UNIVERSIDADE CATÓLICA PORTUGUESA

Sustainability-Linked Bonds:

An Empirical Analysis on ESG Score Performance

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An Empirical Analysis on ESG Score Performance

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by

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Resumo

As *Sustainability-Linked Bonds (SLBs)* surgiram recentemente no mercado de títulos sustentáveis e foram concebidas para associar as condições dos títulos ao cumprimento de objetivos ambientais, sociais e de governação (ESG). A literatura existente levanta algumas preocupações sobre a credibilidade e a ambição dos objetivos estabelecidos pelas empresas, reforçando a necessidade de investigação empírica sobre o seu impacto real nos ESG *scores*.

Esta investigação tem como objetivo avaliar se a emissão de SLBs está associada a alterações estatisticamente significativas nos ESG *scores* e se essas alterações se tornam significativas após um período de tempo. Esta dissertação foca-se exclusivamente nas empresas que emitiram SLBs entre 2019 e 2022, analisando a dinâmica dos *scores* dentro dos emissores deste título. Para isso, foram utilizadas variáveis de tempo em torno da emissão deste instrumento (2 anos antes e 2 anos depois da data de emissão), de forma a capturar se existe uma mudança estatisticamente significativas e quando é que ela ocorre. A análise abrange empresas de várias indústrias e sectores, aplicando modelos de efeitos fixos para avaliar a associação entre a emissão de SLB e a progressão nos ESG *scores*, testando ao mesmo tempo o momento desse efeito.

Os resultados revelam que apenas se observa um coeficiente estatisticamente significativo nos ESG *scores* no segundo ano após a emissão destes títulos. Estas conclusões indicam que as melhorias nos ESG *scores* da empresa após a emissão de SLB não são imediatas, sendo que só se tornam observáveis num horizonte mais longo.

Palavras-chave: *Sustainability-Linked Bonds; ESG scores; Sustentabilidade empresarial.*

Abstract

Sustainability-linked bonds (SLBs) have recently emerged in the sustainable bond market and are designed to link bond conditions to the achievement of environmental, social and governance (ESG) objectives. The existing literature raises some concerns about the credibility and ambition of those targets set by the issuing firms, reinforcing the need for empirical research on their impact on ESG scores.

This research aims to assess if the issuance of SLBs is associated with statistically significant changes in ESG scores and if those changes become statistically significant after some time. This dissertation focuses exclusively on firms that issued SLBs between 2019 and 2022 while analysing the dynamics of scores within SLB issuers. Based on this, we used time variables around the issuance of this instrument (2 years before and 2 years after the issue date) to capture if there is a statistically significant change and when it occurs. The analysis covers firms from different industries and sectors, applying fixed effects models to assess the association between the SLB issuance and the progression in ESG scores while also testing the timing of this effect.

The results show that a statistically significant coefficient in ESG scores is only observed in the second year after the bond is issued. These findings indicate that the improvements in the firm's ESG scores after the issuance of SLBs do not occur immediately and become observable over a longer horizon.

Keywords: *Sustainability-Linked Bonds; ESG scores; Corporate sustainability.*

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List of Abbreviations

CSR	Corporate Social Responsibility
ESG	Environmental, Social and Governance
ISIN	International Securities Identification Number
KPI	Key Performance Indicator
PR	Premium Redemption
RIC	Reuters Instrument Code
SLB	Sustainability-Linked Bond
SLBP	Sustainability-Linked Bond Principle
SPT	Sustainability Performance Target
UN	United Nations

1. Introduction

Over the past few years, sustainable finance has gained significant importance in the global economy due to the growing environmental and social challenges affecting the overall system's stability. Events such as COVID-19, the war in Ukraine and the increasing urgency to address climate change have pushed market participants to rethink the role of finance in building long-term resilience. This approach integrates environmental, social and governance (ESG) factors into investment and financing decisions to promote sustainability and to incorporate non-financial risks into capital allocation decisions. It has become a central concern for governments, corporations, regulators and investors (Feldhütter et al., 2024) and achieving a balance between economic development, environmental responsibility and social well-being is now a global priority.

In this context, firms are progressively integrating sustainable practices into their operations, regulators enforce stricter frameworks and investors adapt their portfolio strategies to include ESG investment opportunities while shaping firms to adjust to this new reality, through market expectations. Global initiatives, such as the United Nations (UN) 2030 agenda, guide and support firms to rethink their business models, policies, social behaviour and investment strategies (United Nations, 2015). In parallel, the Paris Agreement set an ambitious target to limit global warming below 2°C above pre-industrial levels (Bolton et al., 2021), demonstrating the international commitment to sustainability actions.

Financing the transition to a more sustainable economy requires instruments that align private capital with long-term environmental and social goals. Sustainable finance promotes economic and social development while setting the stage for a sustainable future. It is critical for promoting social inclusion, increasing productivity, fostering competitiveness, generating employment and

supporting international trade (World Bank, 2024). In this context, ESG bonds are increasingly used to fund environmental projects, social initiatives and governance-related improvements to build an investment opportunity that is aligned with responsible investing practices (Nasdaq, 2024). These instruments channel investments into activities with positive ESG outcomes, such as carbon emissions reduction, natural resources protection and social equality promotion, positioning the ESG fixed-income market as a key driver of the shift to a low-carbon and socially inclusive economy.

ESG fixed-income solutions are designed for institutional investors to integrate ESG factors, manage risks not captured by traditional analysis and align investments with specific values by including different instruments. The most common ones are green bonds that finance environmental projects, social bonds that finance projects designed to address social challenges and sustainability bonds that combine both purposes. However, these instruments' focus is restricted to finance-specific projects, which limits their impact to predefined initiatives rather than supporting the firm's overall sustainability. While their objectives align with ESG principles, they have been criticized for lacking substance and failing to promote structural change (Anderson & Kish, 2024).

As the need for a more dynamic and flexible financing solution increases, a new bond category is introduced: Sustainability-Linked Bonds (SLBs). This type of bonds emerged in 2019, and it differs from other ESG instruments by linking the firm's sustainability performance to the financial characteristics of the bond. These bonds present a flexible approach, as they do not limit the firm to finance specific projects, and its interest rate is directly linked to the achievement of predefined Key Performance Indicators (KPI) based on the firm's Sustainability Performance Targets (SPT). SLBs are designed to link sustainability outcomes with financial terms, raising the question of the potential impact that SLBs can have on ESG scores. However, this remains an open empirical question.

Despite the growing relevance of this instrument, there is no empirical evidence if SLB issuance is associated with statistically significant changes in ESG scores and if those changes emerge only after a certain period. This research aims to test these two dimensions, focusing on if there is a significant change in ESG scores after the SLB issuance (H1) and if this effect materialises over time (H2).

This dissertation aims to address this gap while analysing SLB issuance between 2019 and 2022, covering firms from different countries and sectors. The study uses ESG scores as an indicator to measure a firm's ESG performance, which reflects how firms are assessed in terms of responsible behaviour and long-term risk management. The analysis applies a panel data methodology and introduces time variables in the model to evaluate the score variation in the years following the issuance and when they become observable. The following chapters present fixed effects regression models to test both hypotheses.

