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The Economics of Sustainability Linked Bonds

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Abstract

We develop a conceptual framework to understand the incentive structure and pricing mechanisms of Sustainability-Linked-Bonds (SLBs). The model allows us to characterize the conditions under which an SLB is incentive compatible for a firm. We further derive a novel measure which identifies the extent of mispricing and potential wealth transfers between claim-holders at issuance. The model also allows us to compare the correct market yield of SLBs to the standard yield quoted by the industry. The comparison of the two yields suggests that the industry generally overstates the yield discount for firms that issue SLBs. The model generates several testable predictions. For instance, we provide evidence that SLBs which are overpriced according to our measure experience negative returns in the secondary market after issuance. We further show that for these overpriced bonds, the stock price reaction at issuance is significantly positive, which is consistent with a wealth transfer from bond - to shareholders Finally, we document a significant relationship between the mispricing measure and the issuing firms' ESG ratings, a relationship that is complex and non-linear.

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

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1 Introduction

At the United Nations' COP26 conference in Glasgow in 2021, global leaders convened and joined forces to reduce global GHG emissions and discuss a more effective implementation of the Paris Agreement. Although countries expressed a great consensus to take climate action, a massive financing gap still remains to meet the world's ambitious climate targets and to finance the energy transition. Similarly, social and governance objectives, as stated in the SDGs, will require massive financing that cannot be achieved only via public funds. Thus, the private sector becomes an important actor in this path to creating a more sustainable global economy and in this context their debt financing tied to sustainability objectives plays an increasingly important role. As of 2013, debtors started to issue so-called green, social and more generally sustainable bonds. With these instruments, sustainable finance and related security design have become a major trend in debt finance markets.

The most commonly used sustainability related fixed income instruments are green bonds (see Flammer (2021). These instruments allow firms to raise funds for specific and often pre-defined green projects. In other words, the use of the proceeds from such green bond issuance is restricted to specific projects. Perhaps, a reluctance to issue green bonds is related to the restricted use of proceeds and therefore lower flexibility for the issuer to use the money raised. More recently, so-called Sustainability-Linked-Bonds (SLBs) have started to emerge as an attractive alternative. Indeed, SLBs do not bind the collected money to be used for specific investments only. In contrast, funds raised through the issuance of SLBs can be used for all sorts of expenses. Instead of prescribing what the proceeds can be used for, SLBs follow a logic of obtaining results through linking coupon payments to the achievement of specific sustainability targets :indeed, coupon penalty payments are due if a specific Key Performance Indicator (KPI) is not reached by the issuing firm at a predetermined date. These KPIs and their subsequent fulfillment could potentially immunize SLBs from greenwashing if their incentive compatible mechanisms

were properly designed. Given the infancy of the SLB market, we know very little about the incentive compatibility of these debt instruments (i.e., do these bonds really incentivize managers to attain the sustainability targets), about their pricing in the primary bond market, their performance in the secondary market, and finally about the conditions under which SLB issues would allow genuinely motivated firms to signal their dedication to sustainability goals.

In this paper, we attempt to fill these gaps. We start 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 main questions: First, when are SLBs incentive compatible, that is, when can they induce managers to exercise costly effort in order to achieve their stated KPIs at a pre-defined horizon? We show that this can be accomplished when the coupon penalty is large enough. Second, we ask if it is possible to define a model-free measure of SLB's fair pricing and develop a novel measure capturing an SLB's mispricing, a measure we denote by ML.

ML is defined as the difference between the SLB issue price and a lower bound divided by the distance between an upper and a lower bound to the bond price. The lower bound is the theoretical bond price assuming the KPI is never reached, and therefore no penalty is paid. The upper bound is the theoretical bond price assuming the KPI is reached with certainty, and therefore the penalty is guaranteed. It is a model-free relative mispring measure that allows us to circumvent the fact that we don't observe the probability of a firm reaching its KPI nor the sustainability appetite and thus demand of investors for a specific SLB issue. We show that the measure plays a crucial role in determining the SLB's market pricing efficiency in the primary market. Finally, we ask under what conditions can sustainability-committed firms really signal their types by issuing these types of bonds?

In a second step, we test some of the model's implications. Specifically, we focus on three main empirical implications resulting from our model and establish the following three empirical findings: First, when our pricing measure ML is strictly larger than one,

SLBs issues are overpriced. Such overpricing subsequently leads to a post-issuance decrease in their prices on the secondary bond market. The secondary market performance difference between overpriced and underpriced bonds is about 1 percent over a 30 days horizon. Second, when ML is greater than 1, we document a significant wealth transfer from the bondholders to the shareholders of the issuing firms: in an event study setting conditional on overpricing (i.e., $ML > 1$) we find that the larger ML, the more positive the stock price reaction on the issuance date of the bond. Third, there is large heterogeneity in the pricing (and resulting yield discounts or premiums) of these bonds but we document a significant though complex and non linear relationship between these bonds ML measures and their issuing firms ' ESG ratings. The latter is due to the fact that we assume that both the probability of reaching the KPI and the investors appetite and derived monetary benefit from the SLB's environmental impact depend on the firm's ESG score. Moreover, a further contribution of our paper is to question the standard industry practice of quoting yields on these bonds and systematically documenting yield discounts because of the lack of consideration of the expected coupon penalty faced by these firms. Finally, our paper sheds light on some policy measures that would make this nascent debt market more efficient and the SLB issues more incentive-compatible.

Our paper makes three important contributions to the emerging literature on sustainable debt markets : it is the first study to provide a conceptual framework to examine the incentive compatible mechanism embedded in the security design of SLBs and to provide a simple measure of their departure from efficient pricing. Second, it adds to the growing empirical literature on green bonds and SLBs more recently by documenting circumstances - in terms of ML levels - under which these bonds are overpriced and thus lead to undesirable wealth transfers from bondholders to shareholders of the issuing firms. Finally, the model contributes to the growing literature in asset pricing that allows for the existence of "green" investors or more generally of investors with sustainability preferences (see Pástor, Stambaugh, and Taylor (2021), and Pedersen, Fitzgibbons, and Pomorski (2021).

The structure of the paper is the following: In Section 2, we provide a short review of related papers. Section 3 presents an example of a typical SLB issue, followed by descriptive statistics of the young SLB market. Section 4 presents our theoretical model and its main testable predictions. Section 5 describes the data and our main empirical analysis. Section 6 concludes with a summary of our main findings, as well as with some policy recommendations.

2 Literature review

Our paper is primarily related to research focusing on green bonds. For instance, Zerbib (2016) compares the yield of green and equivalent plain-vanilla bonds to estimate the yield differential between green and otherwise identical conventional bonds and lower yields on green than on other conventional bonds, i.e., an average small negative green bond premium. His analysis shows also 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. Baker, Bergstresser, Serafeim, and Wurgler (2018) 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. The positive response is more pronounced for first-time issuers and green bonds that are externally certified. Furthermore, after issuance, the environmental rating of the issuing firms increase and the firm-level CO2 emissions decrease. In addition, equity ownership by long-term and green investors increases. Based on her evidence, Flammer (2021) argues that firms issue green bonds to send a credible signal of their environmental commitment, whereas 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. The researchers

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 repeating issuers receive an additional premium compared to companies that only issue one time. In case of financial institutions, they cannot find a yield differential at the times of issuance. The researchers argue that investors are unable to connect the green bonds issued by the financial institution to a green investment project and therefore there is no green premium for issuers from the financial sector (see Fatica et al. (2021)).

Whereas 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 with societal benefits by comparing green bonds to identical non-green bonds issued by the same issuers on the same day. The researchers document that pricing for green and non-green issues are identical. Therefore, in a real market environment, investors are not willing to trade off their wealth for environmental projects. When holding risk and payoffs of green and non-green bonds constant, the researchers can show that investors are indifferent between both 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 look at stock-price and stock turnover sensitivity of managers' 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 to carbon pricing, but rather that carbon pricing make green bonds more effective.

Given that Sustainability-Linked-Bonds (SLBs) are rather new instruments, it is not surprising that the literature that focuses on these instruments is still in its infancy. Liberadzki, Jaworski, and Liberadzki (2021) examine whether SLBs that were recently issued by Tesco and which 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.

The recent and more comprehensive empirical study by Kölbel and Lambillon (2022) uses a bond matching technique initially developed to study the fair pricing of green bonds and documents for a large sample of 102 SLBs that issuers benefited from a sustainability price premium which is larger for callable bonds and for bonds that bear a higher coupon step-up. More precisely, they identify an average yield discount for their sample of -29.2 bps which compares favorably with the average coupon step-up of 26.6 bps, thus companies in their sample collect a net average benefit of 3.5 mio USD. Given that some SLB issuers have higher yield savings than the potential coupon penalty, the authors argue that there is some degree of greenwashing prevailing in this new sustainable bond market segment.

