The Economics of Sustainability Linked Bonds

Finance Working Paper N° 820/2022
October 2023

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Abstract

We develop a framework to understand the incentive structure and pricing of sustainability-linked bonds (SLBs). It provides conditions under which SLBs are incentive compatible for firms. We propose a novel mispricing measure for SLBs. Using the model and the mispricing measure, we derive and test several empirical predictions. We show that SLBs that are overpriced at issuance experience negative returns in the secondary market. The stock price reaction at issuance is significantly more positive for large and overpriced SLB issues with higher mispricing levels, consistent with a wealth transfer from bond- to shareholders. Finally, we document a significant relation between the mispricing measure and firms' ESG ratings.

Keywords: ESG investing, sustainability linked bonds, security design, managerial incentives, mispricing

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The Economics of Sustainability-Linked Bonds*

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Abstract

We develop a framework to understand the incentive structure and pricing of sustainability-linked bonds (SLBs). It provides conditions under which SLBs are incentive compatible for firms. We propose a novel mispricing measure for SLBs. Using the model and the mispricing measure, we derive and test several empirical predictions. We show that SLBs that are overpriced at issuance experience negative returns in the secondary market. The stock price reaction at issuance is significantly more positive for large and overpriced SLB issues with higher mispricing levels, consistent with a wealth transfer from bond- to shareholders. Finally, we document a significant relation between the mispricing measure and firms' ESG ratings.

Keywords: Sustainability-linked bonds, SLB, security design, ESG investing, managerial incentives, mispricing, wealth transfer

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1 Introduction

At the United Nations' COP 27 conference in Sharm el-Sheikh in November 2022, global leaders convened to take action towards achieving the world's collective climate goals. Although countries expressed a strong consensus to take climate action, a large financing gap remains to meet the world's ambitious climate targets and finance the energy transition. In a similar spirit, achieving the ambitious social and governance objectives spelled out in the Sustainable Development Goals (SDGs)[1] will also require substantial financing that cannot come only from public sources. Thus, the private sector is an important player in achieving the ambitious objective of creating a more sustainable global economy. In this context, firms' debt financing tied to sustainability objectives will play an increasingly important role.

Over the last decade, corporate borrowers have accelerated their issuance of green, social, and more generally sustainability-related bonds. As sustainability-related debt instruments gain prominence and usage, sustainable finance and associated security design issues have evolved into a significant trend within debt markets. The most commonly used sustainability-related fixed-income instruments are green bonds (Zerbib 2019, Flammer 2021). These instruments allow firms to raise funds for specific and often predefined green and environmental projects. More recently, sustainability-linked bonds (SLBs) have emerged as a potentially attractive alternative. SLBs do not require the issuer to allocate the proceeds of the issue exclusively to designated green investment projects. In contrast, funds raised through the issuance of SLBs can be used for all sorts of investments and expenses. Instead of prescribing what the proceeds can be used for, SLBs follow the logic of linking coupon payments to the achievement of specific sustainability targets. More specifically, SLBs are designed such that coupon penalty payments are due if a specific sustainability oriented key performance indicator (KPI) target is not reached by the issuing firm at a predetermined date. Given the infancy of the SLB market, we know very little about (i) the incentive compatibility of these novel debt instruments (i.e., do these

[1] See https://sdgs.un.org/

bonds actually incentivize managers to achieve sustainability targets), (ii) their pricing in the primary bond market, (iii) their performance in the secondary market, and (iv) the conditions under which SLB issues would allow genuinely motivated firms to signal their commitment to sustainability goals.

In this paper, we attempt to fill these gaps. We begin by providing a stylized conceptual framework in which these questions can be addressed. The one-period SLB pricing model that we develop allows us to focus on the following questions: First, when are SLBs incentive compatible, that is, when can they induce firms to exercise costly effort to achieve the stated KPI target at the predefined horizon? We show that this can be accomplished whenever the coupon penalty of the SLB is large enough. Second, we ask whether it is possible to define a model-free measure of an SLB's fair pricing and develop a novel measure capturing an SLB's relative mispricing. We call this measure the *mispricing level* and denote it by ML.

ML is defined as the difference between the SLB issue price and a lower pricing bound divided by the distance between an upper and a lower pricing bound. The upper bound is the theoretical bond price assuming the KPI target is never reached and, therefore, the penalty is guaranteed. The lower bound is the theoretical bond price assuming that the KPI target is reached with certainty and, therefore, the penalty is not paid. It is a model-free relative mispricing measure that allows to circumvent the fact that in practice, we observe neither the probability of a firm achieving the KPI nor the sustainability appetite and thus demand of investors for a specific SLB issue. We show that our ML measure plays a crucial role in determining SLB market pricing accuracy in the primary market.

In a second step, using both the model and the mispricing measure, we establish the following three empirical findings: First, as the pricing measure ML increases, SLB issues tend to become overpriced. The overpricing subsequently leads to a post-issuance decrease in the SLBs' prices on the secondary market. The post issuance secondary market under-performance of overpriced SLBs is approximately -0.5 percent over a 20-day horizon after issuance. Second, when SLB issues are overpriced and large, we also document a significant wealth transfer from the bondholders to the shareholders of the issuing firms. Specifically, in an event study setting, we find that when the SLB issue is sizeable relative to the market value of the equity of the firm, the more overpriced (underpriced) the SLB, the more positive (negative) the stock price reaction around the issuance date of SLBs. More specifically, a combined one standard deviation increase in ML and in the relative size of the issue leads to a positive cumulative abnormal stock return of about 0.9 percent during the 5 day post issuance window. The positive relation between cumulative abnormal returns around issuance and ML is consistent with mispricing induced wealth transfers from bond- to shareholders. Third, we document a positive and significant relation between ML and the issuing firm's ESG ratings. The latter supports our conjecture that the probability of reaching the KPI target and the investors' appetite and derived monetary benefit from the SLB's environmental impact depend on the firm's ESG score. The latter and more precisely the governance rating of the firm play the role of a proxy for the issuer's credibility.

We then extend our theoretical framework and also examine under what conditions sustainability-committed firms can signal their types through the issuance of SLBs. This analysis allows us to compare the correct market yield of SLBs to the standard yield quoted by the industry. The comparison shows that the industry generally overstates the yield discount for firms that issue SLBs, mainly because industry practice consists of calculating the yield to maturity of the SLB without accounting for the conditional coupon penalty. We question the standard industry practice that results in systematically documenting yield discounts.

Our paper contributes to the emerging literature on sustainability-related debt securities and more specifically on SLBs by providing the first conceptual framework that allows one to study the conditions under which these bonds create the right incentives for managers to exert effort to meet the sustainability KPI targets and the conditions that allow dedicated firms to signal their commitment to their stated sustainability KPIs. Second, we contribute to a better understanding of the pricing of these bonds by providing a "model-free" measure that makes it possible to infer the degree of SLB mispricing and leads to testable implications. In the empirical part, we then show that 36 % of issued SLBs are overpriced at issuance, that is display $ML > 1$, which amounts to the issuance price being superior to the theoretical upper bound (i.e., the theoretical bond price assuming the KPI target is never reached). Subsequently, the overpricing leads to negative cumulative returns on the secondary market. We then demonstrate through an event study in equity markets that the overpricing ultimately translates into a wealth transfer from the bond- to the shareholders of the firms issuing SLBs when the SLB issues are large. Finally, our empirical analysis supports the model's prediction that the level of (ML) depends on the firm's ESG performance.

The structure of the paper is the following: In Section 2, we provide a brief review of related papers. Section 3 presents an example of a typical SLB issue, followed by descriptive statistics of the nascent SLB market. Section 4 introduces our theoretical model and its main testable predictions. Section 5 describes the data and the computation of the mispricing measure. In Section 6, we test the main implications from the model and discuss the main empirical results. Section 7 concludes the paper with a summary of its main findings, as well as with some policy recommendations.

2 Literature review

Our paper is primarily related to the existing research on green bonds. For instance, Zerbib (2019) compares the yield of green and equivalent plain vanilla bonds to estimate the yield differential between green and otherwise identical conventional bonds and finds lower yields on green than on other conventional bonds, i.e., an average small negative green bond premium. His analysis further shows that issuer sector and rating are important drivers of the green bond premium. Finally, he documents larger premiums for financial bonds and bonds with low ratings. Pástor, Stambaugh and Taylor (2022) document a yield discount for green bonds issued by the German government. Baker, Bergstresser, Serafeim and Wurgler (2022) use a simple asset pricing framework with non-pecuniary utility to investigate the pricing and ownership of U.S. municipal green bonds. They find a premium on green municipal bonds compared to otherwise similar ordinary bonds. Flammer (2021) documents that equity investors react positively when a corporate green bond issuance is announced, a result also found in Tang and Zhang (2020). The positive response is more pronounced for first-time issuers and green bonds that are externally certified. Furthermore, after issuance, Flammer (2021) shows that the environmental rating of the issuing firms increases and that the firm-level CO2 emissions decrease. Based on her evidence, Flammer (2021) argues that firms issue green bonds to send a credible signal of their environmental commitment. Thus, her study does not support the competing greenwashing or access to cheaper cost of capital hypotheses. Finally, she finds no evidence for a greenium. Fatica, Panzica and Rancan (2021) also focus on the pricing of green bonds at issuance. They document a green bond premium for bonds issued by supranational institutions and for corporate green bonds. The premium is larger for bonds with external assurance than for self-labeled bonds. They find supporting evidence of reputation building, as repeat issuers receive an additional premium compared to companies that only issue once. In the case of financial institutions, they cannot find a yield differential at the times of issuance. They argue that this is because investors are unable to connect the green bonds issued by these financial institution to a specific green investment project. (Fatica et al. 2021)

While several recent papers find a premium on green bonds, Larcker and Watts (2020) argue that the "greenium" is essentially equal to zero. They examine investors' willingness to exchange wealth for societal benefits by comparing green bonds to identical non-green bonds issued by the same issuers on the same day. They document that the prices of green and non-green issues are identical. They interpret this as indicating that in a real market environment, investors are not willing to trade off their wealth for environmental projects. Holding the risk and payoffs of green and non-green bonds constant, they show that investors are indifferent between the two types of securities.

Based on the empirical green bonds literature, Daubanes, Mitali and Rochet (2021) create a signaling model where firms have incentives to start green projects because of managerial incentives to avoid carbon penalties. They examine the stock price and stock turnover sensitivity of managerial compensation across variations of carbon pricing. They find supporting evidence for the importance of managerial incentives but also that this importance mainly depends on carbon prices. Finally, they argue that green bonds should not be seen as a substitute for carbon pricing but rather that carbon pricing makes green bonds more effective.

Given that SLBs are rather new instruments, it is not surprising that the literature that focuses on these instruments remains in its infancy. Liberadzki, Jaworski and Liberadzki (2021) examine whether SLBs that were recently issued by Tesco and had greenhouse gas emissions reduction targets were fairly priced. Their main empirical finding is that the yield differential between comparable SLBs and non-ESG bonds issued by Tesco is negative, which is suggestive evidence of a form of a sustainability price premium for these SLBs.

