Bonds with Benefits: An Empirical Investigation of Sustainability-Linked Bonds

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Abstract

Sustainability-linked bonds (SLBs) are the youngest and fastest-growing instrument of the sustainable debt market, with unique properties that should incentivise companies to become more sustainable. Yet there is little empirical evidence on SLBs. This thesis investigates three potential rationales for issuing SLBs: to obtain a lower cost of capital, to signal dedication to sustainability, and to commit to sustainability targets. First, using a matching method, we find that SLBs are issued at a yield discount compared to conventional bonds. Second, using an event study, we find that the stock market reacts positively to the announcement of SLB issuances and the reaction is stronger for first-time issuers. Third, by investigating SLB contracts, we find that the financial penalties for failing to achieve the sustainability performance targets are small. Our results suggest that companies may issue SLBs to obtain a lower cost of capital and to signal dedication to sustainability. However, it is unclear whether companies issue SLBs to commit to sustainability targets.

Keywords: Sustainability-linked bonds, Sustainable finance, Sustainability premium, Signalling, Incentives

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1. Introduction

The world is facing major societal challenges including climate change, rising inequality and demographic change (Acemoglu et al., 2022). In response to these challenges, sustainable finance has emerged as a key instrument for the financial sector to fund and encourage sustainable projects (Mocanu et al., 2021; Bakken, 2021). Sustainable finance has transformed debt markets over the past decade and fuelled many financial innovations. The sustainable debt market has grown rapidly and 2021 was the fastest-growing year so far, with an annual growth of 114% (Thygesen et al., 2022). Within the sustainable debt market, sustainability-linked bonds (SLBs) are the youngest and fastest-growing instrument, with an annual growth of over 800% in 2021 (Thygesen et al., 2022). SLBs are bonds with financial and structural characteristics that may vary depending on whether the issuer achieves predefined sustainability targets (ICMA, 2020). Despite the growing scale of SLBs, little is known about this new financial instrument and there are many open questions to explore. For example, it is unclear how SLB characteristics may affect issuers, how SLBs are different to green bonds and why companies issue them. This thesis fills a gap in the literature by empirically investigating the rationales of public companies for issuing SLBs.

Understanding what SLBs do and why companies issue them is important for four main reasons. First, SLBs have unique properties that should incentivise companies to become more sustainable. Their performance-based structure differs significantly from the use-of-proceeds structure of more mature green, social, and sustainable bonds (Vulturius et al., 2022). From a scientific perspective, it is important to investigate the performance-based structure to determine whether it is well designed in its current form. Second, it may seem puzzling that companies choose to issue SLBs instead of conventional bonds given the restrictive nature of SLBs in tying companies to sustainability targets. A seemingly superior strategy may be to issue conventional bonds and independently improve sustainability (Flammer, 2021) [1]. Nevertheless, the SLB market has been growing rapidly and it is important to understand why. Third, future policy and regulatory efforts are aimed at expanding the SLB market (Vulturius et al., 2022). Credible empirical evidence is needed to inform policy and regulatory action. Fourth, academic research on SLBs is scarce because of limited data on the instrument

[1] This follows from optimization theory (Flammer, 2021). The feasible set is largest when optimizing an unconstrained objective function. Any unconstrained optimum is (weakly) superior to a constrained optimum. Firms issuing conventional bonds have an unconstrained objective function and therefore a (weakly) superior optimum than firms issuing SLBs.

(Vulturius et al., 2022). To our knowledge, only two other studies empirically analyse SLBs, both of which focus on pricing (Kölbel and Lambillon, 2022; Berrada et al., 2022). Therefore, further empirical investigation on SLBs is called for.

This thesis explores three potential rationales for issuing SLBs. First, companies may issue SLBs to obtain a lower cost of capital (Kölbel and Lambillon, 2022). If investors get additional utility from holding SLBs because of the sustainability component, they may bid up the price of SLBs and be willing to accept lower yields. If the benefit of the yield discount outweighs the potential penalty from failing to achieve the sustainability performance targets (SPTs), issuers may benefit from a lower cost of capital (Kölbel and Lambillon, 2022). Second, companies may issue SLBs to credibly signal their dedication to sustainability (Berrada et al., 2022). Dedication refers to the willingness to give time and energy to sustainability because of the conviction that sustainability is important. Such a signal is useful because companies are better informed about their dedication to sustainability than their investors (e.g., Lyon and Montgomery, 2015). Third, companies may issue SLBs to make a commitment to sustainability targets. A commitment refers to "any action taken in the present that binds an organization to a future course of action" (Sull, 2003). Companies may want to make a commitment to help them focus on the material issues, prioritize tasks and improve sustainability performance.

We start the investigation by shedding light on corporate SLBs through descriptive statistics. In terms of regions, Europe has issued the majority of SLBs, representing 68% of the sample by amount issued. As for industries, SLBs are more prevalent in capital intensive industries such as utilities and materials. Industries with lower capital intensity, such as information technology, are still able to access the SLB market. SLB issuers choose a variety of key performance indicators (KPIs) covering environmental, social and governance (ESG) objectives. The most common KPI category is greenhouse gas (GHG) emissions, with 69% of SLBs including at least one KPI on GHG emissions. To our knowledge, this is the first study to manually compile data on the KPIs that issuers choose.

We then provide empirical evidence on the three potential rationales for issuing corporate SLBs, making use of a unique dataset compiled from Bloomberg, Refinitiv Eikon and Capital IQ. First, we use a matching method to estimate the yield differential at issuance between an SLB and a counterfactual conventional bond. We use exact matching to ensure the issuer, credit rating, bond seniority, currency and maturity type are the same. We then select the nearest neighbour based on the logarithm of the issuance amount and the coupon. Our results suggest that SLBs are issued at a yield that is 15 basis points (bps) lower than conventional bonds on average. The benefit of the yield discount is greater than our crude estimate of the cost of the discounted expected penalty. Therefore, companies may issue SLBs to benefit from a lower cost of capital.

Second, we use an event study method to assess how the stock market reacts to the announcement of SLB issuances. To our knowledge, this is the first study to explore the stock market reaction to the announcement of SLB issuances. We find evidence that the stock market reacts positively. The average cumulative abnormal return (CAR) is 1.07% in an 11-day window around the announcement date. Further, the average CAR is significantly larger for first-time issuers of SLBs. Our findings support the signalling rationale. Therefore, companies may issue SLBs to signal their dedication to sustainability.

Third, we investigate SLB contracts to evaluate whether the incentives to commit to sustainability targets are strong. We find that the financial penalty is small relative to the investments required to achieve the ambitious sustainability performance targets (SPTs). This suggests the financial incentives are weak. However, other incentives, such as reputational damage when failing to achieve the SPTs, may be sufficient to incentivize companies to commit. Therefore, it is unclear whether companies issue SLBs to commit to sustainability targets.

The thesis proceeds as follows. Section 2 reviews the related literature. Section 3 provides background on the SLB market. Section 4 outlines the theoretical framework used. Section 5 describes the data and presents descriptive statistics on SLBs. Section 6 presents the method, results, and robustness of the cost of capital argument. Section 7 presents the method, results, and robustness of the signalling argument. Section 8 presents the method and results of the commitment argument. Section 9 discusses the implications and limitations of our results. Section 10 concludes.

2. Literature review

The academic literature on sustainability-linked bonds (SLBs) is scarce due to the infancy of the SLB market. To our knowledge, only two other studies empirically analyse SLBs, both of which were circulated as working papers in the past six months (Berrada et al., 2022; Kölbel and Lambillon, 2022). To better understand the rationales for issuing SLBs, we explore the broader literature on the sustainable debt market. We focus on green bonds since they are the most researched sustainable debt instrument with the largest amount of available data.

Our thesis is most closely related to two large and growing research areas within the sustainable debt literature. First is the research on the price premium that analyses the pricing of sustainable bonds in comparison to conventional (non-sustainable) bonds (e.g., Baker et al., 2018; Zerbib, 2019; Larcker and Watts, 2020). Second is the research on the stock market reaction to the announcement of sustainable bonds (e.g., Baulkaran, 2019; Wang et al., 2020; Tang and Zhang, 2020; Flammer, 2021). Our thesis also builds on the latest literature on the incentive structure of SLBs (Berrada et al., 2022).

In terms of the price premium of green bonds (the "greenium"), studies find mixed empirical results. This is likely due to methodological design misspecification (Larcker and Watts, 2020). The greenium research primarily focuses on municipal bonds because of their unique institutional features (e.g., Karpf and Mandel, 2017; Baker et al., 2018; Larcker and Watts, 2020). Using a Blinder-Oaxaca decomposition, Karpf and Mandel (2017) find that green bonds are issued at a yield that is 8 basis points (bps) higher than conventional bonds. However, the estimates may be biased since the authors compare taxable and non-taxable securities in their tests (Larcker and Watts, 2020). Using a pooled fixed-effects regression, Baker et al. (2018) find that green bonds are issued at a yield that is 6 bps lower than conventional bonds. This suggests a green bond price premium. However, Baker et al.'s (2018) approach inadequately controls for nonlinearities and issuer-specific time variation, which may lead to spurious inferences (Larcker and Watts, 2020). To avoid these methodological issues, more recent studies use strict matching methods that match each green bond to a quasi-identical conventional bond of the same issuer. Zerbib (2019) finds a small but significant price premium (yield discount) of 2 bps while Larcker and Watts (2020) find a green bond premium of zero. Using a similar matching method on corporate green bonds, Flammer (2021) finds a green bond premium of zero.

As for the price premium of SLBs, Kölbel and Lambillon (2022) are the only authors to investigate it so far. Using the matching method, the authors find that 65% of SLB issuers benefit from a sustainability price premium. In a sample of 102 SLBs, they estimate an average yield discount of 29.2 bps, which is larger than the average coupon step-up of 26.6 bps that issuers pay if they fail to achieve their sustainability performance targets (SPTs). This means that some issuers benefit from a lower cost of capital even if they do not achieve their targets. However, the estimates may be misleading because the dataset includes certain bonds mislabelled as SLBs in Bloomberg's fixed income database (e.g., Beijing Infrastructure Investment Co., Ltd in December 2018). We attempt to avoid this flaw by manually verifying each bond in our dataset to confirm it is an SLB. Also, the authors omit the bond's credit rating as a matching criterion due to insufficient data. This is an important limitation since the credit rating is a proxy for the bond's risk, which directly affects bond yields. We attempt to improve the counterfactual by requiring an exact match in credit rating between the SLB and conventional bond. Using this stricter matching, we find a smaller but significant average yield discount of 15 bps. Our findings therefore contribute to the small literature on the price premium of SLBs.

Regarding the stock market reaction to the announcement of green bond issuances, the literature largely agrees that the stock market reacts positively (Cortellini and Panetta, 2021). Flammer (2021) examines a global sample of 565 corporate green bonds and finds a significant cumulative abnormal return (CAR) of 0.49% in a short event window around the announcement date. The positive reaction is more pronounced for first-time issuers and externally certified green bonds. The findings on green bonds differ to the findings on conventional bonds, which show no significant abnormal returns around the announcement date (Eckbo et al., 2007). Compared to conventional bond announcements, green bond announcements include information on both (i) a bond issuance and (ii) a signal of dedication to sustainability. The positive stock market reaction to green bond issuances is likely due to the signal of the company's dedication to sustainability, rather than the bond issuance itself (Flammer, 2021). These findings are in line with the broader literature that shows that shareholders generally respond positively to environmentally-friendly behaviour (e.g., Flammer, 2013) and corporate social responsibility (e.g., Edmans, 2011; Krueger, 2015). Some earlier studies find negative stock market reactions to green bond announcements when analysing shorter 2-day event windows (e.g., Roslen et al., 2017; Lebelle et al., 2020). However, these estimates may be misleading since the event windows neglect the possibility that some information may have been known to the public prior to the announcement date. We attempt to avoid this flaw by analysing an 11-day event window, in line with the recent literature (e.g., Flammer, 2021; Tang and Zhang, 2020).