Our paper contributes to this emerging literature on sustainability related debt market securities and more specifically on SLBs by providing the first conceptual framework that allows us to study when these bonds create the right incentives for managers to exert effort to meet their sustainability KPIs and the conditions that allow dedicated firms to signal their commitment to their stated sustainability KPIs. Secondly, we contribute to a better understanding of these bonds pricing mechanism by providing a "model-free" measure that allows to infer the degree of SLBs mispricing and that leads to testable implications. We show that this measure denoted by ML depends non-linearly on the firm's ESG performance and the total coupon penalty. Analyzing the distribution of the mispricing proxy shows that about 20 % of the SLB issues are overpriced (i.e., display $ML > 1$, that is superior to the theoretical upper bound). The mispricing ultimately translates into an empirically documented wealth transfer between the bond and the shareholders of these SLB issuing firms.

3 SLB structure and institutional background

3.1 SLB mechanism

According to the ICMA (International Capital Market Association)[1], Sustainability-Linked-Bonds 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."

In contrast to Green Bonds, the issuer commits to a predefined, quantifiable, and verifiable sustainable objective. This objective is documented and includes a time horizon over which the sustainability objective is to be reached. Objectives must fulfill two main criteria. First, they must be measurable through a Key Performance Indicator (KPI). Second, objectives must be assessed against a predefined Sustainability Performance Target. In addition, the proceeds raised from a sustainability bond issue can be used for general purposes and are not bound to a specific green project.

Another difference with respect to green bonds is that the company may address not only environmental topics, but also other sustainability topics such as governance related or social outcomes. In principle, SLBs can cover environmental, social, and governance issues. In practice, however, most SLBs are related to environmental issues. Analyzing SLBs that can be identified in Bloomberg, we find that 233 bonds addres environmental targets (233) followed by governance targets (23) and social targets (21). Within the environmental KPIs companies mainly focus on GHG emissions reduction targets (174), followed by renewable energy targets (35), energy efficiency targets (27), waste reduction (20) and water management related targets (17). Regarding governance targets, companies mainly commit to greater board diversity or employee diversity. Only 8 companies address social targets. The nature of the targets can vary from linac (linear accelerator) installed and patient reached to reduction in accident frequency and training underprivileged people. Finally, some step-ups can be triggered by a decrease of the companies'

[1]The International Capital Market Association or ICMA is a self-regulatory organization and trade association for participants in the capital markets.

overall ESG rating.

The financial structure of the SLBs can change after issuance, depending on whether the relevant KPI is reached or not. The change of payment structure is initiated by a predefined trigger event. Most often, this trigger event corresponds to the company failing to achieve its KPIs at a predefined observation date. If the company fails to reach its KPI in time, the coupon will *step-up* by a predefined penalty. Some SLBs include a coupon step-down option if the KPI is reached, but this structure is less common. 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 occur less commonly. In the latter two structures, the coupon structure is unaffected. Through Key Performance Indicators ("KPIs") and Sustainability Performance Targets ("SPTs") the materiality and ambitiousness of the company's objectives can be externally verified and quantified. Independent and external verifiers can issue a Second Party Opinion before the bond is issued and certify that the SLB framework is Sustainability Linked Bonds Principles (SLBP) aligned. After issuance, the external verifiers can provide verification and monitoring if a KPI is reached after issuance.

3.2 Example: Enel SLB Issue October 2020

An illustrative example of an SLB with a common structure is the SLB issued by Enel Finance International NV on October 20th, 2020. Enel is a Netherlands-based company that raises funds for companies belonging to the Enel Group. The sustainability linked bond (XS2244418609) was issued on October 20th 2020 and matures on October 20th 2027. It carried a BBB credit rating and was issued at 97.747 per cent of the Aggregate Nominal Amount. The bond comes with a 1 per cent fixed coupon rate that is subject to a 25bps coupon step-up option. The additional coupon step-up is conditional on a step-up event concerning the 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. Like many SLBs, 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). VE uses a scale for the KPI's relevance and SPTs ambition from weak, limited, robust to advanced and maps the firm's objectives to the Sustainable Development Goals (SDGs). Overall, VE identifies Enel‘s Sustainability-Linked Framework as aligned with the Sustainability-Linked-Bond-Principles (SLBP) and in line with best practice. The KPI relevance and SPTs ambition are assessed to be advanced and which is the highest category on the scale.

Figure 1 about here.

In figure 1, we illustrate the step-up mechanism of an SLBs.

3.3 Market size and evolution

The Sustainability Linked Bond Markets is growing strongly. In Bloomberg, there were a total of 434 bonds flagged as Sustainability-Linked as of February 2022. While in 2018 only one SLB with $0.22 billion was issued, the number of SLB issued per year has increased steadily over time to 338 issues in 2021 amounting to $160billion. The average issue amount for the sample is $473 million.

Compared to the about 4,600 green bonds issued since 2013, these numbers might seem small. However, the average issue amount for SLBs is already larger than that of green bonds, which stood at about $326 million as of 2021. The larger scale of SLB issues might be due to the key differences between SLBs and green bonds which we highlight in section 3.2.

Figure 2 about here.

Figure 3 about here.

In Figure 2 we can see the number of SLBs issued from 2018 to February 21, 2022. The number of issues per year increases over time. In 2021 the number of SLBs issued was 338 which is 7.5 times more than in 2020. Similarly, Figure 3 shows that in 2021 SLBs worth $160bn were issued, compared to only $16bn in 2020.

The number of SLBs issued in the first two months of 2022 is already comparable to the total number issued in 2020. Whereas the amount issued by these bonds already exceeds with $19.32bn the total amount in 2020 by around 3 billion. The numbers demonstrate the rising popularity of these instruments which is most likely going to persist in the following years.

4 The model

In this section we develop a theoretical framework to analyze the pricing and incentive aspects of SLBs. We then introduce our measure of potential mispricing ML and describe how it relates to the firm's ESG score. We also analyze the relation between ML and the firm's cost of financing, emphasizing the potential signaling effect.

4.1 Fair pricing and incentives

We develop first an analysis of the valuation of sustainability linked bonds. For that purpose, we propose a highly stylized model which focuses on two elements: (i) the incentive compatibility structure of the coupon penalty, i.e., do SLBs incentivize managers to engage efforts to improve the environment? (ii) The environmental benefit perceived by investors, i.e., are managerial incentives affected by the presence of environmentally concerned investors?

We consider a one period model. There is one firm with 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 a sustainability linked bond (SLB) with face value F at maturity (maturity date is time 1). The environmental performance[2] 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 the environmental performance is bad. 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 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 the environmental performance of the firm.

The fair price of the bond for a risk neutral investor who derives no benefit/cost from

[2]In this section we focus on environmental performance to simplify notation, but the model applies by extension to social and governance KPI as well.

the environmental performance of the firm is

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

Consider first the case where investors assume the manager will provide no effort. 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 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 exercised by the manager if the discounted " expected penalty saving "is higher than the cost of exercising the environmental investment. We show in the appendix that replacing the penalty structure with a bonus structure, where the investors agrees to an interest payment reduction in case the KPI is reached, generates the same incentive structure.

Let us assume now that investors internalize the environmental performance, 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 doesn't internalize the environmental performance and would not exert effort in the absence of the bond issue. It follows that the environmentally concerned investor is willing to participate in the bond offering).

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

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

Exerting no effort yield $V(0) = 0$ 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 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

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

and 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 actual infrastructure cost paid by the firm to improve the environmental performance. For some parameters values the investor pays more than the actual cost of infrastructure, this is the case when the following condition holds*

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

W is then the amount directly transferred from the bond investors to the shareholders of the firm.

4.1.1 An empirical measure of SLBs under/over pricing

In practice, it might prove difficult to observe or infer the probabilities $\overline{p}$, $\underline{p}$ and the bond investors' private benefit d, which in turn precludes a direct analysis of the potential wealth transfers described above, and other issues related to over and under pricing. To circumvent this difficulty, we introduce the variable ML which is an empirically observable proxy for either the (risk adjusted) probability of reaching the KPI or the extent of under and/or over pricing.

Assume we observe a sustainability linked bond 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 $B(x, y, z)$ a standard bond with face value x, coupon y and maturity z. For the sustainability linked bond, we have the following upper and lower bounds, respectively

UB and LB:

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

The upper bound can be replicated using two different bond portfolios and the lower bond is simply obtained via the price of a straight pure vanilla bond assuming the penalty is never reached. These quantities can also be computed using pre-defined yield curves, which can be specific to the issuer, or associated to the industry, currency and credit rating.

