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Financing climate change mitigation efforts:

A comparison within bond markets instruments

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PREFACE AND ACKNOWLEDGMENTS

A thesis process is never an easy journey; however, this was an exciting time and opportunity to research further in the environmental finance field, a passionate topic for me and many others.

I want to express my gratitude to the many people that gave some of their precious time to speak and discuss different ideas, pushing the boundaries of what started “as an intention to do something related to” to what is now the thesis that I summited, marking the end of this academic stage.

I need to thank Emilie for her support, listening, and reading during the many deliveries of this process. I also would like to thank Antti Yang, my supervisor, for his valuable comments and questions that made me improve, elaborate, and express my ideas better. I want to thank Andres Otero as well, who made time in his busy agenda to discuss about this topic.

Finally, I must thank my family because, without their support, none of this would be possible.

Abstract

This thesis first focuses on analyzing the primary bonds market, where we investigate the existence of a premium in the sustainability-liked and green bond markets. The results indicate mixed outcomes depending on the methodology and specifications used to prove it. However, our average model indicates the existence of a significant and consistent premium in both markets. The second part of our thesis analyzes how different variables effects and impact the sustainability-linked bond yield, explicitly focusing on exploring the different entails of sustainability performance targets. Our findings indicate that bonds linked to different SPTs carry different premiums; bonds linked to energy efficiency and renewable energy consistently face a lower yield, according to our results.

Keywords: bond market, green bonds, sustainability-linked bonds, environmental finance

Contents

I. Introduction

Sustainable investing is seen as one of the best ways to offset the "physical manifestations of a changing climate are increasingly visible across the globe, as are their socioeconomic impacts"(Mckinsey & company, 2022).Therefore, governments, institutions and people are concentrating their efforts on finding ways to mitigate as much as possible the adverse effects of global warming investing in a business that declare their intentions to meet this agenda.

Financial markets play a crucial role in allocating resources to industries that declare their intentions to transit and adapt to a greener economy.Through this capital allocation, financial institutions could and will shape the whole economy depending on which businesses and activities they will finance.

The cost of capital that an enterprise face impacts directly in its financial structure and also in the investment decisions that in the long run shape the capital structure of companies. That is one of the reasons for the increasing interest of researchers and financial professionals to prove if there exists a greenium in the green bonds and now with the appearance of this novel instrument called sustainability-linked bonds if this greenium could also be founded here.

Sustainability-linked bonds are driven by specific KPIs and is a relevant and interesting question to address which is the specific impact of the yield that has the most common KPIs chosen by the enterprise when setting their environmental goals at the moment of the issuance of the bonds.

The main interest of this research is to focus on the **primary bond market**, specifically the one of green and also the novel instrument of sustainability-linked bonds, both instruments part of the investable universe of the bond market that in 2020 amounted for USD **123.468, 6** bn which in relative terms represent the around the 53 of the securities markets. The magnitude of bond markets demonstrates the capacity that it has when it comes to financing projects and how using this financial instrument, we could be able to support a sustainable transition to a green and prosperous economy[1].

At the end of 2021, labelled debt issuance reached USD 734.7 bn in sustainable debt(Climate bond initiative , 2021). This number not only shows the appetite from investors to go and purchase these instruments but also shows the increasing importance that are getting the **ESG**

[1]See in appendix A. for more information

components as a way to manage climate risk in the investment portfolios in the economy. This aspect is becoming progressively more and more important at the moment of investment managers are making their decisions on where to allocate their investments.

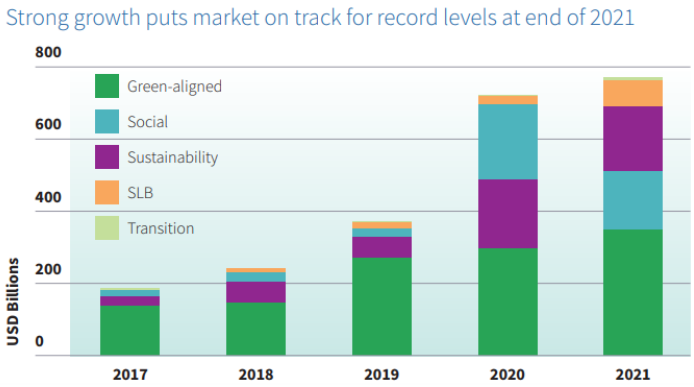

Figure 1: Sustainable debt market source: Climate bond initiative

One important point to consider about all this new type of debt is how trusty and also how committed are the issuers to transiting to a greener economy. Here comes the role of secondary party opinions that certificates the achievements of the KPI previously established at issuance and in the case of green bonds rating them to have an ESG score that could ensure bonds holders that the issuer companies follow what they said and avoid using these instruments just to greenwash their image. This cost should be taken into consideration and could impact the decision of a company making them choose between one instrument and another in their funding decision process. "The cost of second parties' opinions is estimated to be 0.3 and 0.6 bps, depending on the level of work."(Hachenberg & Schiereck, 2018).

Hereafter, this research will be organized as follows: In the section II. "literature review" will be presented the main findings of the previous literature about green and sustainability linked bonds. In the section III. "hypothesis" will be presented the research question to be examined in this thesis. Then in the section IV. "data", the objective of it is to present the key figures and give a big picture of which is the current situation in both markets. In the section V. "methods", we will discuss theoretically the advantages of using a parametric or propensity score matching methodology to reach our conclusions. In the section VI. "results", will be presented the main findings of the hypothesis tested. In the section VII. "Conclusions", I will conclude with a summary of the main findings and implications of the research conducted, and

finally in the section VIII. "Limitations" and in the section IX. "Further discussion" we will comment the main challenges for this research and possibles way to investigate further in environmental finance topics.

II. Literature review

Sustainable investing is growing at a fast pace, that is why research more and more are interested in knowing what the main implications of this increasing type of investment are not only for the returns for investors but also the implication for the whole actors in the economy, that declare to be in a transition to a greener economy and are investing in adapting their business models into a greener one.

Gilchrist, Yu, and Zhong conducted a systematic literature survey where they concentrated on the factors that affect business participation in environmentally responsible activities in the context of green bonds and green loans, as well as their potential rewards at the same time arriving at the conclusion that ESG practices are not only beneficial to the financial shareholders of the company but also impact positively to the non-financial shareholders around it. The same was done by Bhutta, Tariq, Farrukh, Raza, and Iqbal, which using a systematic literature review methodology explore the mechanism of financing eco-friendly projects and their effects on its stakeholders their main conclusion are that green bonds are the instrument called to finance the green transition, and secondly they remark the importance of a clear and transparent regulatory environment that makes able to grow to this instruments.

Another topic of interest for researchers has been green assets as a tool for managing risk, specifically climate risk. Sharfman and Fernando explore the effect of an improvement of the climate risk management on the cost of capital of US firms, arriving to the conclusion that firms that improve their climate environmental performance benefits from a lower cost of capital, a shift from equity financing to debt financing, therefore, having the tax advantages of going into more leverage without incurring in distressing costs.

Besides the interesting research done by the last authors presented, the main focus of this thesis is to explore the existence of a premium on the bond market because its existence will have implications in the cost of debt that firms face and could be taken as a competitive advantage for firms that have business models that are harmless to the environment. In the following subsections, we will explore the research made on the pricing aspect of SLB and Green bonds.

A. Sustainable linked bonds

Sustainable linked bonds, SLB from now on, differ from green bonds in the way that the instrument is structured in such a way that the "coupon is linked to the issuer achieving a predetermined sustainability performance target"(Kölbel & Lambillon, 2022), thereby the reason for its name. Being structured like this is a slight but significant difference in comparison to green bonds because in this manner, the issuer acquirer a compromise of achieving a previously defined KPIs and in the case of not meeting them, it will receive a punishment in the form of an increase in the cost of its debt.

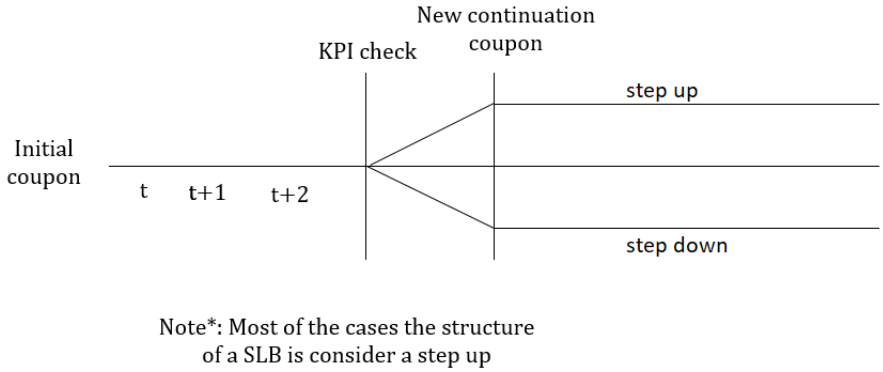

Figure 2: Structure of coupon penalty in SLB bonds

Nowadays, the typical mechanism that follows the SLB is a 0.25 bps step-up in case of not achieve the SPT previously defined but also is seen according to Kölbel and Lambillon that are some SLB that are structured the other way around, having a step-down mechanism which in case of achieving the target gives the enterprise a discount in its cost of debt.