To our knowledge, we are the first study to empirically investigate the stock market reaction to the announcement of SLB issuances. Our study therefore fills a gap in the literature on SLBs. We find a significant average CAR of 1.07% in an 11-day window around the announcement date. The average CAR is larger for first-time issuers, consistent with the signalling argument. This suggests that companies may issue SLBs to signal their dedication to sustainability. Our results therefore add to the evidence of a positive association between sustainability and stock market performance (e.g., Klassen and McLaughlin, 1996; Flammer, 2013).

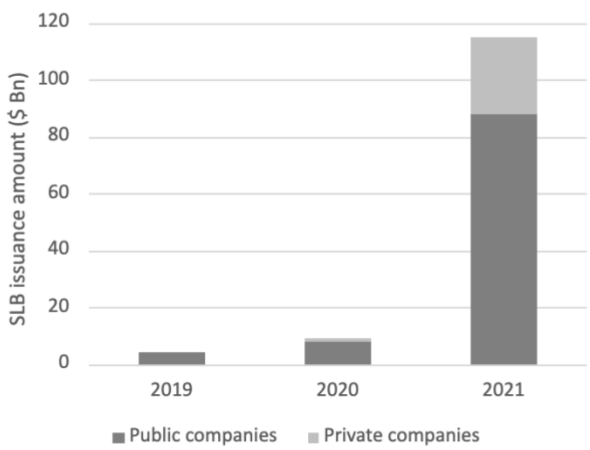
Compared to other sustainable debt instruments, SLBs are unique because of their performance-based structure (sections 3.2. and 3.3.). This structure is intended to incentivise issuers to achieve their sustainability targets. Berrada et al. (2022) develop a conceptual framework to evaluate the incentive structure of SLBs. They show that SLBs are only incentive compatible when the coupon penalty is sufficiently high. We add to this study by showing that the penalties seem small. The most common coupon step-up of 25 bps would imply an 11% increase on the average coupon rate in our sample. The small penalties suggest that SLBs may not be incentive compatible in their current form. However, other incentives, such as reputational damage when failing to achieve the SPTs, may be sufficient to incentivize companies to commit. Therefore, SLBs remain a promising instrument and further research is required to determine whether they are incentive compatible.

3. Background on the sustainability-linked bond market

3.1. Market size and growth

Sustainability-linked bonds (SLBs) are the youngest and fastest-growing instrument of the sustainable debt market (Thygesen et al., 2022). The world's first SLB was issued in September 2019 by Italian utility company Enel. Since then, the corporate SLB market has grown at a rapid and accelerating pace. The total cumulative issuance amount reached over $125 Bn by the end of 2021 (Graph 1). In comparison, the cumulative issuance of green bonds reached $1759 Bn, social bonds $408 Bn and sustainability bonds $337 Bn by the same date (Vulturius et al., 2022). Europe has issued the majority of SLBs, followed by Asia Pacific and North America (Vulturius et al., 2022).

Graph 1. SLB issuance amount by public and private companies.



Source: Bloomberg fixed income database
Note: This graph shows the total SLB issuance amount (in $ Bn) between 2019 –2021

3.2. SLB mechanism

According to the International Capital Markets Association (ICMA), SLBs are "any type of bond instrument for which the financial and/or structural characteristics can vary depending on whether the issuer achieves predefined sustainability/ESG objectives" (ICMA, 2020). Progress on sustainability objectives is measured through key performance indicators (KPIs), which are quantifiable metrics. KPIs may cover environmental, social and governance objectives. Issuers set sustainability performance targets (SPTs) with a predefined timeline associated to each KPI. For example, consider Enel's first SLB issuance in September 2019. The KPI is "renewable installed capacity percentage" (Enel, 2019). The associated SPT is "to achieve, by December

31st, 2021, a percentage of installed renewable generation capacity (on a consolidated basis) equal to or greater than 55% of total consolidated installed capacity" (Enel, 2019).

The ICMA provides voluntary guidelines on the structuring, disclosing and reporting of SLBs in its sustainability-linked bond principles (SLBP) (ICMA, 2020). According to the SLBP, KPIs should be material to the issuer's business and of high strategic significance. To improve credibility, they should be measurable and externally verifiable. In Enel's case, the KPI of renewable installed capacity percentage is material since Enel is in the electric and gas utilities sector. Enel's KPI is also measurable and verifiable, defined as the ratio of the renewable energy installed capacity to total installed capacity. The SLBP states that SPTs should be ambitious and demonstrate a sustainability improvement beyond the "business as usual" trajectory. Further, they should be based on a combination of benchmarks including science-based scenarios and official national or international targets. The SLBP recommends that issuers regularly report on the performance of SPTs and externally verify them by second-party opinions (SPOs). SPOs provide pre-issuance assurance on a bond's alignment with the SLBP. The evaluation of Enel's SPTs was done by the SPO provider Vigeo Eiris. The SPT is assessed to demonstrate an advanced level of ambition, which is the highest category on the scale (Vigeo Eiris, 2020).

A key innovation of SLBs relative to other sustainable debt instruments is their performance-based structure (Vulturius et al., 2022). If the sustainability targets are not achieved, issuers face a financial penalty. Penalty examples include coupon step-ups, increases in the redemption price, charitable donations or carbon offset purchases. The most common penalty is a one-time coupon step-up of 25 basis points (bps) (Kölbel & Lambillon, 2022). In Enel's case, failure to increase the percentage of renewable installed capacity to 55% by 31st December 2021 would lead to a coupon step-up of 25 bps starting from the first interest period subsequent to the publication of the assurance report of the auditor (Enel, 2019). With an initial coupon of 265 bps and a maturity date on 10th September 2024, the coupon-step up implies a 9.4% increase in coupon rate over 2.5 years. When SPTs need to be achieved close to the maturity date of the bond, issuers may choose alternative penalties (Vulturius et al., 2022). For example, Schneider Electric issued an SLB in November 2020 with a target date on 31st December 2025 and a maturity date on 15th June 2026. Failure to achieve its SPTs by the 31st December 2025 would lead to a premium payment amount of 0.50% of the nominal unit value of the bond (Schneider Electric, 2020).

The intention underlying the performance-based structure of SLBs is to incentivize issuers to achieve the sustainability targets (ICMA, 2020). According to contract theory, connecting financial compensation to performance measurements should increase the alignment of interests between agents and principals (Milgrom and Roberts, 1992). We can apply contract theory to the setting of SLBs. Bondholders (principals) may gain additional utility by investing in companies with strong sustainability performance (Baker et al., 2018). However, issuers (agents) may shirk on sustainability performance since it is costly to achieve and difficult to measure. SLBs connect a financial penalty to sustainability performance, increasing the alignment of interests between issuers and bondholders. To further increase the alignment, the SLBP recommend the penalty to be meaningful and commensurate to the bond's original characteristics (ICMA, 2020).

3.3. Comparison of SLBs and green bonds

The performance-based structure of SLBs differs from the use-of-proceeds structure of the more mature green, social and sustainability (GSS) bonds. In the performance-based structure of SLBs, issuers may use the bond for general purposes subject to committing to predefined sustainability targets. By contrast, in the use-of-proceeds structure of GSS bonds, issuers commit to using the proceeds to exclusively finance or re-finance projects that have a positive environmental or social impact (ICMA, 2021). In the case of green bonds, issuers commit to using the proceeds to finance or re-finance eligible green projects.

Green bonds are the most widely used instrument of the sustainable bond market, comprising 67% of the market by the end of 2021 (Vulturius et al., 2022). However, green bonds have been criticized on two main accounts. First is the issue of exclusivity (Coldeweijer and Hsu, 2021). Green bonds may exclude some issuers from participating if they cannot identify sufficient capital expenditures in projects with a positive environmental impact. Second is the risk of greenwashing. Despite issuing a green bond, an issuer could worsen its environmental performance through other projects that are not included in the bond's framework (Caldecott, 2020).

To some extent, SLBs address the criticisms raised against green bonds. First, since the proceeds of SLBs can be used for general purposes, more companies may be able to issue them than green bonds (Coldeweijer and Hsu, 2021). For example, companies in the consumer sector may find it easier to set sustainability KPIs than to find green capital expenditures. Second, SLBs have an embedded incentive scheme. SLBs require issuers to commit to ambitious SPTs that encompass the overall sustainability performance of the company. The SPTs and associated financial penalties may reduce the risk of greenwashing if the incentive scheme is properly designed (Berrada et al., 2022).

However, the incentive scheme of SLBs has been criticised by investors, which suggests that greenwashing is still a risk. First, SPTs can be devised to be easily achievable since the SLBP do not provide definitions on what is considered material or ambitious (Liberatore, 2021). For example, Tesco issued two SLBs in 2021 with an SPT of reducing carbon emissions by 60% by 2025 relative to a 2015 baseline. This target was set as early as in 2017 (Tesco, 2017) and carbon emissions had already been reduced by 37% by 2019 relative to a 2015 baseline (Sustainalytics, 2020). Therefore, the target does not seem particularly ambitious since it does not consist of an improvement beyond the current sustainability strategy. Second, the performance-based penalties may not be steep enough to incentivise issuers to prioritize SPTs (Liberatore, 2021). Though the most common coupon step-up is 25 bps, 75% of respondents in a survey of 170 investors believe this is not high enough (ELFA, 2021). Occasionally, coupon step-ups are less than 25 bps. For example, Level 3 Financing issued an SLB in 2021 with a coupon of 375 bps and a coupon step-up of 12.5 bps (Lewis, 2021). This represents merely 3% of the initial coupon rate. Also, though some step-ups may seem large at first glance, they must be considered relative to the SPT target date and maturity. For example, UltraTech Cement issued a 10-year SLB with a coupon of 280 bps and a seemingly large coupon step-up of 75 bps (Iyer, 2021). However, the SPT target date is just 6 months before maturity making the effect of the step-up negligible since it will only apply on one coupon payment. Third, a large share of SLBs have a callable feature. If the bond is redeemed before the SPT target date, an issuer may avoid the financial penalty (ELFA, 2021). Though the incentive scheme of SLBs has been criticized by investors, the ingenuity of the scheme is promising enough to merit further investigation.

4. Theoretical framework

4.1. Asset pricing model with non-pecuniary preferences

The first potential rationale for issuing sustainability-linked bonds (SLBs) is to obtain a lower cost of capital. If investors get additional utility from holding SLBs because of the sustainability component, they may bid up the price of SLBs and be willing to accept lower yields. If the pricing premium is higher than the penalty paid when issuers fail to achieve their sustainability performance targets (SPTs), issuers benefit from a lower cost of capital.

To better understand the cost of capital argument, we consider the standard asset pricing model with non-pecuniary preferences (e.g., Angel and Rivoli, 1997; Fama and French, 2007). We use Baker et al. (2018)'s model on green bonds and apply it to the SLB setting. The key assumption is that there are two groups of investors, one with a sustainability preference and the other without. Both groups face a one-period portfolio choice problem and choose a vector of portfolio weights *w* of every security. They have a common risk aversion parameter γ, common expectations for returns *r* and risk $\sum$. Both groups are mean-variance maximisers, but only Group 2 cares about sustainability performance. This means that Group 2 gains additional utility from holding securities with positive sustainability performance $s > 0$. We assume that the average *s* is zero. The two groups maximize their objective function U given by,

$$Group\ 1: \max_{w'_1} \mathrm{U}_1 = \boldsymbol{w'}_1 \boldsymbol{r} - \frac{\gamma}{2} \boldsymbol{w'}_1 \sum \boldsymbol{w}_1 \quad (1)$$

$$Group\ 2: \max_{w'_2} \mathrm{U}_2 = \boldsymbol{w'}_2 \boldsymbol{r} + \boldsymbol{w'}_2 \boldsymbol{s} - \frac{\gamma}{2} \boldsymbol{w'}_2 \sum \boldsymbol{w}_2 \quad (2)$$

The two groups clear the market using their available capital α_1 and α_2,

$$\frac{\alpha_1}{\alpha_1+\alpha_2} \boldsymbol{w_1} + \frac{\alpha_2}{\alpha_1+\alpha_2} \boldsymbol{w_2} = \boldsymbol{w_m} \quad (3)$$

where w_m is a vector of the market portfolio weights. We derive the two groups' optimal portfolio weights,

$$\boldsymbol{w}_1 = \frac{1}{\gamma} \Sigma^{-1} \boldsymbol{r} \quad (4)$$

$$\boldsymbol{w}_2 = \frac{1}{\gamma} \Sigma^{-1} (\boldsymbol{r} + \boldsymbol{s}) \quad (5)$$

Since the average s is zero, we substitute the market Sharpe ratio σ_m^2 for the inverse of risk aversion γ. Solving gives an adjusted capital asset pricing model (CAPM) equation,

$$\boldsymbol{r} = \frac{r_m}{\sigma_m^2} \sum \boldsymbol{w}_m = \boldsymbol{\beta} r_m - \frac{\alpha_2}{\alpha_1 + \alpha_2} \boldsymbol{s} \quad (6)$$

Equation (6) shows that securities with positive sustainability scores (such as SLBs) have lower expected returns. This is because investors with non-pecuniary preferences for a security will bid up their price. The standard asset pricing model with non-pecuniary preferences predicts that SLBs will be issued at a at a price premium. This price premium implies a yield discount. The yield discount can be shown in the bond pricing equation,

$$Bond\ price = \frac{coupon_1}{(1+YTM)^1} + \frac{coupon_2}{(1+YTM)^2} + \cdots + \frac{coupon_n}{(1+YTM)^n} + \frac{face\ value}{(1+YTM)^n} \quad (7)$$

where YTM is the yield to maturity. Ceteris paribus, the YTM decreases if the bond price increases.