For a given sustainability linked bond, we can now define the variable ML

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

If the bond is fairly priced $ML \in [0, 1]$ and represents a market assessment of the issuing firm's ability to reach the KPI at date τ, with $ML = 1$ a perceived guaranteed failure, and $ML = 0$ a perceived guaranteed success. 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 set of empirical implications.

Empirical implication 1 *For a given sustainability linked bond, $ML > 1$ indicates overpricing. It follows that bonds with $ML > 1$ at issue should significantly underperform on the secondary bond market.*

Overpriced sustainability bonds are potentially good news for equity investors, because they imply that firms raise funds at a lower rate and suggest wealth transfers from bondholders to shareholders:

Empirical implication 2 *For a given sustainability linked bond, $ML > 1$ indicates*

overpricing. It follows that if bonds are issued with $ML > 1$, stock prices should react positively to $ML > 1$ reflecting the potential wealth transfer.

4.1.2 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 to the case $X_1 = g$ are assumed constant. We extend here 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 score, which we label s. This seems plausible as a better ESG rated firm may be perceived as having greater potential and credibility to reach its KPI . Also many institutional investors pursue investment strategies such as positive screening or ESG integration which could explain the link between d and the firm's ESG rating. We therefore assume $\overline{p} = p(s)$ and $d = d(s)$. Using the SLB price given in Equation (1), we can write ML as follows

$$ML = (1 - p(s)) + (p(s) - \underline{p})\frac{d(s)}{G}. \tag{3}$$

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

Empirical implication 3 *Controlling for bond characteristics, we expect ESG scores to be significantly related to ML. Furthermore, Equation (3) implies that the relation*

between ML, ESG scores, and conditional penalty G is non-linear.

4.2 Signaling and total cost of financing

SLBs can provide managers with a signaling mechanism. They can be used to reveal a firms' environmental concerns, and in particular separate them from others which issue conventional bonds. In this section, we provide an analysis of the firm's cost of financing with a particular focus on cost of 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 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 corre-

sponds 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 it finances itself by 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 section Remark 1). This may happen when bondholders have a strong appetite and are willing to pay a lot for environmental improvements. Such wealth transfers could be avoided if f had to be disclosed upfront in the firm's issuance prospectus.

Figure 4 illustrates the situation for various level of environmental benefit perceived by investors and 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 case (i) and (iii) where bond investors environmental concerns lead them to sponsor the firm into investing in improved infrastructure (effort f).*

Figure 4 about here.

4.2.2 Cost of financing perceived by 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 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 as it does not include the fixed cost paid by the manager/firm. Since $d > 0$ we have only 2 cases

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

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.

4.2.3 Cost of financing assuming KPI is reached

The financial industry's standard to quote the yield on an SLB doesn't account for the potential coupon penalty. Assuming 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 $\hat{\pi}^e_{\text{ind}} < 0$.

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 as follows

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

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 $G > 0$. 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 infrastructure cost), a more correct measure of the cost of financing is given by $\hat{\pi}^e$ which relates to ML as follows

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

Notice 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 $G(1 - \overline{p})\,(1 + R)$.

Figure 5 displays the additional cost of financing as measured by the industry and as perceived by the market. The latter appears above the former as we are assuming that $\overline{p} = 0.2$ and hence inferior to 1. Figure 6 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. Notice however that the surface always exists whenever $\overline{p} < 1$.

Figure 5 about here.

Figure 6 about here.

Thus, to summarize, our conceptual framework allows us to characterize the situations when the SLB is incentive compatible for the firm, it allows us further to rely on a model-free measure ML which identifies the extend of potential mispricing and wealth transfers associated with an SLB at issuance (even though managerial effort and investors ESG preferences are unobservable) and finally it allows us to distinguish the proper market

yield of such bonds from the standard yield quoted by the industry. This, in turn, allows us to state that the industry generally overstates the benefits from firms to issue SLBs. In the next section, we turn to the empirical validation of our model's main predictions.

5 Empirical Analysis

In this section we first describe our data and detail the procedure followed to construct the variable ML. We then proceed to test the empirical implications derived in section 4.

5.1 Data description

We collect data from Bloomberg, Refintiv, and corporate websites. We start by extracting all bonds in the Bloomberg database labeled as "Sustainability-Linked-Bond." As of February 2022, there were 434 on Bloomberg labeled as SLB. The earliest issue date is on the 18th of November 2018 and the latest on the 10th of February 2022.

Besides the issuing companies' names and the bond issuance dates, we collect ISINs, maturity dates, announcement dates, coupon rates, currency of the issue, and issue amount in USD for each bond. We use ISINs to match the bonds extracted from Bloomberg with the Refinitiv database. We also collect the note description, which provides important information about the coupon step-up option and step-up date of the SLB.

Not all bonds have an ISIN on Bloomberg, and we can therefore not match all of them. We drop all bonds without ISINs. Furthermore, we exclude all bonds that have a callable feature that could affect the pricing[3]. We keep only bonds with a clean-up call option (where the bond can be called within the last three months before maturity) and make-whole callable feature (as this call option comes with high cost for the company and is therefore unlikely to be used).

[3]Appendix A.2 derives the conditions under which the call feature of an SLB does not affect the effort decision by the manager.

We only work with bonds we can identify with their Bloomberg ISIN on Refinitiv and therefore verify the information on Bloomberg. For the remaining bonds, we use the note descriptions on Bloomberg and Refinitiv to infer the coupon step-up, i.e., the penalty, and the step-up date. If the step-up date is not explicitly mentioned, we use the coupon date following the observation date. If there is no information about the coupon step-up and/or step-up date in neither Refintiv nor Bloomberg, we collect the data either from the bond prospectus or from the announcement on the companies' websites.

To assess the credit rating of the bond, we collect the data item *bond rating* from Refinitiv. If there is no bond rating we use the issuer rating. Finally, we collect the company economic and business sector classification from Refinitiv.

In Table 1 we display summary statistics. We provide basic information on the sustainability linked bonds and issuer information (e.g., ESG Scores).

In total, the final sample has about 180 SLBs. The average Issuance Price is 99.76 and the original yield to maturity as reported by Refinitiv is 2.86. The average coupon is 2.92, which is paid 1.8 times per year on average, suggesting that a considerable number of bonds has semi-annual coupon payments. The median rating of SLBs is BBB.

The average coupon step-up penalty is around 28bps, and the median step-up is 25bps. In fact, the large majority of companies uses a step-up of 25 bps given that the first quartile of the Penalty variable is also 25bps.

The step-ups also differ in terms of the step-up dates. The average time until a coupon step-up can be triggered (a variable we denote by τ) is 4.83 years, which is on average about 59 % of the time to maturity. The average maturity of the SLBs is 8.2 years.

A variable of interest in our analysis is the cumulative potential penalty. We calculate it as follows: Total cum. penalty $= (T - \tau) \times G$, where G denotes the periodic penalty, and T the time to maturity. On average, the cumulative potential penalty is 87bps.

Table 1 about here.

We also collect some additional information at the bond- and issuer-level. For in-

stance, we observe that about 40 percent of the bonds have a second party opinion. We go through the second-party assessments that we can find and hand-collect two additional variables, i.e., Target Ambition, which measures if the second party thinks that the target is ambitious and KPI relevance, which is an assessment of whether the target is financially material to the company. We also collect a variable from Refinitiv if the bond is eligible for the ECB bond buying program: approximately 20 percent are ECB-eligible. Finally, we also collect ESG scores from Refinitiv.

5.2 Constructing ML

To construct ML, we need the issue price of the SLBs and bond prices to construct the bond portfolios, which set the lower and upper bounds. We obtain the issue price from Refinitiv.

Payment details

To construct the upper and the lower bounds, we use the issue date, the maturity date, the coupon rate, the coupon frequency, the penalty (e.g., coupon step-up), and the step-up date (i.e., the date on which the potential step-up is triggered). Combining issue and maturity dates, we calculate the maturity T in years. Relating maturity and step-up dates allows inferring τ, which is the time until the coupon is paid without the penalty and after which the step-up option can be activated.

Discount factor

To discount the occurring payments properly, we use three different types of credit curves with different coverage. We obtain the credit curve data from Refinitiv. Specifically, Refinitiv offers issuer specific credit curves and curves that are based on currency, rating, and sector (economic[4] or business[5]). They use a minimum of five bonds to calculate the curves.

Issuer curves can be retrieved tenors for 1-10 years, 12 years, 15 years, 20 years, 25

[4]We refer to the economic sector curve in Refinitiv as sector curve in this paper

[5]We refer to the business sector curve in Refinitiv as sub-sector curve in this paper

years, and 30 years.