One of the biggest issues today for sustainable investment is the missing of a common taxonomy that allows investors to compare in an easy and transparent way different instruments and rely on that they are effectively addressing environmental problems. It is because of the absence of a common taxonomy that the sustainable linked bond principles proposed by **ICMA** in June 2020 were the first step to building a common framework and defining what type of KPI should be used to set the target for the SLB bonds suggesting that they must be relevant, measurable, externally verifiable and possible to be benchmarked. ICMA intended through these voluntary principles to provide guidelines to unify the structure and scheme among all market participants

providing the grounds to make possible the growth of this novel instrument in the bond market. Due to the newness of the SLB instrument, an essential element is to have a standardized framework not only in the continent but also around the globe, so in this way, the incentives of investors will increase due to better transparency, comparability, and reliance of the instruments and in consequence, this will produce and increase of demand from the investors that have the willingness to buy sustainable assets. However, nowadays, the financial actors are still figuring out what is the best way to standardize this new instrument and make them reliable in terms of which and how companies will be using the funds raised under the grounds of making possible a transition to a greener economy.

Accounting for USD 8.781 millions in 2020 according to Lester (2022), SLB are expected to raise its issuance with the help of the publication of the sustainability-linked bond principles that provided the framework to this novel instrument, positioning this instrument as a concrete alternative to make possible the green transition and avoid greenwashing from the company side.

B. Green bonds

"A recent development in corporate finance is the use of corporate green bonds—that is, bonds whose proceeds are committed to finance environmental and climate-friendly projects, such as renewable energy, green buildings, or resource conservation"(Flammer, 2021). Back in 2007, the European investment bank issued the first bond of this type, initiating with it the beginning of the use of bonds as an instrument for financing projects labelled as green. Green bonds differs from sustainable linked bonds in the way that they are not connected to achieving targets; instead, their governance lies in the ODS [2] framework.

The recent "investor appetite for ESG investing in bonds is supported by a growing body of research that suggest that companies that proactively address sustainability and governance issues may lower their credit and default risk". (Madhavan & Sobczyk, 2020) In the research conducted by (Madhavan & Sobczyk, 2020) they studied the risk-return relationship between ESG and green bonds with the intention of exploring and testing the existence of an alpha related to ESG criteria, founding that the ESG factor does not affect the relationship between risk-return, meaning that they do not carry a greenium[3].

Although there is no unanimous consensus about the existence of a greenium carried by green

[2]To see the complete list of ODS objective go to appendix B.

[3]Greenium is defined as a positive reward outside the risk-return relationship that are carried by green bonds

bonds, "most of the works focusing on the bond market suggest that companies with high environmental performance benefit from a lower cost of capital" (Zerbib, 2018). In the work of Zerbib (2018) he studied the bond market with the objective of identifying the existence of a green bond premium due to investor pro-environmental preferences. His study used data from July 2013 to December 2017, founding a small but significant green premium of **2 bps**. The author suggests that "the lower cost of debt for companies with good environmental performances should be more related to a lower level of risk than to non-pecuniary motives" (Zerbib, 2018) this founding is consistent with the conclusion of Madhavan and Sobczyk.

In an effort to provide an answer to the same research question, Baker, Bergstresser, Serafeim, and Wurgler investigated the municipal green bonds using an asset pricing model arriving to the conclusion that these types of municipal green bonds are sold for a premium, and the ownership is more concentrated where they are of better risk quality and appears greener in comparison to their pairs. These results are consistent with whatGoss and Roberts established in their study "The impact of corporate social responsibility on the cost of bank loans", where they found an average premium between 7 to 18 bps in comparison to firms that have environmental concerns in the US bank loan market.

On the other hand, studies such as the one made by Larcker and Watts suggest that the greenium does not exist at all. Taking advantage of the municipal security markets, they detect economically equivalent pricing for green and non-green issues when comparing green securities to close to identical securities issued for non-green purposes by the same issuers on the same day, and this conclusion comes to challenge the results published by Baker et al..

The existence of mixed evidence in the bond market was reviewed by Liaw, applying a systematic review methodology and separating primary from secondary markets arrive at the conclusion that the differences in sample sizes, time periods, methodology, and the characteristics of each issuing corporation and bond are likely to be responsible for the contradictory findings.

Much research has been done around the sustainable investing topic, but because of the novelty of the instrument and at the same time being a market in an early stage of development, there is not still yet a unanimous consensus on their characteristics in pricing, risk, returns, lack of a taxonomy of the instrument or if there are additional implications for firms that participate issuing this types of instruments. The last more than disappoint us should be a motivation to research further and, in this way push this market to mature making it bigger and enhance its

impact on the economy.

III. Hypothesis

As exposed in the section literature review, there is mixed evidence regarding the existing or not of a premium in green bonds, and less evidence could be found in the SLB landscape as is it a new instrument coming to the bond market.

Theoretically was suggested that "In equilibrium, green assets have low expected returns because investors enjoy holding them and because green assets hedge climate risk" (Ľuboš Pástor, Stambaughb, & Taylor, 2021) this provides a mathematical framework to what was before proposed by Heinkel, Kraus, and Zechner (2001). If the last holds, green bonds and also sustainability-linked bonds should carry a premium and will lower the cost of debt for the companies, thereby would become optimal for companies to adapt their business model to "greener" models to take advantage of this situation.

The last assumption motivates our research question for this thesis making this the following: Which is the optimal debt instrument between SLB, greens or the traditional conventional bonds when it comes to a debt issuance from enterprises to finance their activities.

To answer the first question presented, we build two hypotheses as follows:

1. First hypothesis: SLB issued yield differ significantly to conventional bonds

$$\mathbf{Y_{SLB}} - \mathbf{Y_{Convetional}} < 0 \tag{1}$$

2. Second hypothesis: Green bonds issued yield differ significantly to conventional bonds

$$\mathbf{Y_{green}} - \mathbf{Y_{Conventional}} < 0 \tag{2}$$

If the first hypothesis is valid will means that for companies, the cost of capital will be cheaper in relative terms issuing a sustainable linked bond in comparison with a conventional one.

The second hypothesis, if confirmed will means that the cost of capital for enterprises that issue green bonds is cheaper relative to the conventional bond option.

An alternative explanation for the existence of a premium in this type of asset is that because of their novelty, specially SLB, there is a limited supply of them and, at the same time, also an increasing demand from the investors. Therefore, having a short supply combining this with an

excess of demand makes for companies, in general, an attractive way to finance their activities in addition to all the CSR benefits that the instrument carries itself.

A second part of the thesis will be to provide a further analysis focusing entirely on sustainable linked bonds, testing the impact on the cost of debt of different KPIs used as a threshold of compliance according to the goals set at the moment of the issuance of this instrument and later explore the effect on yield of having in addition of the inherent KPIs a reported ESG score on the instrument.

IV. Data

The objective of this section is to explain in detail how the database was created for then make it possible to apply the methodology proposed in the section METHODS to conduct the analysis then. This dataset is split into two samples. The first one contains SLB and conventional bonds, and the second contains green bonds and conventional bonds. In this thesis, we consider SLB and green bonds as our treatment group for each sample and conventional bonds as our control group, which are the same for both samples.

All the data was collected from the Bloomberg fixed income database and complemented with different sources of information in case of missing values, specifically when there the missing value was a yield at issue following the procedure in Kölbel and Lambillon, the last information was taken from refinitiv Morningstar.

Until May 2022, the entire universe of SLB outstanding was 472 bonds. However, Bloomberg does not have all the information about them, and there are bonds with missing information regarding their yield at issue. Because of the last situation, in case there were still missing values for the yield at issue, we took the bond out of the sample. This reduced the sample to 378 issues which is a number still statistically significant to conduct this analysis. For the same sample but for the conventional type of bonds, we collected 8592 issues that will, as was mentioned before, serves as a control group for the posterior analysis made after. Finally, our sample before matching has 8970 bonds just for the case of the SLB analysis.