Prediction 1: SLBs are issued at a yield discount.

The predicted yield discount in the asset pricing model does not account for the potential penalty an issuer faces if it fails to achieve its SPTs. As a result of the potential penalty, the bond's YTM may increase. Therefore, the predicted yield discount may be an overestimate of the real yield discount (Berrada et al., 2022). Ex ante, it is unclear whether SLB issuers benefit from a lower cost of capital. Given that the penalty occurs several years after issuance, and it occurs only with a probability of failing to achieve the SPTs, it is likely that the benefit of the yield discount is larger than the discounted expected penalty on average (Kölbel and Lambillon, 2022). Therefore, SLB issuers may benefit from a lower cost of capital.

4.2. Signalling

The second potential rationale for issuing SLBs is to signal dedication to sustainability (Berrada et al., 2022). Dedication refers to the willingness to give time and energy to sustainability because of the conviction that sustainability is important. Companies are better informed about their dedication to sustainability than their investors (e.g., Lyon and Montgomery, 2015) because the dedication is unobservable. This information asymmetry creates a transaction cost since it is difficult for investors to differentiate companies that are dedicated to sustainability from those that are not. Recent studies find that investors have a preference for sustainability (e.g., Ilhan et al., 2021, Dyck et al., 2019). Therefore, companies should reduce the information asymmetry by sending investors credible signals of their dedication (Akerlof, 1970; Williamson, 1985). One such signal is to issue an SLB since the bond reveals the company's dedication to certain sustainability targets (Berrada et al., 2022).

For the signal to be credible, it must be costly to mimic by companies that are not dedicated to sustainability (Spence, 1973). Issuing an SLB is likely a credible signal for two main reasons. First, SLB issuers pay a financial penalty if they do not achieve their SPTs. The expected penalty is likely larger for non-dedicated companies because they have a higher probability of failing to achieve their targets. For example, non-dedicated companies may lack the ability or motivation needed to achieve their targets. Second, the cost of an SLB includes the cost of effort paid to increase the probability of achieving the targets (Berrada et al., 2022). The effort may include infrastructure costs, establishing an SLB framework, and regularly measuring and reporting on KPIs. The cost of effort is likely higher for non-dedicated companies since they do not derive additional utility from sustainability improvements (Berrada et al., 2022).

The signalling argument can be empirically tested by analysing the stock market reaction to the announcement of SLB issuances (Flammer, 2021). If issuing SLBs credibly signals dedication to sustainability, the stock market should react positively to the announcement of SLB issuances.

Prediction 2: The stock market reacts positively to the announcement of SLB issuances.

Further, the first time a company announces an SLB issuance, it conveys new information to the market. Subsequent announcements may be less informative to investors since companies often use the same KPIs and SPTs for several SLBs. Therefore, the signal is likely stronger for first-time issuers. In line with the findings on green bonds (e.g., Flammer, 2021), the stock market should have a stronger positive reaction for first-time issuers.

Prediction 3: The positive stock market reaction is stronger for first-time issuers of SLBs.

4.3. Commitment

The third potential rationale for issuing SLBs is to make a commitment to sustainability targets. A commitment refers to "any action taken in the present that binds an organization to a future course of action" (Sull, 2003). An action becomes a commitment if it limits a company's future options such that the action is costly to reverse. An SLB can be viewed as a commitment because it is a written contract between an issuer and its bondholders. The contract defines certain sustainability performance targets (SPTs) and the timeline in which these must be achieved. The performance-based structure of the contract limits the issuer's future options as the issuer faces a predefined penalty if the targets are not achieved. Further, the issuer may face reputational damage if they fail to achieve the SPTs (Kölbel and Lambillon, 2022).

Companies may make a commitment through an SLB to increase the probability that they achieve their sustainability targets. A commitment increases this probability in two ways (Sull, 2003). First, managers may gain a clearer sense of focus and may better prioritize tasks. For example, if the annual key performance indicator (KPI) reporting shows that the company is lagging behind the target, it is more difficult for managers to ignore the problem due to the fear of paying the penalty. Managers may act more quickly to ensure the company is on track to achieve the targets. Second, employees may gain a motivational boost from the clarity of the target. In particular, the target date may create a sense of urgency and help employees work efficiently.

Increasing the probability of achieving sustainability targets is beneficial as sustainability may be valuable to firms in the long run (Tang and Zhang, 2020). For example, ESG improvements may improve financial performance (e.g., Klassen and McLaughlin, 1996; Edmans, 2011), organisational processes (e.g., Eccles, Ioannou and Serafeim, 2014) and risk management (e.g., Giese et al., 2019). Also, some companies may have an intrinsic preference for sustainability and may gain utility by improving sustainability performance.

If companies issue SLBs to commit to sustainability targets, we expect them to structure the SLBs with strong incentives to achieve the targets. The incentives are strong if the discounted ‘expected penalty saving’ is higher than the cost of the sustainability investments required to achieve the SPTs (Berrada et al., 2022).

Prediction 4: Companies choose high penalties when issuing SLBs to have strong incentives to achieve the SPTs.

5. **Data**

5.1. Data sources and manipulation

We compile a unique dataset of sustainability-linked bonds (SLBs) that aggregates data at the bond level for the period September 1, 2019 to March 12, 2022. The data come from three official sources: Bloomberg, Refinitiv Eikon and S&P Capital IQ.

The main data source is Bloomberg's fixed income database, from which we extract data on all available corporate SLBs. For each bond Bloomberg provides information on the issuer name, announcement date, issuance date, issuance amount, yield at issuance, currency, maturity, coupon, credit rating and issuer's country of domicile. We restrict the sample to the SLBs issued by public companies. If the SLB is issued by a subsidiary that is privately owned, but the parent company of the subsidiary is publicly owned, we classify the issuer as a public company. We notice there are some labelling errors in the data. For example, there are a number of sustainability-linked loans and sustainability-linked Schuldscheine mislabelled as SLBs. Also, though the world's first SLB was issued by the utility company Enel in September 2019 (Vulturius et al., 2022), Bloomberg indicates that Beijing Infrastructure Investment Corporation Limited issued an SLB in December 2018. We manually verify that each bond is an SLB by looking through company press releases and credible news sources. We drop any errors in the data. The restrictions result in a sample of 202 SLBs issued by 123 unique public companies.

The second data source is Thomson Reuters' Refinitiv Eikon database. Similar to Bloomberg, Refinitiv Eikon provides detailed information at the bond level. We use it to complete our dataset where Bloomberg has missing values on SLB characteristics such as yield at issuance and credit ratings.

The third data source is S&P Capital IQ which provides daily stock market data. We extract the stock prices of all the issuers in our sample between July 2, 2018 and April 8, 2022, excluding weekends. We also extract the prices of the leading stock market indices from the countries in which the issuers are listed between the same dates.

To explore the variations in SLB contracts, we manually compile data on the key performance indicators (KPIs), sustainability performance targets (SPTs) and penalties of the SLBs in our sample. We retrieve the data from company press releases, bond prospectuses, second-party opinions, and credible news sources. We assign each KPI to a KPI category. We choose narrow categories to be as informative as possible on companies' sustainability objectives. Unfortunately, the data is not always publicly disclosed. There is missing KPI information for 8 bonds and missing penalty information for 28 bonds.

5.2. Descriptive statistics on corporate SLBs

To shed light on the regions and industries that issue SLBs, we provide descriptive statistics on our sample. Table 1 provides a breakdown of SLBs by region. Europe has issued the majority of SLBs, representing 68% of the sample by amount issued. Within Europe, the Netherlands, France and Luxembourg are the largest issuers.

Table 1. SLBs across regions.

Region	# SLBs (% of sample)	Amount issued ($ Bn) (% of sample)
Europe	121	74
	(60%)	(68%)
Asia Pacific	45	15
	(22%)	(14%)
North America	25	15
	(12%)	(13%)
South America	8	5
	(4%)	(5%)
Africa	3	1
	(1%)	(1%)
Total	202	109

Note: This table reports the number of SLBs and total amount issued (in $ Bn) by region. Our sample includes all corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022.

Table 2 shows a breakdown of SLBs by industry. We map the issuers' BICS (Bloomberg Industry Classification System) to the Global Industry Classification Standard (GICS), which is a common standard used by market participants globally. Utilities has issued the largest amount of SLBs, representing 27% of the sample by amount issued. Industries with lower capital intensity, such as information technology, are still able to access the SLB market. This is likely an improvement over the green bond market, which is more exclusive to those industries with large capital expenditures (Coldeweijer and Hsu, 2021).

Table 2. SLBs across industries.

Industries	# SLBs (% of sample)	Amount issued ($ Bn) (% of sample)
Utilities	43 (21%)	30 (27%)
Materials	31 (15%)	14 (13%)
Industrials	27 (13%)	11 (10%)
Consumer Staples	24 (12%)	13 (12%)
Consumer Discretionary	22 (11%)	14 (13%)
Real Estate	17 (8%)	6 (5%)
Financials	12 (6%)	5 (4%)
Information Technology	9 (4%)	4 (3%)
Health Care	7 (3%)	6 (6%)
Energy	6 (3%)	3 (3%)
Communication Services	4 (2%)	3 (3%)
Total	202	109

Note: This table reports the number of SLBs and total amount issued (in $ Bn) by industry. Industries are defined according to the Global Industry Classification Standard (GICS). Our sample includes all corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022.

Table 3 shows the variety of KPIs chosen by SLB issuers. There are 328 KPIs for the 202 SLBs in our sample, implying that the average SLB has 1.6 KPIs. Though SLBs may cover environmental, social and governance KPIs, the majority relate to the environment. The most common KPI category is greenhouse gas (GHG) emissions, with 69% of SLBs including at least one KPI on GHG emissions. GHG emissions are measurable, verifiable and can be benchmarked to science-based targets, which may make them easier to set in line with the sustainability-linked bond principles (SLBP). 63% of KPIs in the GHG category relate to scope 1 and 2 emissions, either in absolute or intensity terms (appendix table A1). An example is scope 1 and 2 GHG emissions intensity (in tonnes of CO2 equivalent per unit of production). Only 28% of KPIs in the GHG category include scope 3 emissions which is concerning given that scope 3 emissions often make up the largest portion of a company's carbon footprint (Chang et al., 2018). In terms of social and governance objectives, KPIs range from patient reach, to reduction in accident frequency, and greater diversity among employees. A more detailed description of the KPIs included in each category is provided in the appendix (appendix table A1). The variety of KPIs highlights the flexibility of SLB contracts.