This research is motivated by the rapid expansion of the SLB market and the growing pressure for transparency observed in these instruments. Although SLBs are designed to link financial conditions to sustainability performance, there is no empirical research on a potential statistically significant influence that they have on ESG scores and, if such an impact occurs, how long it takes to be observed. This dissertation addresses this gap while focusing on the observable progression of ESG scores after SLB issuance. The main contribution to the literature is to provide empirical evidence on if ESG scores change in the years after the bond is issued and if those changes become statistically significant after some time. By limiting the analysis to SLB issuers and avoiding assumptions about firms' intentions or signalling effects, the study contributes to understanding how this new instrument impacts the ESG score performance in practice.

2. Literature Review

2.1. ESG Fixed-Income Market

2.1.1. Market Growth and Context

As sustainability becomes an important topic for global policy and investment strategies, fixed-income markets are gaining relevance as they are a potential channel for financing long-term development objectives. A report from the United Nations (2024) estimates that around USD 4 trillion per year will be needed to achieve the Sustainable Development Goals, with developing countries requiring the highest share of investment. Most financing is expected from debt markets and bank lending channels, highlighting the role of ESG debt instruments in aligning financial cashflows with sustainability objectives (Berrada et al., 2022; Feldhütter et al., 2024).

The increasing prominence of ESG fixed-income instruments reflects a continuous innovation in sustainable debt market and growing investor preferences for ESG (Berrada et al., 2022). Investors increasingly integrate ESG factors into their portfolios, believing that carbon emissions represent a material risk for firms (Krueger et al., 2020). This shift contributes to the growing popularity of sustainable funds, stocks and bond indices (Poggensee, 2024).

The market is mainly comprised of three categories: green bonds, social bonds, and sustainability bonds. These instruments finance specific environmental and/or social projects, following frameworks such as the Green Bond Principles (GBP) and Social Bond Principles (SBP) from the International Capital Market Association (ICMA, 2021). Green bonds represent a significant portion of the ESG fixed-income market (Zerbib, 2019; Flammer, 2021), particularly in sectors where environmental factors can substantially impact the firm's financial and

operations performance (Flammer, 2021). Despite their growth, these bonds have been criticised for their limited coverage, as proceeds are linked to predefined projects, which limits the firm's ability to commit to broader corporate sustainability (Anderson & Kish, 2024).

In response to these limitations, SLBs emerged as a new instrument in the ESG fixed-income market, offering a flexible structure that links financial conditions to a firm's sustainability outcomes. Their structure links the cost of debt to the achievement of specific Key Performance Indicators (KPIs) and Sustainability Performance Targets (SPTs) (ICMA, 2020). Additionally, the use of proceeds is not limited to specific projects, providing issuers greater flexibility while creating financial incentives to meet sustainability goals. This structure allows for more flexible capital use while introducing performance incentives linked to ESG targets, potentially improving transparency and accountability.

Although it is relatively new in the market, SLBs are already gaining market relevance, reinforcing the innovation trend in sustainable finance (Berrada et al., 2022). However, there are concerns regarding target ambition, transparency and the risk of "*greenwashing*," particularly when firms select easy targets to meet (Kölbel & Lambillon, 2023).

2.1.2. Green Bonds as a Benchmark Instrument

Given their longer history and more established framework, green bonds are often used as a benchmark for comparison when analysing the role of SLBs in corporate sustainability performance. Green bonds are among the most established instruments in the ESG fixed-income market, and although they and SLBs have the potential to support ESG practices, they differ in structure and

scope. Green bonds finance specific green projects, while SLBs are linked to the firm's overall sustainability performance.

The announcement of green bonds issuance has been associated with a positive reaction among equity investors, with the capability of increasing the environmental score and decreasing the firm's CO_2 footprint (Flammer, 2021). According to Poggensee (2024), SLBs differ from green bonds, as they focus on a range of ESG objectives over the medium and long term rather than financing specific projects. While the framework differs, the findings suggest that SLB announcements are also associated with favourable short-term equity market reactions. Furthermore, the market response tends to be stronger when SLBs include ambitious performance targets.

Firms with experience in green bonds are more likely to issue SLBs as they are already familiar with sustainability frameworks and have internal systems for tracking and reporting (Berrada et al., 2022). This previous experience reduces barriers to issuing SLBs, as firm's already have mechanisms for monitoring their sustainability metrics. These bonds can be used for all types of investments and expenses, giving firms more freedom in allocating the funds raised through the bond (Berrada et al., 2022). Although SLBs allow for flexible 6use of proceeds, they have remained focused on environmental objectives. This indicates that, in practice, SLBs have been predominantly used for environmental targets, with less frequent inclusion of social and governance KPIs (Berrada et al., 2022).

2.1.3. Sustainability-Linked Bonds: Structure and Flexibility

SLBs emerged in 2019 as a flexible ESG fixed-income instrument that links financing terms to the achievement of sustainable predefined KPIs (Berrada et

al., 2022; ICMA, 2024). This new instrument creates financial incentives to pursue measurable ESG improvements through the establishment of KPIS based on SPTs. Each SLB can include multiple KPIs, a metric for evaluating performance, aligned with the SPTs, the predefined goals the firm intends to meet.

The Sustainability-Linked Bond Principles (SLBP) recommend that KPIs be material, measurable and aligned with the firm's core sustainability strategy. Additionally, SPTs should be ambitious, extend business expectations and aim to demonstrate credible sustainable commitments (ICMA, 2024). Firms are encouraged to obtain external verification to confirm this alignment and enhance transparency. These disclosures are important for investment decision-making, especially because ESG reporting lacks globally standardized requirements (Darnall et al., 2022).

SLBs that are well structured and aligned with credible targets are traded at higher prices and lower yields on the issue date (Kölbel & Lambillon, 2023), reflecting investor preference for ESG practices. In this case, investors are paying higher prices while sacrificing their investment return to hold an ESG bond, often referred to as a "*greenium*" (Zerbib, 2019). This dynamic can result in a lower cost of capital for issuers while raising discussions about a potential wealth transfer from bondholders to shareholders (Poggensee, 2024). These issues highlight the importance of transparency, target ambition and independent verification of SLBs.

Coupon payments are adjusted depending on if the predefined KPIs are achieved by a specified date. In most cases, failure to meet the targets results in a coupon increase as a penalty (Berrada et al., 2022). Less frequently, if the target is achieved, the coupon can be reduced, the compensation can be donated to charities or firms can purchase carbon credits without impacting the coupon payment structure (Berrada et al., 2022; Feldhütter et al., 2024). The economic value attributed to the ESG component of an SLB is closely linked to the

magnitude of the penalty applied for not meeting those targets (Berrada et al., 2022).

Given that SLBs are linked to medium and long-term SPTs, any measurable changes in ESG performance take time to become observable. This temporal dimension is central to our empirical strategy, which pretends to identify when the changes in ESG scores become statistically significant.

2.2. ESG Adoption by Firms

Firms are increasingly adopting ESG practices for several strategic purposes. Their motivations include improving reputation, gaining easier access to capital and showing that their commitment to sustainability goes beyond marketing, avoiding the risk of being seen as "*greenwashing*". In this context, Feldhütter et al. (2024) report that the risk of "*greenwashing*" was the main concern of SLBs in a survey of professional investors. Some critics point out that firms can set easy targets to meet and benefit from the resulting reputation without making a meaningful effort toward sustainability (Kölbel & Lambillon, 2022; Feldhütter et al., 2024). Based on this, ESG practices can serve both strategic alignment and external perception purposes, depending on how firms choose to implement and communicate them.