For the case of green bonds, this decision of the data collection was not straightforward because in 2018 the EU High-Level Group on Sustainable Finance in their final report [4], suggest changes to the structure of the instrument. These recommendations were made to increase the transparency

[4]Financing a sustainable European economy EU High-Level Expert Group on Sustainable finance (2018)

of the green bond market, building trust in the investor and all the market participants. Other authors also suggest that due to the low liquidity at the beginning of the market, the estimations made using the entire time frame of prospects will bias the conclusions of any research conducted. Nonetheless, we decided to use all the information available regarding green bonds. We took from Bloomberg all universe till May 2022 has until then 4859, after screening for the ones that have information regarding the yield at issue, we finished with 1916 bonds from 2011 till 2022.

A. SLB Linked bonds

This new class of bonds are novel, which is remarkably interesting but has at the same time the challenge that we do not have extensive data to research about this specific topic and neither on how this instrument interacts in the moment of going into the market.

The database for the SLB analysis contains variables such as issuer name, CUSIP, coupon, yield at issue, maturity, currency, industry, year, area, the amount issued, maturity type, type of target KPI, and ESG score, among others that we used to characterize each bond. These variables were fundamental later when proceeding with the implementation of both matching and later the posterior regression analysis conducted.

In the figure presented below, we can see how fast is growing the issuance of this type of instrument since the first one was issued in 2018 when the Chinese company Beijing Infrastructure Investment Co Ltd [5] used this mechanism to finance their activities.

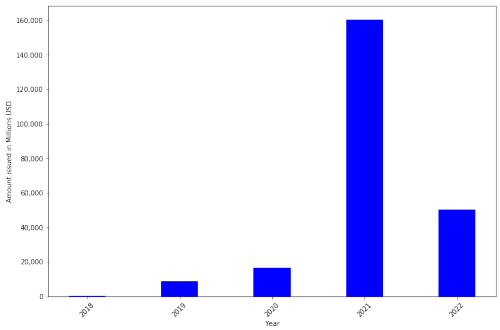

Figure 3: Number of SLB issued

Nowadays, Europe, North America and Asia [6] lead in terms of issuance of this type of

[5] According to Bloomberg information this is the first SLB putted in the market but many sources of information attribute to ENEL the first issuance of this instrument

[6] See in Appendix C. for the details of the cumulative amounts in each area

instrument, making together more than 91% of all the prospects in the market being Germany, France and China the most prominent participants coherently with the size of their economies and their declared willingness to transit to an economy with lower CO2 emissions.

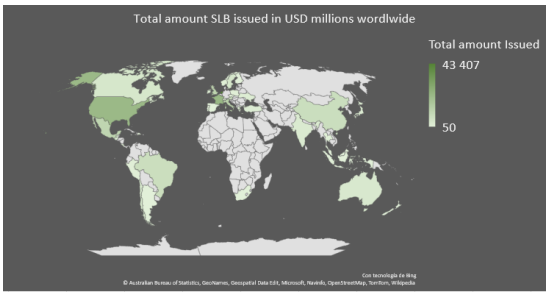

Figure 4: SLB issued around the globe

B. Green bonds

Green bonds are instruments that are longer on the market, and for that reason, there is also a more significant number of issuances. The first green bond was issued in 2007 by the European investment bank as a solution to finance projects related to environmental purposes, but it was not until 2014 that the market started to kick off exponentially to arriving at the 1 USD trillion milestone in December 2021.

In the graph below, it can be seen the exponential growth that the green market experience from its begging until what it is today.

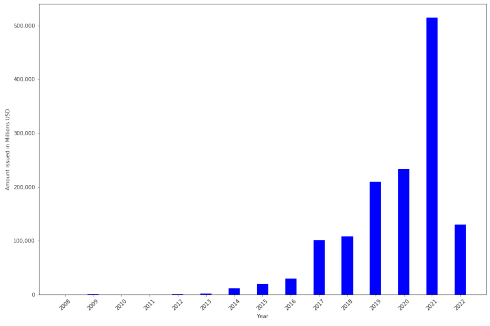

Figure 5: Green bonds issued and projection source: Climate bond initiative

One remarkable difference that arises when analyzing the data is that US corporates are much more involved with this type of instrument than SLB. This is an exciting fact to follow in the

coming years to see how the SLB are adopted in the US and if the existence of the new instrument replaces green bonds and lowers the growing tendency of the green market in that country.

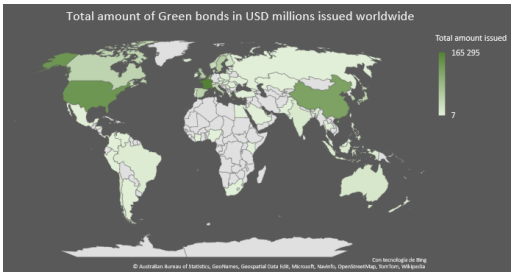

Figure 6: Green bonds issued around the globe

To make possible a comparison analysis between the premium found, the database contains variables which are the same for both samples, SLB and Green bonds. After having collected all the treatment bonds of each type, we proceeded to collect the conventional sample that served as a control group for our matching analysis.

C. Conventional bonds

Particularly important for this research is to have an extensive database that contains 8592 different conventional bonds with similar characteristics of each governmental or corporate issuer that had issued green or sustainability-linked bond and have available data about the yield at issue to then apply the proposed methodology in section methodsV.

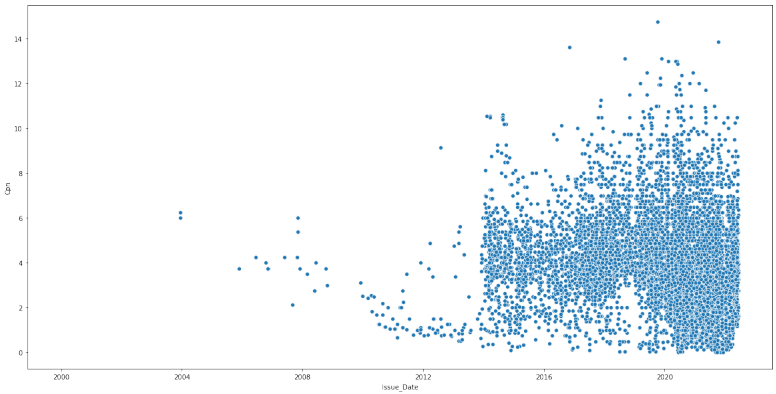

Figure 7: Sample of conventional and its respective coupon

Table N°1: Conventional bonds issued by continent		
Continent of the issuer	Number of bonds	Amount Issued in M USD
Asia	1 006	699 445
North América	5 157	5 509 079
Europe	1 888	1 874 347
América	328	239 052
Oceanía	170	122 523
África	43	29 214

Due to the use of the matching methodology, the database and the control group should be extensive enough not to restrict the match between issues and, in this way provide robustness to the analysis when calculating the differences between yields for each instrument.
On one hand, one significant advantage of collecting conventional bonds is that we have extensive data to do it, but on the other hand, we will have to restrict the number of bonds to be collected to the bonds that are issued by companies that already had issued green or sustainable bonds in the past. This is under the assumption that bonds issued by the same issuer in the same period just differ in the fact of being green, sustainable-linked or conventional[7].

V. Methodology

The goal of this section is to present the methodology used to address our research questions previously exposed in the section hypotheses. To answer them, we need to know if green and sustainable-linked bonds carry or not a premium. To do so, we followed a matching methodology in two steps; first, we did a matching based on similar characteristics of the bonds that we had available and then to make a propensity score matching to have a robustness check and see if our results still hold, this PSM matching was made running probit and logit regression according to the same characteristics previously used.
We needed to use this methodology because we do not have the possibility to observe the ideal case; this means that we do not have the same bond being SLB or Green and conventional at

[7]This restriction was relax partially in the PSM allowing bonds to match with counterfactual of the same continent

the same period of time, in other words, we do not have the factual and the contra factual in the same period of time.

In the ideal case we would be able to perfectly isolate the effect of being SLB or Green over a conventional. However, this is not possible, so we use two different methodologies to solve this problem and have a fair approximation using a non-parametric and later a parametric matching to isolate the effects of being Green and SLB over its contra factual conventional bond.

Finally, in order to answer the second part of our analysis, we run different models using an ordinary least square methodology to isolate the effect of the variables of interest and their effect on the cost of debt.

A. Matching procedure by characteristics

This matching methodology was built by collecting bonds from companies that issued Green or SLB bonds and had also issued conventional bonds in the past. In this way, under the assumption that the financial structure, risk perception, business ability, and all the non-observables characteristics of the company did not change, we could isolate the effect of a bond of the same company of being Green or SLB and then compare how much the yield required by investor changed in relation to a conventional bond.

As a first step, we collected all the samples of SLB and Green universe available on Bloomberg. Then, using this as a reference, we download all the conventional bonds from enterprises that issued this type of bond with an issuance date after 2013 and have information about the yield at issue.