Table 3. KPIs chosen by SLB issuers.

	# KPIs	Share of SLBs with KPI (%)
Greenhouse gas emissions	177	69%
Renewable energy	39	18%
Recycling	21	10%
Sustainability certification	21	8%
Diversity	15	6%
Healthcare access	12	3%
Biodiversity	8	3%
Energy efficiency	7	3%
Sustainable cities	6	3%
Water consumption	5	2%
Wastewater management	4	2%
Food waste	3	1%
Labour safety	2	1%
Missing information	8	4%
Total	328	n.m.

Note: This table reports descriptive statistics on the number of KPIs in each category and the share of SLBs with each KPI. Our sample includes all corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022.

6. Yield discount of sustainability-linked bonds

6.1. Matching method

An econometric challenge in studying the pricing difference between sustainability-linked bonds (SLBs) and conventional bonds is selection bias in the construction of an SLB sample. Ideally researchers want a setting in which companies randomly issue SLBs, but this is impossible to find in reality. Instead, we follow the literature in using a matching method. The paper closest to ours in terms of method is Kölbel and Lambillon (2022). The matching method matches each SLB to a similar conventional bond from the same issuer. The aim is to isolate the effect of the sustainability-linked label on the yield at issuance. Thus, the bond characteristics that affect the yield at issuance must be as similar as possible for both bonds in the pair. The main advantage of the matching method is that it provides a good counterfactual bond. The counterfactual effectively controls for confounding factors that could otherwise lead to spurious inferences (Larcker and Watts, 2020). We follow three main steps in the matching method.

First, we create a dataset of the SLBs and conventional bonds issued by SLB issuers. For each SLB issuer, we extract all available conventional bonds issued between January 1, 2010 and March 22, 2022 from Bloomberg's fixed income database. Bloomberg's database has some missing values on yield at issue and credit rating which we complete using Refinitiv Eikon's database. We then remove any remaining observations with missing values on yield at issue and credit rating. We also remove any issuers that have only issued SLBs but no conventional bonds. This gives us a sample of 590 bonds, of which 117 are SLBs, issued by 73 unique issuers.

Second, we match each SLB to a similar conventional bond issued by the same issuer. To determine the matching criteria, we use a combination of theory and prior literature. A large difference in liquidity can have a significant effect on the yield (Zerbib, 2019). As a liquidity control, we require the conventional bond to have been issued within 5 years of the SLB. This is in line with other studies that allow 5 years (Kölbel and Lambillon, 2022) or 6 years (Zerbib, 2019). To limit the maturity bias, we limit the maturity difference between the conventional bond and SLB to 3 years, in line with Kölbel and Lambillon (2022). These two restrictions result in a sample of 314 bonds. We then use exact matching to ensure the issuer, credit rating, bond seniority, currency, and maturity type[2] are the same. We control for credit rating and bond seniority since this reflects the riskiness of the bond. We control for maturity type given the important pricing effects related to call options (Larcker and Watts, 2020). After exact matching, we pick the nearest neighbour using the Mahalanobis distance based on the log(issuance amount) and coupon. We restrict the log(issuance amount) as a further liquidity control and we restrict the coupon as this directly affects the yield. We match without replacement, allowing each SLB to be matched with only one conventional bond.

To find the optimal matching specification we assess covariate balance and remaining sample size after matching. Assessing balance involves verifying that the distributions of the covariates of the SLBs and conventional bonds are similar. A higher covariate balance reduces the sensitivity to model misspecification and ensures the estimated effect is close to the true effect. However, a higher balance comes at the cost of a smaller sample size. The matching specification should attempt to come as close as possible to perfect balance (Ho et al., 2007) while maintaining an acceptable sample size. We assess balance based on the standardized mean difference (SMD) in the means of each covariate, the variance ratio and the average distance between the empirical cumulative distribution function (eCDF) of the covariates across the groups. An absolute SMD close to 0 indicates good balance and a common recommendation is a threshold of 0.1 for prognostically important covariates (Greifer, 2022). A variance ratio close to 1 indicates good balance and a ratio between 0.5 and 2 is generally acceptable. An eCDF mean closer to 0 indicates better balance. We also compute the SMD, variance ratio and eCDF on the square of each covariate and their interaction. To improve balance, we include a caliper that imposes a maximum distance allowed in the matching. We set the caliper equal to 0.5 for the coupon and 0.8 for the log(issuance amount) so that the maximum absolute SMD is below 0.1. The final sample consists of 104 bonds, or 52 matched pairs.

Table 4 reports descriptive statistics on the balance in the full sample compared to the balance in the matched sample. There is a clear improvement in balance after matching. Absolute SMDs are below 0.1 (column 2), variance ratios are close to 1 (column 4) and eCDF statistics are close to zero (column 6). The largest absolute SMD after matching is 0.096 for the covariate *Coupon*. The improved balance is visually depicted in the eQQ plots which show the covariate distributions for the entire sample and the matched sample (appendix Graph A1). Taken

[2] Maturity type provides information on whether the bond is callable, putable, convertible, sinkable or redeemed at maturity.

together, the descriptive statistics suggest balance in the matched sample and support the Mahalanobis specification combined with exact matching.

Table 4. Balance assessment.

	SMD		Variance Ratio		eCDF Mean	
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Matched	All	Matched	All	Matched
Log(amount issued)	0.447	0.044	0.670	1.106	0.109	0.037
Coupon	-0.159	-0.098	0.836	0.937	0.052	0.034
Log(amt. issued)^2	0.441	0.048	0.707	1.111	0.109	0.037
Coupon^2	-0.180	-0.084	0.722	0.774	0.052	0.034
Log(amt. issued)*cpn	-0.139	-0.093	0.848	0.950	0.045	0.032
Obs.	314	104	314	104	314	104

Note: This table reports descriptive statistics on the balance in the full sample ("all") compared to the balance in the matched sample ("matched"). SMD is the standardized mean difference in the means of the covariates in the treated group versus the control group. An absolute SMD close to 0 indicates good balance. The variance ratio is the ratio of the variance of the treated group to that of the control group. A variance ratio close to 1 indicates good balance. The eCDF mean is the mean difference in the overall distribution of the covariates between the treatment groups. An eCDF mean close to 0 indicates good balance.

Third, we carry out a hypothesis test on the matched sample and interpret the results. The null hypothesis is that there is no difference between the mean yield at issuance of SLBs compared to conventional bonds. We perform a standard paired two-sided t-test,

$$t_1 = \frac{\frac{1}{N}\sum_{i=1}^{N}(Y_i^{SLB} - Y_i^{C})}{s_e} \tag{8}$$

where N is the number of matched pairs in the sample, Y_i^{SLB} is the yield at issuance of the SLB, Y_i^C is the yield at issuance of the matched conventional bond and s_e is the standard error for the mean difference in yields. The standard paired t-test assumes the difference in yields is normally distributed. The Shapiro-Wilk normality test is insignificant (p = 0.429), suggesting the normality assumption is met. We also perform a nonparametric Wilcoxon test to test the difference in medians between SLB and conventional bond yields.

Our matched sample seems representative of the full sample of SLBs issued by public companies (appendix Table A2). First, the matched sample covers 26% of the total number of SLBs and 29% of the total SLB market volume. Second, the average issuance amount is similar suggesting that the issuers in the matched sample raise a similar amount of funds to the full sample. Third, the matched sample includes observations from all the industries represented in the full sample. However, the matched sample overrepresents SLBs issued by companies in

North America and Asia-Pacific and underrepresents those issued by companies in Europe, South America and Africa. Given the country of domicile may affect investors' interests in SLBs and hence the yield discount, the difference in regional representation may affect the interpretation of our results.

6.2. Matching method results

Table 5 reports estimates of the mean and median yield at issuance of SLBs compared to matched conventional bonds of the same issuer. The sample consists of 52 matched pairs. The mean SLB yield is 15 basis points (bps) lower than the mean conventional bond yield. The difference in mean is statistically significant at the 5% level. The difference in median is -2 bps and is statistically significant at the 10% level. The result suggests that SLBs are issued at a yield discount compared to conventional bonds.

Table 5. Is there a sustainability premium for SLBs?

	Yield at issuance (%)	
	Mean	Median
SLB	2.028	2.122
Matched conventional bond (CB)	2.177	2.140
Difference (SLB – CB)	-0.149**	-0.018*
p-value (difference)	0.025	0.051
Matched pairs	52	52

Note: This table reports estimates of the mean and median yield at issuance of SLBs and matched conventional bonds. The sample consists of 52 matched pairs. For each matched pair, the difference in mean (median) is tested using a standard paired two-sided t-test (Wilcoxon test). *** p<0.01, ** p<0.05, * p<0.1

Though SLBs are issued at a yield discount compared to conventional bonds, this may not translate into a lower cost of capital for SLB issuers. The performance-based structure of SLBs means that bond characteristics, such as the coupon, may change before the bonds matures. If issuers achieve their SPTs, they will benefit from a lower cost of capital. However, if issuers fail to achieve their SPTs and the penalty is enforced, they may face an increased cost of capital. It is therefore possible that the yield discount we find is an overestimate (Berrada et al., 2022).

A recent study suggests that some issuers that fail to achieve their SPTs also benefit from a lower cost of capital because the penalty is lower than the sustainability premium on average (Kölbel and Lambillon, 2022). To gain a better understanding of the effect of the penalty on the yield to maturity (YTM), we make a crude IRR estimation (appendix Table A3). We consider an SLB with the same characteristics as the average SLB in our sample, with a target date of 4 years, maturity of 8 years, annual coupon rate of 2.35% and coupon step-up of 25 bps. We assume the bond is priced at par, with a face value of $100, and that coupons are paid on an annual basis. If the issuer achieves its SPTs, the YTM is 2.35% since the bond is bought at par. If the issuer fails to achieve its SPTs and pays the coupon step-up until maturity, the YTM increases to 2.47%. Therefore, the increase in the YTM from failing to achieve the SPTs is 12 bps. The mean yield discount of 15 bps is larger than the average increase in yield of 12 bps caused by the financial penalty, suggesting a lower cost of debt of 3 bps on average.

Though the 3 bps difference seems small, our corrected yield is an upper bound as we assume the step-up is paid for sure. In reality this happens with some probability, which is priced in the yield. To get a finer estimate of the "true" YTM, we would need to estimate the probability that the company fails to achieve its SPTs and the length of time the penalty applies for. Estimating the probability requires more data and is beyond the scope of this thesis.

In addition to the penalty seeming lower than the sustainability premium on average, some issuers may avoid the penalty altogether. 64% of the SLBs in our sample are callable. If the target date falls after the end of the non-call period, an issuer can redeem the bond before the target date and avoid the penalty (ELFA, 2021). Issuers of callable SLBs can therefore benefit from a lower cost of capital regardless of whether they achieve their SPTs.

6.3. Matching method robustness

The quality of the matching method depends on the balance and sample size achieved in the matching specification. However, it is a subjective judgement whether the balance and sample size are reasonable. As shown in Table 6, we perform two robustness tests to assess the sensitivity of our results to alternative specifications.

First, we create a sample with a stricter limit on the maturity difference to improve the balance (Panel A). In our baseline method we allow for a difference in maturity of 3 years, in line with Kölbel and Lambillon (2022). This maturity difference is more lenient than studies on green bonds that allow 1 or 2 years (e.g., Zerbib, 2019). We test the sensitivity of our results to a stricter maturity constraint of 2 years. The other restrictions in the baseline method apply. This results in a more balanced but smaller sample of 43 matched pairs. Column (1) shows that the estimate of the difference in means has a similar magnitude to the baseline results, with significance at the 5% level. Column (2) shows an insignificant estimate which suggests there is no difference in medians. However, given the small sample size, we may not have sufficient power to detect a sustainability premium, even if it exists.