A contemporaneous study by Kölbel and Lambillon (2023) uses a bond matching technique initially developed to study the fair pricing of green bonds and documents that issuers benefited from a sustainability price premium (yield discount). Specifically, they identify an unconditional but insignificant yield discount for their sample of -9 bps and a significant discount of -21.5 bps when controlling for other bond characteristics. The latter compares favorably with the average penalty; thus, companies in their sample collect a net average benefit of 3 Mio USD. It is worthwhile mentioning that their matching procedure uses bonds with similar characteristics and then compares the SLBs and matched bonds yields (like the industry standard), without accounting for any coupon penalty. They actually compare the yield of the SLB to what we define as the lower bound when computing the mispricing measure ML. For instance, an SLB with a given issue price could thus show a greenium according to their procedure, while still not exceeding the upper bound in our setting and thus being in fact fairly priced. Ignoring the coupon penalty makes it impossible to distinguish the required premium originating from additional expected cash flows from the greenium originating from non-financial aspects such as environmental preferences or excess demand for sustainable debt. This may create the "illusion" of a greenium in some of their documented mispricings.

The conceptual paper by Barbalau and Zeni (2022) focuses on security design and rationalizes the coexistence of green bonds and SLBs. For that purpose, they propose a model of firm financing that embeds verifiable moral hazard, manipulation, and asymmetric information. They show that green bonds correct for moral hazard because they involve costly verification of actions but give rise to an opportunity cost of committing to financing a project before learning about its outcomes. In contrast, SLBs eliminate this commitment cost, but to the extent that the measurement systems on which contingencies are based can be manipulated, they can lead to "a distortion discount." The authors show that if the firm's distortion cost is high, SLBs are the first-best issues. On the other hand, if the cost of distortion is low, then green bonds become optimal.

3 A primer on SLBs

3.1 SLB structure

According to the ICMA (International Capital Market Association)[2], 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."

The issuer of an SLB commits to a predefined, quantifiable, and verifiable sustainable objective. This objective is documented in the issuance prospectus and includes a time horizon over which the sustainability target must be reached. Objectives must fulfill two main criteria. First, they must be measurable through a KPI. Second, objectives must be assessed against a predefined sustainability performance target (SPT). In Figure 1,

[2]The International Capital Market Association or ICMA is a self-regulatory organization and trade association for capital market participants.

we illustrate the step-up mechanism and payout profile of an SLB. In this figure, we can observe that if the firm does not reach the KPI at the target date, the coupon is augmented by the coupon step-up until the maturity date of the issue.

Figure 1 about here.

In principle, SLBs can bear environmental, social, and governance targets. In practice, however, most SLBs rely on an environmental targets. In Table 1, we tabulate the characteristics of the 336 SLBs that we can identify in Bloomberg from December 2018 to February 2022 and for which we can obtain an ISIN identifier and an issue date.

Table 1 about here.

Panel A of Table 1 shows that the large majority of SLB issues address exclusively environmental matters (79.17%) or a combination of ESG (3.57%) or EG (3.57%) topics. Very few SLBs (less than two percent) address G or S issues. Regarding the specific target KPI, Panel B of Table 1 shows that the majority of SLBs are concerned with greenhouse gas emissions (47.7 %). The second most common KPI used is renewable energy (11.82 %). There are very few ESG, governance, or socially focused KPIs. Note that there are also some SLBs for which Bloomberg does not identify a KPI (13.13 %).

The payout structure of SLBs can change after issuance, depending on whether the relevant KPI target is reached or not. The change in the payment structure is initiated by a predefined trigger event. Typically, this trigger event corresponds to the company failing to achieve the specific KPI by a predefined observation date. If the company fails to reach the KPI in time, the coupon will in most cases *step-up* by a predefined penalty (almost 95% of the bonds; see Panel D of Table 1). However, some SLBs include a coupon step-down option if the KPI is reached, but this structure is less common (only 2.2 % of SLBs). Other SLBs have penalties where the company can choose to purchase predefined

CO2 emission offsets or donate a predefined amount to a charitable organization. Again, these structures are less common. In the latter two structures, the coupon payment structure is unaffected.

Panel C shows that SLBs are predominantly issued in Europe with 46.08 %, followed by North America with 35.84 % and only 13.25 % are issued in Asia. Finally, panel E shows that SLBs are present in most economic sectors, but most notably in Utilities, Basic Materials, Industrials, and Financials.

3.2 Example: Enel SLB issue October 2020

An illustrative example of an SLB with a common structure is the SLB that was issued by Enel Finance International NV on October 20th, 2020. Enel Finance is a Netherlands-based company that raises funds for companies belonging to the Enel Group, which is an Italian company active in the energy sector. The SLB (XS2244418609) was issued on October 20th, 2020, and matures on October 20th, 2027. It carried a BBB credit rating and was issued at 97.75 percent of the aggregate nominal amount.

The bond comes with a one percent fixed coupon rate that is subject to a 25 bps coupon step-up option. The additional coupon step-up is conditional on a step-up event concerning Enel's KPI "Renewable Installed Capacity Percentage". The company commits to reach 60% of renewable installed capacity by 2022 compared to its baseline level in 2019 (SPT). Failing to reach the target in time triggers the coupon step-up where the coupon of 1% p.a. increases by 0.25 percentage points. The new coupon rate of 1.25% p.a. must be paid until maturity.

In December 2022, Enel reported a 63% renewable installed capacity and thus met its KPI target at the step-up date, and therefore no coupon penalty was triggered.

The Enel issue comes with a second party opinion evaluation. The evaluation of Enel's sustainability-linked financing framework was performed by Vigeo Eiris (VE), which is now part of Moody's. For the evaluation, VE uses a scale for KPI relevance and the SPT ambition. The range goes from weak, limited, robust, to advanced and maps the firm's objectives to the SDGs. Overall, VE assesses Enel's sustainability-linked framework as aligned with the Sustainability-Linked Bonds Principles and in line with best practice. The KPI relevance and SPT ambition are assessed to be "advanced," which represents the highest category on VE's evaluation scale.

3.3 Market size and evolution

The SLB market has grown strongly since its inception. Bloomberg identifies a total of 454[3] outstanding bonds flagged as 'Sustainability-Linked" as of February 2022. In contrast, in 2018 (as shown by Figure 2), there was only one single SLB. The amount raised through the single 2018 SLB issue was $0.22 billion, whereas the total amount raised through all SLBs issued in 2021 was approximately $160 billion.

Figure 2 about here.

Figure 2 shows that the number of SLBs issued from 2018 to February 2022, increased steadily over time. In 2021, the number of SLBs issued was 338, which is 7.5 times more than in 2020. Similarly, Figure 2 shows that in 2021 SLBs worth $160bn were issued, compared to only $16bn in 2020, implying that in value terms the market has grown tenfold betweem 2020 and 2021. The number of SLBs issued in the first two months of 2022 is already exceeding the total number issued in 2020 and the amount raised by these issues (approximately $27.39bn) exceeds the total amount raised in 2020 by more than $10bn. Taken together, these figures demonstrate the rising popularity and prominence of these instruments.

3.4 Differences with respect to green bonds

SLBs are not the first type of sustainability-related fixed-income instrument. The most prominent sustainability-linked fixed income securities are so-called green bonds (see,

[3]ISIN and issue dates are only available for 336 bonds out of the total universe of 434. The statistics of the previous section and the empirical analysis therefore rely on the smaller identified sample.

for instance, Zerbib (2019) or Flammer (2021)). SLBs differ from green bonds in many respects. First, green bonds do not have any contingencies in terms of the magnitude of the coupon payments. In addition, the proceeds raised from an SLB issue can be used for general-purpose expenses. In contrast, funds raised through green bond issuance are bound to fund exclusively green projects and expeneses. Hence, the lack of a constraint regarding the usage of funds gives a company more flexibility in how to use the money raised through SLBs. Due to this flexibility, SLBs might be an attractive way to raise money for companies. However, this flexibility comes with a potential cost: in contrast to green bonds, SLBs come with a coupon step-up option that is contingent on the company's sustainability performance.

Another important difference with respect to green bonds is that the company may address not only environmental topics through SLB issues but also other sustainability topics such as those related to governance issues or social outcomes. However, as we saw above, much fewer SLB issues are actually related to non-environmental issues, suggesting that firms currently do not exploit this possibility.

Note also that in terms of market size, there are important differences between green bonds and SLBs. Compared to the approximately 4,600 green bonds issued between 2013 and 2022, the number of SLB issues might seem small. However, the average issue amount for SLBs is already larger than that of green bonds. The larger scale of SLB issues might be due to the key differences between SLBs and green bonds mentioned above.

4 The model

In this section, we develop a theoretical framework to analyze the pricing and incentive mechanisms of SLBs. We then introduce the measure of the potential mispricing ML and describe how it can be used to derive testable predictions about SLB mispricing at issuance as well as resulting wealth transfers between bond- and shareholders. We also examine how ML relates to the firm's ESG score and, finally, analyze the relation between ML and the firm's cost of financing, emphasizing the potential signaling effect of SLB issuance.

4.1 Fair pricing and incentives

We first propose an analysis of the valuation of SLBs. For that purpose, we introduce a highly stylized model that focuses on two elements: (i) The incentive compatibility structure of the coupon penalty, i.e., do SLBs incentivize managers to engage in efforts to improve the environment? (ii) The environmental benefit perceived by investors in order to determine whether managerial incentives are affected by the presence of environmentally concerned investors. We focus on an SLB with an environmental KPI to simplify notation, but the model also applies by extension to social and governance KPIs.

We consider a one-period model. There is one firm with an activity aligned with its risk-neutral manager and a unit mass of competitive risk-neutral investors. There is an inelastic risk-free technology paying R per period. At time 0, the firm issues an SLB with face value F at maturity (the maturity date is time 1). The environmental performance is modeled by $X_1 \in \{g, b\}$ where g is the good state. The SLB promises a conditional coupon payment penalty G if $X_1 = b$, i.e., when its environmental performance is poor.[4] The manager can exert effort $e \in \{0, 1\}$ to increase the probability $p(e)$ of $X_1 = g$. We assume that $p(1) = \overline{p} > \underline{p} = p(0)$. A unit of effort has a monetary cost of f to the manager. We can interpret the cost of effort to the manager, f, as actual infrastructure cost paid by the firm to improve its environmental performance.

The fair price of the bond for a risk-neutral investor who derives no benefit/cost from the environmental performance of the firm is

$$B_0 = \frac{F + G(1 - p(e))}{1 + R}.$$

Consider first the case where investors assume that the manager will provide no effort.

[4] Payment of the penalty occurs with certainty in the bad state as we do not consider the possibility of default.

In this case, investors offer the highest possible value for the SLB, that is $B_0 = \frac{F+G(1-\underline{p})}{1+R}$. The manager's valuation $V(e)$ at time 0 is therefore

$$V(e) = \frac{F + G(1-\underline{p})}{1+R} - \frac{F + G(1-p(e))}{1+R} - ef.$$

Exerting no effort yields $V(0) = 0$, and exerting effort yields

$$V(1) = \frac{G(\overline{p} - \underline{p})}{1+R} - f,$$

and it follows that effort is exerted if

$$\frac{G(\overline{p} - \underline{p})}{1+R} > f.$$

Assuming that the coupon penalty is large enough to verify the above condition and that f is known by investors, then they can offer the lower price for the SLB $B_0 = \frac{F+G(1-\overline{p})}{1+R}$, and $V(e)$ becomes

$$V(e) = \frac{F + G(1-\overline{p})}{1+R} - \frac{F + G(1-p(e))}{1+R} - ef.$$

In this case, we have in the presence of effort $V(1) = -f$ and in the absence of effort

$$V(0) = \frac{G(\underline{p} - \overline{p})}{1+R} < 0.$$

It follows that effort is exerted when $V(1) > V(0)$, i.e., when $\frac{G(\underline{p}-\overline{p})}{1+R} < -f$ or alternatively, $\frac{G(\overline{p}-\underline{p})}{1+R} > f$.