After doing that, we screen for the candidates using the following criteria to do so:

- Issuer: The issuer for each match between SLB and conventional and the match for the green to conventional should be the same in all matches.
- Year of issuance: To avoid differences in the economic environment that could bias our analysis, we allow the match to have three possibilities, the first same year of issuance, the second one year of difference and finally, three years of difference.
- Issued amount: In order to make two bonds comparable, they should be in the same range of money involved, is because we control by the amount issued, and we allow matches that do not differ in great magnitude from its contra factual.

The assumption that nothing except the type of the bond Green, SLB, or Conventional changed could be taken as strong, but this methodology is widely used and accepted in many fields of study such as economics, finance, medicine, and many others. We believe that restricting criteria used to make the match gives validity to the comparison between the factual green or SLB bonds and their conventional match.

B. Propensity matching scores

To give a robustness check and test if the results hold changing because of the methodology employed, we used a propensity score matching methodology, which was first defined as "the propensity score is the conditional probability of assignment to a particular treatment given a vector of observed covariates" (Rosenbaum & Rubin, 1983). Using this methodology, we expect to generate a match between two different types of bonds, from one side the green bond or SLB bond and from the other a conventional bond being the control group. Always with the goal of answering the first research question related to the existence of a sustainability premium in both instruments.

The main challenge that we want to solve using this methodology as explained in Shaikha, Simonsen, J.Vytlacil, and Yildiz (2009) is that we are never able to observe the counterfactual scenario; this means that we are not able to see for the same observation both cases at the same time, treatment and non-treatment[8] for the same bond in this case.

"The method of matching resolves this difficulty by matching each participant with a nonparticipant that is similar in terms of observed characteristics X" (Shaikha et al., 2009), here at different from the last matching methodology proposed we relax the fact of letting the issuer being the same and based different observables characteristics we allow Green and SLB to match their counterfactual in the conventional universe of our sample.

Mathematically is essential to mention that when we are implementing this methodology, we are implying that all the non-observables different than from the ones used to make the match are equal, meaning that the error between the groups are orthogonal in their construction; in other words they are independent from each other.

For running our propensity score matching, we use the same database explained in section data IV., and we define the probability of being in the treatment (Green or SLB) to be as determined

[8] treatment group defined as green bonds or SLB bonds; Non-treatment group defined as conventional bonds

by the following characteristics:

- Year of issuance: As the same as the last match procedure, we want to control by control by the possible differences in the economic environment. In this case, we did not relax this assumption as each observation has its own score from which it is then matched.
- Amount issued: The amount issued could impact the yield required by investors, assuming economies of scale so we control by this characteristic to make comparable both bonds.
- Continent: To give more freedom to the match, we allow the bonds to be in the same continent as we believe that the conditions do not change dramatically between a country and another[9].

Finally, to conclude with the first part of the analysis, we compared the differences between the premiums founded using both methodologies and if there are significant differences in terms of yields paid by the issuers. In case that this exists, this will have financial and economic implications because when it comes to the decision to choose between a green bond and a sustainability-linked bond at the moment of financing the business activities through the market raising money, companies will want to optimize their capital structure and this could have an implication in the decision of one over the other.

To the best of our knowledge, this third research question was not addressed before, mainly because of the novelty of the SLB instrument, and we think it is a relevant question not only for the companies that want to transit to a greener economy but also for regulators, non-governmental organizational and public policy makers whose could focus their efforts on potentiating one instrument over another.

C. Regression analysis

After having completed the first part of the analysis, where our main goal was to prove the existence of a premium or not in the SLB and Green bond market, we continue exploring the sustainability-linked market and the impacts on the yield of different variables.

The variables explored are the class of the bond issuer, the existence of a reported ESG score, the different sustainability performance targets set to measure the enterprise's accomplishment,

[9]North America was separated from South America to account for the differences between them

and the effect of the different maturity type on SLB.

In order to explore and analyze the variables mentioned and their specific effects. To do so, we conducted different regressions models intending to isolate the effects of each of them and then arrive at meaningful conclusions that aim to understand in a better manner the factors that drive the yield in this novel market.

The first equation presented explores the effect of whether the bond issuer is a governmental or a corporate institution. To do so, we will test the following regression:

$$Yield_{SLB} - Yield_{Conventional} = Constant + \beta_1 Governments + \beta_i Controls_i + \beta_i Year_i + \xi \quad (3)$$

The second model aims to explore the impact that a sustainability-linked bond reports an ESG score and how it impacts it in terms of yield. To do so, we conducted the following regression:

$$Yield_{SLB} - Yield_{Conventional} = Constant + \beta_1 ESG_{Existance} + \beta_i Control_i + \beta_i Year_i + \xi \quad (4)$$

The third model is built to explore the different impacts of the sustainable performance targets chosen at the issue moment and shows how and with what the enterprise is engaging when entering the SLBs market.

$$Yield_{SLB} - Yield_{Conventional} = Constant + \beta_1 SPT_i + \beta_i Control_i + \beta_i Year_i + \xi \quad (5)$$

To conclude, following the study of Kölbel and Lambillon, we wanted to explore the impact of a bond having the feature of being callable or not and prove with our data if this feature has a negative impact on the yield[10]. This presence of a callable feature is highly relevant in the case of SLBs because enterprises are allowed to call in advance the outstanding debt in case of knowing they are not achieving an SPT, which means avoiding suffering a penalty. Therefore, this situation could be considered a possible source of greenwashing detected in this market.

In order to explore the last exposed, we conduct the following regression:

$$Yield_{SLB} - Yield_{Conventional} = Constant + \beta_1 MTY_i + \beta_i Control_i + \beta_i Year_i + \xi \quad (6)$$

D. Robustness check and consistency

D.1. Different matching methodologies

For the case of both matching methodologies, we perform a Cohen test proposed in Cohen (1988) to extend our analysis and provide robustness to our outcomes.

[10] Consider a negative impact in the yield an increase of it

We perform this test with the objective of analyzing whether the mean of the two sample groups differs in all the models used to generate the match.

The test performed is as follows:

$$d = \frac{M_2 - M_1}{\frac{\sqrt{SD_1^2 + SD_2^2}}{2}} \tag{7}$$

With the use of this test, we check the results obtained under the two matching procedures presented in the section V.

D.2. Regression analysis

For the case of the regression analysis, all models are performed under different specifications to give robustness to the conclusions deduced from them.

In addition, fixed effects are used to control by different aspects inherent to the economic cycle, robust errors are used to control for the possible heteroscedasticity present in regressions errors, and finally control variables such as continent, class, and industry were added to give consistency to our estimated coefficients.

VI. Results

In this section, the main findings of the methodology applied will be presented, and the results are divided into three main parts: The first will present the matching results and the average treatment effect from both groups SLB and Green bonds according to each restriction used, second we will present the results of the propensity matching score methodology for both treatments groups, and finally we will present the results of the regression analysis conducted to explore the different effect of the KPI in the yield of SLB bonds.

A. Matching by characteristics

A.1. Sustainability linked bonds

As presented in the section methodology for this matching procedure, the first match made considered bonds issued only in the same year calendar. For the second case, we relaxed this restriction to one calendar year of difference, and for the third and last match, we relaxed this to a three-calendar year.

In the following table, the ATE found for our sample of SLB bonds matched with their conventional pair for each case.

Table N°2: Average treatment effect after matching procedure for SLB:
Model 1: bonds issued the same year
Model 2: 1 year difference of issuance
Model 3: 3 year difference of issuance

Model	**N° matches**	**Average treatment effect**
(1)	23	0,04%
(2)	47	-0.102%
(3)	74	-0.466%

As shown in the table above, the first model found twenty-three pairs of bonds that matched according to our specifications as a result of the matching the ATE of being SLB on the yield of 4 **basis points**. For the second model, we found forty-seven pairs. The reason of the increase of bonds matched is of simple intuition as we relaxed the restriction of matching and eased it to one calendar year. For this case, we found a premium of -10 **basis point**, which economically speaking is not significant but shows the first signal of the existence of a premium in the SLB market. Finally, in the third model where we relaxed our year restriction to 3 years calendar, we matched seventy-four pairs of bonds and the premium increased to -46.6 **basis point**, which is the higher found in our models and consistent with the findings of Kölbel and Lambillon whose have found a premium of -29 **basis points**.
It is also essential to consider when proceeding with a matching methodology that we need to show that the subsamples used to perform the match are representative of the entire sample from where we want to conclude. The table below presents the main variables of interest that we considered to perform the match.