Second, we create a sample with less strict criteria to increase the number of matched bonds (Panel B). Rather than restricting the maturity difference to 3 years, we control for the maturity difference by finding the nearest neighbour using the Mahalanobis distance, in line with Flammer (2021). We adjust the caliper to 0.8 on all covariates such that the largest absolute covariate SMD is below the 0.1 threshold. The other restrictions in the baseline method apply. This results in a larger but slightly less balanced sample of 67 matched pairs. Column (3) shows that the estimate for the difference in means has a similar magnitude to the baseline results, with significance at the 5% level. Column (4) shows an insignificant estimate which suggests there is no difference in medians. However, the absolute SMD on Coupon^2 is 0.1 which suggests there may be imbalance. Imbalance may cause biased estimates as there is often a high correlation between the mean or maximum absolute SMD and the extent of bias (Greifer, 2022).

Table 6. Matching method robustness tests.

	Panel A Yield at issuance (%)		Panel B Yield at issuance (%)	
	Mean (1)	Median (2)	Mean (3)	Median (4)
SLB	1.845	1.109	2.143	2.472
Matched CB	1.986	1.701	2.255	2.346
Difference (SLB - CB)	-0.141*	-0.592	-0.112*	0.126
p-value (difference)	0.074	0.119	0.098	0.183
Matched pairs	43	43	67	67

Note: This table reports two robustness tests. Panel A restricts the difference in maturity to 2 years, instead of 3 years. Panel B controls for the maturity difference by finding the nearest neighbour using the Mahalanobis distance. For each matched pair, the difference in mean (median) is tested using a standard paired two-sided t-test (Wilcoxon test). *** p<0.01, ** p<0.05, * p<0.1

7. Stock market reaction to the announcement of sustainability-linked bond issuances

7.1. Event study method

To investigate how the stock market reacts to the announcement of corporate sustainability-linked bond (SLB) issuances, we use a short-run event study method. Our method is closest to the one used by Flammer (2021), who studies the announcement effects of green bonds. An event study is an empirical analysis used to investigate the stock market reaction to a specific event. Event studies combine two attractive features. First, event studies use a difference-in-differences- like identification which helps estimate the effect of the event when the event is not randomized. Second, event studies summarize the impact of an event into one statistic. Given that the market capitalization represents the net present value (NPV) of future cash flows to equity, changes in the market capitalization reflect the NPV of gains or losses due to the event.

To run the event study, we first make some adjustments to our sample. Occasionally, a given company announces several SLBs on a given day. To avoid double-counting, we restrict our sample to SLBs announced on unique issuer-days. Issuer-days refers to the number of unique days on which a given firm announces SLB issuances, summed across all firms (Flammer, 2021). One company, Simpar S. A., only became public on 18th September 2020 and does not have sufficient trading days prior to the announcement date of the SLB. We therefore cannot estimate the "normal" returns and drop the 2 SLBs it has issued from the sample. The restrictions result in a sample of 158 SLBs issued by 122 unique companies. Our sample is representative of the full sample of public SLBs (appendix Table A2).

In line with Ball and Brown (1968) and Fama et al. (1969), we follow four main steps in the event study. First, we define the event day (t0) as the date on which a company announces the issuance of an SLB. The announcement date is the relevant date, as opposed to the issuance date, since it represents the day on which the SLB information is released to the market. Unfortunately, Bloomberg's data on the announcement date contains some errors. Therefore, we manually compile the announcement dates by searching through company press releases, investor relations materials and reliable financial news sources. To increase reliability, we cross-check the publicly available data we find with Bloomberg's data. The dates are consistent for the large majority of SLBs. When the date of the publicly available data is not the same as Bloomberg's, we choose the publicly available date if it is from a reliable source and published before the issuance date of the bond. If we do not find a source fulfilling these criteria, we use the announcement date from Bloomberg.

Second, we specify the market model as the model characterizing "normal" returns. The "normal" return is the return that would be expected had the event not taken place (Campbell et al., 1997). The market model predicts R_{it}, the return of company *i* on day *t*, based on its correlation with R_{Mt}, the actual market return on day t,

$$R_{it} = \alpha_i + \beta_i * R_{Mt} + \varepsilon_{it} \tag{9}$$

where $E[\varepsilon_{it}] = 0$. We use country-specific market returns by taking the leading stock market index from the country in which the company is listed. We estimate the coefficients α_i and β_i using ordinary least squares (OLS) in the estimation window. As per Flammer (2021), the estimation window corresponds to 200 trading days before the first event window, [-220, -21]. The window is out of sample to prevent the event from affecting the parameter estimates of the market model.

Third, we calculate and aggregate the abnormal daily returns during the event window. The event window of interest is the 11-day window ranging from five days before to five days after the event, [-5, 5]. In line with Krueger (2015), we include five days prior to the event to account for the risk of information leakage and five days following the event to account for a staggered effect. To confirm the results are not driven by unrelated trends around the event date, we also consider the event windows [-20, -11], [-10, -6], [6, 10], [11, 20]. The abnormal daily return AR_{it} of company *i* on day *t* is calculated as,

$$\widehat{AR_{it}} = R_{it} - \hat{R}_{it} \tag{10}$$

To aggregate the abnormal daily returns through time, we calculate the cumulative abnormal return (CAR). The CAR is based on arithmetic compounding and assumes daily rebalancing. For each company *i*, the CAR is calculated as the sum of abnormal returns for each day within the event window,

$$\widehat{CAR}_i(t_1, t_2) = \sum_{t_1}^{t_2} \widehat{AR_{it}} \tag{11}$$

To obtain the mean effect across companies, we calculate the average cumulative abnormal return $\overline{CAR}(t_1, t_2)$,

$$\overline{CAR}(t_1, t_2) = \frac{1}{N} \sum_{i=1}^{n} \widehat{CAR_i(t_1}, t_2) \tag{12}$$

To estimate the variance $\widehat{Var}[\,\overline{CAR}(t_1, t_2)]$, we use the cross section of cumulative abnormal returns,

$$\widehat{Var}[\ \overline{CAR}(t_1, t_2)] = \frac{1}{N^2} \sum_{i=1}^{n} (\widehat{CAR_i(t_1}, t_2) - \overline{CAR}(t_1, t_2))^2 \quad (13)$$

An important assumption for the variances to be consistent is that the abnormal returns are uncorrelated in the cross-section (Campbell et al., 1997). This assumption is valid when the event day is not common to the companies. Even when the event day is common, if the companies are not from the same industry, the market model reduces the inter-correlations to zero (Brown and Warner, 1982). Using country-specific market indices further reduces inter-correlations. In our sample, we have no instances of two firms from the same industry and country with the same event day. Therefore, we assume that the abnormal returns are uncorrelated in the cross-section.

Fourth, we carry out a hypothesis test and interpret the results. The null hypothesis is that the average CAR is zero. Using large sample theory, the average CAR follows the normal distribution,

$$\overline{CAR}(t_1, t_2) \sim N[0, var(\overline{CAR}(t_1, t_2)] \quad (14)$$

The two-tailed t-test statistic is defined as,

$$\theta_1 = \frac{\overline{CAR}(t_1,t_2)}{\widehat{Var}[\ \overline{CAR}(t_1,t_2)]^{\frac{1}{2}}} \quad (15)$$

We make three important assumptions in the event study. First, the model for the "normal" returns is well-specified. Had the event not taken place, the stock return of a company should be close to the "normal" return. To support the case for this assumption, we carry out two robustness tests using alternative models to estimate the "normal" returns: the Fama-French 3-factor model (Fama and French, 1993) and the market model with the global market index (section 7.3., Table 9). Second, relevant information on the event is not transmitted into the stock price before the event window. To account for the risk of information leakage, we include five days prior to the announcement date. To support the case for this assumption, we carry out two robustness tests with longer and shorter event windows (section 7.3., Table 9). Third, market efficiency ensures that relevant information is instantaneously transmitted to the stock price after the event. It is difficult to guarantee that the three assumptions are simultaneously correct. Therefore, we follow best practice in the literature when choosing the length of the event window (e.g., Krueger, 2015; Flammer, 2021).

7.2. Event study results

Table 7 reports estimates of the average cumulative abnormal return (CAR) with the corresponding standard error for different event windows. The average CAR in the event window [-5, 5] is 1.07% and is statistically significant at the 5% level. The average CAR is insignificant across the remaining event windows, suggesting our findings are not driven by coincidental events around the announcement date. The estimates in Table 7 suggest that the stock market reacts positively to the announcement of SLB issuances.

Table 7. Stock market reaction to the announcement of SLB issuances.

Event window	CAR (%)	Std. err. (%)
[-20, -11]	0.528	0.545
[-10, -6]	-0.222	0.356
[-5, 5]	1.067**	0.537
[6, 10]	0.150	0.352
[11, 20]	-0.778	0.517
Obs.	158	158

Note: This table reports the average CAR as a percentage for different event windows around the SLB announcement date. The sample consists of 158 issuer-day observations. *** p<0.01, ** p<0.05, * p<0.1

Table 8 reports estimates of the average CAR for first-time issuers of SLBs compared to subsequent issuers. The results suggest that first-time issuers have a large and significant average CAR (1.45%), but subsequent issuers have an insignificant average CAR (-0.21%). We test the difference in average CARs using a standard two-sided t-test and find that the difference is significant at the 10% level (p = 0.092). The t-test requires normal distribution of the data. We assume normality as the sample size is larger than 30, which is sufficient for the central limit theorem to hold. The results support the signalling argument because a first-time issuance conveys new information to the market about the company's dedication to sustainability.

Table 8. Stock market reaction to the announcement of SLBs for first-time issuers compared to subsequent issuers.

	Obs.	CAR (%)	Std. err. (%)
1. First-time issuers [-5, 5]	122	1.445**	0.659
2. Subsequent issuers [-5, 5]	36	-0.214	0.706

Note: This table reports the average CAR for first-time issuers (row 1) and subsequent issuers (row 2) in the event window [-5, 5].
*** p<0.01, ** p<0.05, * p<0.1

7.3. Event study robustness

Table 9 shows four robustness tests that verify the plausibility of assumptions made in the event study. First, our event window of five days before and after the announcement date accounts for the possibility of information leakage and a staggered effect. Some studies use a slightly longer event window with five days before the announcement date and 10 days after, [-5, 10] (e.g., Flammer, 2021). We run the event study using this event window to account for the possibility of a longer staggered effect. As shown in row 1, the results are qualitatively the same. The average CAR is slightly larger (1.22%) than in the [-5, 5] event window, suggesting that the positive stock market reaction continues to increase after the announcement.

Second, we verify whether the results are significant when removing the assumption of information leakage and a staggered effect. Some studies use a shorter event window with one day before and after the announcement, [-1, 1] (e.g., Zhou and Cui, 2019). We run the event study using this shorter event window in row 2 and find that our estimates lose their significance. This suggests that the assumption of information leakage and a staggered effect is important.

Third, we assume that the market model is well-specified and accurately predicts companies' stock returns. If the explanatory power of the market model is small, the estimate of the "normal" return $\hat{R}_{it}$ may be biased leading to incorrect estimates of the abnormal returns. We suspect that the "normal" returns may be explained by additional factors beyond the market factor during the sample period. Therefore, we also run the event study using the Fama-French 3-factor model (Fama and French, 1993). The 3-factor model includes the market factor, the size factor (SMB) and the book-to-market factor (HML). We extract the daily market, SMB and HML factors from Kenneth French's publicly available website (French, 2022). We use region-specific factors (Europe, North America, Asia Pacific excl. Japan, Japan). If the region is not available, we categorize the issuer country as either a developed market or an emerging market. As shown in row 3, the results remain qualitatively the same. The average CAR in the event window [-5, 5] is slightly larger (1.40%) and significant ($p<0.05$). The sensitivity test suggests the results are robust to using an extended set of factors. We do not test robustness to the Carhart 4-factor model (Carhart, 1997) nor the Fama-French 5-factor model (Fama and French, 2015) since the marginal explanatory power of the additional factors is likely small (Campbell et al., 1997).

Fourth, we assume that companies' stock returns are best explained by country-specific market returns. If the explanatory power is low, the estimates of the abnormal returns may be biased. We suspect a lower explanatory power for companies listed in a different country to the country of domicile or country of risk (e.g., Constellium SE). Therefore, we also run the event study using a global market index (MSCI World Index). As shown in row 4, the results remain qualitatively the same. The average CAR in the event window [-5, 5] is slightly larger (1.39%) and significant (p<0.05). The sensitivity test suggests that the results are robust to using a global market return. However, the country-specific indices are preferred since they help reduce cross-sectional correlation in the abnormal returns.