Proposition 1 *When the coupon penalty is large enough, i.e., when it satisfies the condition*

$$\frac{G(\overline{p} - \underline{p})}{1+R} > f,$$

effort is exerted by the manager, and investors pay the corresponding lower fair price

$$B_0 = \frac{F + G(1 - \overline{p})}{1 + R}.$$

The above condition states that effort will only be exerted by the manager if the discounted "expected penalty savings" exceed the cost of carrying out the environmental investment.[5] We show in Appendix A.1 that replacing the penalty structure with a bonus structure, where the investors agree to an interest payment reduction if the KPI is reached, generates the same incentive structure.

Let us now assume that investors internalize the environmental performance, namely, they attribute a positive monetary value d to the case $X_1 = g$. In the absence of a bond issue, the manager exerts no effort $e = 0$, and hence $p(e) = \underline{p}$. When the investors participate in the bond issue, the potential increase in effort yields a monetary improvement of $d\left(p(e) - \underline{p}\right) \geq 0$.

In this case, the fair value of the SLB to the environmentally concerned investor is

$$B_0 = \frac{F + G(1 - p(e))}{1 + R} + \frac{(p(e) - \underline{p})d}{1 + R},$$

and the investor is willing to pay more for the bond. (NB: it is implicitly assumed that the manager does not internalize the environmental performance and would not exert effort in the absence of the bond issue. Under these conditions, the environmentally concerned investor is willing to participate in the bond offering).

The manager's valuation for no assumed effort is given by

$$V(e) = \frac{F + G(1 - \underline{p})}{1 + R} + \frac{(\underline{p} - \underline{p})d}{1 + R} - \frac{F + G(1 - p(e))}{1 + R} - ef.$$

[5] It can be shown that adding the possibility of default to the model yields a condition similar to that in Proposition 1, and this holds even if the probability of default is affected by the effort of the firm. In that case, the lower bound for the coupon penalty changes and also depends on the probability of default.

Exerting no effort yields $V(0) = 0$, and exerting effort yields

$$V(1) = \frac{G(\overline{p} - \underline{p})}{1 + R} - f,$$

and it follows that effort is exerted if

$$\frac{G(\overline{p} - \underline{p})}{1 + R} > f.$$

This is identical to the situation described in Proposition 1.

If the investors assume effort, the manager's valuation is

$$V(e) = \frac{F + G(1 - \overline{p})}{1 + R} + \frac{(\overline{p} - \underline{p})d}{1 + R} - \frac{F + G(1 - p(e))}{1 + R} - ef.$$

Exerting no effort yields

$$V(0) = \frac{(\overline{p} - \underline{p})d}{1 + R} - \frac{(\overline{p} - \underline{p})G}{1 + R}$$

and exerting effort yields

$$V(1) = \frac{(\overline{p} - \underline{p})d}{1 + R} - f.$$

It follows that effort is exerted if

$$\frac{(\overline{p} - \underline{p})d}{1 + R} - f > \frac{(\overline{p} - \underline{p})d}{1 + R} - \frac{(\overline{p} - \underline{p})G}{1 + R},$$

which is equivalent to

$$\frac{G(\overline{p} - \underline{p})}{1 + R} > f,$$

which again corresponds to the condition identified in Proposition 1 and therefore yields the following proposition

Proposition 2 *When the coupon penalty is large enough, i.e., when it satisfies the condition*

$$\frac{G(\overline{p} - \underline{p})}{1 + R} > f,$$

effort is exerted by the manager, and investors who derive a private benefit d from the environmental performance improvement pay the corresponding fair price

$$B_0 = \frac{F + G(1-\overline{p})}{1+R} + \frac{(\overline{p} - \underline{p})d}{1+R}. \tag{1}$$

This amount is actually the maximum price that investors would pay, but we may think that in a competitive environment, where bonds are often oversubscribed, environmentally concerned investors will bid up to this maximum value to maximize their chances of participating in the bond issue.

Remark 1 *We defined the cost of effort to the manager, f, as the actual infrastructure cost paid by the firm to improve its environmental performance. For some parameter values, the investor pays more than the actual cost of the infrastructure and in this case when the following condition holds*

$$W = \frac{(p(e) - \underline{p})d}{1+R} - f > 0, .$$

W represents the amount directly transferred from the bondholders to the shareholders of the firm.

It can be shown that if the coupon penalty is paid to a third party (a nonprofit organization, for example), a wealth transfer to shareholders is less likely to happen and occurs only if

$$\frac{(\overline{p} - \underline{p})d}{1+R} - f - \frac{G(1-\overline{p})}{1+R} > 0.$$

4.1.1 An empirical measure of SLB mispricing

In practice, it might prove difficult to observe or infer the probabilities $\overline{p}$, $\underline{p}$, and the bond investors' private benefit d. The unobservability, in turn, precludes a direct analysis of the potential wealth transfers described above and other issues related to SLB over- and underpricing. To circumvent this difficulty, we introduce the "mispricing level" variable denoted by ML, which is an empirically observable proxy for either the (risk-adjusted) probability of reaching the KPI ($ML \in [0, 1]$) or the extent of SLBs' under- ($ML < 1$) or overpricing ($ML > 1$).

Assume that we observe an SLB at price B_0 with maturity T, face value F, initial coupon C, and conditional penalty G starting at date $\tau \leq T$. We denote by $B(x, y, z)$ the price of a standard bond with face value x, coupon y, and maturity z. For the SLB, we can define the following upper and lower pricing bounds, UB and LB, respectively:

$$\begin{aligned} UB &= B(F, C + G, T) - B(F, C + G, \tau) + B(F, C, \tau) \\ &= B(F, C + G, T) - B(F, G, \tau) + B(F, 0, \tau) \\ LB &= B(F, C, T) \end{aligned}$$

The mispricing level ML relies on simple arbitrage bounds. The upper bound UB delivers a cash flow stream that is superior or equal at all dates to that of the SLB, while the lower bound LB delivers a cash flow stream that is inferior or equal at all dates to that of the SLB. There is an arbitrage opportunity if the SLB lies outside the range defined by the lower and upper bounds. To the extent that we can observe the bonds necessary to form the upper and lower bounds, the mispricing level ML can be obtained without any modeling assumptions. The upper bound which assumes that the penalty is reached with probability one can be replicated using a portfolio of three different straight bonds. In contrast, the lower bond is simply obtained via the price of a straight pure vanilla bond assuming the penalty is never reached. The table below indicates which bonds should be used to construct the respective bounds.

For a given SLB, we can now define the mispricing level ML as

$$ML = \frac{B_0 - LB}{UB - LB}. \tag{2}$$

From Proposition 1 (or Proposition 2 with $d = 0$), if the bond is fairly priced, then $ML \in$

Table: Construction of the upper and lower bounds

	1	...	τ	...	...	T
(1) $B(C+G,T,F)$	C+G	C+G	C+G	C+G	C+G	C+G+F
(2) $B(G,\tau,F)$	G	G	G+F			
(3) $B(0,\tau,F)$			F			
$UB = (1) - (2) + (3)$	C	C	C	C+G	C+G	C+G+F
$LB = B(C,T,F)$	C	C	C	C	C	C+F

[0, 1] and represents the market assessment of the issuing firm's ability to reach the KPI at date τ, with $ML = 1$ being a perceived guaranteed failure (the KPI will not be reached) and $ML = 0$ being a perceived guaranteed success (the KPI will be reached for sure). Note that ML is a probability if agents are risk-neutral or a risk-adjusted probability otherwise. With the above definitions, we can state our first empirical implications.

Empirical implication 1 *For a given SLB, $ML > 1$ ($ML < 0$) indicates overpricing (underpricing) at issue on the primary market. If secondary bond markets are efficient, bond returns should be negatively related to ML.*

Empirical implication 1 is a conditional test of market efficiency on the secondary bond market. It is conditional as it starts from the observed mispricing (inefficiency) on the primary market measured by ML.

Overpriced sustainability-linked bonds at issuance are potentially good news for equity investors, because overpricing implies that firms raise funds at a lower rate and suggests wealth transfers from bondholders to shareholders:

Empirical implication 2 *For a given sustainability-linked bond, the likelihood of over-*

pricing increases with ML. It follows that stock returns of the issuing[6] *companies should increase with ML following the issue, reflecting the potential wealth transfer from bond- to shareholders.*

4.1.2 ML and the pricing model

The pricing model developed so far shows the dependence between the bond prices and the SLB issue's characteristics under several assumptions. Relying on the model, we can now replace the elements composing the bounds and the SLB price itself by their theoretical counterparts. We can therefore re-write, under the assumptions of the model, the mispricing level as a function of various bond characteristics.

To match the setup of the model, we assume $C = 0$ and $\tau = T = 1$. In that case the upper bound is obtained under the assumption that the probability of reaching the KPI is equal to 0

$$UB = B_0(P(e) = 0) = \frac{F + G}{1 + R}$$

and the lower bound under the assumption that the probability of reaching the KPI is equal to 1

$$UB = B_0(P(e) = 1) = \frac{F}{1 + R}.$$

Using the definition of ML together with the two previous expressions and the SLB fair price equation (with investors' environmental concern) provides an analytical model-based expression for ML

$$\begin{aligned} ML = \frac{SLB - LB}{UB - LB} &= \frac{\frac{F+G(1-\overline{p})+d(\overline{p}-\underline{p})}{1+R} - \frac{F}{1+R}}{\frac{F+G}{1+R} - \frac{F}{1+R}} \\ &= (1 - \overline{p}) + (\overline{p} - \underline{p})\frac{d}{G}. \end{aligned} \tag{3}$$

When the environmental concern is absent, i.e. when $d = 0$, ML coincides with the

[6]Note that sometimes the SLBs are issued by an issuing company's finance arm. As in the example described in section 3.2, the entity issuing the SLB was the financing subsidiary Enel Finance International NV. In such cases, the stock market reaction should be observed for the parent company.

probability of not reaching the KPI. This is intuitive given that investors in our model discount all cash flows at the risk free rate.

4.1.3 ML and ESG performance

In the previous sections, both the upper bound on the probability of reaching the KPI, $\overline{p} = p(1)$, and the positive monetary value d associated with the case in which $X_1 = g$ are assumed to be constant. We now extend the analysis by assuming that both $\overline{p}$ and d are related to the firm's ESG performance, as proxied for example by its ESG rating, which we label by s. This seems plausible, as a better ESG rated firm may be perceived as having greater potential and credibility to reach its KPI especially by responsible investors who care about environmental issues. We therefore assume $\overline{p} = p(s)$ and $d = d(s)$. Using Equation (3) that relates ML to the SLB characteristics, we can reinterpret it as follows:

$$ML = (1 - p(s)) + (p(s) - \underline{p})\frac{d(s)}{G}.$$

The relation between ML and the firm's ESG performance can be studied more formally:

$$\frac{\partial ML}{\partial s}(s) = p'(s)\left(\frac{d(s)}{G} - 1\right) + d'(s)\left(\frac{p(s) - \underline{p}}{G}\right).$$

For the abovementioned reasons, it seems reasonable to assume that $p'(s) > 0$ and $d'(s) > 0$. The link between ML and ESG scores, however, is not obvious because the two terms on the RHS of the above expression may act in opposite directions when $\frac{d(s)}{G} < 1$. We will analyze this relation in the empirical section, assuming different functional forms for $p(s)$ and $d(s)$.