A firm's reputation is one of its most valuable intangible assets, resulting from its ability to balance and fulfil its stakeholder interests. A strong reputation improves financial performance and supports long-term survival (King & Whetten, 2008). Based on the increasing concern on sustainable aspects, ESG and Corporate Social Responsibility (CSR) are often used to demonstrate the firm's commitment to sustainability, enhancing their reputation and generating customer loyalty through value alignment. The use of these strategies might

influence the firm's ESG score, although those effects are not necessarily immediate or easy to isolate.

Such initiatives are also associated with lower risk exposure, as they might help firms prevent social and environmental incidents and promote financial stability (Nirino et al., 2022). However, sustainability practices can go against short-term interests of shareholders, as they often require investments in projects that do not generate immediate financial returns. Even if shareholders increasingly value sustainability, financial returns are still a key priority. This tension reinforces the importance of demonstrating how sustainability initiatives can contribute to long-term value creation, especially when short-term returns are not guaranteed and cannot be observable. Managing stakeholder relationships is not only an ethical obligation but also a strategic tool to achieve financial and organizational success (Brown & Forster, 2013).

Sustainability practices can potentially contribute to an improvement in firm's ESG score, depending on the implementation and disclosure of ESG information. Firms with high ESG scores are often perceived as less risky, can benefit from better access to financing and are more attractive to institutional investors. Strong corporate governance mitigates agency problems and supports strategic decision-making, facilitating the integration of sustainability into core business operations and long-term growth strategies (Naciti, 2019).

2.3. ESG Preferences Among Investors

Investors are increasingly concerned with generating a positive impact through their investments, as they recognise that climate risks create financial implications for their portfolio firms (Krueger et al., 2020). According to Feng et al. (2022), investors and analysts perceive ESG as an important factor affecting a

firm's market value and financial performance. In the long term, sustainability and social responsibility are expected to be integrated into corporate strategies and no longer be seen as separate from the core business. The importance that they attribute to ESG suggests that, beyond financial gains, they also value the environmental and social consequences of their choices (Bonnefon et al., 2022).

A firm's ESG performance is often associated with differences in financial performance, operational resilience and risk exposure. As a result, conscious investors might select firms that appear more advanced in ESG integration, as they will be better prepared and more resilient to future challenges, including regulatory changes and environmental and social pressures.

The growth of the ESG fixed-income market reflects this ethical and environmental awareness while making a strategic move to mitigate long-term financial risks. This is in line with Aureli et al. (2019), who argue that investors are increasingly prioritising long-term sustainability over short-term performance. These preferences reinforce the relevance of understanding how firms' ESG score performance evolves over time, particularly after important sustainability actions.

2.4. SLB Issuance: Structure and Reasons

SLBs might be issued for several reasons, including attracting investors, improving financial conditions and/or demonstrating alignment with sustainability objectives, but the intention behind these issuances is not always observable. While some firms aim to improve their ESG performance, others might prioritise the reputational benefits of issuing a SLB, even without substantial changes in their sustainability practices (Feldhütter et al., 2024).

Kölbel and Lambillon (2023) emphasise that, in many cases, the SLB premium exceeds the financial penalty for failing the predefined targets. This allows firms to benefit from the issuance even if the performance goals are not achieved. Despite this, there is no clear evidence of systematic "*greenwashing*" in the SLB market (Feldhütter et al., 2024).

The credibility of the predefined KPIs and the transparency of the reporting are critical factors in how the market perceives SLBs. When KPIs are ambitious and easily measurable, SLBs can be seen as a potential tool to promote a firm's sustainability commitment. Poggensee (2024) notes that investors tend to assess SLBs based on the credibility of specific KPIs rather than the overall ESG scores. These considerations reinforce the need for further academic research on the relationship between SLB issuance and measurable changes in ESG scores.

2.5. ESG Scores as a Performance Metric

An ESG score is a metric that evaluates a firm's sustainability performance across environmental, social and governance dimensions. Analysts, investors and researchers usually use these scores to assess the firm's sustainability performance. However, the literature highlights important concerns regarding their consistency, comparability and lack of methodological transparency.

ESG scores are calculated using different and often unclear methodologies, as there is no standardised framework guiding their construction (Walter, 2020; Yu & Zhang, 2021; Ehlers et al., 2023). Furthermore, Walter (2020) argues that ESG rating providers have their own methodologies that are not publicly disclosed. These limitations make it difficult to assess how the ESG scores are calculated and which indicators they prioritise.

The literature also recognises the low correlation between the ESG scores provided by the different rating agencies. This divergence results from different methodological choices, indicator selections and interpretations of ESG performance (Walter, 2020; Yu, 2021). As a result, the same firm can obtain different ESG assessments depending on the rating provider.

Despite these limitations, ESG scores continue to be one of the most used tools by academic researchers and investment analysts to assess and measure corporate sustainability. Given the absence of a globally standardised ESG reporting framework and the challenges to retrieve ESG data across firms, scores can serve as a *proxy* indicator of firm's ESG performance. Therefore, this dissertation uses ESG scores as the dependent variable in the regression analysis while explicitly recognising the methodological limitations associated with their construction and interpretation.

3. Research Question

Based on the literature review, there is limited evidence on the association between SLB issuance and ESG scores, particularly regarding the time it takes for changes to become statistically significant. This lack of evidence is partly explained by the fact that SLBs are a relatively new financial instrument with data available only since 2019. In particular, the existing studies focus more on green bonds, leaving SLBs less explored, despite their growing issuance and flexible structure. This context makes SLBs a relevant object of empirical analysis in the sustainability finance field. Given the growing importance of sustainable finance for governments, corporations, regulators and investors (Feldhütter et al., 2024), this study aims to address this gap by exploring the following research question:

> *"Does the issuance of Sustainability-Linked Bonds lead to an impact on ESG score performance that only becomes statistically significant after a certain period?"*

To address this question, we use data from LSEG Refinitiv and apply a fixed effects panel model, following Flammer (2021), who employed this approach to assess the impact of green bonds on firms' environmental performance. This approach controls for unobservable firm-specific characteristics that could influence ESG scores independently of SLB issuance. To further explore the impact of SLBs on ESG score performance, we note the following hypotheses:

> *Hypothesis 1 (H1): The issuance of Sustainability-Linked Bonds has a statistically significant impact on firms' ESG scores.*

Although SLBs are relatively new and their market volume remains low, they have grown rapidly (Kölbel & Lambillon, 2022). This growing popularity suggests that this bond has the potential to become a key tool for promoting

corporate sustainability. SLBs incentives firms to achieve sustainability targets, as failure to meet them typically results in financial penalties. This link between ESG performance and cost of capital encourages firms to make measurable improvements in their ESG practices, with potential implications on ESG scores.

Unlike other ESG fixed income instruments, SLBs do not require proceeds to be allocated to specific projects. This flexibility allows firms to improve their overall ESG performance rather than being limited to one specific pillar. While SLB issuance might be associated with improvements, the effect might not occur immediately. ESG improvements require structural and behavioural changes by the firm, and it takes time, so assessing the timing of these changes is essential to understand how ESG performance evolves after issuance.

