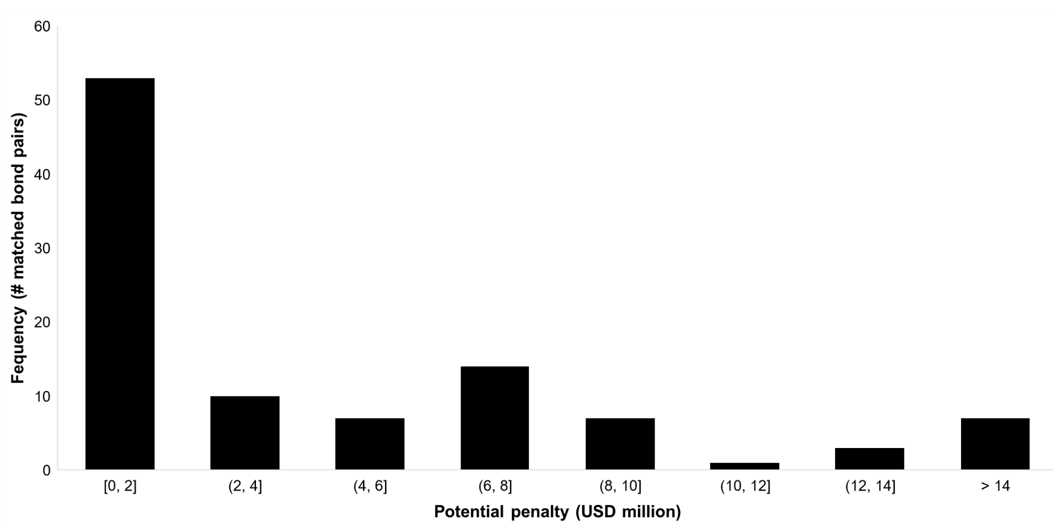

Figure A.3. Distribution of yield differential by potential penalty.

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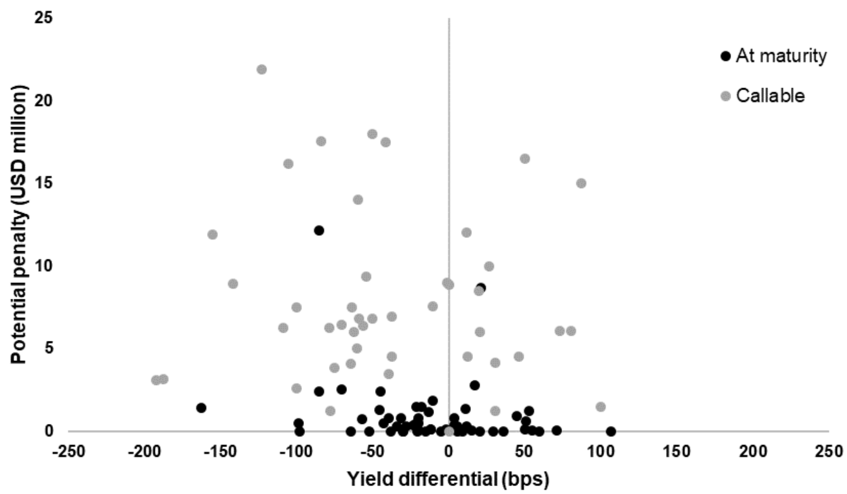

Figure A.4. Financial savings vs. potential penalty per bond pair.

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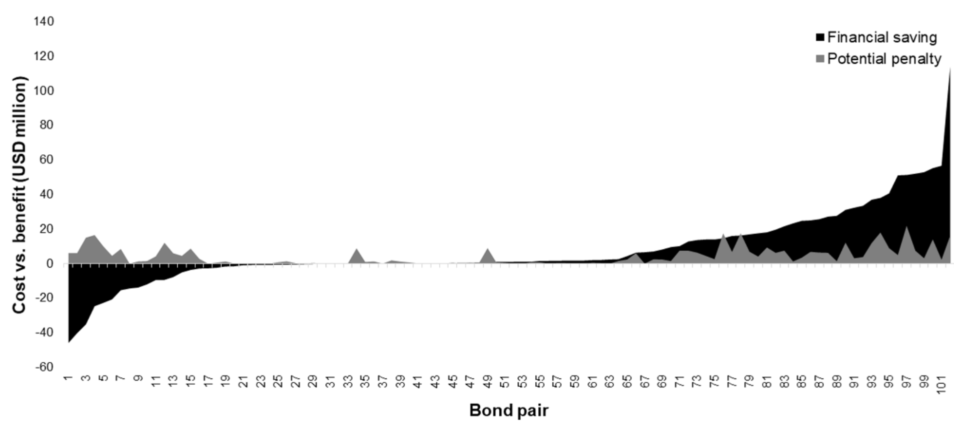

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