Table 9. Event study robustness tests.

	Obs.	CAR (%)	Std. err. (%)
1. Market model [-5, 10]	158	1.217*	0.686
2. Market model [-1, 1]	158	0.145	0.261
3. Fama French 3 factor model [-5, 5]	158	1.398**	0.573
4. Global market index [-5, 5]	158	1.387**	0.591

Note: This table reports different ways of measuring the average CAR of SLB announcements. Row 1 uses an event window of [-5, 10], which is longer than in the main specification. Row 2 uses an event window of [-1, 1], which is shorter than in the main specification. Row 3 uses the Fama-French 3-factor model instead of the market model. Row 4 uses a global market index (MSCI World Index) instead of country-specific indices. *** p<0.01, ** p<0.05, * p<0.1

8. The incentive scheme of sustainability-linked bonds

8.1. Method of evaluating the incentive scheme of SLBs

To evaluate whether sustainability-linked bonds (SLBs) are structured with strong incentives, we investigate SLB contracts. We assess whether the discounted 'expected penalty saving' is higher than the cost of implementing the sustainability investments required to achieve the sustainability performance targets (SPTs) (Berrada et al., 2022). Unfortunately, companies do not disclose the cost of the sustainability investments. To explore the potential cost, we assess the ambitiousness of SPTs based on whether they are externally verified by a second-party opinion (SPO) and whether they are science-based. To explore the 'expected penalty saving', we assess the magnitude of financial penalties. We measure the coupon step-up as the largest possible step-up should the issuer fail to achieve all its SPTs. Though the analysis is very high-level, it provides one way of evaluating the incentive scheme of SLBs ex ante.

8.2. Incentive scheme evaluation

The SPTs set by companies seem ambitious on average. Table 10 shows the share of SLBs with an SPO and the share of SPTs that are verified by the Science Based Targets initiative (SBTi). As shown in row 1, 78% of SLBs have a publicly available SPO that vouches for a minimum standard of ambition. Though in certain cases we disagree with the SPOs[3], on balance we trust their judgement since they are provided by leading ESG researchers such as Sustainalytics and Vigeo Eiris. In terms of whether the SPTs are science-based, it is only possible to assess when there are scientific benchmarks available. Currently there are scientific benchmarks for GHG emissions in most industries. As shown in row 2(ii), 67% of SPTs related to GHG emissions are verified by the SBTi and in line with the 'well below 2 degrees Celsius' target (United Nations, 2015). 10% of SPTs are not in line with the well below 2 degrees Celsius target. The remaining 23% are either from companies in industries that are not covered by the SBTi or do not provide information on whether they are science-based. Given that the large majority of SLBs have SPOs and science-based SPTs, this suggests that the SPTs are ambitious on average. Therefore, the sustainability investments required to achieve the SPTs are likely considerable.

[3] For example, we view Tesco's SPT as lacking ambition since the target was set in 2017 and had already been partly achieved when the SLB was issued in 2021. However, Sustainalytics views the SPT as ambitious, highlighting the alignment of the trajectory with the SBTi (Sustainalytics, 2020). See discussion in section 3.

Table 10. Summary statistics of SPT ambitiousness.

	# SLBs (% of sample)	# SPTs (% of sample)
(1) Second-party opinion (SPO)	157	n.a.
	(78%)	
(2) Science-based target	n.a.	128
(i) % of full sample		(39%)
(ii) % of SPTs related to GHG emissions		(67%)
Obs.	202	328

Note: This table reports the number of SLBs verified by a second-party opinion (SPO) and the number of sustainability performance targets (SPTs) with a science-based target. It is only possible to assess whether SPTs are science-based when there are scientific benchmarks available. Currently there are scientific benchmarks for GHG emissions in most industries. This is why we show the share of SPTs related to GHG emissions with a science-based target (2ii). Our sample includes all corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022.

However, the penalties that companies face if they fail to achieve their SPTs seem small. Table 11 shows the various penalties. The most common penalty is a one-time coupon step-up of 25 basis points (bps), included in 44% of SLBs in our sample. The mean SLB coupon rate in our sample is 235 bps, so a potential step-up of 25 bps would imply an 11% increase on the initial coupon rate. Other penalties such as coupon step-downs and cash premiums are also used, but these are less common.

The strictness of the penalty should be assessed in light of the SLB's target date and maturity. The target date refers to the date on which the performance of each KPI is observed against the SPT (ICMA, 2020). In our sample, the target date is between 1 and 11 years after the issuance date, with an average of 4 years. The maturity is between 1.5 and 20 years, with an average of 8 years. On average, the target date is 4 years earlier than the maturity date. This means that an issuer of an SLB with a coupon step-up of 25 bps that fails to achieve its SPTs faces a maximum potential penalty of 100 bps. Multiplying the maximum potential penalty by the average issuance size and discounting by the average cost of debt, the expected saving if the issuer does not pay the penalty is $4.2 M (appendix Table A4). On average, $4.2 M represents 0.8% of the issue size.

Table 11. Summary statistics of SLB penalties.

Penalty	# SLBs (% of sample)
Coupon step-up	148 (73%)
Step-up = 25bps	88 (44%)
Step-up > 25bps	43 (21%)
Step-up < 25bps	10 (5%)
Step-up (undefined)	7 (3%)
Cash premium on bond principal	11 (5%)
Two-sided (step-up or step-down)	6 (3%)
Charitable donations	4 (2%)
Carbon offsets	3 (1%)
Coupon step-down < 10 bps	2 (1%)
Missing information	28 (14%)
Obs.	202

Note: This table reports the number and share of SLBs with each penalty. Our sample includes all corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022. The coupon step-up is the largest possible step-up should the issuer fail to achieve all its SPTs.

Considering the costly sustainability investments required to achieve the SPTs relative to the small penalties when failing the SPTs, it seems the incentive scheme of SLBs is fairly weak. Our finding is in line with investor concerns (Liberatore, 2021) and recent studies (Kölbel and Lambillon, 2022). The incentive scheme appears weaker when considering that issuers may choose a target date that is very close to maturity or include a callable feature that allows the issuer to redeem the bond before the target date. The weak incentive scheme does not seem to support the argument that companies issue SLBs to commit to sustainability targets.

9. Discussion

This thesis shows evidence that sustainability-linked bond (SLB) issuers benefit from both a yield discount and a positive stock market reaction. It also suggests that the incentive scheme embedded in SLBs is fairly weak. In light of these results, we evaluate the theoretical framework on asset pricing with non-pecuniary preferences, signalling and commitment. We also discuss the potential limitations and implications of our thesis.

First, the results are consistent with the theoretical prediction from the standard asset pricing model with non-pecuniary preferences that sustainable assets are issued at a lower yield (section 4.1.). In a sample of 52 matched pairs, SLBs have a mean yield discount of 15 basis points (bps) compared to conventional bonds and a median yield discount of 2 bps. Our estimate of the mean yield discount is 50% smaller than Kölbel and Lambillon's (2022) estimate of a 29.2 bps yield discount. The difference may be due to the stricter matching methodology we use. Our finding of a significant SLB yield discount differs to the recent findings of no yield discount for corporate green bonds (e.g., Flammer, 2021). This may suggest that the demand for SLBs is higher than for green bonds, or that investors expect companies to miss their sustainability performance targets (SPTs) and pay the penalty.

It is difficult to determine whether the estimated yield discount translates into a lower cost of capital since the probability of failing to achieve the SPTs is unknown. If the probability of failure is equal to 0, the average issuer benefits from a lower cost of capital. If the probability of failure is above 0, it is unclear whether the average issuer benefits from a lower cost of capital due to the penalty. A back-of-the-envelope calculation suggests an average issuer faces a 12 bps increase in yield to maturity if the probability of failure is equal to 1 (section 6.2.). The mean yield discount of 15 bps is larger than the estimated 12 bps increase in yield from the penalty, suggesting that issuers also benefit from a lower cost of capital when they fail to achieve their SPTs. However, the median yield discount of 2 bps is lower than the 12 bps increase in yield from the penalty. In practice, since the average probability of failure is between 0 and 1, it is likely that the average issuer benefits from a lower cost of capital. In addition, 64% of the SLBs in our sample are callable. If the target date falls after the end of the non-call period, an issuer can redeem the bond before the target date and avoid the penalty (ELFA, 2021). Issuers of callable SLBs can therefore benefit from a lower cost of capital regardless of whether they achieve their SPTs (Kölbel and Lambillon, 2022). Our findings are in line with Kölbel and Lambillon's (2022) finding that 65% of companies benefit from a lower cost of capital.

If SLB issuers benefit from a lower cost of capital on average, the announcement of an SLB issuance may cause a positive stock market reaction because shareholders benefit from the cheaper financing. However, the effect of the lower cost of capital on the stock market is likely small because SLB debt represents only a small portion of a company's total debt. In our sample, SLB debt comprises 7% of total debt on average[4]. To investigate the effect of a lower cost of capital from an SLB issuance on a company's equity value, we make a crude estimation based on a simple free cash flow model (appendix B). We consider a company that has the same weighted average cost of capital (WACC) as the market average, based on global data updated on January 5, 2022 (Damodaran, 2022). We compare the company's equity value in two scenarios: (i) if its debt consists of 100% conventional bonds and (ii) if its debt consists of 7% SLBs and 93% conventional bonds. We estimate that an SLB yield discount of 15 bps decreases the WACC by 0.03 percentage points. This leads to a 0.08% increase in the equity value. The increase in equity value is even lower if the issuer fails to achieve its SPTs. Based on this crude estimation, we believe that the stock market reaction to a lower cost of capital from an SLB is small. Therefore, the lower cost of capital is likely not sufficient to explain the average cumulative abnormal return (CAR) of 1.07%.

Second, the results are consistent with the two predictions from signalling theory (Section 4.2.). In line with the first prediction, we find evidence that the stock market reacts positively to the announcement of SLB issuances. In a window of 11 days around the announcement date, the average CAR is 1.07%. In line with the second prediction, the average CAR is significantly larger for first-time issuers of SLBs, at 1.45%. This supports signalling theory because the first-time issuance of an SLB conveys new information to the market and is a stronger signal. To our knowledge, this is the first study to explore the stock market reaction to the announcement of SLB issuances. Our results are consistent with findings on the positive stock market reaction to the announcement of green bond issuances (e.g., Flammer, 2021; Tang and Zhang, 2020). While Flammer (2021) finds that the average CAR in the event window [-5, 10] is 0.49% for green bonds, we find that the average CAR in the same window is 1.22% for SLBs (section 7.3, Table 9). This may suggest that the signalling effect is stronger for SLBs, or that there are other factors that make the stock market react more positively to SLBs than green bonds. For example, a part of the stock market reaction could be explained by the larger yield discount.

[4] The median SLB issuance amount is $0.5 Bn compared to the median total debt of $6.8 Bn. We use the median total debt rather than the mean to avoid positive skewness from companies in the financial services industry. The total debt figure is based on data from the year 2020, provided by S&P Capital IQ.

Our results are also in line with the prevailing view among industry practitioners. For example, a recent investor survey highlights that "SLBs are a good example of how issuers can credibly signal their sustainability targets by linking them to financial incentives" (Michaelsen & Hagman, 2021).

One may question whether the signal remains credible if SLB issuers benefit from a lower cost of capital. For the signal to remain credible, it must be costly for a company that is not dedicated to sustainability to mimic. We assume that the probability of failing to achieve the SPTs is higher for non-dedicated companies because of the lack of motivation or ability (section 4.2.). Therefore, the discounted expected penalty is higher for non-committed companies and they are less likely to benefit from a lower cost of capital. In addition, the cost of issuing an SLB includes the fixed cost of effort, which is higher for a non-dedicated company that does not derive utility from sustainability improvements (Berrada et al., 2022). Therefore, it seems that issuing an SLB is a credible signal of dedication to sustainability.