Empirical implication 3 *Controlling for the SLB's characteristics, we expect ML to be significantly related to the firm's ESG rating.*

4.2 Signaling and the total cost of financing

SLBs can provide managers with a signaling mechanism. They can be used to reveal firms' environmental credentials and in particular to separate them from other firms that issue conventional bonds. In this section, we provide an analysis of the firm's cost of financing with a particular focus on the cost of environmental effort to the manager, f, and the investors' environmental benefit d. Our goal is to characterize conditions under which costly signaling yields a separating equilibrium.

Note that when the bond is fairly priced, the yield, i.e., the cost of financing, is by assumption equal to R. The cost of financing as perceived by the firm should however incorporate the fixed cost of effort (or environmental infrastructure) paid at time 0 to increase the probability of reaching the KPI.

4.2.1 Cost of financing perceived by the firm

In the presence of environmentally concerned investors, the firm's additional cost of financing (in terms of yield) π^e can be computed as follows:

$$\frac{F + G(1-\overline{p})}{1+R} + \frac{(\overline{p}-\underline{p})d}{1+R} - f = \frac{F + G(1-\overline{p})}{1+R+\pi^e}.$$

We have 3 distinct cases:

$$\begin{array}{llll} (i) & \pi^e = 0 & \text{if} & \dfrac{(\overline{p}-\underline{p})d}{1+R} = f \\ (ii) & \pi^e > 0 & \text{if} & \dfrac{(\overline{p}-\underline{p})d}{1+R} < f \\ (iii) & \pi^e < 0 & \text{if} & \dfrac{(\overline{p}-\underline{p})d}{1+R} > f \end{array}$$

Considering a situation where two types of firms are present and only one is willing to pay a positive signaling cost, only case (ii) allows for a separating equilibrium. This corresponds to the case where the firm is willing to pay more for environmental improvements than required by the bondholders due to their derived benefits from the environmental investment, and thus the firm finances itself at a higher cost of debt to signal its "genuine" commitment. When d is large enough compared to f, all firms benefit from a financing cost reduction, and signaling a *good* behavior is rewarded by the market. In that case, firms pool, issue SLBs, and invest in environmental infrastructure. However, this is all done at an increased cost to the bond investors and may actually benefit the shareholders (see Remark 1). This may happen when bondholders attach great importance to environmental improvements and are willing to pay a great deal for such improvements. Wealth transfers could be mitigated if f had to be disclosed upfront in the firm's SLB issuance prospectus.

Figure 3 illustrates the separating and pooling regions for various levels of environmental benefit perceived by investors and environmental effort cost to the manager.

Remark 2 *If firms do not have a preference for signaling a specific behavior, they choose to issue non SLBs in case (ii). SLBs are issued only in cases (i) and (iii) when bond investors' environmental concerns lead them to sponsor the firm to invest in improved infrastructure (effort f).*

Figure 3 about here.

4.2.2 Cost of financing perceived by the market

The additional cost of financing (in terms of yield) $\hat{\pi}^e$ perceived by the market, which we define as the additional yield component needed to equate the expected proceeds of the bond with the discounted expected repayment, can be computed as follows:

$$\frac{F + G(1 - \overline{p})}{1 + R} + \frac{(\overline{p} - \underline{p})d}{1 + R} = \frac{F + G(1 - \overline{p})}{1 + R + \hat{\pi}^e}.$$

It differs from the firm's additional cost of financing π^e because it does not include the fixed cost paid by the manager/firm. Since $d > 0$ we have only 2 cases:

$$\begin{aligned} &(i) \quad \hat{\pi}^e = 0 \qquad \text{if} \qquad \frac{(\overline{p} - \underline{p})d}{1+R} = 0 \\ &(ii) \quad \hat{\pi}^e < 0 \qquad \text{if} \qquad \frac{(\overline{p} - \underline{p})d}{1+R} > 0 \end{aligned}$$

When the bond is fairly priced, from the market's perspective, the firm always benefits from a discount ($\hat{\pi}^e \leq 0$) when it issues an SLB.

Note that this apparent discrepancy between the cost of financing perceived by the firm and the market could be resolved if the infrastructure cost f could be verified and publicly disclosed.

4.2.3 Cost of financing assuming KPI is reached

The financial industry's standard approach as well as the matching technique used by Kölbel and Lambillon (2023) both rely on the yield on an SLB without accounting for the potential coupon penalty. Assuming that the KPI is reached with certainty, we can specify the *"industry standard"* firm's additional cost of financing $\hat{\pi}^e_{\text{ind}}$ as follows:

$$\frac{F + G(1-\overline{p})}{1+R} + \frac{(\overline{p} - \underline{p})d}{1+R} = \frac{F}{1+R+\hat{\pi}^e_{\text{ind}}}.$$

We can see that $\hat{\pi}^e_{\text{ind}} < \hat{\pi}^e$. When the bond is fairly priced and following the industry standard, issuing an SLB always implies a yield discount, that is, $\hat{\pi}^e_{\text{ind}} < 0$. However, this yield discount can be "illusory" as we will see below.

4.2.4 Yield and ML

The *"industry standard"* firm's additional cost of financing $\hat{\pi}^e_{\text{ind}}$ can be related to ML by noting that from Equations (1) and (2),

$$ML = (1 - \overline{p}) + (\overline{p} - \underline{p})\frac{d}{G}. \tag{4}$$

It follows that

$$\hat{\pi}^e_{\text{ind}} = \left(\frac{F}{F + ML \cdot G} - 1\right)(1 + R).$$

We can identify three distinct cases:

1. $ML > 0$ and $G > 0$, then $\hat{\pi}^e_{\text{ind}} < 0$
2. $ML = 0$ or $G = 0$, then $\hat{\pi}^e_{\text{ind}} = 0$
3. $ML < 0$ and $G > 0$, then $\hat{\pi}^e_{\text{ind}} > 0$

This yield does not account for the expected penalty and indicates that a discount is given to the firm, i.e., $\hat{\pi}^e_{\text{ind}} < 0$, whenever $ML > 0$ and $G > 0$, that is whenever an SLB issue is overpriced and bears a penalty which it generally does. This does not indicate that the firm actually benefits from a discount. Even if we do not take into account the cost of effort f (which can also be understood as an environmental infrastructure cost), a more correct measure of the cost of financing is given by $\hat{\pi}^e$, the yield perceived by the market, which, from Equation (4), relates to ML as follows:

$$\hat{\pi}^e = \left(\frac{F}{F + ML \cdot G} + G(1 - \overline{p}) - 1\right)(1 + R).$$

Note that $\hat{\pi}^e$ and $\hat{\pi}^e_{\text{ind}}$ coincide only when the probability of reaching the KPI is equal to 1, i.e., $\overline{p} = 1$. In general, the so-called *greenium*, is overestimated by the industry by an amount equal to the expected capitalized penalty, $G(1 - \overline{p})(1 + R)$.

Figure 4 about here.

Figure 4 displays the additional cost of financing as measured by the industry and as perceived by the market. The latter appears above the former because we assume that

$\overline{p} = 0.2 < 1$. The figure shows that in both cases, the greenium increases when ML increases and when the coupon penalty increases. Figure 5 indicates the region where a "false" yield discount is measured, that is, when the industry standard identifies a yield discount whereas the additional cost of financing as correctly perceived by the market is positive. The surface represented in the example is large, as the probability of reaching the KPI is low. Note however that the surface always exists whenever $\overline{p} < 1$. It is important to further remark that the surface increases significantly with the size of the penalty G, all other things being equal.

Figure 5 about here.

Thus, to summarize, this conceptual framework allows one to characterize the situations when an SLB is incentive compatible for the firm, that is when the coupon penalty is high. Using the model-free measure ML that identifies the extent of potential mispricing, the framework also allows to identify wealth transfers between bondholders and shareholders associated with an SLB at issuance (despite the fact that managerial effort and investors' ESG preferences are unobservable). Finally it allows us to distinguish the proper market yield of SLBs from the standard yield quoted by the industry. This, in turn, allows us to demonstrate that the industry , by ignoring the threat of the coupon penalty, generally overstates the benefits of SLB issuance to firms. In the next section, we turn to empirically testing the model's main predictions.

5 Data and sample construction

Our sample consists of sustainability-linked bonds issued from December 2018 to February 2022. The data is gathered from multiple sources. Bond characteristics are retrieved from Refinitiv and Bloomberg, stock returns, and market capitalization are retrieved from Refinitiv, ESG scores are retrieved from MSCI. Yield curves used for the computation of ML are retrieved from Refinitiv. Additional bond characteristics related to the nature of the KPI or the availability of third party opinion are hand-collected from the respective bond prospectuses or company websites.

We follow the description of ML in section 4.1.1 to construct the portfolios of bonds which replicate the lower and upper bound of the SLB. The respective bond prices are computed using the corresponding bond characteristics and matching sector yield curves from Refinitiv.[7] These yield curves are rating, currency, and business sector specific. Refinitiv uses a minimum of five bonds with the same rating, currency, and business sector for calculations.

We remove bonds with callable feature or floating rates, and discard some bonds with data errors which could not be explained by the data provider (e.g., incompatible cash flow dates, missing penalty information). We keep only bonds with step-up penalty, i.e. we discard step-down and non-financial penalties like donations or purchases of carbon offsets. To deal with outliers of ML, we drop observations that deviate from the median by more than five times the interquartile range.

Our initial bond universe based on availability of ISIN and issue date consists of 336 issues and following the above filtering procedure we are able to obtain 146 values for ML. Summary statistics are presented in Table 2 - Panel A.

Table 2 about here.

The average issue price is 99.75 with an average coupon of 3.09. The average coupon step-up penalty is approximately 31 bps, and the median step-up is 25 bps. In fact, a large majority of companies uses a step-up of 25 bps given that the first quartile of the variable Penalty is also 25 bps. As a consequence, the distribution of the coupon step-up (or penalty) is clustered and this could make the empirical analysis delicate. To remedy this problem, we use the cumulative discounted penalty ($CumDisPenalty$) in the analysis. This corresponds to the present value of all future possible penalties. Table 2 -

[7] When required, we linearly interpolate the yield curves to match the cash flow dates.

Panel A shows that the cumulative discounted penalty displays significant cross sectional variation with a standard deviation of 0.49, making it a more suitable variable for the empirical analysis.

The SLBs also differ in terms of step-up dates. The average time until a coupon step-up can be triggered (a variable we denote by τ) is 4.58 years, which represents on average approximately 60.6 percent of the bond's time to maturity. The average time to maturity of the SLBs is 7.56 years.

The median value of ML is -0.78, supporting the notion that the median SLB is underpriced. We observe that 53 percent of the issues in the entire sample have an ML strictly smaller than 0 while 36 percent have an ML strictly greater than 1.

Panels B, C, and D provide summary statistics for the sub-samples used to test each of the 3 empirical implications. These sub-samples do not necessarily overlap as they rely on different data availability restrictions. In each panel, we add information relating to data specifically used to test the corresponding empirical implication and also repeat the summary statistics for ML in the sub-sample.

Table 2 - Panel B provides summary statistics for an SLB's cumulative return over the 20 trading days following issuance, a variable we denote $TotRet20$. We use the issue price and gross prices[8] at trading day 20 to compute these cumulative returns. The average $TotRet20$ is slightly negative and equal to -0.07. The distribution of ML in this sub-sample is similar to the one in Panel A for the initial bond universe.