Table N°3: Sample and subsample description for each SLB matched				
SLB	**Yield at issue**	**Cpn**	**Amount**	**Duration**
Full sample	3.11%	3.21%	611 800 240	8.27
Match 1	2.75%	2.75%	787 205 217	8.65
Match 2	2.76%	2.79%	692 904 468	9.51
Match 3	3.08%	3.09%	735 233 784	9.08

As we can see in the table, the average coupon, amount issued and duration of the whole sample and the one of each match do not differ in a great manner, and this confirms that our treatment and control group follows a similar distribution.

For the case of the conventional bonds, we do see that the average coupon and amount are lower for all the sub-samples. This could be explained by the fact that the average coupon and amount of SLB are lower than conventional bonds, and when performing the matches, the conventionals which have a big coupon or are big in their amount are not taken into consideration to do the analysis.

Table N°4: Sample and subsample description for each conventional matched				
Conventional	**Yield at issue**	**Cpn**	**Amount**	**Duration**
Full sample	4.06%	4.20%	986 226 624	10.20
Match 1	2.71%	2.66%	726 866 522	10.91
Match 2	2.83%	2.81%	678 695 234	10.51
Match 3	3.43%	3.41%	657 873 213	9.59

In addition, to check the significance of the results from our matching analysis and provide robustness to them, we conduct a Cohen test. The result of the test for each model are provided in the table below:

Table N°5: Result of Cohen test performed to each model	
Model	**N° matches**
(1)	0.0233
(2)	-0.0594
(3)	-0.2345

The results of the Cohen test for models 1 and 2 indicate that there is not a significant mean difference between the yields of SLBs and conventionals, making it hard to support the model's outcome. On the contrary, the model conducted for model 3 indicates a significant mean difference which allows us to support the model's outcome about the existence of a premium in the sustainability-linked bond market.

Finally, the results found under this methodology are consistent with what other authors have found before when exploring the sustainability-linked bond market. With this, we provide additional robustness to the previous findings and confirm the existence, at least for this early stage, of a premium over this kind of bond instrument. However, we want to go further in exploring the existence of the premium, and that is why in the PSM subsection we will present the results of the propensity score methodology

A.2. Green bonds

For the case of green bonds, we have the advantage that our treatment sample is composed of a more considerable number of securities, and in this way, this gave us the possibility to increase the probability of finding a good match that could then make us arrive at a more consistent economic interpretation of the results found.
The ATE founded on green bonds are presented in the following table:

Table N°6: Average treatment effect after matching procedure for Green bonds:

Model 1: bonds issued the same year

Model 2: 1 year difference of issuance

Model 3: 3 year difference of issuance

Model	**N° matches**	**Average treatment effect**
(1)	202	-0.533%
(2)	281	-0.521%
(3)	328	-0.487%

The first model used found 202 pairs of bonds and with them a premium of -53 **basis points** which has high economic significance. Using the second model, we matched 281 pairs of bonds, the increase of pairs is consistent, which the analysis over the SLB and the premium found also decreases to -52 **basis points**. Finally, the last model used found 328 pairs and found a premium of -48 **basis points**, which is lower than the found in both model used before, but still slightly higher than the case of SLB.

For the case of the matching procedure of green bonds, we present the average yield, coupon, amount and duration of the full and sub-samples. We can see this in the table presented below:

Table N°7: Sample and subsample description for each green matched

Green bonds	**Yield at issue**	**Cpn**	**Amount**	**Duration**
Full sample	2.41%	2.38%	10 685 605 327	8.19
Match 1	2.82%	2.79%	2 447 512 030	8.65
Match 2	2.67%	2.64%	3 671 448 861	8.62
Match 3	2.71%	2.68%	4 940 909 238	8.70

Table N°8: Sample and subsample description for each conventional matched

Conventional	**Yield at issue**	**Cpn**	**Amount**	**Duration**
Full sample	4.06%	4.20%	986 226 624	10.20
Match 1	3.35%	3.11%	1 299 992 713	10.02
Match 2	3.19%	3.00%	1 287 835 477	9.92
Match 3	3.19%	3.03%	1 239 423 160	10.06

When looking at the average amount of green bonds, we could notice that it is almost ten times higher than the one of the conventional sample. Our explanation for this is that the yield at issue for green bonds is reported mainly on deals where huge amounts of money are involved. On the contrary, with conventionals, we do have more information and so different reported yields at issue that are not depending on the level of the amount issued. This enormous difference is corrected after the match is performed.

The average duration and also the coupon are slightly lower for the green bonds matched than for the conventional bonds used as the control group. This difference is incremental when relaxing the matching year issuance criteria from 0 to 3 years.
Additionally, to check the significance of the results from our matching analysis and provide robustness to them, we conduct a Cohen test. The result of the test for each model are provided in the table below:

Table N°9: Result of Cohen test performed to each model

Model	**N° matches**
(1)	-0.2677
(2)	-0.2435
(3)	-0.2297

The results of the Cohen test for all the models conducted suggest the existence of a statistical mean difference between the means of green and conventional bonds used to calculate the average treatment of each subsample. The last results ensure the existence of the premium found in our models.

Lastly, the main difference between the premiums found in the SLB and Green bond market is while on the green market, the premium is consistent in sign and magnitude in the SLB growth in a significant manner when relaxing the restriction of the year of issuance. Another stylized fact to mention is that the sign of the green bond premium never changes at the difference of the SLB premium found that changes in model one from not existing to a premium in model three.

What is important to mention in this part of the analysis is that under this procedure, we are making a match based on qualitative parameters, and in this way all our conclusion is influenced

by the previous decision made at the moment of defining the variables that will make possible the match between one security and other. Even today, there is an interesting debate on which matching procedure gives better results than the other. Therefore, we will follow presenting the same analysis under a PSM methodology to improve the robustness of our findings.

B. Propensity matching score

Under a propensity score matching methodology, we relaxed the matching restriction of the bond pairs to be from the same issuer. Instead, we allow bonds to match in a continent level, again controlling by the amount issued and the issuance year. Important here is to note that under this methodology, each bond was assigned a score and then matched according to the near neighbour in a maximum radio of $\frac{1}{2}$ standard deviation of the whole sample.

B.1. Sustainability linked bonds

We calculate the propensity scores matching running a regression with the goal of estimate the probability of each observation being part of the treatment, in this case being SLB. For this case we estimate a regression with a dummy variable that indicates if the observation is part or not of the treatment in the dependent part and then in the independent side of the equation the variables that determine this probability, for this case we used the amount of issuance, the continent and the issuance year.

The equation that estimates this score is presented below:

$$Treatment_{SLB} = Continent_i + Year_i + Amount\_issued$$

After the scores being estimated, we present the propensity score matching results for being part of the sustainable-linked bond universe graphically below:

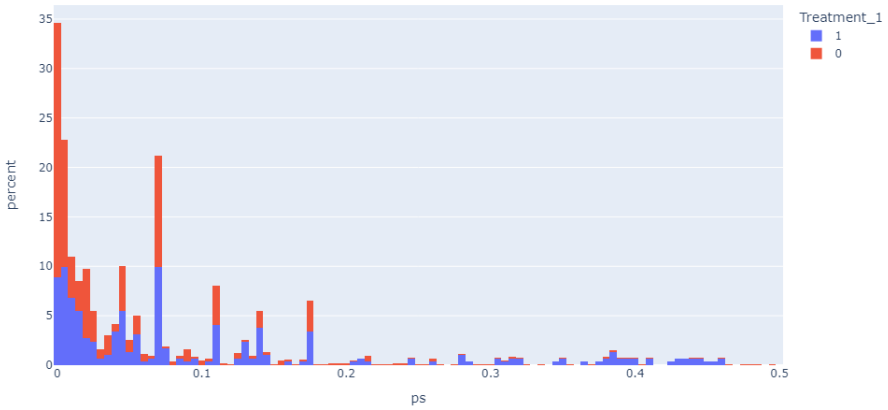

Figure 8: Propensity score distribution treatment and control group

We could see the overlapping of the treatment group and the control group, which will allow us to explore the yield difference between them later.