Third, the results do not seem to support the prediction from the theory on commitment (section 4.3.). Our findings suggest that the financial incentives to commit to sustainability targets are weak. The financial penalty is small relative to the expected investments required to achieve the ambitious SPTs. This finding is in line with Kölbel and Lambillon (2022), who argue that the high share of callable bonds and the possibility to reduce the penalty restricts companies' commitment to SPTs. Therefore, it does not seem that an important rationale for issuing SLBs is to commit to sustainability targets as otherwise we would expect companies to structure their SLBs with stronger incentives.

However, though the financial incentives seem weak, they are likely better than the alternative of not having any financial incentives. Also, there may be other important incentives that we have not considered. For example, failure to achieve the SPTs may cause reputational damage. The fear of reputational damage may be sufficient to incentivise a company to achieve its SPTs. Therefore, further research is needed to better understand whether companies issue SLBs to commit to sustainability targets.

A few limitations of our study are worth highlighting. First, regarding the matching method, our small sample of matched pairs limits the power of statistical tests and increases the margin of error. We attempt to increase the sample size in a robustness test, but this comes at the cost of reduced balance which may introduce bias (section 6.3, Table 6, columns 3 and 4). Further, reasonable uncertainty persists because our estimates are affected by the degree of balance required. When we require a very strict balance, our results become less significant (section 6.3, Table 6, columns 1 and 2). Though the stricter balance may be theoretically more sound, it is unreasonable because it makes the sample size too small. Therefore, we believe our specification is the best approach given the dataset available.

Second, in terms of the event study, our data on the announcement date is imperfect as it is difficult to identify on which day information is released to the market. We attempt to control for this by using publicly available data from reliable sources and verifying it with Bloomberg's fixed income database. The publicly available data we find differs to Bloomberg's announcement date on several occasions, which suggests lack of clarity on the real announcement date. Further, some companies publish their SLB framework several weeks or months before issuing an SLB. It is possible that relevant SLB information is transmitted into the stock price before the event window. However, we believe that the announcement of the SLB constitutes new information to the market since it confirms the structural and financial characteristics of the SLB including the SPTs, penalty, coupon, maturity, and issuance size.

Third, regarding the SLB incentive scheme, our evaluation is based on an ex-ante view of SLB contracts and is based on a number of assumptions. In future research, an alternative method of evaluating the incentive scheme could be to look at issuer outcomes, from an ex-post view. For example, one could look at the proportion of SLB issuers that achieve their targets compared to the proportion of companies that achieve sustainability targets outside the contract of an SLB. However, given the infancy of the SLB market, it is not yet possible to analyse issuer outcomes due to insufficient data.

Fourth, our findings are based on under three years' worth of SLB issuances and should be viewed as preliminary evidence. The market for corporate SLBs is at a very early stage and it is possible that companies' rationales will change over time. For example, as the SLB market becomes more regulated, it may be that the signalling effect becomes more important. Also, as the supply of SLBs catches up with demand, it is possible that SLBs become structured with stronger incentives. So far, SLB demand has considerably exceeded supply which suggests that issuers have the bargaining power (Rennison, 2021). As issuance increases and the balance of power shifts, investors may be able to request harsher penalties. Further research is needed to determine whether our findings can be generalized to future years.

Fifth, there may be further rationales for issuing SLBs than the ones explored in this thesis. For example, companies may issue SLBs to diversify their investor base by attracting shareholders with a sustainability preference. This rationale has been suggested in the literature on green bonds (e.g., Flammer, 2021; Tang and Zhang, 2020). However, we were not able to investigate long-term changes in the equity base due to the infancy of the SLB market, with most SLBs having been issued in 2021.

Despite its limitations, this thesis sheds light on unanswered questions about SLBs. Our analysis suggests that companies may issue SLBs to obtain a lower cost of capital and to signal their dedication to sustainability. This thesis may help guide future companies and investors on understanding how SLBs work and whether to pursue them. It may also help guide policy decisions on the governance of the SLB market. For example, governance authorities may be advised to address investors' concerns of 'sustainability washing' if a lower cost of capital and positive signalling are to be sustained (Liberatore, 2021). In particular, a common understanding of how to assess the materiality of KPIs and the ambitiousness of targets would be useful to gain confidence in SLBs (Mylläri and Ray, 2022). Governance authorities may also call for more transparency in bond prospectuses by requiring companies to disclose the cost of the sustainability infrastructure needed to achieve the SPTs (Berrada et al., 2022). This disclosure would help investors better understand companies' incentives and whether they are issuing SLBs to commit to sustainability targets.

10. <u>Conclusion</u>

This thesis is one of the first studies to shed light on sustainability-linked bonds (SLBs). We first present descriptive statistics on SLBs. We show that SLBs are most prevalent in Europe and in capital intensive industries such as utilities and materials. Issuers choose a variety of key performance indicators (KPIs), though most relate to environmental objectives.

We then investigate three potential rationales for issuing SLBs: to obtain a lower cost of capital, to signal dedication to sustainability, and to commit to sustainability targets. Our results suggest that companies issue SLBs to obtain a lower cost of capital and to signal dedication to sustainability. First, SLBs are issued at a yield discount compared to conventional bonds. The benefit of the yield discount is larger than the discounted expected penalty, suggesting issuers may obtain a lower cost of capital. Second, the stock market reacts positively to the announcement of SLB issuances. The reaction is stronger for first-time issuers. The positive reaction suggests that equity investors perceive SLB issuances as signals of dedication to sustainability. Our results are consistent with the theoretical predictions of the standard asset pricing model with non-pecuniary preferences and signalling theory. However, it is unclear whether companies issue SLBs to commit to sustainability targets. The financial penalties seem too small to provide sufficient incentives to commit. For SLBs to provide incentives, other effects such as reputational damage for failing to achieve the sustainability performance targets (SPTs) would need to be large. To our knowledge, this is the first study to focus on companies' rationales for issuing SLBs. Our findings may help companies and investors understand how SLBs work and whether to pursue them.

The SLB market is in its early stages with many open questions to explore. This thesis calls for further research. First, as the SLB market grows and more data become available, future research could provide larger scale evidence on companies' rationales for issuing SLBs. It would be interesting to shed light on other rationales not addressed in this thesis. Second, further research on the commitment rationale is needed. The incentive scheme embedded in SLBs is unique, and it is important to understand exactly which incentives make companies commit to their targets. Third, future research could explore the sustainability-related additionality of SLBs over the long-term. For example, studies could assess how often issuers achieve their SPTs. Studies could also compare the sustainability performance of SLB issuers with issuers of other types of sustainable debt. More generally, given the magnitude of the problems SLBs are trying to address, further research on SLBs and sustainable finance is needed.

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Appendix A

Table A1. List of KPIs in sample.

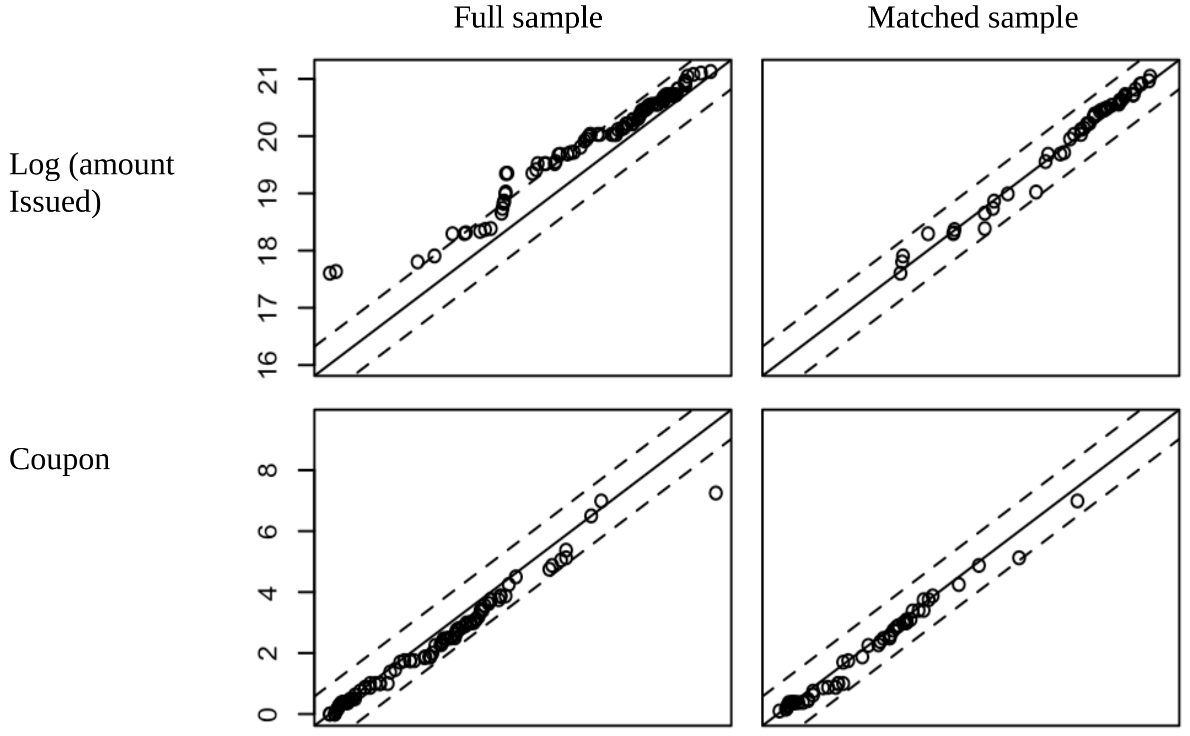
	# KPIs
Greenhouse gas (GHG) emissions	**177**
Absolute emissions	
Absolute Scope 1 and 2 GHG emissions (in tCO2e)	41
Absolute Scope 3 GHG emissions (in tCO2e)	22
Absolute Scope 1, 2 and 3 GHG emissions (in tCO2e)	6
Absolute GHG emissions (in tCO2e)	5
Absolute CO2 emissions (in tCO2)	2
Absolute Scope 1 CO2 emissions (in tCO2)	2
Absolute Scope 1 natural gas emissions reduction (in Mm3)	2
Absolute Scope 1 and 2 GHG emissions (in tCO2e) in France	1
Absolute Scope 1 and 2 GHG emissions (in tCO2e) in South African portion of portfolio	1
Emission intensity	
Scope 1 and 2 GHG emission intensity (in tCO2e/unit of production)	20
Scope 1 GHG emission intensity (in tCO2e/unit of production)	16
Scope 1 CO2 emission intensity (in tCO2/unit of production)	9
Scope 3 GHG emission intensity (in tCO2e/unit of production)	8
Scope 1, 2 and 3 GHG emission intensity (in tCO2e/unit of production)	6
Scope 1 and 2 GHG emission intensity (in tCO2e/unit of revenue)	5
Scope 1 GHG emission intensity (in tCO2e/unit of production) in the Chemical, Energy and Fertilisers Division	3
Scope 1, 2 and 3 GHG emission intensity (in tCO2e/unit of revenue)	3
Scope 3 GHG emission intensity (in tCO2e/unit of revenue)	2
CO2 emission intensity (gCO2/unit of production)	1
Scope 1 and 2 CO2 emission intensity (in tCO2/unit of production)	1
Scope 1 and 2 CO2 emission intensity (in tCO2/unit of revenue)	1
Scope 1 and 2 GHG emission intensity (in tCO2e/unit of EBITDA)	1
Scope 1, 2 and 3 net carbon intensity	1
Other	
Scope 1 and 2 GHG emissions (absolute and intensity)	8
Reduction of Sulphuric Oxide (SOx) emissions in metric tons	2
Contributions to CO2 emissions reductions, including the generation of renewable energy, compared to CO2 emissions	1
GHG emissions related to recycling activities in France (in tCO2e)	1
Scope 1 and 2 net carbon footprint upstream	1
Scope 1, 2 and 3 net GHG lifecycle emissions	1
n.a.	4
Renewable energy	**39**
Percentage of total electricity consumption coming from renewable energy sources (in %)	8
Renewable energy capacity installation (in MW)	8
Renewable Installed Capacity Percentage (in %)	6
Percentage of renewable energy sources (in %)	4
Increase the utilisation of renewable electricity in 3 retail divisions (in %)	3
Percentage of renewable energy in rental properties in the Greater Bay Area	2
Additional transformer capacity (in MVA)	1
CO2-free electricity used	1