Table 2 - Panel C provides summary statistics for the variables used in the equity event study. *Relative Issue* defined as the nominal amount of the bond issue over the firm's (or parent's) equity market capitalization at the time of the bond issuance expressed in percentage terms. We use this additional variable when testing empirical implication 2. The median SLB issue represents about 2.70 percent of the issuers equity market

[8] Refinitiv Datastream defines the gross price as the sum of the clean price and the accrued interest. Accrued interest is a system generated value based on the coupon and day count convention provided in the prospectus/terms condition of the issue. Clean prices are derived by Datastream using the following hierarchy logic to determine the best available price: Composite bid price (CMPB), Refinitiv Evaluated bid price (TRPB), Market price (MP) from exchanges, illiquid CMPB price, and illiquid TRPB price.

capitalization. The distribution of ML in this sub-sample is again similar to the one in Panel A for the full bond universe.

Table 2 - Panel D provides summary statistics for the ESG scores, aggregated and dis-aggregated, used when testing empirical implication 3. Scores are extracted from MSCI in September 2019. We use lagged MSCI Ratings as our sample starts in late 2018 and as those ratings display a certain stickiness over time. In Panel D, we observe that the average Absolute ESG score[9] is equal to 5.37 and is therefore lower than the average Weighted ESG score[10] which is equal to 5.87. The average individual E, S, and G scores amount to 5.77, 4.61 and 5.53 respectively. Once again, the distribution of ML in this sub-sample is similar to the one in Panel A for the initial bond universe.

6 Empirical analysis

6.1 Empirical implication 1: Post-issuance SLB performance on the secondary market

Values of $ML > 1$ imply that the SLB is overpriced. Empirical implication 1 states that these overpriced bonds should therefore underperform post-issuance if there are some arbitrageurs in the secondary market.

To test if overpriced bonds subsequently underperform, we now estimate several OLS regression specifications in Table 3. Specifically, we regress the 20 day post-issuance returns of the bonds denoted by *TotRet20* on ML with and without control variables and fixed effects. Standard errors are double clustered by issue date- and issuer, in order to reflect that bonds issued on the same day and/or by the same firm are not independent.

Table 3 about here.

[9] The Absolute ESG score is computed based on the weighted average of scores received on all industry-relevant Key Issues contributing to the overall ESG Rating of a company.

[10] The Weighted ESG score is computed by normalizing the Weighted Average Key Issue Score to the industry peer set and by adjusting to reflect any Ratings Review Committee overrides. This score determines the overall company rating.

Consistent with the first implication, we find in Column (1) of Table 3 that the coefficient on ML is negative and significant, indicating that overpriced bonds have lower post issuance cumulative returns. The economic magnitude of this effect is quite sizeable as a one standard deviation increase in ML is associated with a -0.56 (8.13×-0.069) percent lower 20 day cumulative post-issuance return. This effect reflects a sizeable 25 percent relative to the standard deviation of $TotRet20$.

In Column (2) we control for the credit rating of the bond or, if unavailable, the issuer credit rating. The variable *RatingN* takes lower values for better credit ratings (e.g., AAA=1, BBB=4). Controlling for the credit rating does not affect the magnitude of the coefficient estimate. In Columns (3) and (4), we control for the coupon and the cumulative discounted penalty, respectively. In these regressions, the coefficient associated with ML remains negative and significant. In Columns (5)-(8), we saturate the model further by simultaneously including the previous control variables and successively adding year, currency, and industry fixed effects: the main result becomes slightly more significant relative to the previous specifications. We observe an economically significant decrease of the 20 day cumulative return of between -0.68 and -0.76 percent for a one standard deviation increase of ML depending on the selected specification. Thus, we conclude that our first model implication is supported by the data, i.e., overpriced SLB issues subsequently underperform in the secondary market.[11]

6.2 Testing Empirical implication 2: Wealth transfer from bondholders to shareholders

To test whether, consistent with Empirical implication 2, issuing mispriced SLBs results in wealth transfers between different types of securityholders, we conduct an event study using stock returns. For each SLB issue for which stock returns are available for the issuing firm (or its parent, when a finance subsidiary issues the bond), we calculate

[11] The results are robust to total returns computed with different event windows, e.g. 2, 10, or 15 trading days and/or to restricting the sample to clean prices defined as market prices (MP) from exchanges only. These tables are available upon request.

abnormal returns as the difference between the firm's stock return and the market index in the country in which the firm is headquartered. We calculate cumulative abnormal returns between the SLB issuance date and five trading days later.

We hypothesize that the mispricing of SLBs should have an effect on equity prices—and thus result in wealth transfers—primarily when the SLB issue is sufficiently large relative to the equity market capitalization of the issuing firm. In other words, if an SLB issue is mispriced, but the bond issue represents only a small fraction of the equity capital of the firm, we do not expect a meaningful stock market reaction. However, when the issue amount of the mispriced bond is large relative to the market value of the equity capital of the firm, we expect a stronger stock market reaction. To capture this phenomenon, we compute the variable *Relative Issue*, which is the ratio of the SLB issue nominal amount over the firm's equity market capitalization (the ratio is expressed in percentage terms).

Table 4 about here.

In column (1) of Panel B in Table 4, we regress the cumulative abnormal returns from the issuance date to five days after on the variable *Relative Issue*, ML, and the interaction term *Relative Issue* $\times$ ML. We expect a positive coefficient for the interaction, that is more positive cumulative abnormal returns when the SLB issue is (i) large relative to the equity capital of the issuing firm (i.e., higher values for *Relative Issue*) and (ii) more overpriced (i.e., greater values for ML). Standard errors are double clustered at the issuer and issue date level. The coefficient on the interaction is positive and significant in Column (1). A positive coefficient estimate is consistent with the conjecture that when bond issues are more underpriced (overpriced), the stock market reacts more negatively (positively). In terms of economic magnitude, an SLB with a standard deviation higher mispricing (7.21) and a standard deviation higher value for *Relative Issue* (7.96) is subject to a 0.92 percent higher cumulative abnormal stock return (=$0.016 \times 7.96 \times 7.21$) during that time interval. Similar to the bond event study, we include year, industry, and country fixed effects in columns columns (2)–(5), which reduces the magnitude of the regression coefficient slightly. We also conduct two placebo tests in Panels A and C of the same table, whereby we perform the same analysis using the CAR(-5,-1) and the CAR(+5,+10) and in both cases the coefficient associated with the interaction term is negligible and always insignificant. Overall, the analysis in Table 4 supports the idea of wealth transfers between bond- and shareholders when SLBs are mispriced (see Empirical implication 2).

6.3 Empirical implication 3: *ML* and ESG ratings

Another implication from the theoretical analysis in Section 4.1.3 is a potential relation between ML and a firm's ESG performance, as measured by its ESG rating.

Table 5 about here.

In Table 5, we explore this relation in an OLS regression framework. We regress ML on the issuer-level ESG scores from MSCI. We use both an absolute and an industry weighted ESG score. The absolute score captures a firm's absolute ESG performance, whereas the industry adjusted score should be seen as a best-in-class measure of a firm's ESG performance, where the performance is measured relative to industry peers. In Panel A, we use the best-in-class ESG scores. In Panel B, we use the absolute ESG scores. We find a positive relation between ML and a firm's ESG performance in both panels albeit the coefficient is larger for the absolute score. In both panels, this relation becomes stronger once we include fixed effects to control for, e.g., unobservable issuer- and bond-specific characteristics such as the currency of the SLB issue or the industry of the issuer. In terms of economic magnitudes, a one standard deviation increase in the absolute ESG score is associated with an increase in ML of between 0.79 and 2.19 depending on the specification chosen, which represents a sizeable 13 to 37 percent of the standard deviation of ML.

Table 6 about here.

Finally, it is important to mention that in our setting the ESG score of the firm is supposed to capture the credibility of the issuing firm when it comes to meeting its KPI. We conjecture that this credibility can be indirectly captured by the individual governance score of the firm, that is why in the three panels of Table 6 we examine the relationships between ML and each of MSCI's individual E, S, and G pillar scores. Consistent with our conjecture, the coefficient associated with each individual rating pillar is only significant for the G Score as can be observed by looking at the coefficient associated with G in Panel C. Overall, it should be noted that the tests in Tables 5 and 6 are estimated on an even smaller sample as we require ESG scores to be available for the issuers. Hence, the lower number of ESG issues available to estimate the models could result in power issues preventing us from identifying a more significant effect.

7 Conclusion

This study develops a novel conceptual framework designed to foster a better understanding of the intended and unintended incentive and pricing effects as well as wealth transfers associated with issuing SLBs. The conceptual framework allows us to characterize the situations in which the SLB is incentive compatible for the firm, that is, when the cumulative discounted coupon penalty is sufficiently large. Second, we propose a measure of an SLB's mispricing (denoted by ML), which identifies the extent of over/underpricing and allows to study wealth transfers associated with SLBs' issuance (despite the fact that the managerial effort to reach the KPI target and investors' ESG preferences and appetite for SLBs are unobservable). Finally, the conceptual framework enables us to compare the true market yield of SLBs with the standard yield quoted by the industry. The latter analysis allows us to conclude that the industry generally overstates the benefits (in terms of yield discount) to SLBs' issuing firms.

Our model also delivers several testable predictions, which we take to the data by computing the mispricing measure using the issue prices of SLBs and these bonds' upper and lower pricing bounds, which are obtained from the hypothetical prices of plain vanilla bond portfolios calculated using comparable yield curves. We first confirm that when ML is high at issuance, overpricing occurs, which subsequently leads to falling SLB prices in the secondary bond market. We further demonstrate that when the SLB issue is large relative to the equity market capitalization of the issuing firm, the more overpriced (underpriced) the SLBs at issuance, the more positive (negative) the stock market reaction upon issuance. Higher cumulative abnormal stock returns for issuing firms with higher ML are consistent with wealth transfers from the bond- to shareholders in those firms. Finally, we document a significant positive relation between ML and the bond-issuing firms' ESG ratings which seems to be essentially driven by the governance rating pillar. The latter observation is consistent with the conjecture that the governance rating stands as a proxy for the issuing firms credibility when it comes to meeting its KPI.

This study leads to several policy implications. First, one should require greater transparency in the bond prospectus and certification process by requiring that firms also disclose the parameter f, that is, the cost of implementing the environmental (or social or governance) infrastructure needed to reach the KPI. Second, for overpriced bonds, the wealth transfer to shareholders can be mitigated if part or all of the coupon penalty is actually externalized (as in the case of a charity donation). Third, greater sustainable finance literacy among investors is needed to prevent the overpricing of these issues, which ultimately benefits the shareholders of the issuing firms. To achieve this goal, investors' and, in particular, institutional investors' flows should be channeled less mechanically into these issues because their excess demand for sustainable assets is in part driving these abnormal price premiums and their unintended wealth transfers. Finally, we would recommend prudence with the practice of relying on the industry standard for quoting excessive yield discounts and publicizing them in the press[12,13,14]. In principle, the ML measure could be used as a simple tool to assess if the pricing of these bonds is fair by accounting for their expected discounted penalty.