Sector curves cover the tenor yields of 3 months, 6 months, 1-10 years, 12 years, 15 years, 20 years, 25 years, and 30 years

For tenors for which no yield is given, we interpolate linearly with the two closest yields available. Furthermore, we interpolate annual yields to construct semi-annual yields to price bonds with semi-annual coupon payments. Bonds with quarterly coupon payments we treat as semi-annual coupon paying. We use issuer, sector, and sub-sector credit curves.

UB and LB

The lower bound (LB) is the price of a bond with fixed coupon equal to the SLB original coupon, that is without penalty. This corresponds to the lowest possible fair price of the SLB, when the probability of reaching the KPI is 1.

The upper bound (UB) is the price of a bond with fixed coupon equal to the SLB original coupon until the step-up date and SLB original coupon plus the penalty from the step up date until the maturity. This corresponds to the highest possible fair price of the SLB, when the probability of reaching the KPI is 0. This upper bound can be constructed as a portfolio of three bonds as indicated in section 4.1.1.

ML is constructed using the lower bound, the upper bound and the issue price of the SLB as in equation (2).

Table 2 about here.

Table 2 shows summary statistics of the pricing related variables (e.g., the bonds needed to construct the bounds, but also UB, LB, and ML etc.). These are the empirical counterparts to the theoretical objects (see also section 4.1.2 for more information). To deal with extreme observations of ML, we drop observations that deviate from the median more than five times the interquartile range. The median value of ML is -1.65, consistent with the notion that the median SLB is underpriced. This is consistent with a median

issuance price of 99.91 (see Table 1). The number of observations is higher in this table because we price the bonds using (i) issuer, (ii) sector, and (iii) sub-sector curves. Hence, if an issuer curve is available, we can price the bond in three different ways and thus potentially have three pricing observations per bond.

5.3 Testing empirical implication 1: Post-issuance SLB performance on secondary market

Values of $ML > 1$ imply overpricing. Empirical implication 1 states that these bonds should therefore underperform post-issuance. Figure 7 shows secondary market returns for the SLBs during the first 30 days after issuance conditional on ML. We form two portfolios. First, a portfolio of bonds for which $ML < 0$. The second portfolio contains bonds with $ML > 1$. We restrict the analysis to bonds which are priced using the currency, rating, and sector specific yield curves. We calculate bond returns based on daily bid close prices.

The graph plots the average cumulative returns for the two portfolios. Consistent with empirical implication 1, we find that overpriced bonds (i.e., bonds with $ML > 1$) exhibit negative cumulative returns of about one percent up to thirty days post issuance. In contrast, bonds with $ML < 0$ (i.e., underpriced bonds) do not exhibit issuance returns different from zero.

Figure 7 about here.

In Table 3, we confirm that the result of differential post-issuance secondary market returns depending on whether bonds are over- or underpriced is not driven by other observable or unobservable differences between these bonds. To do so, we regress the 30-day cumulative post issuance bond return on a dummy variable indicating ML>1. Standard errors are double clustered by issue date and ultimate parent level to reflect that bonds issued on the same day or by the same firm are not independent. Consistent with

the graphical evidence of Figure 7, we find in column (1) of the table that the coefficient on the dummy is negative and significant. In column (2) we control for the credit rating of the bond or, if unavailable, the issuer credit rating. The variable *ratingN* takes on lower values for better credit ratings (i.e., AAA=1, BBB=4, etc.). If anything, controlling for the credit rating strengthens the difference. In column (3) we control for the original yield as reported by Refnitiv. In columns (4)-(6) we control for coupon, penalty, and the issue price. In all these regressions, the dummy remains negative and significant. In Columns (7)-(8) we saturate the model further by simultaneously controlling for the previous control variables and successively adding Year, Currency, and Industry fixed effects: the return difference between over- and underpriced bonds (i.e., the coefficient estimate for the dummy $ML > 1$ remains significant across these specifications. We observe an economically significant impact ranging from 1 to 1.4 % depending on the specification. Thus, we can state that our first model implication is supported by these empirical results.

Table 3 about here.

5.4 Testing empirical implication 2: Wealth transfer from bondholders to shareholders

To test if, consistent with empirical implication 2, overpriced SLB issuance results in wealth transfers between different types of investors, we carry out an event study using stock returns. For each firm issuing an SLB and for which stock returns are available, we calculate abnormal returns as the difference between the firm's stock return and the market index in the country in which the firm is headquartered. Following Flammer (2021), we calculate cumulative abnormal returns between five days prior to the issuance date and 10 days after. We split the sample in two groups, i.e., $ML < 0$ and $ML > 1$.

Table 4 about here.

For the two groups, we separately regress in Table 4 the cumulative abnormal returns on a constant and ML : see column (2) for $ML < 0$ and column (4) for ML>1. We also report the regressions for the whole sample (column 1) and $0 \leq ML \leq 1$ (column 3). The analysis shows that abnormal returns are increasing in ML for the group of overpriced bonds (column 4), consistent with overpriced SLBs resulting in wealth transfers from bondholders to shareholders. However, cumulative abnormal returns around the issuance date are not related to ML in the group of bonds for which ML < 0. In terms of economic magnitudes, the regression estimate in Column (4) Table 4 implies an about 1.8 percentage points higher CAR for an interquartile range increase in ML (conditional on $ML > 1$).

5.5 Testing empirical implication 3: ML and ESG score

5.5.1 Linear regression analysis

Another implication from the theoretical analysis in section 4.1.2 is a potential relation between ML and a firm's ESG performance as measured by its ESG rating. In Table 5, we explore this relation in an OLS regression framework. We regress ML on the issuer-level ESG score. We use all available pricing data (i.e., in case we have priced the same bond using Issuer, Sector and Sub-sector credit curves), we would use three observations for this bond. To account for the resulting clustering at the SLB level, we cluster standard errors at the SLB-level. In Panel A, we use the total ESG score. In Panels B-D, we use the E, S, and G component scores. We tend to find a positive relation between ML and a firm's ESG performance. This relation become stronger once we control for pricing effects, which we control for by including fixed effects for the credit curve used to construct ML, and other unobservable issuer- and bond specific characteristics (e.g., the year, the currency, the rating of the issue) as well as the industry of the issuer. The relation between ML and the ESG scores is most pronounced when using the Environmental component (Panel B).

The last finding seems plausible given that the large majority of the sustainability linked rely on environmental KPIs.

Table 5 about here.

5.5.2 Structural estimation

In section 4.1.2 we establish how ML varies when both the probability of reaching the KPI and the monetary value d to the bondholders associated to the case $X_1 = g$ depend on the issuing firm's ESG score. In particular, Equation (3) highlights the non-linear relation between ML, the ESG score and the conditional penalty G. In this section, we estimate a non-linear model with the following functional form assumptions. The private value of environmental improvement (d) is given by

$$d(\text{ESG}) = d_0 + \beta_0 \text{ESG} + \beta_1 \text{ESG}^2,$$

and the probability of reaching the KPI is given by

$$\overline{p}(\text{ESG}) = ESG^{\alpha}.$$

It follows that ML can be written as

$$ML = (1 - \text{ESG}^{\alpha}) + (\text{ESG}^{\alpha} - \underline{p}) \frac{d_0 + \beta_0 \text{ESG} + \beta_1 \text{ESG}^2}{G}.$$

The parameters to be estimated are $\Theta \in \left(\alpha, d_0, \beta_0, \beta_1, \underline{p}\right)$ and the observations are triplets (ML, ESG, G).[6] We estimate the model using a non-linear least square approach.

Table 6 about here.

[6] One observation with coupon penalty close to 0 is removed from the sample, we hence focus on 112 observations instead of the 113 observations in the previous analysis.

The results are presented in Table 6. All model parameters are statistically significant and the adjusted R-Squared is 0.443. The dependence between the probability of reaching the KPI and the ESG is positive and convex, with an estimated $\hat{\alpha} = 2.2795$. Moreover, the environmental benefit to investors, d, is significantly related to ESG, but the relation is indeed nonlinear with a positive coefficient $\hat{\beta}_0$ on the linear term and a negative coefficient $\hat{\beta}_1$ on the quadratic term. These last results support our third testable implication regarding the non linear relationship between ML and the firm$^s ESGrating$.

Figure 6 about here.