According to Nirino et al. (2022), the results of environmental and social investments need time to materialize. Also, the ESG score providers issued the rating based on firms' available information and periodic sustainability disclosures, which introduces a delay between the real ESG improvements and their reflection in external ratings. This suggests that SLB issuance might be followed by changes in ESG scores that only become statistically significant after a certain time period. This leads us to consider a second hypothesis:

> *Hypothesis 2 (H2): The impact of Sustainability-Linked Bonds on ESG scores is not immediate, only being statistically significant after a certain time period.*

These hypotheses guide the empirical strategy, which aims to assess the presence and timing of statistically significant changes in ESG scores following SLB issuance. While the first hypothesis focuses on identifying if there is a measurable impact of SLB on ESG scores, the second hypothesis explores the time frame of this potential impact, recognizing that the improvements might take time to become statistically significant. Since the literature suggests that ESG

investments takes time to produce observable outcomes, the empirical strategy uses different time periods to capture this effect.

The analysis focuses on the overall ESG score, both globally and across individual pillars, allowing us to assess if the impact of SLBs differs between environmental, social and governance dimensions. This distinction is relevant as previous authors defended that there is still a predominant focus on environmental actions. Berrada (2022) finds that, after issuance, SLB issuers decarbonise faster than non-issuers, providing evidence of a measurable and positive impact, particularly on the environmental pillar.

While SLBs are designed to target a range of sustainability goals, they remain focused on environmental actions, suggesting that firms have not yet fully exploited their potential to address social and governance issues (Berrada et al., 2022). This reinforces the importance of disaggregating ESG scores, which could mask important differences across pillars. The next chapter presents the methodology to test the two hypotheses, including the data construction process, variable definitions and the fixed effects panel model applied to estimate the relationship between SLB issuance and ESG performance over time.

4. Data Selection and Empirical Methodology

4.1. Sample Construction and Exclusion Criteria

SLB data was extracted from the LSEG Refinitiv database. To focus on ESG score dynamics within the private sector, only corporate bonds from 2019 onwards were retained. To this purpose, the sample was treated using the following exclusion criteria, applied sequentially:

- Bonds without an ISIN or RIC, which are necessary to extract firm and bond level data (18 exclusions);
- Bonds issued by governments, central banks, agencies or municipalities, which are excluded due to different regulatory frameworks and lack of ESG scores (142 exclusions);
- Bonds issued from 2023 to 2025, as the model requires up to two years of post-issuance data for panel estimation (79 exclusions).
- Bonds with missing ESG score data across the observation window (from two years before to two years after issuance) (410 exclusions).

After applying these criteria, the final sample consists of 305 corporate SLBs issued between 2019 and 2022, all with complete ESG score data covering the entire observation window defined for the analysis. Table 1 presents the sample construction.

Table 1 - Sample Construction

Sample Construction Steps	Bonds excluded	Remaining bonds
Initial SLB Database (LSEG Refinitiv)	—	954
No ISIN/RIC	18	936
Non-corporate issuers	142	794
Issued in 2023 to 2025	79	715
Missing ESG score data	410	305

4.2. Panel Descriptives and Sample Characteristics

Table 2 illustrates the structure of the sample, based on six panels summarising key characteristics of the SLB issuances.

Panel A presents the annual distribution of SLB issuances, ranked by year. The SLB market experienced significant growth until 2021, recording the highest number of tranches (156) and the largest issued amount of USD 89.03 billion, representing 54.63% of the total amount issued over the full period. In 2022, the issuance number declined to 132 tranches and USD 59.17 billion.

Panel B presents the geographic distribution of SLB issuers, ranked by the number of bonds issued. European countries represent the largest share of the sample, with 157 bonds issued and a total amount of USD 108.90 billion, which is 66.83% of the total amount. The Netherlands is the top issuer within Europe, accounting for 50 tranches and 29.08% of the total amount. North America (21.78%) and Asia (7.98%) follow Europe regarding issuance amount. Although Asia has a significant number of tranches, it represents a low volume in terms of the amount issued.

Panel C presents the sector distribution of SLB issuers, ranked by the number of bonds issued. Energy and Utilities are the sector leaders with 77 tranches and a total issuance of USD 57.79 billion, representing 35.46% of the total amount. The next most represented sectors are Industrials (53 tranches) and Materials (39 tranches).

Panel D shows the SLBs distribution by market of issue, ranked by the number of bonds issued. The domestic market dominates the sample with 138 tranches and a total issued amount of USD 40.74 billion, representing 25.00% of the total amount. This is followed by Eurobond market (119), foreign (35) and global markets (13) in terms of number of bonds issued. Although domestic markets

lead in the number of tranches, Eurobonds account for more than twice the total amount issued, highlighting their relevance in larger transactions.

Panel E shows the distribution of SLBs by coupon action type, ranked by the number of bonds issued. The step-up coupon structure is the most frequently used mechanism, appearing in 210 tranches and representing USD 139.29 billion (85.48% of the total issued amount). Other mechanisms are less frequent, such as premium redemption (PR) and hybrid structures combining step-up and PR, representing 5.86% and 1.08% of the total amount, respectively.

Finally, Panel F explores the use of proceeds associated with SLBs, ranked by the number of bonds issued. Most issuances (179) are linked to corporate purposes, representing USD 112.51 billion and 69.04% of the total amount, which confirms that SLBs do not restrict the use of the funds to specific projects. M&A and refinancing activities represent the second largest category in terms of amount issued with 15.23%, followed by green projects (7.72%).

The sample is concentrated in the European market, predominately of energy and utilities firms issuing step-up SLBs for general corporate purposes. These characteristics reflect the flexibility and growing adoption of SLBs across sectors and regions and provide relevant context for the following empirical analysis.

Table 2 - SLBs characteristics and classification.

Panel A: Emission of SLBs by year				
Year	**Nr. of tranches**	**% of Total Tranches**	**Issued Amount [USD Millions]**	**% of Total Issued Amount**
2019	6	1.97%	5,8816.89	3.57%
2020	11	3.61%	8,943.86	5.49%
2021	156	51.15%	89,030.93	54.63%
2022	132	43.28%	59,165.83	36.31%
Total	**305**	**100.00%**	**162,957.51**	**100.00%**

Table 2 - SLBs characteristics and classification (cont.)