It is also interesting to see the available universe of bonds in terms of their yields because it is with what we will compare after the matching procedure is done. The last described could be seen in the following figure:

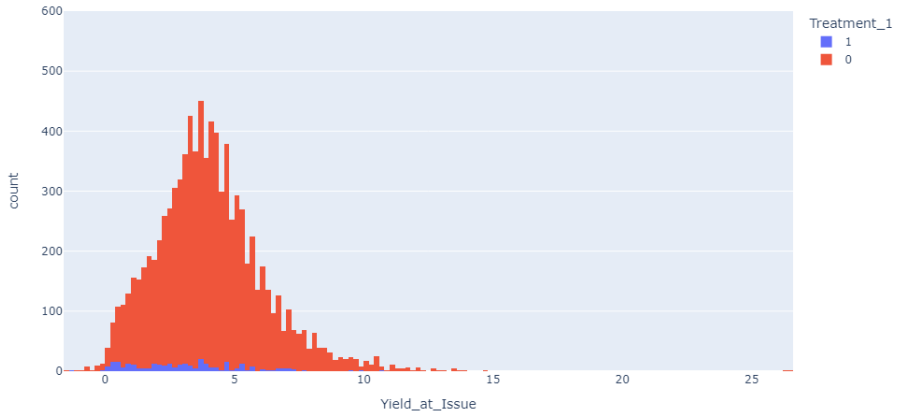

Figure 9: Yield at issue distribution treatment and control group

For the case of the SLB, we found thirty-four pairs that meet our matching requirements, as shown in the table below:

Table N°10: Average treatment effect after propensity score matching procedure for sustainability-linked bonds: The matching procedure is determined by variables continent, year and amount issued of each bond in the sample

Model	N° matches	Average treatment effect
(1)	34	0.2446%

In this case, we did not find a statistically significant result, and the difference in yields is 24,46 **basis points** which cast doubt on the last finding when matching by the same issuer criteria. Nonetheless, the results contradict the first hypothesis presented, which SLB carry a green premium; this is not a complete conclusive result because we cannot ensure that the mean of the yields from each group is different.

To extend our analysis, we perform a Cohen test to test whether the mean of the two sample groups differs; the test performed is as follows:

$$d = \frac{M_2 - M_1}{\frac{\sqrt{SD_1^2 + SD_2^2}}{2}} \tag{8}$$

The results of the Cohen test is 0.125, which suggest a low statistical power to then point that the means are different or not.

As was presented, the result contradicts the one found in models 2 and 3 when matching by the same issuer. However, it seems reasonable to believe that because of the reduced sample size and the small significance derived from the Cohen test, the conclusion that derives from it could be statistically called into question.

Finally, we believe that one alternative here is to see if the premium appears when relaxing the neighbourhood radio where the counterfactual bonds are searched; this could allow us to find more matched and, in consequence, a possible premium but will lose economic significance because of the assumption that the errors between treatment and control group are orthogonal could be violated.

B.2. Green bonds

For the case of green bonds, we used the same procedure as the one used for SLB. For this specific case we estimated again the probability of being part of the treatment being determined

by the continent, the amount issued and the year of each bond.

The equation that estimates this score in this case is presented below:

$$Treatment_{Green} = Continent_i + Year_i + Amount\_issued$$

After being estimated the propensity score matches results, we present them is the graph below:

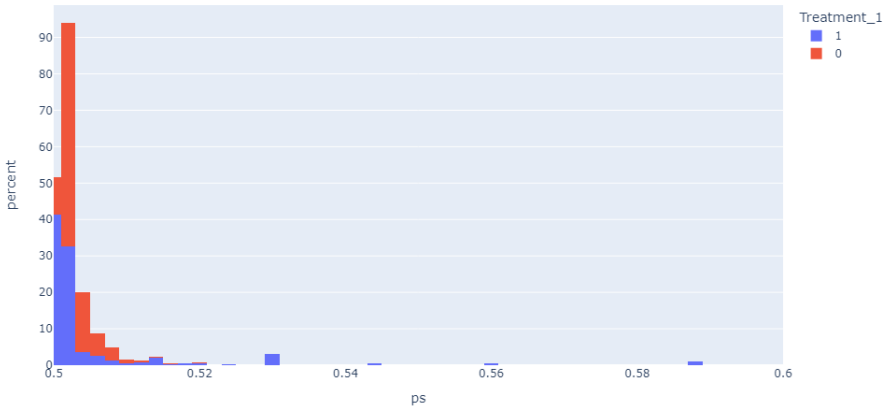

Figure 10: Propensity score distribution treatment and control group

Graphically we could see how both groups overlap, and the overlapping group will be our matching candidates.

For the case of green bonds, we present the available universe of bonds in terms of their possible yields and what we will compare after having done the matching procedure. The stylized fact is shown in the following figure:

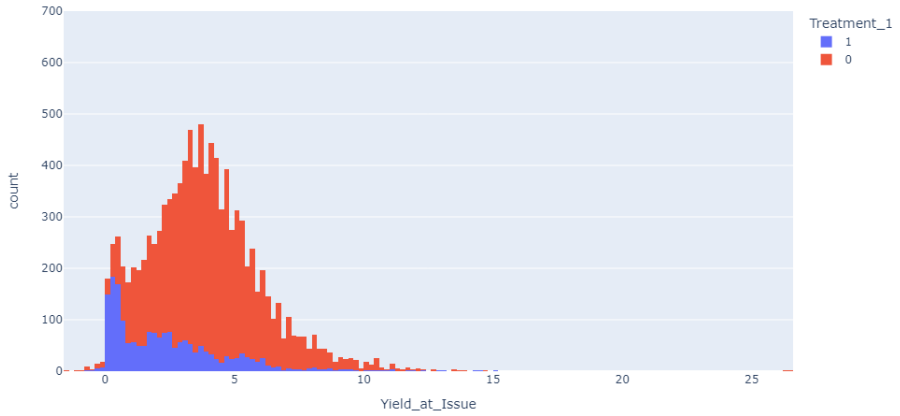

Figure 11: Yield at issue distribution treatment and control group

For the case of green bonds, we found eighty-five bonds that matched with their contra factual, and the results are presented in the table above:

Table N°11: Average treatment effect after propensity score matching procedure for green bonds: The matching procedure is determined by variables continent, year and amount issued of each bond in the sample

Model	**N° matches**	**Average treatment effect**
(1)	85	-1.8023%

The premium found in this case is 180 **basis points** which is statistical significant so that we could make a conclusion over it. The existence of this premium is consistent with the model presented before but not in its magnitude, in this case the one found is much higher. One alternative to this finding is to change the radius of where the neighbour could be found making this more strict. However, we believe that tighten it will bring nothing but noise to our models, and we could decrease the number of pairs dramatically and at end finish with few pairs, which could make us bring out the wrong conclusions.

Additionally, we performed a Cohen test which we test if there exists a difference between the average yield between the control and the treatment group. The result of the test is 0.789, and this indicates that the difference is significant and qualified as big.

To conclude this part of the results section, we could see that the results of the analysis made on SLB and Green bonds differ in respect to the before matching performance in its effect size for the green bonds and disappears for the case of SLB.

C. Regression analysis over SLB

To extend our analysis and as presented in the section methodology, we explore through a regression analysis different variables of interest that could impact the yield of a sustainability-linked bond at its issuance.

The first challenge that we encountered was as we only had 74[11] matched pairs for SLBs; for conducting our analysis, we needed to relax our matching restriction and search for more pairs. In this way have more data to run our differentials models. We proceed with including differentials as our dependent variable of our models because it allows us to correct for factors such as credit risk, liquidity, or market conditions at the issuance day of the bond matched. We complemented the already matched bonds paring them with one similar in their characteristics, such as maturity, country, industry, and amount issued, to later be able to run our regressions models using differentials as explained before.

The first model presented explores the impact of whether the issuer is a governmental institution or not. The results of this regression are inconsistent, mainly because we only had four governmental institutions that issued bonds, and the rest 288 are corporates, which does not allow us to arrive at a meaningful conclusion due to data limitations

[11] Model N°3 presented in VI., subsection A.1. matching by characteristics

Table N°12: Regression results from main analysis:
Model 1 = Controlled OLS with robust errors;
Model 2 = FE regression; Model 3 = Controlled FE regression with robust errors

Dependent variable: Yield differential	(1)	(2)	(3)
Constant	-3.24***	-1.66**	-0.79
	(1.10)	(0.501)	(1.60)
Government	2.29**	-0.99**	-0.89
	(0.904)	(1.126)	(0.565)
Control variables	Yes		Yes
Fixed effects		Yes	Yes
Observations	204	204	204
R2	0.1174	0.0529	0.1213

Note: * p<0.1; ** = p<0.05; ***= p<0.01

The second model explores the impact of the existence of an ESG score; 43% of our sustainable linked bonds report an ESG score and, according to previous research conducted by Apergis, Poufinas, and Antonopoulos suggests that reported ESG scores impacts negatively the yield of a bond. The results of our regression are presented in the table below:

Table N°13: Regression results from main analysis: Model 1 = OLS robust errors;
Model 2 = Controlled OLS; Model 3 = FE regression;
Model 4 = Controlled FE regression with robust errors

Dependent variable: Yield differential	(1)	(2)	(3)	(4)
Constant	0.105	-1.88	-1.66	-2.70
	(0.231)	(0.784)	(1.126)	(1.48)
ESG existence	-1.32***	-1.08***	-1.33***	-1.08***
	(0.326)	(0.327)	(0.32)	(0.327)
Control variables		Yes		Yes
Robust errors	Yes	Yes	Yes	Yes
Fixed effects			Yes	Yes
Observations	204	204	204	204
R2	0.0737	0.1619	0.1190	0.2010

Note: * p<0.1; ** = p<0.05; ***= p<0.01

The results confirmed that having a reported ESG score negatively impacts the yield that faces an SLB. Furthermore, the results presented are consistent even when they are evaluated under different specifications to check the robustness of our findings. Finally, the magnitude of the result found indicates that having a reported ESG score reduces in **1.08%** the yield of this type of bond.