[12] ESG-linked transactions typically raise a book 30%-40% larger than their non-sustainable counterparts (see https://www.spglobal.com/marketintelligence/en/news-insights/blog/esg-sustainability-linked-bonds-offer-pricing-perk-for-right-high-yield-credits)

[13] The company launched a €1bn June 2027 tranche at 38bp over swaps, a €1.25bn June 2030 note at plus 50bp and a €1bn June 2036 bond at 65bp. That implied concessions of 3bp on the six-year note, 5bp–10bp on the nine-year note and 10bp on the 15-year note. Books were €3.1bn-plus, €3.6bn-plus and €3.7bn-plus, respectively. (see https://www.ifre.com/story/2908666/enel-speeds-transition-with-jumbo-slb-b6xb6tmvml)

[14] On Monday, oil company Eni also paid a premium on its inaugural SLB. The issuer priced a €1bn 0.375% June 2028 at swaps plus 50bp, for a concession of 3bp–5bp. (see https://www.ifre.com/story/2908666/enel-speeds-transition-with-jumbo-slb-b6xb6tmvml)

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Figures

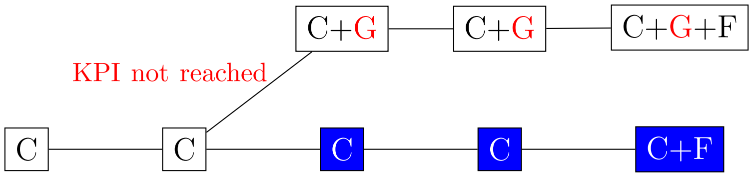

Figure 1: SLB payment structure

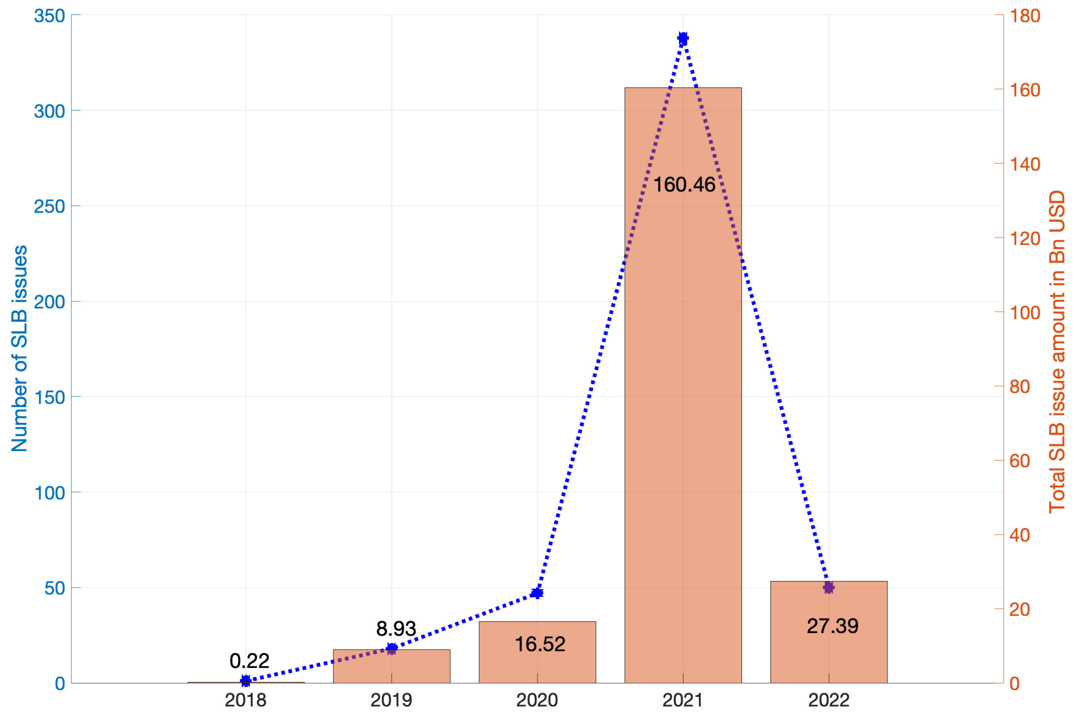

Figure 2: Number and total amount of SLB issued.

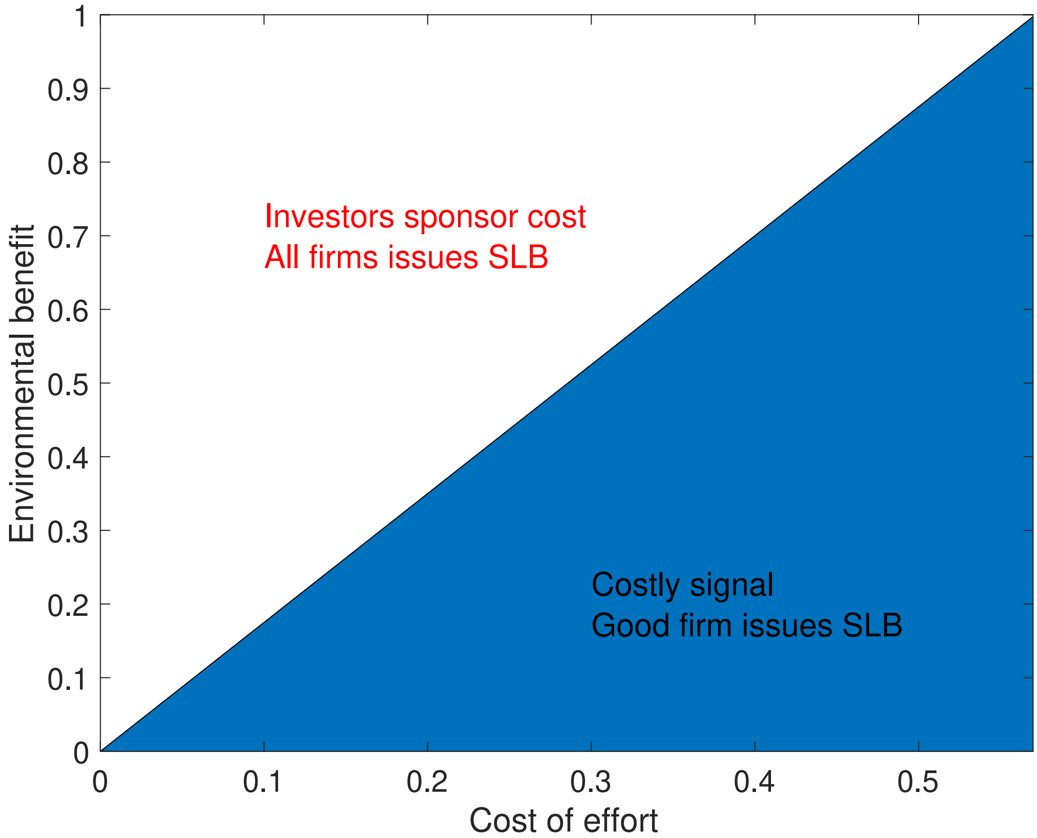

Figure 3: Separating and pooling regions for different levels of environmental benefit perceived by investors and effort cost to the manager. $\overline{p} = 0.8$, $\underline{p} = 0.2$ and $R = 0.05$.

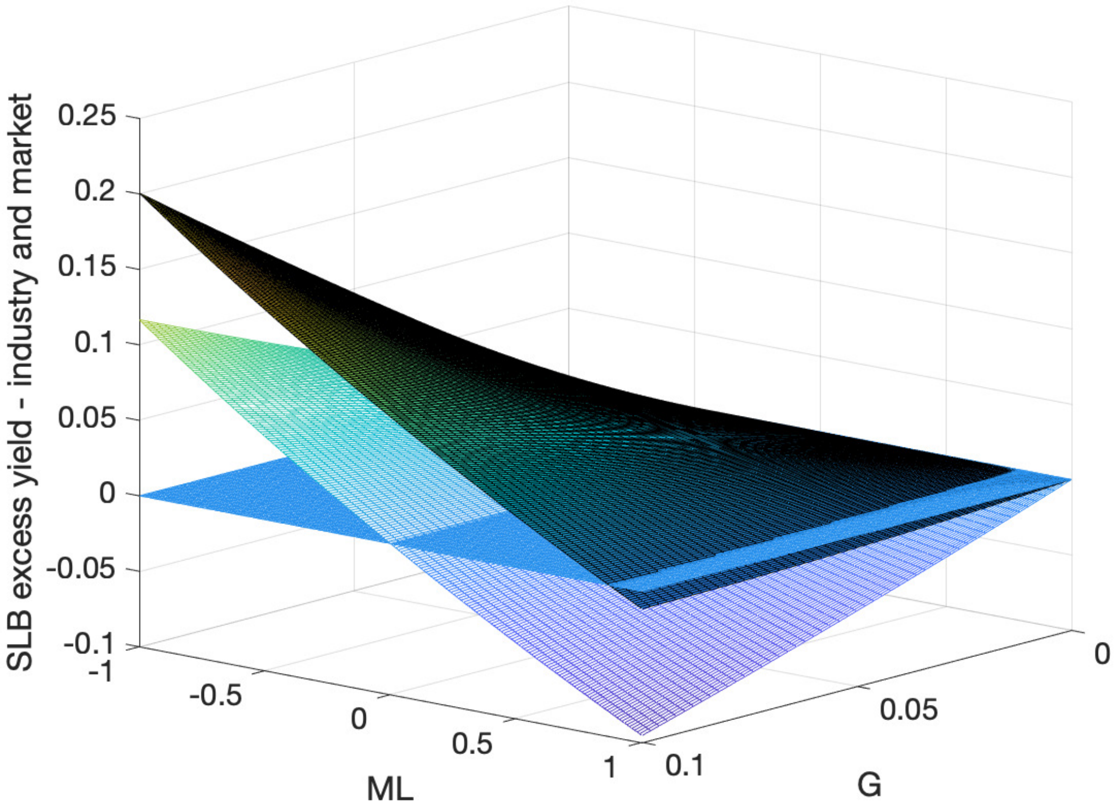

Figure 4: Excess yields from *industry* standard (light shaded) and perceived by the market (dark shaded) as a function of ML and penalty G. We assume that $R = 0.05$, $F = 1$ and $\overline{p} = 0.2$.

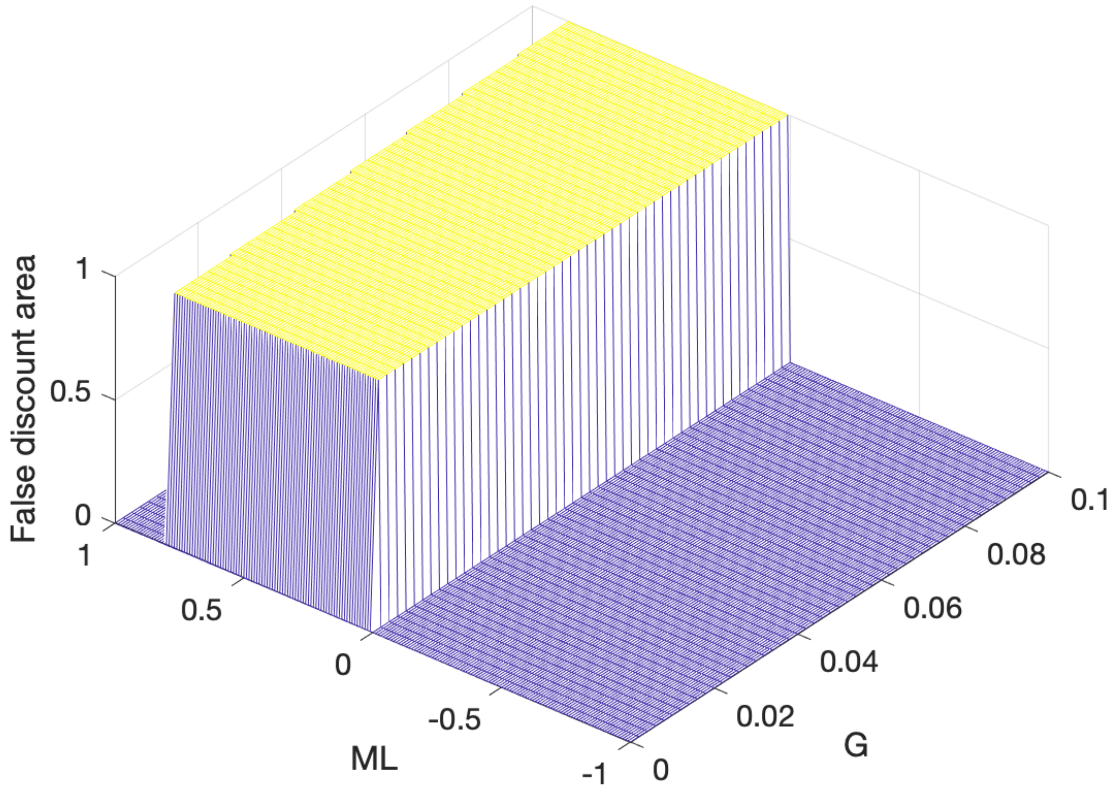

Figure 5: Indicator of a false discount as a function of ML and penalty G. We assume that $R = 0.05$, $F = 1$ and $\overline{p} = 0.2$.