Panel B: Geographic distribution of SLB issuers (by country and region)				
Geographic Location of Issuer	**Nr. of tranches**	**% of Total Tranches**	**Issued Amount [USD in Millions]**	**% of Total Issued Amount**
Europe	**157**	**51.48%**	**108,898.55**	**66.83%**
Netherlands	50	16.39%	47,395.07	29.08%
France	25	8.20%	17,194.26	10.55%
United Kingdom	14	4.59%	8,564.33	5.26%
Luxembourg	14	4.59%	11,470.84	7.04%
Italy	11	3.61%	6,477.59	3.98%
Sweden	9	2.95%	908.35	0.56%
Germany	8	2.62%	4,197.11	2.58%
Austria	5	1.64%	3,750.00	2.30%
Greece	4	1.31%	1,838.38	1.13%
Turkey	4	1.31%	2,300.00	1.41%
Ireland	3	0.98%	2,068.03	1.27%
Norway	3	0.98%	404.47	0.25%
Poland	2	0.66%	516.58	0.32%
Switzerland	2	0.66%	481.26	0.30%
Portugal	1	0.33%	142.74	0.09%
Czech Republic	1	0.33%	648.84	0.40%
Finland	1	0.33%	540.70	0.33%
Asia	**69**	**22.62%**	**13,011.81**	**7.98%**
Japan	22	7.21%	3,342.04	2.05%
Thailand	18	5.90%	1,541.20	0.95%
China	17	5.57%	3,959.39	2.43%
India	4	1.31%	1,800.00	1.10%
Singapore	3	0.98%	830.01	0.51%
Hong Kong	3	0.98%	1,350.00	0.83%
Taiwan	1	0.33%	75.78	0.05%
Philippines	1	0.33%	113.39	0.07%
North America	**53**	**17.38%**	**35,497.87**	**21.78%**
United States	21	6.89%	19,590.70	12.02%
Mexico	21	6.89%	10,225.60	6.28%
Canada	8	2.62%	4,931.57	3.03%
Cayman Islands	1	0.33%	400.00	0.25%
Virgin Islands (British)	1	0.33%	200.00	0.12%
Bermuda	1	0.33%	150.00	0.09%
Latin America	**14**	**4.59%**	**3,741.82**	**2.30%**
Brazil	9	2.95%	2,591.82	1.59%
Argentina	3	0.98%	150.01	0.09%
Chile	2	0.66%	1,000.00	0.61%
Oceania	**6**	**1.97%**	**1,615.16**	**0.99%**
Australia	5	1.64%	1,557.85	0.96%
New Zealand	1	0.33%	57.31	0.04%
Africa	**6**	**1.97%**	**192.31**	**0.12%**
South Africa	6	1.97%	192.31	0.12%
Total	**305**	**100.00%**	**162,957.51**	**100.00%**

Table 2 - SLBs characteristics and classification (cont.)

Panel C: Sector Distribution of SLBs

Sector Distribution of the Issuer	Nr. of Tranches	% of Total Tranches	Issued Amount [USD in Millions]	% of Total Issued Amount
Energy & Utilities	77	25.25%	57,785.95	35.46%
Industrials	53	17.38%	13,536.33	8.31%
Materials	39	12.79%	20,453.37	12.55%
Financials	24	7.87%	15,198.54	9.33%
Consumer Staples	23	7.54%	10,961.66	6.73%
Other	22	7.21%	12,851.63	7.89%
IT & Communication	21	6.89%	10,275.15	6.31%
Real Estate	15	4.92%	2,453.28	1.51%
Industrials (Other)	13	4.26%	8,181.88	5.02%
Consumer Discretionary	10	3.28%	3,596.48	2.21%
Healthcare	8	2.62%	7,663.24	4.70%
Total	**305**	**100.00%**	**162,957.51**	**100.00%**

Panel D: Market of issue of SLBs

Market of issue	Nr of tranches	% of Total Value	Issued Amount [USD in Millions]	% of Total Value
Domestic	138	45.25%	40,743.60	25.00%
Eurobond	119	39.02%	85,953.92	52.75%
Foreign	35	11.48%	24,360.00	14.95%
Global	13	4.26%	11,900.00	7.30%
Total	**305**	**100.00%**	**162,957.51**	**100.00%**

Panel E: Coupon Action Type Distribution of SLBs

Coupon Action Type	Nr. of Tranches	% of Total Tranches	Issued Amount [USD in Millions]	% of Total Issued Amount
Coupon Step-up	210	68.85%	139,295.68	85.48%
Other Structure	56	18.36%	11,332.89	6.95%
PR	27	8.85%	9,543.98	5.86%
Step-up or Step-down	5	1.64%	386.46	0.24%
Step-up & PR	3	0.98%	1,757.28	1.08%
Early Redemption	2	0.66%	386.28	0.24%
Step-down	1	0.33%	54.95	0.03%
Carbon Credit	1	0.33%	200.00	0.12%
Total	**305**	**100.00%**	**162,957.51**	**100.00%**

Panel F: Use of Proceeds of SLBs

Use of Proceeds	Nr. of Tranches	% of Total Tranches	Issued Amount [USD in Millions]	% of Total Issued Amount
General Corporate Purpose	179	58.69%	112,507.75	69.04%
Green Projects	56	18.36%	12,576.05	7.72%
Infrastructure & Industry	8	2.62%	1,810.86	1.11%
M&A / Refinancing	35	11.48%	24,811.26	15.23%
Other / Not Specified	18	5.90%	7,021.95	4.31%
Social Projects	9	2.95%	4,229.64	2.60%
Total	**305**	**100.00%**	**162,957.51**	**100.00%**

4.3. Empirical Model and Estimation Strategy

To analyse the impact of SLB issuance on ESG score performance, we estimate the panel regression model presented in equation (1). The empirical strategy tests two hypotheses. First, we assess if SLB issuance has a statistically significant impact on ESG scores (H1). Second, we evaluate if statistically significant changes are observable immediately or only after a certain time period (H2).

To ensure the robustness of the results, we estimate two versions of the model: one using the full sample without the leverage variable (336 observations) and a second using a reduced sample including leverage (219 observations). This variable was included based on Berrada (2022), who defends that firms with higher leverage have greater incentives to issue this type of bond. As both specifications produce consistent results in terms of coefficient signs and significance, the first is reported as the main model, while the second serves as a robustness check.

$$(1) \quad SCORE_{it} = \alpha_0 + \beta_1(PostBond_{it} \times TimePeriod_{it}) + \beta_4 Sector_i + \beta_5 Country_i + \beta_6 CouponActionType_i + \varepsilon_{it}$$

The dependent variable is the ESG score (overall or by pillar), and the independent variable is the interaction term between a post-issuance dummy and the categorical Time Periods, capturing the evolution of ESG scores after SLB issuance. We applied a panel data regression model with fixed effects to isolate the impact of SLB issuance on ESG scores while controlling for firm and bond characteristics.

To test H1, we analysed if ESG score performance followed a statistically significant upward trend after the issuance. To test H2, we explore if this is an immediate effect or if it requires some time before becoming statistically

significant. The models were estimated for the overall ESG score and separately for the environmental, social and governance pillars.

Table 3 outlines the time structure used in the regression model. The six time periods are defined relative to the bond issue date (T = 0), enabling a detailed observation of ESG score performance across the observation window. One month before the bond issuance (T = –0.08) was included to control for possible short-term adjustments and anticipated effects that could influence the ESG scores just before their formal issuance. This was considered to obtain a cleaner comparison with the issuance date (T = 0) and a more accurate estimate of post-issuance effects.

Appendix A presents a detailed description of the dependent and independent variables from LSEG Refinitiv to help with their interpretation.

Table 3 - Time Periods SLB Issuance and Hypothesis Testing Objectives

Time	Time Period	Purpose of Selection
–24	24 months before issuance	Establishes a baseline for ESG performance before any potential anticipation effects.
–12	12 months before issuance	Tests for early ESG improvements before to bond issuance.
–1	1 month before issuance	Controls for short-term adjustments just before issuance.
0	Issuance date (reference)	Serves as the reference period for comparing before and after issuance ESG score variation.
12	12 months after issuance	Assesses short-term changes in ESG scores after issuance (H1 and H2).
24	24 months after issuance	Assesses delayed changes in ESG scores after issuance (H1 and H2).

2.1. Variable Description and Construction

This section describes the variables used in the empirical analysis, including ESG score as the dependent variable, the explanatory variable to test the effect of SLBs on ESG score and the fixed effects to control for structural heterogeneity.