The third model explores the effect of the KPI used when setting the sustainability performance target at the issuance of the bond. This is relevant not only from a financial point of view but also for policymakers who want to know the best alternative to finance the projects that mitigate climate change's adverse effects through this instrument.

To start with this analysis, we present the different sustainable performance targets that are used to measure if the enterprise accomplishes meeting its sustainable goals set at the issued time. According to our available universe of sustainable-linked bonds, the detail is presented in the table below:

Table N°14: Different SPTs used on the universe of SLB issuance, amount issued in USD and corresponding % of market share

KPI or SPT	N° Issues	Amount USD	%
Renewable energy	11	9 575 120 000	5.4%
Energy efficiency	7	8 435 530 000	4.7%
ESG Score	5	1 556 160 000	0.9%
Water consumption	5	3 800 000 000	2.1%
Gender Equality	2	1 400 000 000	0.8%
Greenhouse gas emissions	121	120 302 680 000	67.3%
Sustainable farming and food	1	1 673 600 000	0.9%
Other	9	5 747 580 000	3.2%
Transport	0	370 000 000	0.2%
Circular economy	2	990 630 000	0.6%
Not reported	41	24 794 370 000	13.9%
Total	**204**	**178 645 670 000**	**100%**

Presented the different SPTs, we wanted to explore the impact of each on the yield differential. Therefore, the results of the regression analysis conducted are presented in the table below:

Table N°15: Regression results from main analysis: Model 1 = OLS;
Model 2 = OLS robust errors; Model 3 = Controlled OLS;
Model 4 = FE regression; Model 5 = Controlled FE regression with robust errors

Dependent variable: Yield differential	(1)	(2)	(3)	(4)	(5)
Constant	0.47	0.47	0.11	1.758	0.79
	(0.363)	(1.30)	(0.869)	(1.554)	(1.765)
Water consumption	0.96	0.96	1.07	1.02	1.10
	(1.104)	(1.30)	(1.11)	(1.32)	(1.12)
Sustainable farming and food	0.69	0.69	0.72	0.56	0.62
	(2.358)	(0.475)	(0.479)	(0.494)	(0.48)
Renewable energy	-3.37***	-3.37***	-3.021***	-3.42***	-2.86***
	(0.791)	(0.841)	(0.831)	(1.045)	(1.091)
Green house gas emissions	-1.04**	-1.04**	-0.88*	-0.83	-0.63
	(0.42)	(0.512)	(0.514)	(0.581)	(0.610)
Gender equality	-0.48	-0.48	0.52	-0.29	0.71
	(1.687)	(0.475)	(0.649)	(0.583)	(0.74)
Energy efficiency	-1.68*	-1.68***	-1.61**	-1.59**	-1.48**
	(0.95)	(0.626)	(0.642)	(0.662)	(0.699)
ESG score	-1.04	-1.04	-0.89	-0.86	-0.67
	(1.104)	(1.08)	(1.1)	(1.14)	(1.19)
Circular economy	-1.85	-1.85***	-1.33	-1.67**	-1.12
	(1.687)	(0.597)	(0.888)	(0.688)	(0.96)
Other	-2.17**	-2.17**	-2.10*	-1.86*	-1.75
	(0.857)	(0.993)	(1.099)	(1.00)	(1.12)
Control variables			Yes		Yes
Robust errors		Yes	Yes	Yes	Yes
Fixed effects				Yes	Yes
Observations	204	204	204	204	204
R2	0.1193	0.1193	0.1496	0.1392	0.1728
R2 adjusted	0.0784				

Note: * p<0.1; ** = p<0.05; ***= p<0.01

According to our regressions, models one and two show that bonds whose SPT are attached to renewable energy, greenhouse gas emission, circular economy, or energy efficiency are the ones that impact the yield more negatively and, therefore, the most relevant ones. However, after conducting the robustness check using fixed effect, robust errors, and control variables, the

SPT attached to renewable energy and energy efficiency are the only ones that prevail. For this reason, we do believe that this effect is consistent, significant, and economically meaningful being the renewable energy which has the higher impact, decreasing the yield by **2,86%** and in the case of a bond linked to an energy efficiency SPT decreasing it by **1,48%**. On the other side, bonds linked to SPT related to water consumption, sustainable farming and food, or gender equality do not seem to negatively impact the bond yield. Nonetheless, we need to point out that this conclusion could be taken as meaningless because testing them under all our specifications, the variables do not show consistency and are not statistically significant either.

The fourth model explores the effect of the maturity type of SLB, intending to know if bonds that have a callable feature are punished by investors, implicitly giving them a penalty on their yield. This callable feature is one potential source of greenwashing detected, as the enterprise could call the bond before maturity if they know in advance that they will not meet the target previously agreed. This problematic fact is also mentioned in Kölbel and Lambillon, the authors call into question the truly sustainable compromise of issuing an SLB with this specific maturity type attribute.

The results of our regressions models are presented in the table below:

Table N°16: Regression results from main analysis: Model 1 = OLS robust errors; Model 2 = Controlled OLS; Model 3 = FE regression; Model 4 = Controlled FE regression with robust errors

Dependent variable **Yield differential**	(1)	(2)	(3)	(4)
Constant	4.5***	4.38	4.10**	4.84**
	(0.981)	(1.434)	(1.686)	(2.07)
Callable	-4.84***	-5.02***	-5.02***	-5.12***
	(1.000)	(1.124)	(1.009)	(1.132)
At maturity	-5.98***	-5.83***	-6.14***	-5.867***
	(1.037)	(1.155)	(1.064)	(1.174)
Convertible	-5.91***	-5.99***	-4.42***	-4.32***
	(0.981)	(1.109)	(1.151)	(1.245)
Control variables		Yes		Yes
Robust errors	Yes	Yes	Yes	Yes
Fixed effects			Yes	Yes
Observations	204	204	204	204
R2	0.0732	0.1731	0.1226	0.1751

Note: * p<0.1; ** = p<0.05; ***= p<0.01

As we can see in the tables presented, in all our models, the different features explored in the maturity type are callable, at maturity, and convertible. All the variables negatively impact the yield of the bond; however, the magnitude of the "At maturity" feature is more important than the "Callable" one; this could mean that investors reward in a greater manner when enterprises fully engage and left out the option to call the debt before the end of the period agreed. At the same time, the fact that an SLB that carries a "callable" feature and is not punished could call into question the real reason why enterprises are using this instrument to finance their business activities.

Interestingly the feature "Convertible" also appears as significant and has a negatively consistent impact on the yield; however, we need to point out that economically is too early to draw conclusions about the SLB that carry this feature because they are not that a big portion of the universe of SLBs [12].

[12] less than 1% in our subsample

Altogether, these presented models are a good starting point for understanding different variables that precisely impact the SLBs universe. Notwithstanding, we also need to carefully look at the results and interpret them using a critical point of view when making conclusions about them. The main reason for the last is the reduced number of outstanding bonds currently in the market due to the early stage of this market, which could generate a sample bias when analyzing them.

VII. Conclusions

A. Sustainability linked bonds

This novel instrument appears as a solution to provide financing to eco-friendly enterprises, taking into consideration as a whole their activities and directly linking them to their environmental performance. SLB also is a way to give access to enterprises that do not have access to the green bond market because now they do not have to engage the use of the money in just one project. Instead, they are allowed to finance their whole operations.

We found that SLB carries a premium in its yield, the implication for companies becomes cheaper to finance their operations and new projects using this instrument as they through this instrument face a lower debt cost. Nonetheless, we need to point out that our conclusions could be challenged in the near future when the sample growth from the approximately 500 bonds that are today outstanding in the universe of SLB.

The existence of a greenium in SLB could be eroded in case enterprises meet the sustainability performed target compromised, which will have as a direct consequence the increase of the debt cost by the increase of the coupon paid by the firm.

As a novel instrument, there are still plenty of aspects to research about this. However, nowadays, this instrument appears to be a solution to solve the greenwashing claims over the green bond market, making companies genuinely engage in achieving environmental specific targets as an entire unit and not just at a project level.

B. Green bonds

For the case of green bonds, using our two methodologies, we found evidence of the existence of a premium. However, we need to point out that this finding is limited to the scope of the sample used to search this premium. However, the existence of a premium in the green bond

market using the entire universe available in the Bloomberg fixed income database is consistent with the evidence previously found around the green bond market, which started in 2007 and in 2014 exploit growing exponentially.