Tables

Table 1: SLB Characteristics

This tables displays the SLBs' characteristics for the largest sample (N=336) of bonds gathered from Refinitiv and Bloomberg from December 2018 to February 2022. Panel A describes the Sustainability Target Themes on bond basis based on the KPI description from Bloomberg. Panel B shows the single KPI items listed in Bloomberg. Note that a single bond can have several KPI items. Panel C shows the Issuer location. Panel D shows the Penalty structure based on the notes description from Bloomberg. Panel E shows the Economic Sector based on the Refinitiv classification.

Panel A: Sustainability Target Theme

N=335	Percentage	Count
E	79.17%	266
S	0.00%	0
G	1.79%	6
ESG	3.57%	12
ES	0.60%	2
SG	0.00%	0
EG	3.57%	12
No description	11.31%	38
Total	**100.00%**	**336**

Panel B: KPI items (several per bond)

N=456	Percentage	Count
Affordable housing	0.22%	1
Biodiversity	0.44%	2
Circular economy	3.28%	15
Education	0.66%	3
Energy efficiency	6.35%	29
ESG Score	2.63%	12
Gender Equality	3.06%	14
Greenhouse gas emissions	47.70%	218
Labor	1.97%	9
Other (not specified)	13.13%	60
Renewable Energy	11.82%	54
Sustainable farming and food	1.09%	5
Sustainable souring	0.66%	3
Transport	1.31%	6
Water consumption	5.69%	26
Total	**100.00%**	**457**

Panel C: Issuer location

N=332	Percentage	Count
Asia	13.25%	44
Europe	46.08%	153
North America	35.84%	119
Rest of World	3.31%	11
South America	1.51%	5
Total	**100.00%**	**332**

Panel D: Penalty structure

N=317	Percentage	Count
Carbon offset	1.57%	5
Donation	1.57%	5
Step-down	2.20%	7
Step-up	94.65%	301
Total	**100.00%**	**318**

Panel E: Economic Sector

N=331	Percentage	Count
Academic & Educational Services	0.30%	1
Basic Materials	16.92%	56
Consumer Cyclicals	6.04%	20
Consumer Non-Cyclicals	10.27%	34
Energy	4.83%	16
Financials	15.41%	51
Government Activity	0.30%	1
Healthcare	3.02%	10
Industrials	13.90%	46
Real Estate	7.25%	24
Technology	2.72%	9
Utilities	19.03%	63
Total	**100.00%**	**331**

Table 2: Summary statistics

This table displays summary statistics at the bond-level for all SLBs issued from December 2018 to February 2022 for which we can obtain an ISIN and an issue date in Refinitiv and Bloomberg. For each variable, we use the maximum available number of observations. Panel A displays summary for the whole bond universe (N=336). *Issue Price* is the bond's issuance price, When calculating summary statistics for *Coupon* and *Coupon Frequency*, we exclude bonds with floating rates. *RatingN* is the credit rating of the bond at issuance transformed into numerical values (e.g., AAA=1, AA=2, A=3). *Penalty* is the coupon step-up penalty. *CumDisPenalty* is the cumulative discounted penalty. τ is the time between the issuance date from Refinitiv and step-up date from Bloomberg in years. T is the time to maturity of the bond reported by Refinitiv. *ML* is the computed mispricing level. To deal with outliers in ML, we drop observations that deviate from the median by more than five times the interquartile range. Panel B displays summary statistics of the variables used in the bond event study in Table 3. *TotRet20* is the total bond return between the issuance date and twenty days after, expressed in percentage. Panel C displays summary statistics of the variables used in the stock event study of Table 4. The variable *Relative Issue* corresponds to the bond's issue amount divided by the issuer's (or parent's) equity market capitalization at the time of the bond issuance date, and is expressed in percentage terms and excludes values larger then the 99th percentile. *CAR* denotes the cumulative abnormal stock market returns for several event windows around the bond issuance. Abnormal returns are in percentage and market adjusted by subtracting the market index return from the SLB issuing firm's parent stock return. Panel D displays summary statistics for the variables used in the regressions ot Tables 5 and 6, which relate ML and ESG scores. The ESG scores and their component parts come from MSCI as reported in September 2019. *Absolute ESG Score* is the weighted average of scores received on all industry-relevant Key Issues contributing to the ESG Rating of a company whereas the *Weighted ESG Score* is calculated by normalizing the Weighted Average Key Issue Score to the industry peer set.

	count	mean	sd	min	p1	p5	p25	p50	p75	p95	p99	max
Panel A: Bond Universe												
Issue Price	319	99.75	0.65	98.05	98.12	98.70	99.59	100.00	100.00	100.00	100.37	107.75
Coupon (C)	297	3.09	2.04	0.00	0.00	0.26	1.50	3.00	4.25	6.75	9.71	10.75
Coupon Frequency	301	1.70	0.62	1.00	1.00	1.00	1.00	2.00	2.00	2.00	4.00	4.00
RatingN	275	4.17	1.38	1.00	1.00	1.00	4.00	4.00	5.00	6.00	7.00	7.00
Penalty (G)	299	0.31	0.22	0.00	0.03	0.10	0.25	0.25	0.37	0.75	1.20	1.50
CumDisPenalty	156	0.88	0.49	0.06	0.08	0.27	0.49	0.78	1.13	1.77	2.34	2.61
τ	307	4.58	2.46	0.00	0.57	1.14	2.94	4.20	5.47	9.70	11.21	14.96
T	330	7.56	3.15	1.50	2.01	3.01	5.00	7.01	10.01	12.42	20.01	20.01
ML	146	-0.78	7.97	-27.17	-17.31	-12.61	-4.46	-0.22	2.59	7.89	35.80	35.80
$ML > 1$	146	0.36	0.48	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
$ML < 0$	146	0.53	0.50	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00

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	count	mean	sd	min	p1	p5	p25	p50	p75	p95	p99	max
Panel B: Bond Event Study												
ML	139	-0.84	8.13	-27.17	-17.31	-12.61	-4.56	-0.22	2.59	8.26	35.80	35.80
$ML > 1$	139	0.36	0.48	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
$ML < 0$	139	0.53	0.50	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
TotRet20	139	-0.07	2.41	-6.93	-6.43	-4.90	-1.21	0.44	1.43	3.17	4.64	5.62
CumDisPenalty	139	0.91	0.47	0.12	0.24	0.29	0.55	0.88	1.15	1.77	2.34	2.61
Panel C: Stock Event Study												
ML	99	1.59	7.21	-14.73	-14.73	-6.46	-0.93	0.54	3.63	9.66	35.80	35.80
$ML > 1$	99	0.46	0.50	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
$ML < 0$	99	0.39	0.49	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
Relative Issue	99	5.70	7.96	0.05	0.05	0.35	1.14	2.70	8.04	21.17	47.70	47.70
CAR(-5;-1)	99	0.17	2.96	-5.45	-5.45	-4.16	-1.75	0.03	1.85	5.16	8.31	8.31
CAR(0;+5)	99	0.67	4.11	-11.49	-11.49	-5.61	-1.11	0.70	2.35	7.91	13.68	13.68
CAR(+5;+10)	99	0.82	5.11	-7.17	-7.17	-5.82	-1.80	0.22	1.57	6.88	37.56	37.56
Panel D: ML and ESG Performance												
ML	93	0.17	5.99	-17.31	-17.31	-12.61	-1.00	0.23	2.82	7.89	30.44	30.44
$ML > 1$	93	0.41	0.49	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
$ML < 0$	93	0.44	0.50	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
Absolute ESG Score	93	5.37	1.48	1.70	1.70	3.20	4.30	5.30	7.20	7.20	7.30	7.30
Weighted ESG Score	93	5.87	2.65	0.00	0.00	0.30	4.40	6.30	8.30	8.40	10.00	10.00
Environmental Pillar Score	93	5.77	2.35	1.00	1.00	1.70	4.10	5.80	8.10	9.30	10.00	10.00
Social Pillar Score	93	4.61	1.41	1.60	1.60	2.00	4.10	4.70	5.00	7.90	8.60	8.60
Governance Pillar Score	93	5.53	1.66	2.30	2.30	2.60	4.60	5.40	6.60	8.10	8.70	8.70

Table 3: 20-day Post Issuance Performance on Secondary Market (Bond Event Study)

This table shows regressions relating *ML* to the SLB total bond returns over a 20 day horizon starting at the issuance date of the bonds. *RatingN* is the rating of the bond at issuance transformed into numerical values, *Coupon (C)* is the annual coupon rate, *CumDisPenalty* is the cumulative discounted penalty and *TotRet20* describes the total bond returns computed with the *IssuePrice* and the gross price 20 trading days after issuance, from Refintitiv. If there are no prices within the period up to the 60th calendar day, no returns are constructed. If there is no price on the first calendar day the first trading price is taken. Errors are clustered on ultimate parent and issue date level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

	(1) TotRet20	(2) TotRet20	(3) TotRet20	(4) TotRet20	(5) TotRet20	(6) TotRet20	(7) TotRet20	(8) TotRet20
ML	-0.069**	-0.072***	-0.069**	-0.069**	-0.087***	-0.086**	-0.094***	-0.084***
	(-2.37)	(-2.65)	(-2.12)	(-2.37)	(-3.02)	(-2.26)	(-4.03)	(-3.17)
RatingN		-0.378			-0.328	-0.369	-0.252	-0.416
		(-1.10)			(-0.97)	(-0.91)	(-0.66)	(-0.77)
Coupon (C)			-0.003		0.174	0.192	0.251	0.364
			(-0.02)		(1.18)	(0.76)	(1.57)	(1.35)
CumDisPenalty				0.023	0.022	-0.027	-0.093	-0.213
				(0.05)	(0.06)	(-0.07)	(-0.24)	(-0.47)
Observations	139	139	139	139	139	138	138	137
R^2	0.054	0.067	0.054	0.054	0.386	0.393	0.481	0.505
Year FE	N	N	N	N	Y	Y	Y	Y
Currency FE	N	N	N	N	N	Y	N	Y
Industry FE	N	N	N	N	N	N	Y	Y