2.1.1. ESG Score as Dependent Variable

The dependent variable is the ESG score and its three individual pillars, as reported by LSEG Refinitiv, collected for each firm across six time periods around the SLB issuance. While each score is for a specific fiscal year, the updates can occur with a delay. The value retrieved at each time point reflects the most recent score available in the DataStream at each specific date during the data collection. This variable is used to test if ESG scores increase following the issuance of SLBs (H1), and when such changes become statistically significant (H2). Despite the limitations that some authors point out to these scores, these scores are one of the most used tools to measure corporate sustainability. We explicitly recognise the methodological limitations associated with their construction and interpretation, but we use it as many other authors and analyses used to assess a firm's ESG performance.

2.1.2. Main Explanatory Variable: Interaction Term

The main explanatory variable is an interaction term between two components to test if SLB issuance has a significant impact on ESG score performance over time. The first component is a Post Bond dummy that equals one for all observed

periods after the bond issuance (T=1 and T=2) and zero otherwise, capturing changes in ESG scores potentially associated with SLB issuance. The second component is the set of Time Period explained in the previous section. This interaction allows the model to estimate the impact of SLB issuance on ESG scores over time.

2.1.3. Fixed Effects

The model includes fixed effects for the sector, country and bond coupon action type. These control for structural differences that could influence ESG score performance independently of SLB issuance. Sector fixed effects capture variations in regulatory pressure and industry reporting standards. Country fixed effects control for differences in disclosure regulation, investor expectations and national ESG policies. The coupon action type reflects the structure of SLBs, where coupon payments might change based on the achievement of the proposed ESG targets. This mechanism introduces a financial consequence or benefit for firms and, therefore, captures the financial incentives linked to ESG target achievement, which might reflect the issuer's level of commitment. These fixed effects help ensure that the estimated results are not driven by sectoral, geographic or bond-specific characteristics.

3. Regression Results and Discussion

3.1. Univariate Analysis

To understand how ESG scores evolve after SLB issuance, we analyse ESG scores after the bond issuance date. Table 4 shows the analysis covering the overall ESG score and its three components: environmental, social and governance. The average scores improved across all dimensions, which supports the view from Feldhütter et al. (2024) that this instrument can be more effective at directing companies to contribute to a sustainable economy, when compared to other standard sustainable bonds.

The ESG score rises from 69.90 to 72.07 after the issuance. At the pillar level, the environmental score shows the most significant increase in the specific pillars, from 69.88 to 72.93. At the same time, social and governance faced a smaller increase, showing that companies tend to focus more on the environmental dimension. The standard deviations remain stable and the range between minimum and maximum scores also shows small or no changes, suggesting that the improvement is generalised and not driven by outliers.

Although the ESG score increases after SLB issuance, the reason for this effect cannot be explained by the model. Two possible, non-exclusive mechanisms can explain it but cannot be tested with the available data:

i) SLB financing can support investments in projects that improve a firm's ESG practices, which can positively impact its score performance.

ii) The issuance process leads firms to develop internal mechanisms for disclosing and monitoring ESG data, resulting in greater transparency and potentially improved ESG assessments.

These mechanisms are not mutually exclusive and both are consistent with the positive evolution observed in ESG scores. However, the data used in this study do not allow for the distinction between these effects, representing a limitation of the analysis. To further explore these results, the next section presents the regression analysis used to test their statistical significance.

Table 4 - Univariate Analysis

Variable	Average	Standard Deviation	Min	Median	Max
ESG Score					
Pre	69,90	17,09	9,51	74,11	91,26
Post	72,07	15,40	9,51	75,65	94,70
Environmental Score					
Pre	69,88	19,80	0,00	73,43	97,47
Post	72,93	18,38	0,00	75,61	97,72
Social Score					
Pre	72,93	20,38	2,55	77,39	96,21
Post	74,49	18,44	2,16	78,64	95,84
Governmental Score					
Pre	65,66	20,40	6,35	72,52	99,49
Post	67,51	19,34	11,99	74,17	99,49

3.2. Do Sustainability-Linked Bonds impact the firm's ESG score performance?

Table 5 presents the results of fixed effect models estimated for the overall ESG score and its three pillars. The model controls for fixed effects at the sector, country and coupon levels, using a sample of 305 SLBs observed over 6 time periods, totalling 1830 observations per score. Our objective is to test if the issuance of SLBs statistically impacts firms' ESG score performance (H1).

As SLBs are a more flexible instrument compared to other ESG debt instruments, and their financial/structural characteristics vary depending on the achievement of predefined sustainability objectives (ICMA, 2024), they represent

a potentially more effective mechanism to direct companies towards a sustainable economy (Feldhütter et al., 2024). This structure incentivises firms to act in line with their ESG objectives, which can impact their ESG score performance.

According to ICMA (2024), the ESG targets defined by the firms should be ambitious and transparent, as the effectiveness of the bond depends on them. To genuinely generate improvements, SLB needs to have ambitious goals and the use of proceeds must reflect those ambitions. Otherwise, the bond's capability to create real ESG improvements is limited. Some authors raise concerns that firms can set easy targets to meet (Kölbel & Lambillon, 2023; Feldhütter et al., 2024) and, by doing this, they are creating an appearance of ESG responsibility without making genuine efforts to improve (Feldhütter et al., 2024). Although the existing literature explores the impact of SLBs on corporate sustainability, empirical evidence remains limited and isolating specific effects is methodologically complex.

The existing literature tends to point in the same direction: the issuance of SLBs generally improves the firm's sustainable position. According to Poggensee (2025), SLB issuers present a positive abnormal return, especially when SPTs are aligned with science-based targets, demonstrating that SLB commitments, when well structured, act as stronger sustainability indicator. Feldhütter et al. (2024) reinforce this idea. SLBs by linking financial terms to ESG performance, incentivises firms to act accordingly with their ESG objectives, improving their sustainable position. Although the literature indicates that SLBs have the potential to improve the firm's corporate sustainability, this empirical analysis tests if the issuance of this instrument has a statistically significant impact on the ESG scores globally and across individual pillars.

The results in the ESG model [1] present a statistically significant increase two years after the issuance (1.033, $p < 0.01$), while the effect one year after is not

statistically significant. The overall ESG score was significantly lower two years before the issuance (–2.917, $p < 0.01$), and two years after, it shows a positive and statistically significant coefficient (1.033, $p < 0.01$), indicating a clear upward trajectory from the pre to the post-issuance period. This demonstrates that firms were already committed to improving their scores before the bond is issued and continue this path after. It is consistent with the average trends observed in the univariate analysis, where ESG scores increased gradually before and after SLB issuance.

When disaggregating the ESG score, the environmental and social pillars suggest even stronger post-issuance improvements. The environmental score increases by 1.837 points and the social score by 1.239 points, both statistically significant at the 1% level. The governance model [4] also improves the score, but this increase is not statistically significant. The environmental dimension shows the most pronounced change, rising from -4.208 to 1.837 points, reinforcing the idea that firms are still predominantly focused on the environment.

The results presented align with the bonds ESG KPI type structure. Appendix B illustrates the representativeness of the KPIs associated with SLBs, demonstrating that environmental objectives are predominant. Although ESG KPI Type is not an explanatory variable in the regression model, this distribution provides additional context on the improvements registered after SLB issuance in each pillar. The distribution of KPIs is not part of the empirical analysis and is presented only as supplementary descriptive evidence. Following Berrada et al. (2022), despite SLBs being a flexible financing instrument, firms have not yet fully integrated social and/or governance metrics into their ESG targets.