6 Conclusion

This study develops a novel conceptual framework that aims to foster a better understanding of the intended and unintended consequences of SLBs security design. The conceptual framework allows us to first characterize the situations in which the SLB is incentive compatible for the firm, that is, when the coupon penalty is sufficiently high. Second, the framework allows to propose a model-free measure of mispricing (denoted by ML), which identifies the extent of potential mispricing and wealth transfers associated with an SLB at issuance (even though managerial effort and investors ESG preferences and appetite are unobservable). Finally, the conceptual framework allows us to contrast the true market yield of such bonds 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) for firms that issue SLBs. Our model also delivers several testable predictions, which we then take to the data by defining and computing our ML mispricing measure using the SLBs issue prices and these bonds' upper and lower price bounds which are obtained from the hypothetical bond prices obtained from comparable yield curves that price the SLB bonds assuming the KPI is reached and never reached respectively. We show first that when ML exceeds one at issuance, overpricing occurs,

which subsequently leads to falling SLBs prices in the secondary market. We further show that for these overpriced bonds, which represent a quarter of our sample, the stock price reaction at issuance is significantly positive the larger ML, which is consistent with a wealth transfer from the bond to the shareholders of these issuing firms. Finally we document a significant relationship between ML and the bond-issuing firms' ESG ratings. The relation between ML and ESG scores is complex and non-linear and points to the heterogeneity and complexity of the pricing patterns observed in this new bond market segment.

Our study embeds several policy implications. First, one should require greater transparency in the bond prospectus and certification process by requiring that firms also disclose parameter f, that is the cost of implementing the environmental (or social or governance) infrastructure needed to reach the KPI. Second, sustainable finance literacy is needed to prevent the overpricing of these issues which ultimately benefit the shareholders of the issuing firms. To achieve that goal, investors and in particular, institutional investors flows should be channeled less mechanically into these issues as 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 [7] [8] [9] as our ML measure could be a simple conceptually relevant tool to get to the core of the efficent pricing mechanism of these bonds while accounting for their expected penalty component.

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

[8] 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 and 10bp on the 15-year. Books were €3.1bn-plus, €3.6bn-plus and €3.7bn-plus, respectively.

[9] 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. https://www.ifre.com/story/2908666/enel-speeds-transition-with-jumbo-slb-b6xb6tmvml

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Figures

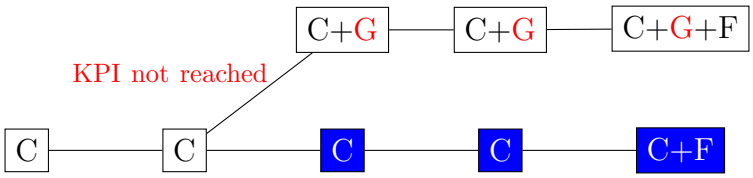

Figure 1: SLB payment structure

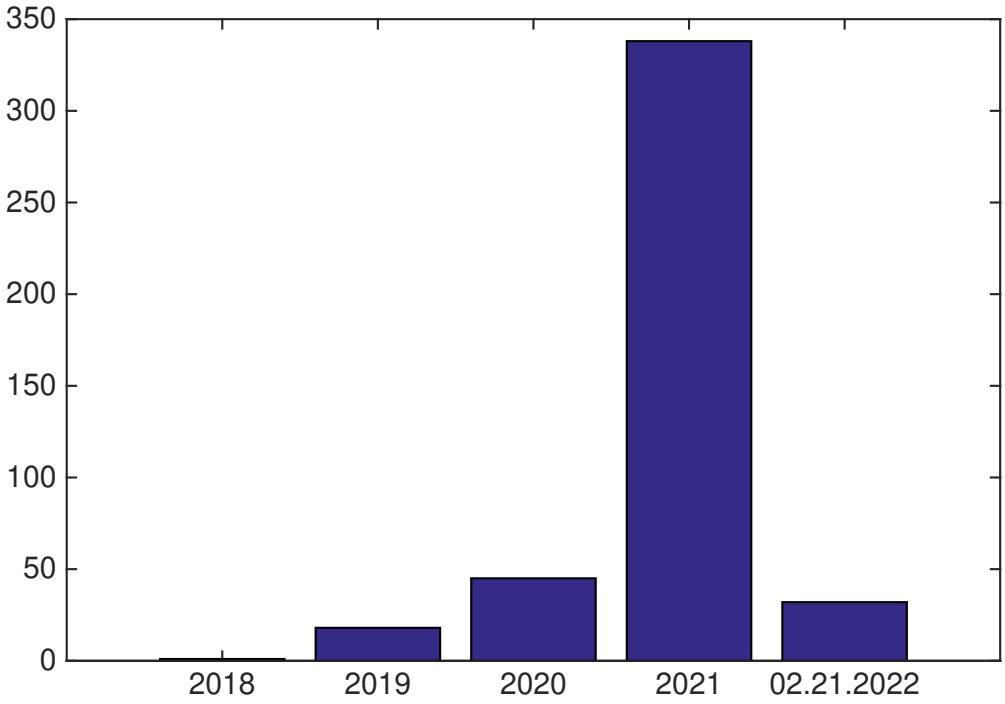

Figure 2: Number of SLB issues

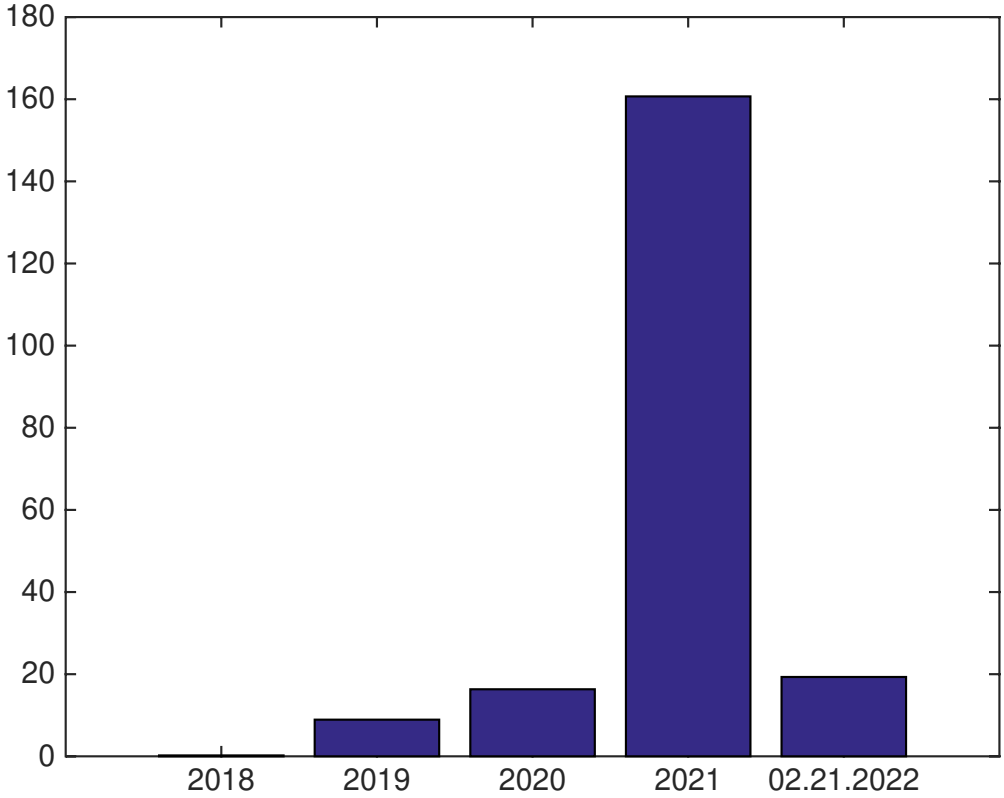

Figure 3: USD amount of SLB issued (in billion USD)