Table 4: Equity Event Study

This table shows regressions relating cumulative abnormal returns (CAR) around the SLB issuance to *ML*. Panel A uses *CAR(-5;-1)* that is the cumulative abnormal stock return computed between five days prior up to one day prior to issuance. Panel B uses *CAR(0;+5)*, which is computed from the issuance day up to five days after issuance, and Panel C uses *CAR(+5;+10)* computed from five days after up to ten days after issuance. The cumulative abnormal stock returns in all panels are computed based on a market model and calculated by subtracting the market index return from the SLB issuing firm's (or its parent's) stock return. *Relative Issue* corresponds to the bond's amount issued divided by the parent's equity market capitalization at the time of the bond issuance, and is expressed in percentage terms. Standard errors are clustered at the Ultimate Parent and Issue Date level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: Pre Issue CAR (-5;-1)					
	(1) CAR	(2) CAR	(3) CAR	(4) CAR	(5) CAR
Relative Issue	-0.056	-0.085	-0.081*	-0.098	-0.083
	(-0.92)	(-1.62)	(-1.76)	(-1.57)	(-1.39)
ML	0.015	-0.018	-0.031	-0.010	-0.032
	(0.19)	(-0.26)	(-0.41)	(-0.15)	(-0.34)
Relative Issue × ML	-0.003	-0.001	-0.002	-0.002	-0.002
	(-0.60)	(-0.26)	(-0.42)	(-0.56)	(-0.37)
Constant	0.530	0.712*	0.697*	0.806**	0.725*
	(1.03)	(2.00)	(1.96)	(2.08)	(1.74)
Panel B: Around Issue CAR (0;+5)					
	(1) CAR	(2) CAR	(3) CAR	(4) CAR	(5) CAR
Relative Issue	0.122	0.127	0.130	0.155***	0.108
	(1.38)	(1.36)	(1.19)	(2.86)	(1.63)
ML	-0.172	-0.147	-0.155	0.058	0.009
	(-1.24)	(-1.06)	(-1.00)	(0.64)	(0.08)
Relative Issue × ML	0.016**	0.016**	0.016**	0.009*	0.011**
	(2.48)	(2.42)	(2.20)	(2.00)	(2.15)
Constant	-0.114	-0.181	-0.203	-0.505	-0.192
	(-0.16)	(-0.25)	(-0.24)	(-1.24)	(-0.38)
Panel C: After Issue CAR (+5;+10)					
	(1) CAR	(2) CAR	(3) CAR	(4) CAR	(5) CAR
Relative Issue	-0.020	-0.011	-0.064	0.059	0.013
	(-0.29)	(-0.15)	(-0.84)	(0.75)	(0.13)
ML	-0.023	-0.026	-0.130	-0.007	-0.064
	(-0.25)	(-0.25)	(-0.89)	(-0.06)	(-0.47)
Relative Issue × ML	0.006	0.005	0.009	0.004	0.006
	(1.45)	(1.18)	(1.64)	(0.76)	(1.13)
Constant	0.833	0.802	1.184	0.432	0.721
	(1.30)	(1.08)	(1.29)	(0.61)	(0.80)
Observations	99	99	97	98	96
Year FE	N	Y	Y	Y	Y
Currency FE	N	N	Y	N	Y
Industry FE	N	N	N	Y	Y

Table 5: *ML* and Issuer ESG Performance

This table shows regressions relating *ML* to ESG scores from MSCI. In Panel A, we use the industry weighted ESG scores and Panel B uses the absolute ESG scores. *Absolute ESG Score* is a weighted average of scores that a firm receives for specific industry-relevant key ESG issues that contribute to the ESG rating of a company. The *Weighted ESG Score* is calculated by normalizing the weighted average key issue score relative to industry peers and thus reflects a best-in-class assessment. Standard errors are clustered on ultimate parent and issue date-level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: Industry Weighted ESG Score					
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML
Weighted ESG Score	0.394	0.517	0.733*	0.637**	0.803**
	(1.32)	(1.64)	(1.88)	(2.07)	(2.23)
Constant	-2.146	-2.866	-4.139	-3.695	-4.668*
	(-0.92)	(-1.21)	(-1.48)	(-1.68)	(-1.81)
Observations	93	93	93	90	90
R^2	0.030	0.144	0.332	0.223	0.404
Panel B: Absolute ESG Score					
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML
Absolute ESG Score	0.535	0.804	1.370*	1.037**	1.481*
	(1.23)	(1.64)	(1.76)	(2.05)	(1.81)
Constant	-2.705	-4.153	-7.194	-5.533*	-7.918*
	(-0.93)	(-1.33)	(-1.58)	(-1.81)	(-1.69)
Observations	93	93	93	90	90
R^2	0.018	0.131	0.314	0.210	0.385
Year FE	N	Y	Y	Y	Y
Currency FE	N	N	N	Y	Y
Industry FE	N	N	Y	N	Y

Table 6: *ML* and Issuer E, S, and G Performance

This table shows regressions relating *ML* to individual pillar scores from MSCI in September 2019. Panel A focuses on the Environmental Pillar Score, Panel B on the Social Pillar Score and Panel C on the Governance Pillar Score. Standard errors are clustered on ultimate parent and issue date level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: Environmental Pillar Score					
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML
Environmental Pillar Score	0.257	0.416	0.580	0.510	0.644
	(0.86)	(1.29)	(1.14)	(1.59)	(1.27)
Constant	-1.314	-2.230	-3.179	-2.892	-3.662
	(-0.55)	(-0.88)	(-0.94)	(-1.18)	(-1.09)
Observations	93	93	93	90	90
R^2	0.010	0.121	0.294	0.190	0.362
Panel B: Social Pillar Score					
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML
Social Pillar Score	0.555	0.907	0.456	1.085	0.215
	(0.75)	(1.32)	(0.59)	(1.32)	(0.27)
Constant	-2.392	-4.016	-1.935	-4.958	-0.951
	(-0.81)	(-1.34)	(-0.54)	(-1.39)	(-0.26)
Observations	93	93	93	90	90
R^2	0.017	0.139	0.268	0.212	0.332
Panel C: Governance Pillar Score					
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML
Governance Pillar Score	0.428	0.459	0.743*	0.565	1.019*
	(0.97)	(1.02)	(1.74)	(1.15)	(1.83)
Constant	-2.198	-2.371	-3.937	-3.097	-5.616*
	(-0.75)	(-0.87)	(-1.45)	(-1.10)	(-1.75)
Observations	93	93	93	90	90
R^2	0.014	0.113	0.298	0.178	0.380
Year FE	N	Y	Y	Y	Y
Currency FE	N	N	N	Y	Y
Industry FE	N	N	Y	N	Y

Appendix A: Model Extensions

In this appendix, we extend the base model to allow first for a bonus payment instead of a penalty and second for callable features.

A.1 Bonds with a coupon bonus

Most SLBs are associated with a coupon penalty when the KPI is not reached. There is however an alternative structure that grants the firm a bonus, or a coupon payment reduction, when the KPI is reached. In this section, we analyze the effect of a bonus structure and the pricing of the SLB and the associated incentives for the manager.

We revert to the model analyzed in Section 4.1 and modify the payoff at maturity to account for the coupon payment reduction. In this case, the payoff to investors at maturity is given by

$$F - G\mathbf{1}_{X_1=g},$$

the investor accepts a reduction in payment of G if the environmental performance is increased. The fair price of the bond in this case is

$$B_0 = \frac{F - Gp(e)}{1+R}.$$

We can see that the terms depending on the probability of improvement, $-Gp(e)$, are unchanged compared to the SLB with a penalty, and it follows that incentives are unchanged. The price of the bond differs from the penalty SLB and reflects the lower payment at maturity. Again, if G is large enough, i.e., when

$$\frac{G(\overline{p} - \underline{p})}{1+R} > f,$$

effort is exerted by the manager, and investors pay the low price

$$B_0 = \frac{F - C\overline{p}}{1+R}.$$

Here again the structure implies that the cost of environmental performance improvement is paid by the manager. When the investor attributes a positive monetary value d to the case of

$X_1 = g$, the incentive is not modified, and the results under the penalty structure carry over to the bonus structure.

A.2 Callable bonds

A large share of SLBs have a callable feature. In this section, we extend the base model to allow for callable bond features and analyze when this setting can modify the incentives of the manager. We maintain the simplicity of the initial model but introduce a stochastic evolution of the interest rate, as otherwise the callable feature would be useless.

There are 3 dates $t \in \{0, 1, 2\}$. The interest rate r_t varies over time. At time 1 $r_1 \in \{\overline{r}, \underline{r}, \}$ with probability q and $(1-q)$, and at time 2, the KPI is measured, and the bond penalty is 0 or G. The probability of reaching the KPI at time 2 follows the description of the previous section and depends on the manager's effort $e \in \{0, 1\}$. At time 1, the bond can be called back at price K.

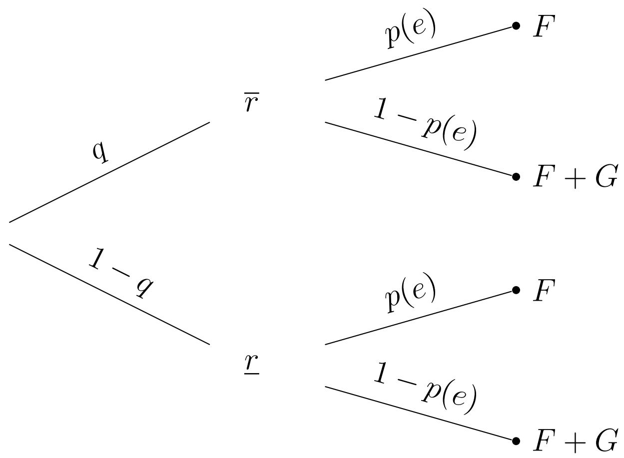

Figure A.1: Two-period Model Description.

The fair price at time 0 becomes

$$\frac{1}{1+r_0}\left(q\ \min\left[K, \frac{F+G(1-p(e))}{1+\overline{r}}\right] + (1-q)\ \min\left[K, \frac{F+G(1-p(e))}{1+\underline{r},}\right]\right)$$

Assume, without loss of generality, that without the KPI-linked penalty, the bond is only called when $r_1 = \underline{r}$, i.e.,

$$K < \frac{F}{1+\underline{r}}$$

in that case, effort is by construction not affected by the call feature since if $K < \frac{F}{1+\underline{r}}$, we necessarily have that

$$K < \frac{F + G(1 - p(0))}{1+\underline{r}}.$$

The potentially problematic case occurs when

$$K > \frac{F}{1+\underline{r}},$$

as we could then observe

$$\frac{F}{1+\underline{r}} < K < \frac{F + G(1-\overline{p})}{1+\underline{r}} < \frac{F + G(1-\underline{p})}{1+\underline{r}},$$

or even

$$\frac{F + G(1-\overline{p})}{1+\underline{r}} < K < \frac{F + G(1-\underline{p})}{1+\underline{r}},$$

which would condition the effort decision.

This can be resolved by assuming that the call exercise price is adjusted by an amount $A > 0$, if the bond is called prior to the KPI measurement (as is done in practice). In that case, we have the following result.

Proposition 3 *If $A > \frac{G(1-\underline{p})}{1+\underline{r}}$, then there is no situation where (i) effort is affected by the call feature and (ii) the bond is called because of the sustainability-linked penalty and not because of interest rate movement.*

As $\underline{p}$ may not be observable in practice, a natural alternative is to set

$$A > \frac{G}{1+\underline{r}}.$$

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