These patterns are also visually represented in Figure 1, which illustrates the evolution of ESG scores before and after SLB issuance. While the overall ESG score improves after the bond is issued, the environmental and social pillars display stronger increases, and the governance pillar remains relatively stable

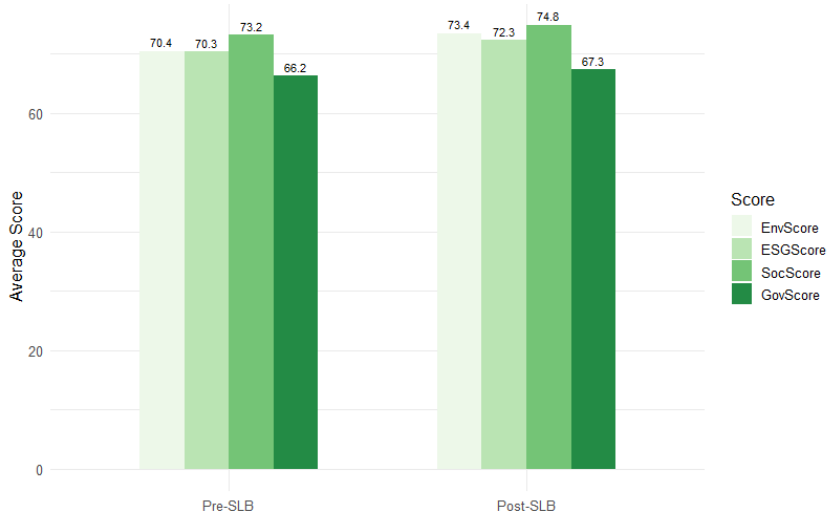
over time. Taken together, these findings provide evidence to support H1: the issuance of SLBs is associated with statistically significant improvements in ESG scores, particularly in the environmental and social dimensions.

Table 5 - Fixed Effects Regression Results: ESG Scores and Pillars

Fixed Effects Regression Results (ESG and Pillars)				
Dependent Variable:	[1]	[2]	[3]	[4]
ESG Score	ESG	E	S	G
Independent Variables:				
Time Period -24 months	-2.917***	-4.208***	-1.614***	-3.000***
	(0.372)	(0.491)	(0.445)	(0.686)
Time Period -12 months	-1.770***	-1.858***	-0.871*	-2.710***
	(0.372)	(0.491)	(0.445)	(0.686)
Time Period -1 month	-0.534	-0.416	-0.184	-1.052
	(0.372)	(0.491)	(0.445)	(0.686)
Time Period 12 months	0.281	0.845*	0.750*	-1.047
	(0.372)	(0.491)	(0.445)	(0.686)
Time Period 24 months	1.033***	1.837***	1.239***	-0.163
	(0.372)	(0.491)	(0.445)	(0.686)
Sector Fixed Effects	Y	Y	Y	Y
Country Fixed Effects	Y	Y	Y	Y
Coupon Action Type Fixed Effects	Y	Y	Y	Y
Number of tranches	305	305	305	305
Time Periods	6	6	6	6
Observations	1830	1830	1830	1830
R^2	0.091	0.112	0.035	0.022
Adjusted R^2	-0.094	-0.069	-0.161	-0.177
F Statistic (df = 5; 1520)	30.456***	38.220***	10.960***	6.790***

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. Standard errors are heteroskedasticity robust and clustered at the firm score level. Since each firm has multiple ESG related scores, we construct a unique panel identifier by combining ISIN/RIC and score type (ESG, E, S and G) to ensure that we have one observation per firm–score per period.

Figure 1 - Evolution of ESG and Pillar Scores Pre and Post SLB Issuance.



3.3. Does the impact of Sustainability-Linked Bonds on ESG scores only become statistically significant after a certain time period?

As discussed in the previous section, Table 5 confirms that SLBs positively impacted ESG scores. Still, this improvement is only statistically significant two years after the bond is issued. The observable temporal lag between the bond issuance and the effect on ESG scores reinforces the relevance of our H2. The impact of SLBs does not occur immediately and it only becomes statistically significant after a certain period of time.

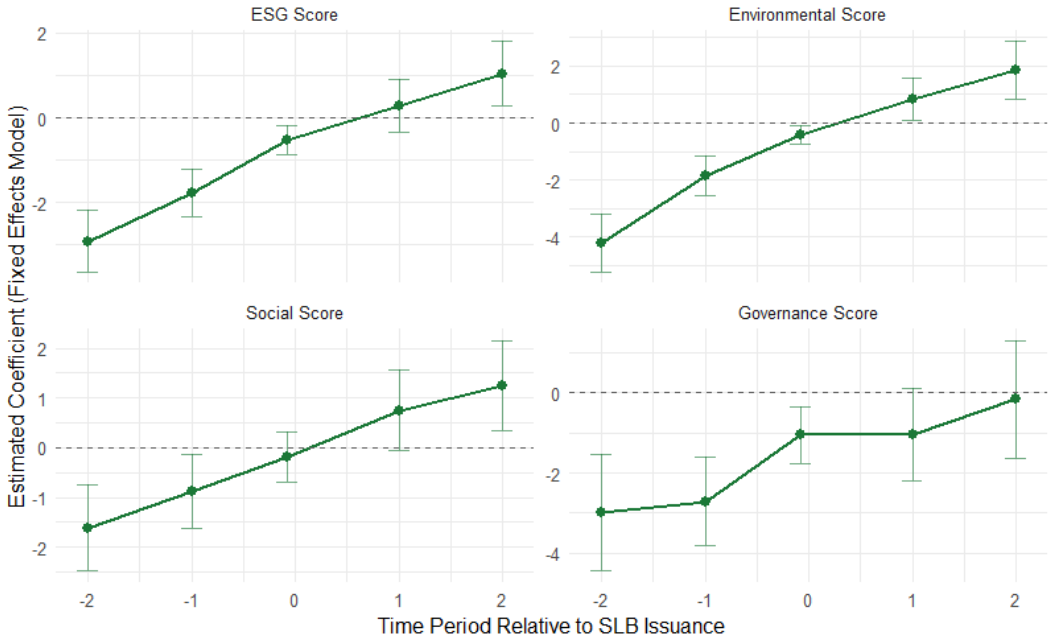
As shown in Table 5, the ESG score does not show a statistically significant increase one year after the issuance. However, when disaggregating by pillars, the environmental and social pillars already present a statistically significant increase in the first year, but only at a 10% level. It is only possible to observe a robust effect on the scores after two years of the bond issuance. At this moment in time, the ESG score becomes statistically significant, and the environmental and social scores become even more robust, with all the tree coefficients presenting a statistical significance coefficient at 1% level. These patterns support the idea that ESG score improvements, globally and by pillars, take time to materialise and only become statistically observable after two years.

Figure 2 illustrates these results by plotting the evolution of the estimated coefficients from the fixed effects regressions across each time period. The reference point is at zero in the horizontal line, and values below this line reflect periods where ESG scores were lower than the baseline (Time Period = 0). In contrast, values above the line indicate improvements in the ESG scores. Also, when the confidence interval crosses zero, we cannot conclude the effect is statistically significant.