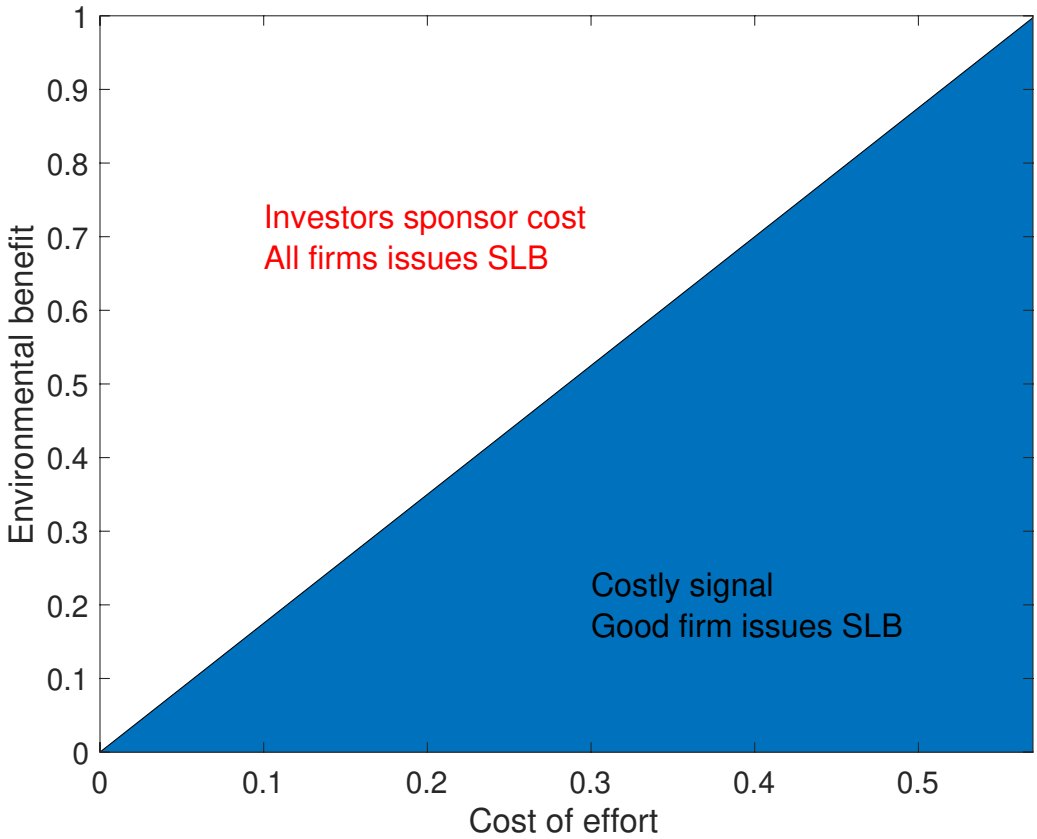

Figure 4: Separating and pooling regions for different levels of environmental benefit perceived by investors and effort cost to the manager. $\overline{p} = 0.8$, $\underline{p} = 0.2$ and $R = 0.05$.

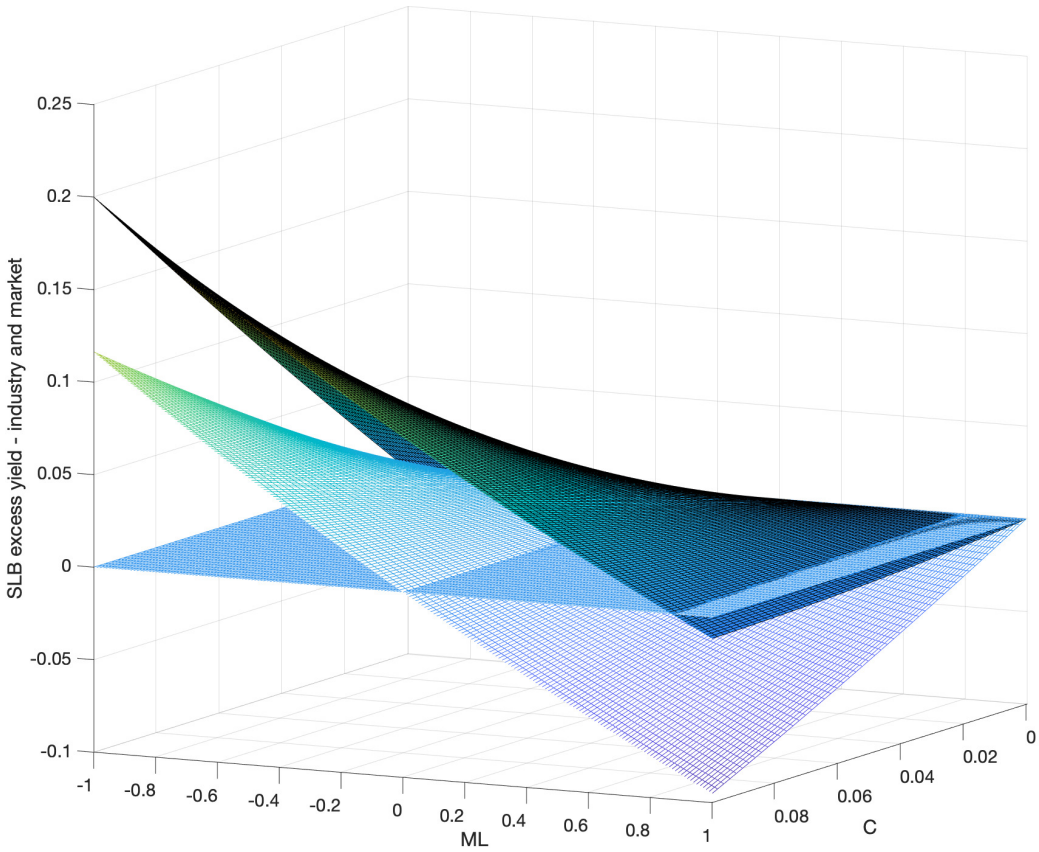

Figure 5: Excess yields from *industry* standard and perceived by the market as a function of ML and penalty C. We assume $R = 0.05$, $F = 1$ and $\overline{p} = 0.2$.

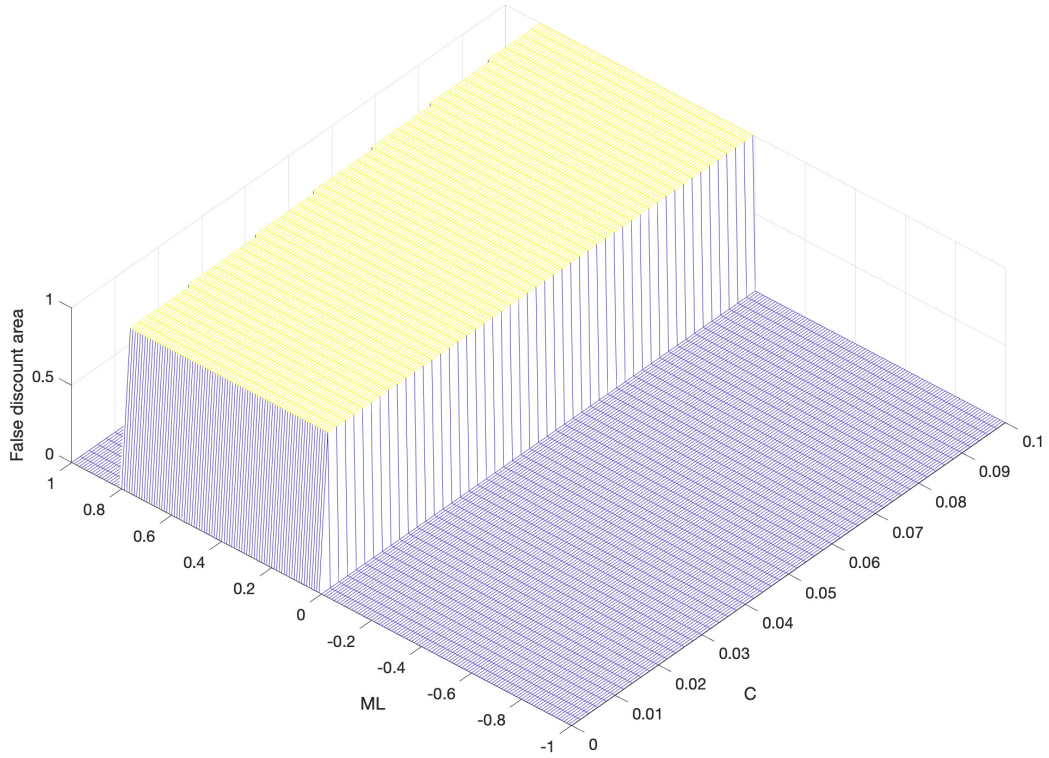

Figure 6: Indicator of a false discount as a function of ML and penalty C. We assume $R = 0.05$, $F = 1$ and $\overline{p} = 0.2$.