Increase renewable power mix in the overall power purchase mix	1
Investment into renewable energy programmes (e.g., "Support Program for Fuyo Renewable Energy 100 Declaration")	1
Wind power capacity (in %)	1
n.a.	3
Recycling	**21**
Percentage of post-consumer recycled (PCR) plastic used in plastic packaging (in %)	3
Post-consumer PET bale input into recycling (in tons)	3
Absolute recycled aluminium input (in kt)	2
Material efficiency in own operations (tonnes non-recycled waste / MW)	2
Percentage of total operational waste diverted from landfills (tonnes of waste recycled or reused / tonnes of total operational waste)	2
Rate of external cullet usage in glass production sites worldwide (in %)	2
Collected expanded polystyrene (EPS) for recycling (in tonnes)	1
Quantity of recycled plastics (in Ktons/year)	1
Share of recycled aluminium input (in %)	1
Share of recycled materials / total materials used in commercial goods (in %)	1
Share of waste reused and recycled (in %)	1
Sustainably processed waste (in k tons)	1
Waste recycled /reused (in tons)	1
Sustainability certification	**21**
ESG Score	4
CDP Climate Change score	3
Annual average ESG Score across portfolio	2
Share of science-based targets with SBTi approval (in %)	2
Percentage of Higg Tier 1 house brand apparel suppliers production volume and related verified production volume	1
ACA Level 4+ Accreditation	1
Consolidated sales index of sustainable products	1
Our City - Index for social sustainability	1
Percentage of Gross Leasable Area (GLA) of properties that are certified sustainable under one or more Eligible Certification schemes	1
Percentage of supplier reviews	1
Selected as a constituent of DJSI World and DJSI Asia Pacific	1
Selected as a constituent of the FTSE4Good Index	1
Selected as a constituent of the MSCI Japan ESG Select Leaders Index	1
Share of properties that obtained at least one high-rank in environmental certification	1
Diversity	**15**
Percentage of women in leadership positions (in %)	4
New capital allocation to female founded or led companies (in %)	2
Representation of racial and ethnic diversity as a % of workforce (in %)	2
Creation of a diversity index	1
Gender diversity from hiring to front-line managers and in leadership teams	1
Indigenous representation as percentage of workforce (in %)	1
Number of underprivileged people trained in energy management	1
Percentage of independent women appointed to the boards of portfolio (in %)	1
Percentage of women among executive positions (in %)	1
Percentage of women investment advisory professionals (in %)	1
Healthcare access	**12**
Number of regulatory submissions in Low- and Middle-Income Countries (LMICs) of medicines across 6 therapeutic areas (TA) of non-communicable diseases (NCD)	4
Product volume through four access programs in LMICs, including donations and social business, across 6 therapeutic areas (TA) of non-communicable diseases (NCD)	4
Access to radiotherapy in underserved markets	2

Flagship programs patient reach	1
Strategic innovative therapies patient reach	1
Biodiversity	**8**
Percentage of tuna vessels with electronic monitoring and/or human observers (in %)	3
Prosperous farmers and food systems	2
Regeneration of the living world	2
Reintroduction and/or reinforcement of wild species into the ecosystem	1
Energy efficiency	**7**
Average efficiency ratio (AER) of the fleet (in gCO2/t-nautical mile)	2
Dollars spent on upgrading and acquiring ships that run on alternative fuels	2
Energy usage ratio (in MJ/L)	1
Green Vehicles as % of the total fleet (in %)	1
Gross financial value of binding commitments towards vessel acquisitions, new buildings and vessel retrofits, which can be powered by low-carbon/alternative fuel sources	1
Sustainable cities	**6**
Percentage of the balance of green loans to adjusted gross loans and advance to customers	2
Thriving communities	2
Completion of Japan's first 12-story fire-resistant wooden commercial facility in the Ginza 8-chome Development Plan	1
Money contributed to environmental reservation and sustainable cities over next 4 financial years	1
Water consumption	**5**
Water consumption intensity (in L/unit of production)	3
Freshwater withdrawal (in L/unit of production)	1
Reduction in water withdrawn from municipal and borehole sources (in ML)	1
Wastewater management	**4**
Industrial water withdrawal intensity	2
Waste treated in material recovery plants	1
Water recycling facilities for sustainable water and wastewater management at poultry operations	1
Food waste	**3**
Food waste per food sales	1
Food waste reduction	1
Percentage of food users & merchants made aware of sustainable food	1
Labour safety	**2**
Lost time injury frequency rate	1
n.a.	1
Missing information	**8**
n.a.	8

Note: This table provides a full list of the KPIs in our sample, ordered by KPI category. Our sample consists of all SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022. We chose the KPI categories and acknowledge there may be some errors of judgement in the categorisation. Occasionally the KPI category was provided by Bloomberg's fixed income database, but we did not find more specific details on the KPI. This explains why there are some non-applicable ("n.a.") values within each category.

Graph A1. eQQ Plots of the matched sample used in the matching method.



Note: This graph depicts the covariate distributions in the full sample and the matched sample used in the matching method. The matched sample has less deviation from the 45-degree line than the entire sample, suggesting improved balance. Log(amount issued) is the natural logarithm of the issuance amount of each SLB. Coupon is the coupon rate of each SLB.

Table A2. Descriptive statistics on the samples used in the analysis.

		(1) Full Sample	(2) Matched Sample	(3) Event Study Sample
Total # SLBs		202	52	158
Total Issuance amt. ($ Bn)		109	32	81
Avg. issuance amt. ($ Bn)		0.54	0.62	0.51
# SLBs by region (% of sample)	Europe	121 (60%)	21 (40%)	86 (54%)
	Asia Pacific	45 (22%)	17 (33%)	40 (25%)
	North America	25 (12%)	13 (25%)	23 (15%)
	South America	8 (4%)	1 (2%)	7 (4%)
	Africa	3 (1%)	0 (0%)	2 (1%)
# SLBs by industry (% of sample)	Utilities	43 (21%)	6 (12%)	29 (18%)
	Materials	31 (15%)	10 (19%)	26 (16%)
	Industrials	27 (13%)	5 (10%)	25 (16%)
	Consumer Staples	24 (12%)	8 (15%)	21 (13%)
	Consumer Discretionary	22 (11%)	3 (6%)	15 (9%)
	Real Estate	17 (8%)	5 (10%)	15 (9%)
	Financials	12 (6%)	4 (8%)	10 (6%)
	Information Technology	9 (4%)	3 (6%)	5 (3%)
	Health Care	7 (3%)	2 (4%)	3 (2%)
	Energy	6 (3%)	2 (4%)	5 (3%)
	Communication Services	4 (2%)	4 (8%)	4 (3%)

Note: This table reports descriptive statistics on the SLBs in three different samples. Sample (1) includes all corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022. Sample (2) includes corporate SLBs issued by public companies between Sep 1, 2019 – Mar 12, 2022 that have a matched conventional bond as per the restrictions in the matching method. Sample (3) includes all corporate SLBs announced by public companies on unique issuer-days between Sep 1, 2019 – Mar 12, 2022. This sample was used in the event study method.

Table A3. Estimation of the yield to maturity of an SLB with penalty payments.

Year	0	1	2	3	4	5	6	7	8
Face value									100
Coupon payments		2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.35
Penalty payments						0.25	0.25	0.25	0.25
Bond price	-100								
Total cash flows	-100	2.35	2.35	2.35	2.35	2.60	2.60	2.60	102.6
Yield to maturity	2.47%								

Note: This table details the calculations made to estimate the yield to maturity (YTM) of an SLB issued by a company that fails to achieve its SPTs. We assume the SLB has the same characteristics as the average bond in our sample, with a target date of 4 years, maturity of 8 years, annual coupon rate of 2.35% and coupon step up of 25 bps. We assume the bond is bought at par, with a face value of $100, and that coupons are paid on an annual basis. As shown, if the company fails to achieve its SPTs and pays the step-up until maturity, the YTM is 2.47%. If the company achieves its SPTs and avoids the coupon step-up, the YTM is 2.35% since the bond is bought at par. Therefore, the increase in the YTM from failing to achieve the SPTs is 12 bps.

Table A4. Calculations for the discounted estimated penalty payment.

Year		5	6	7	8
Issuance amount ($ M)		540	540	540	540
Coupon step-up (%)		0.25	0.25	0.25	0.25
Estimated penalty payments ($ M)		1.35	1.35	1.35	1.35
Discount factor		0.82	0.79	0.76	0.73
Discounted estimated penalty payments ($M)		1.11	1.06	1.02	0.98
Total discounted est. penalty payment ($M)	4.18				

Note: This table details the calculations made in the estimation of the discounted penalty payment. We assume the SLB has the same characteristics as the average bond in our sample, with a target date of 4 years, maturity of 8, issuance amount of $540 M and coupon step-up of 25 bps. We discount the estimated penalty payments by the average cost of debt provided by Damodaran's data website (Damodaran, 2022), at 4.04%.

Appendix B

B.1. The effect of a lower cost of capital on a company's equity value

To investigate the effect of a lower cost of capital on a company's equity value, we use a simple free cash flow model. Consider a company with constant free cash flows (FCF) in perpetuity. The enterprise value may be modelled as,

$$Enterprise\ value = \frac{FCF}{WACC - g} \quad (16)$$

where $WACC$ is the weighted cost of capital and g is the long-run growth rate. The $WACC$ is calculated as,

$$WACC = \frac{D}{E+D} * R_{D,conv} * (1 - T) + \frac{E}{E+D} * R_E \quad (17)$$

where D is the total debt, E is the total equity, $R_{D,conv}$ is the cost of conventional debt, T is the tax rate and R_E is the cost of equity. We assume the company has the market average weighted cost of capital, based on global data updated on January 5, 2022 (Damodaran, 2022). That is: $\frac{D}{E+D}$ is 35.83%, $R_{D,conv}$ is 4.04%, T is 26.06%, R_E is 7.26% and $WACC$ is 5.731%. We further assume that g is 2% in line with inflation and that FCF is 100. If the company's debt consisted 100% of conventional bonds, the enterprise value is,

$$Enterprise\ value_{D,conv} = \frac{100}{5.731\% - 2\%} = 2680 \quad (18)$$

Assuming no preferred stock, minority interests nor cash, the equity value is calculated as,

$$Equity\ value = Enterprise\ value - Debt \quad (19)$$

$$Equity\ value_{D,conv} = (1 - 35.83\%) * 2680 = 1720 \quad (20)$$

Now consider an identical company that is also an SLB issuer. In our sample of SLB issuers, SLB debt comprises 7% of total debt on average[5]. An SLB premium of 15 bps implies that the cost of SLB debt $R_{D,SLB}$ is 3.89%. Using a weighted average, we determine the mixed cost of debt $R_{D,mixed}$,

$$R_{D,mixed} = \frac{D_{conv}}{D_{conv}+D_{SLB}} * R_{D,conv} + \frac{D_{SLB}}{D_{conv}+D_{SLB}} * R_{D,SLB} = 4.03\% \quad (21)$$

where D_{conv} is conventional debt, D_{SLB} is SLB debt and $R_{D,SLB}$ is the cost of SLB debt. Therefore, the $WACC_{Dmixed}$ with mixed debt is lower at 5.728%. As a result, the enterprise value and equity value increase to,

$$Enterprise\ value_{D,mixed} = 2682 \quad (22)$$

[5] The median SLB issuance amount is \$0.5 Bn compared to the median total debt of \$6.8 Bn.

$$Equity\ value_{D,mixed} = 1721 \quad (23)$$

In this example on a company with an average cost of capital, the lower cost of capital from the SLB debt causes a 0.08% increase in equity value. Therefore, our finding of a 1.07% increase in the stock price is likely not fully explained by the lower cost of capital.