The ESG score becomes statistically significant only in the second post-issuance period, transitioning from a negative to a positive coefficient. At the pillar level, we can observe the same pattern in the environmental and social scores. In both cases, the effect is statistically significant only in time period 2, as shown by the error bars that do not overlap zero. It is important to note that although we saw in Table 5 that the social coefficient was statistically significant at the 10% level one year after issuance, the confidence interval in Figure 2 still goes to zero. This shows that the effect is weakly significant after one year. In contrast, the governance score remains statistically insignificant across all periods, suggesting that SLB issuance did not lead to measurable changes in governance-related practices. This graph provides visual confirmation that the impact of SLBs is not immediate and only becomes statistically significant after a certain period of time.

These findings accentuate the importance of allowing sufficient time to assess the effectiveness of SLBs, as short-term evaluations cannot capture their full impact on corporate sustainability performance. As Nirino et al. (2022) reported, the results of sustainability investments take time to materialize. Consequently, there is a temporal lag between the SLB issuance, and the effect captured in the ESG assessments issued by rating agencies. Both Table 5 and Figure 2 show that, although ESG score performance have a positive impact after SLB issuance, these effects only become statistically significant after two years. The delayed effect remains consistent across both the aggregated ESG score and its environmental and social components, reinforcing the robustness of the results.

Figure 2 - Estimated Effect of SLB Issuance on ESG Scores and its Pillars.



3.4. Robustness Checks

To validate the findings, we conducted two robustness tests. First, we re-estimated the fixed effects models by including the firm's leverage as an additional control, given its potential influence on ESG score performance. This reduced the sample to 219 observations with available leverage data. Using leverage was based on Berrada (2022), who argued that firms with higher leverage have more scope to use SLBs. The results remain consistent across ESG dimensions. In particular, the ESG score, and the environmental and social scores continue to exhibit statistically significant effects at the 1% level after two years, confirming the robustness of the findings. As the coefficients remained consistent in sign and significance, we report the first specification as the main model and include the second as a robustness check.

We also conducted placebo tests by estimating the model using only observations before the issuance of the SLB (Time Period < 0). The results indicate a positive trend, showing that firms issuing SLBs were already committed to sustainability. This aligns with Berrada (2022), who argued that firms with higher ESG scores and previous experience with green bonds are more likely to issue SLBs, suggesting a pre-existing commitment to sustainability. These complementary tests strengthen the credibility of the main results and support the empirical validation of H1 and H2.

4. Conclusion

This dissertation analyses if SLB issuance has a statistically significant impact on ESG scores (H1) and if this impact is observable immediately or only after a certain time period (H2). Based on a sample of 305 SLBs issued between 2019 and 2022, we applied fixed effects models with various time periods to assess the impact of SLB issuance on ESG score performance. The analysis indicates that statistically significant changes in the global ESG score are only observed two years after bond issuance, with no significant improvement observed in the first year. When disaggregating the ESG score into its pillars, the results show that the environmental and social scores are weakly significant at the 10% level in the first year and only become robust at 1% level two years after the issue date.

These conclusions support both hypotheses defined in this dissertation: SLB issuance is associated with statistically significant changes in ESG scores (H1) and these improvements take around two years to be statistically significant (H2). This is in line with Nirino et al. (2022), who defended that the results of sustainability investments need time to be observable. Investments made through SLBs might require structural changes and shifts in business behaviour, which take time for the results to become perceptible. This suggests that the timing to evaluate ESG score performance after SLB issuance is critical, as short-term evaluations fail to capture their full impact on firms' sustainability performance.

This analysis recognises several limitations that should be addressed in future research. One limitation is the absence of a control group composed of firms that did not issue SLBs, which limits the ability to assess if the observed changes are specific to SLB issuance or reflect market trends. Another limitation is the short time period used for the analysis. The sample only includes bonds issued

between 2019 and 2022, restringing the sample to 305 SLBs with ESG score information. ESG improvements occur gradually and analysing them over time makes it possible to see if the observed effects persist, grow or disappear. Therefore, recognising these limitations in future studies would strengthen the empirical data and allow for a more robust analysis.

This study contributes to the growing literature on sustainable finance, as it provides empirical evidence that SLBs are associated with statistically significant improvements in ESG scores, globally and by individual pillars, especially in the medium term. Although the time period and sample size are limited, the results suggest that SLBs are associated with improvements in corporate sustainability performance over time.

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Appendices

Appendix A: Variable Definitions.

Variable	Variable Description	Source
Dependent Variable		
ESG Score	Refinitiv ESG Score is an overall company score based on the self-reported information in the environmental, social and corporate governance pillars.	LSEG Refinitiv
Independent Variable		
TRBC Industry Name	The Refinitiv Business Classification (TRBC) Industry Description. TRBC Classifies companies with increasing granularity by Economic Sector, Business Sector, Industry Group, Industry and Activity.	LSEG Refinitiv
Total Assets	Represents the total assets reported by a company or sum of Total Current Assets and Total Non-Current Assets.	LSEG Refinitiv
Total Debt	Represents the total value of all borrowings reported by the company, including short-term and long-term debt.	LSEG Refinitiv
Domicile	The jurisdiction in which a fund is legally incorporated.	LSEG Refinitiv
Coupon Action Type	Coupon payment applicable to the asset, Fixed Income.	LSEG Refinitiv

Appendix B: ESG KPI Type Distribution Across SLBs

ESG KPI Type	Nr. of KPIs	% of Total KPIs
Environmental	380	85,78%
Social	28	6,32%
Governance	20	4,51%
Not Specified	15	3,39%
Total	**443**	**100,00%**

Note: 443 KPIs linked to 305 SLBs in the sample. Not specified category refers to KPIs with no clear pillar attribution in the LSEG Refinitiv.

Appendix C: Prompts list

1. Error correction and optimization of the script in R Studio by identifying and fixing errors in the script execution (e.g. script not correctly running due to incorrect function usage) (ChatGPT).
2. Resolving data visualization issues in R Studio (e.g. graphs that was not displaying as expected) (ChatGPT).
3. Error correction (Grammarly).

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Declaração

Declaro por minha honra ter elaborado o meu trabalho escrito/dissertação, Sustainability-Linked Bonds: An Empirical Analysis on ESG Score Performance, com total honestidade e isenção de qualquer prática fraudulenta, nomeadamente cópia ou plágio.

Declaro ainda conhecer que o cometimento de fraude em momentos de avaliação escrita constitui uma grave violação das regras de ética e conduta académica, vigentes na Universidade Católica Portuguesa, geradora de responsabilidade disciplinar, tal como disposto no Código de Ética e de Conduta desta Universidade – alínea b), nº 3 do artigo 8º e nº 3 do artigo 12º.

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Declaração de IA generativa e tecnologias assistidas por IA no processo de redação

Durante a elaboração do meu trabalho escrito/dissertação, Sustainability-Linked Bonds: An Empirical Analysis on ESG Score Performance, foram utilizadas as ferramentas Grammarly and ChatGPT para as tarefas de correção de erros gramaticais (Grammarly) e correção de erros e otimização do código em R (ChatGPT), tendo sido utilizadas as prompts listadas no final do documento na secção Lista de Prompts. Após a utilização destas ferramentas/serviços, revi e editei o conteúdo conforme necessário e assumo total responsabilidade pelo conteúdo do trabalho apresentado.

Declaro ainda conhecer e respeitar as Regras de Conduta de Inteligência Artificial da Católica Porto Business School.

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