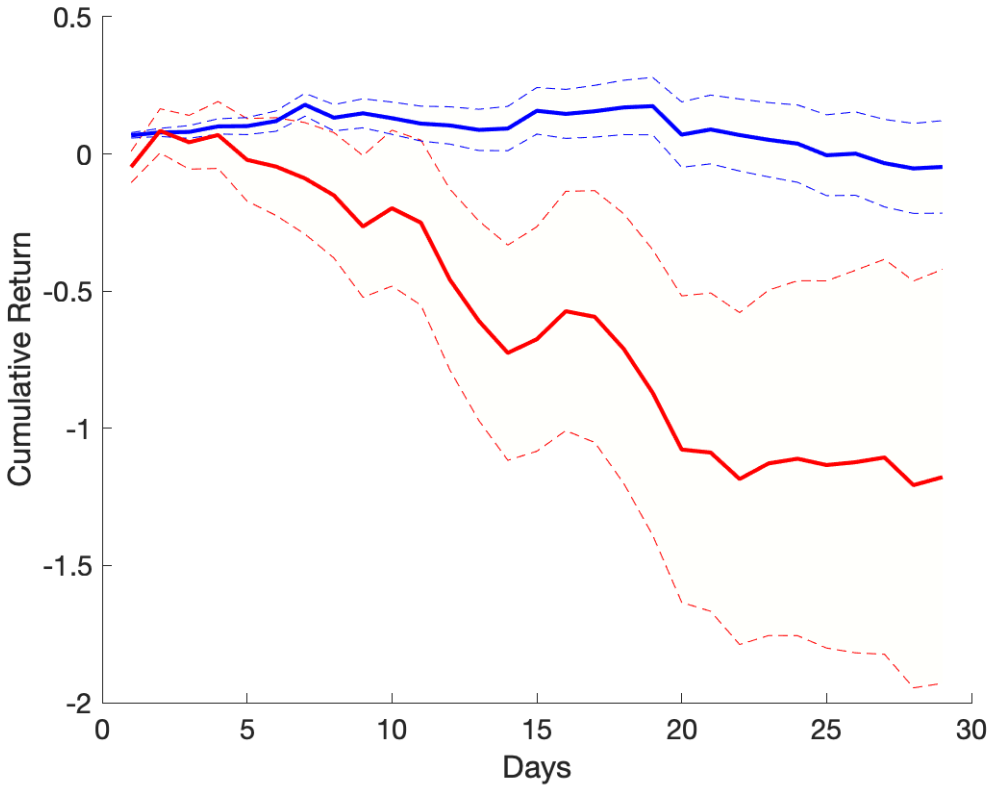

Figure 7: Bond returns 30 days after issuance date for bonds with ML < 0 in blue and ML $>$ 1 in red. The Shaded areas represent 95 % confidence interval. Units are in percentage.

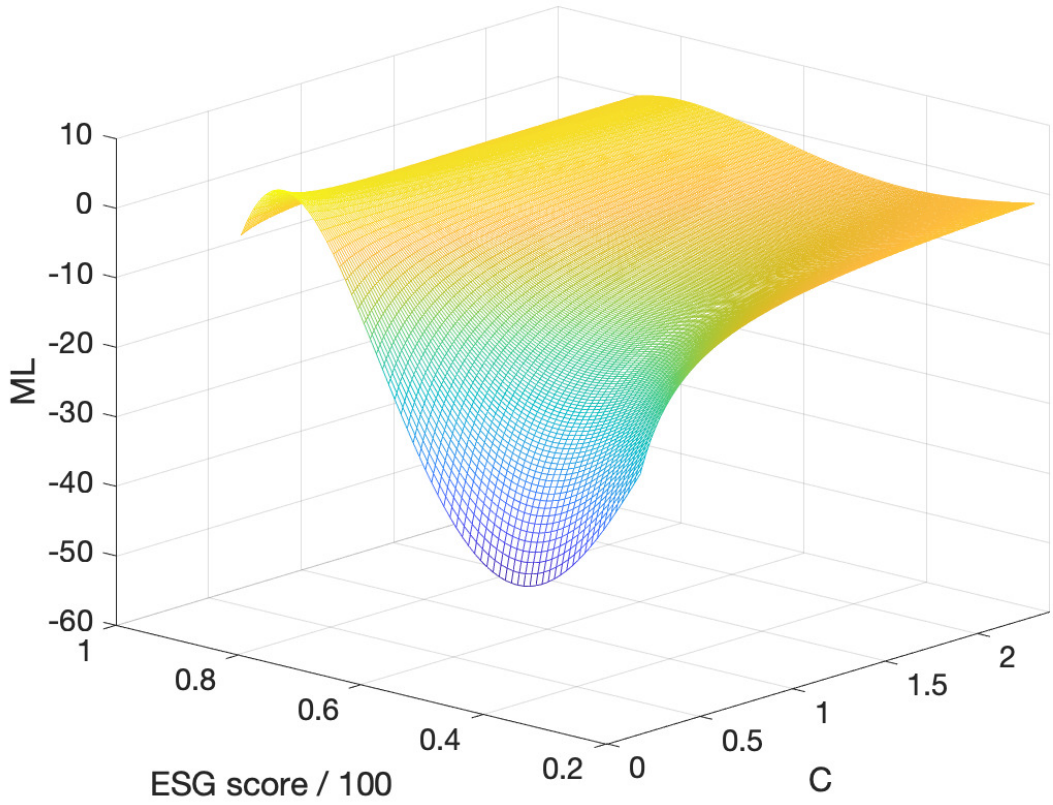

Figure 8: Non-linear fitted model $ML = (1 - \text{nESG}^{\alpha}) + (\text{nESG}^{\alpha} - \underline{p})\frac{d_0 + \beta_0 \text{nESG} + \beta_1 \text{nESG}^2}{C}$, where $\text{nESG} = \text{ESG}/100$ and $\underline{p} = 0$.

Tables

Table 1: Summary statistics

Issuance price is the issuance price obtained from Refinitiv. Original yield is the yield to maturity reported by Refinitiv at issuance. *ratingN* is the credit rating transformed into numerical values (e.g., AAA=1, AA=2, A=3, etc.). IssueAmounUSD is the issue amount obtained from Bloomberg. Penalty is the coupon-step up penalty. τ is the time between issuance date and step-up date in years. T is the time to maturity of the bond. ScondOp is a dummy variable if the SLB is verified by a third party. Target Ambition is a variable that captures whether the KPI target is ambitious. KPI Relevance captures if the KPI is financially material for the issuer. ECB is an indicator variable if the Bond is eligible for the ECB bond purchase prorgram. These variable are collected from the bond issuance documentation. ESG Scores and their component parts come from Refinitiv.

	count	mean	sd	min	p1	p5	p25	p50	p75	p95	p99	max
Issuance Price	180	99.76	0.87	98.06	98.45	98.72	99.44	99.91	100.00	100.00	105.51	107.75
OriginalYield	162	2.86	1.87	0.06	0.08	0.40	1.08	2.73	4.13	5.63	9.50	9.50
Coupon	184	2.92	1.84	0.00	0.00	0.38	1.31	2.88	4.13	5.63	9.50	9.50
Coupon Frequency	184	1.80	0.75	0.00	1.00	1.00	1.00	2.00	2.00	4.00	4.00	4.00
ratingN	180	4.28	1.27	1.00	1.00	2.00	3.00	4.00	5.00	6.00	8.00	8.00
IssueAmountUSD	184	609.83	338.15	1.67	1.80	31.51	389.84	500.22	787.96	1,249.89	1,530.00	1,852.65
Penalty (G)	179	0.28	0.18	0.03	0.03	0.10	0.25	0.25	0.25	0.75	0.75	1.50
τ	184	4.83	2.47	0.59	0.59	1.65	3.05	4.55	5.65	9.87	11.79	12.39
T	184	8.20	3.14	2.01	3.00	4.67	5.53	7.29	10.01	15.01	20.01	20.01
τ/T	184	0.59	0.21	0.12	0.15	0.25	0.45	0.59	0.72	0.97	1.02	1.02
Total cum. penalty $= (T-\tau) \times G$	179	0.87	0.58	0.00	0.00	0.08	0.42	0.77	1.19	2.00	2.72	2.76
SecondOp	184	0.40	0.49	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00
Target Ambition	34	3.57	0.49	3.00	3.00	3.00	3.00	4.00	4.00	4.00	4.00	4.00
KPI Relevance	37	3.45	0.81	2.00	2.00	2.00	3.00	4.00	4.00	4.00	4.00	4.00
ECB	184	0.22	0.42	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
ESG Score	67	69.48	11.50	22.31	22.31	50.04	65.64	71.07	76.49	86.44	88.09	88.09
Social Pillar Score	67	74.04	14.89	12.24	12.24	53.72	63.87	75.08	86.59	91.92	92.83	92.83
Governance Pillar Score	67	63.74	19.22	22.24	22.24	24.10	54.41	65.17	81.07	89.01	99.08	99.08
Environmental Pillar Score	67	68.52	15.82	28.59	28.59	39.15	61.12	69.12	81.21	93.14	95.60	95.60

Table 2: Summary statistics: Bond Pricing Related Variables

This table shows descriptive statistics of the bonds prices for the bonds used to construct ML. The table pools bond prices obtained from using Issuer, Sector, and Sub-Sector curves.

	count	mean	sd	min	p1	p5	p25	p50	p75	p95	p99	max
B(F,C+G,T)	271	106.18	9.22	90.52	92.73	96.63	100.74	103.04	109.63	124.26	140.28	150.94
B(F,G,τ)	271	95.03	5.67	79.28	81.03	83.18	91.22	96.38	99.62	101.06	101.79	102.64
B(F,0,τ)	271	93.70	6.13	76.44	77.24	80.59	89.90	95.79	98.68	100.45	100.58	101.06
LB = B(F,C,T)	271	104.08	9.15	89.69	90.73	94.82	98.98	100.81	107.01	121.62	138.30	148.97
UB	271	104.85	9.19	89.96	92.38	95.71	99.79	101.80	107.78	122.62	139.28	149.94
ML	271	-7.34	15.53	-53.76	-50.93	-44.33	-10.53	-1.65	0.59	6.58	27.02	38.02
$ML > 1$	271	0.21	0.41	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
$ML < 0$	271	0.65	0.48	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00

Table 3: 30-day Post Issuance Performance on Secondary Market (Bond Event Study)
$ML > 1$ is an indicator which identifies overpriced bonds. The variable *ratingN* takes on lower values for better credit ratings. We use bond ratings, and if unavailable, issuer credit ratings. Original yield is the yield as reported in Refinitiv. Coupon, Penalty, and Issue price are taken Refinitiv, Bloomberg, or the Issuer Website. Industry fixed effects are defined according to Refinitiv's Business Classifications (TRBC). Standard Errors are double clustered at the ultimate parent and Issue Date level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

	(1) CumRet30	(2) CumRet30	(3) CumRet30	(4) CumRet30	(5) CumRet30	(6) CumRet30	(7) CumRet30	(8) CumRet30	(9) CumRet30
$ML > 1$	-1.115**	-1.369***	-1.476***	-1.383***	-1.137**	-1.096**	-1.318**	-1.029*	-1.442**
	(-2.33)	(-3.06)	(-3.26)	(-3.19)	(-2.41)	(-2.25)	(-2.22)	(-1.84)	(-2.17)
ratingN		-0.386**					-0.042	-0.387	-0.365
		(-2.02)					(-0.14)	(-1.11)	(-1.07)
Original yield			-0.342*				0.222	-0.037	-0.122
			(-1.80)				(0.26)	(-0.03)	(-0.11)
Coupon				-0.317*			-0.604	-0.036	-0.012
				(-1.72)			(-0.67)	(-0.03)	(-0.01)
Penalty					-0.622		-0.683	-0.436	-0.216
					(-0.52)		(-0.50)	(-0.35)	(-0.18)
IssuePrice						0.122	0.140	0.073	0.074
						(0.32)	(0.45)	(0.22)	(0.19)
Observations	140	140	128	140	140	140	128	127	126
R^2	0.040	0.079	0.096	0.088	0.042	0.041	0.238	0.289	0.331
Year FE	N	N	N	N	N	N	Y	Y	Y
Currency FE	N	N	N	N	N	N	N	Y	Y
Industry FE	N	N	N	N	N	N	N	N	Y

Table 4: Equity Event Study Around Issue Date

Abnormal returns are market adjusted and calculated by subtracting the market index return from the SLB issuing firm's stock return. Standard errors are clustered at the Issue Date level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

	Whole Sample	$ML < 0$	$0 \leq ML \leq 1$	$ML > 1$
	(1)	(2)	(3)	(4)
	car(5,10)	car(5,10)	car(5,10)	car(5,10)
ML	0.018	0.088	6.145	0.285***
	(0.24)	(1.02)	(1.58)	(4.46)
Constant	1.558*	3.861**	-5.396*	-2.408**
	(1.74)	(2.55)	(-2.30)	(-2.12)
Observations	103	62	13	28
R^2	0.001	0.022	0.266	0.348

Table 5: ML and Issuer ESG Performance

This table shows regressions relating ML to ESG scores. In Panel A, we use the overal ESG score from Refinitiv as the dependent variable. Panels B-D use the E,S, and G component scores. Standard errors are clustered at the SLB linked bond-level. t–statistics in parentheses. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$)

Panel A: Total ESG Score						
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML	(6) ML
ESG Score	0.426*	0.421*	0.435*	0.673***	0.458**	0.606***
	(1.92)	(1.95)	(1.85)	(2.88)	(2.52)	(3.95)
Observations	113	113	113	113	113	112
Bonds	62	62	62	62	62	61
R^2	0.158	0.175	0.185	0.336	0.439	0.520
Panel B: Environmental Pillar Score						
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML	(6) ML
Environmental Pillar Score	0.257**	0.244**	0.250**	0.272**	0.267**	0.410***
	(2.36)	(2.27)	(2.24)	(2.22)	(2.60)	(3.77)
Observations	113	113	113	113	113	112
Bonds	62	62	62	62	62	61
R^2	0.113	0.121	0.133	0.205	0.425	0.522
Panel C: Social Pillar Score						
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML	(6) ML
Social Pillar Score	0.173	0.174	0.163	0.322**	0.308**	0.362**
	(1.52)	(1.63)	(1.52)	(2.10)	(2.20)	(2.58)
Observations	113	113	113	113	113	112
Bonds	62	62	62	62	62	61
R^2	0.042	0.065	0.073	0.201	0.414	0.468
Panel D: Governance Pillar Score						
	(1) ML	(2) ML	(3) ML	(4) ML	(5) ML	(6) ML
Governance Pillar Score	0.185*	0.189*	0.188*	0.219*	0.089	0.110
	(1.89)	(1.94)	(1.92)	(1.97)	(1.12)	(1.16)
Observations	113	113	113	113	113	112
Bonds	62	62	62	62	62	61
R^2	0.082	0.108	0.120	0.209	0.376	0.425
Curve FE	N	Y	Y	Y	Y	Y
Year FE	N	N	Y	Y	Y	Y
Currency FE	N	N	N	Y	Y	Y
Industry FE	N	N	N	N	Y	Y
Rating FE	N	N	N	N	N	Y

Table 6: Non-linear least squares

This table presents the estimates of the model:

$$ML = (1 - \text{nESG}^{\alpha}) + (\text{nESG}^{\alpha} - \underline{p})\frac{d_0 + \beta_0 \text{nESG} + \beta_1 \text{nESG}^2}{G}$$

. The model is estimated using non-linear least-squares.

Parameter		Estimate	HAC SE	t-statistic	p-value
α		2.2795	0.54718	4.166	6.27E-05
d_0		-373.8	157.14	-2.3787	0.01913
β_0		937.6	405.41	2.3127	0.022633
β_1		-585.11	260.62	-2.2451	0.026799
N	112				
R2	0.458				
AdjR2	0.443				
F-stat	27.5				

Appendix A: Model extensions

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

A.1 Bond with coupon bonus

Most SLBs are associated with a coupon penalty when the KPI is not reached. There is however an alternative structure which 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 to the manager.

We revert back 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, $-Gp(e)$, is unchanged compared to the SLB with penalty, and it follows that incentives are unchanged. The price of the bond differs from the penalty SLB and reflect 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

$X_1 = g$, 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 it can modify the incentive of the manager. We maintain the simplicity of the initial model but introduce a stochastic evolution of the interest rate, for otherwise the callable feature would be useless.

There are 3 dates $t \in \{0, 1, 2\}$, interest rate r_t varies over time , at time 1 $r_1 \in \{\overline{r}, \underline{r}, \}$ with probability q and $(1 - q)$, 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 managers' effort $e \in \{0, 1\}$. At time 1 the bond can be called back at price K.

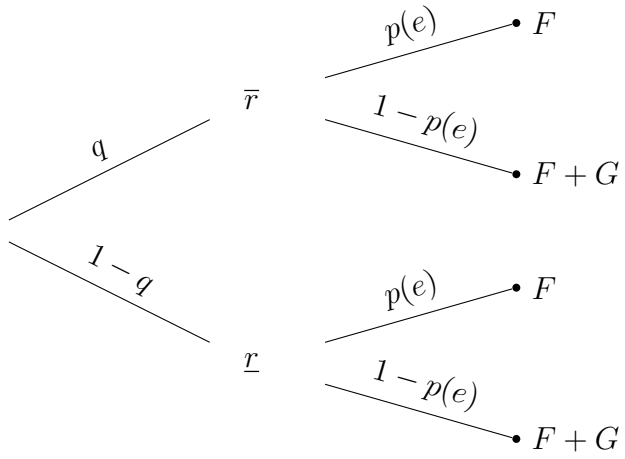

Figure 9: 2-period model's description.

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 exercice 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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