Green bonds today are preferred and more popular over SLB to finance eco-friendly projects; the instrument design allows giant corporates and governmental organizations to finance projects with the objective of allowing them to transit to a greener economy. Moreover, the fact that the green bond market today is more developed than the SLB one provides investors security and trust in the good used of the money under management in green bonds; the funds are invested in projects labelled as green due to their specific characteristics.

To conclude, we need to point out that the great challenge the green bonds market faces today is the nonexistence of a unique taxonomy over the world; this means that some projects that are considered green in one region are not necessarily considered as green in others, making more difficult for investors to screen and find projects that suit them and follow their specific investment mandate. ESG scores are today the primary metric used in these instruments to measure how green the instrument is, but it is still far from being a perfect measure of how sustainable the company is and still faces much criticism

C. Regression Analysis

The result of this analysis indicates that there are exciting features surrounding SLB and the premium is determined by various different variables that we explore through the models presented in section VI.

Although previous literature around bonds indicates that governments generally face lower yields than corporates under similar settings, our findings do not allow us to confirm that in the universe of SLB this still holds. Our results are inconsistent under the models presented and are not statistically significant, mainly due to the lack of observations of governmental institutions issuing sustainability-linked bonds. In addition, this finding shows that the SLB environment is mainly dominated by corporates nowadays.

Our second model shows that having an ESG score reduces the bond yield in **108 basis points** the result is significant and consistent under all our specifications. This finding confirms the negative impact on the bond's yield produced by a reported ESG score. Investors are willing to pay or give up returns for bonds that are more transparent, certificate, and communicate in a

better manner their genuinely engagement with the sustainable activities that they claim to be doing.

The third model presented explores the different effects of the specific sustainability performance target used at the issuance of an SLB. Under our analysis, we concluded that not all SPTs are valued the same.

Sustainable-linked bonds that are linked with sustainable performance targets such as renewable energy and energy efficiency face a significant and consistent lower yield, being **286 basis points** and **148 basis points** lower to their pairs. On the contrary, we do not find evidence of a consistent and significant premium for the SPTs linked to water consumption, gender equality, and sustainable farming and food. However, we could point out that even though metrics linked to the circular economy, ESG score, and greenhouse emission did not show significant always presented consistent negative coefficients, which could be taken as an indicator of how these particular SPTs impact the bond's yield.

The importance of the findings derived from the third model is that does not exist a straightforward relationship indicating that all sustainable-liked bond carries a premium. The existence of the premium will depend on the specific target chosen by the firm to engage with and how investors value the engagement with it.

To conclude this part of the analysis, the fourth model presented explores the impact of the different maturity type, specifically the features of the SLB being callable, at maturity, and convertible. All the variables are negative, consistent, and statistically significant, confirming that none of them impact the SLB yield by increasing it.

Following the concerns of Kölbel and Lambillon mentioned in their paper of the callable feature being a source of greenwashing, the callable feature seems to be punished in comparison to the other but not enough to make firms avoid issuing bonds that carry it.

The main problem of the callable feature is that it could be seen as a source of greenwashing as the company has the right to call the bond before the target day if the KPI metric shows that the objective will not be reached. This stylized fact could damage not only the credibility and trust of the engagement of firms with the SPT set at the issuance of the bond but also could cast doubt on investors that want to invest in this market looking for returns but also making a sustainable impact on the economy.

Additionally, our results also show that the feature of convertibility does have a lower impact in

comparison to the rest features, and investors do not want to give up returns in order to have it. However, we need to point out that this is a preliminary result as convertibles bonds are a minimum part of our subsample.

In a nutshell, our results show that different variables impact the bond yield differently. This could be summarized as having a reported ESG score decreases the bond yield significantly, different sustainability performance targets are valued differently by investors, it is not direct that all bonds carry a premium by them self and finally, the callable feature is not punished enough to avoid issuers to include it in their issuance and this could be seen a potential source of greenwashing that could damage the credibility of the instrument in the long run.

D. Comparison between Green and Sustainability-linked bonds

After the analysis made where we prove the existence of premiums for green and sustainability-linked bonds through our analysis, the next step is to start clarifying which instrument is preferred over the other.

The main implication of having a greenium in both bonds markets in terms of debt cost is to choose the one that is cheaper because it is evident that this will reduce the cost of debt of enterprises that choose to finance their activities using one of these instruments. However, the answer to this question is not that direct because we need to take into consideration which instrument is better for which objective and under what circumstances one is preferred over the other.

Sustainability-linked bonds as a new instrument, whose main characteristic is to use a sustainability performance target with previously defined KPIs, allow the investor community an easier understanding and, more importantly, provide a straightforward measure of the issuers' environmental performance. This instrument appears as an alternative for companies that do not have a sufficient scale to access the green bond market and issue a bond related to just a single project instead issuing a bond linked to the whole performance of the business.

A company that issues a sustainability-linked bond have to be also aware of the possible risks that they face in case of not meeting their compromised target; some of the risks are the followings:

1. Reputational risk: In case an enterprise does not meet the compromise KPI, the enterprise

will face an implicit reputational cost, which will affect the track record of investors, making the subsequent issuance stricter.

2. Increase in the cost of debt: The direct implication of not meeting a target is a step-up that will directly increase the cost of debt for the company, translating into an increase in the coupon paid to the bondholders.

3. Environmental risk: One indirect risk that a company will increase in case of not meeting the target is an increment in its environmental risk. Not meeting the target will mean that the enterprise will have to pay more for its current debt and also that it was not able to adequately adjust its business model to transit to a more sustainable one which in the long run could hurt the enterprise's operations.

Thereafter, the importance of founding a balance between how ambitious and how reachable the KPIs proposed to the investors at the beginning of the issuance.
One additional remark on SLBs is that the main challenge and risk that this instrument face today is the callable feature that some of them have. This feature directly impacts the credibility and engagement of the issuer with the accomplishment of the goal defined at issuance. Moreover, as previous works mentioned, this is an enormous source of greenwashing, giving the companies the incentives of calling the bond to avoid a penalty in case of not meeting the KPI metric compromised.

On the green bond side, the instrument was created in 2007, consolidating its growth with a tremendous increase on 2014 until today. Green bonds prove to be a plausible mechanism to finance eco-friendly projects whose goals are to achieve a zero-emission economy and protect the environment. This instrument is widely used by governmental organizations and corporates worldwide, being until the appearance of SLB and green loans the only debt instrument dedicated fully to providing finance to green projects.
Contrary to SLB, green bonds have a project-level focus, giving companies the opportunity without necessarily having business models that fully engage with net-zero goals or environment protection. Making it possible for brown companies to access green bonds as a source to finance projects that could make them improve their business performance. The main criticism claims that these projects will already be done without the existence of green bonds because of their own profitability. Meanwhile, firms using green bonds as an instrument free up resources that

later are employed to continue seeking polluting activities.

The last claim exposed is the source of the substantial source of criticism of green bonds, adding to this that for many years regulators have been discussing whether they are considered green. This differs according to different taxonomies implemented through the years. Until today there is not a unanimous consensus on what is considered green worldwide, making it hard to compare instruments issued under different regulations. This difficulty exposed reduces the appetite of the investor community to invest "green" because it is not simple to define and monitor the quality of the project in which they are involved adding unnecessary risk to this type of investment.

At the same time, the fact that companies cataloged as "Brown companies" also could issue this type of bond without engaging with a truly environmentally friendly business model or a sustainable strategy, instead just with the purpose of "greenwashing" their image call into question the true impact of green bonds at the end of the day.

To conclude, when enterprises face the decision on how to finance their projects or activities with this kind of debt instrument, they can choose between a green bond or a sustainability-linked bond. The enterprise must consider its size, the project scope they want to finance, the feasibility of achieving its environmental goals, and the additional compliance efforts that involve issuing a green or a sustainability-linked bond to decide which alternative suits them better.

During this research, we conclude that a greenium in both bond markets exists. This premium becomes a competitive advantage for eco-friendly and environmentally involved companies that could lower their debt cost. However, it is not straightforward which instrument is better, and this answer will depend on the specific's characteristics of each company or governmental organization according to their different activities and needs.

VIII. Limitations

In the first part of our analysis, we searched for the existence of a grennium in the SLB and the green bond market; this search is highly influenced by the parameters chosen. The existing literature on the topic often mentions the mixed evidence regarding this specific topic around the green bond market, a conclusion that could be extrapolated to the SLB.

With the data available today, we performed two matching methodologies to look for this premium; regardless, we did this process under two different methodologies[13], we did not find a

[13]Matching by characteristics and propensity score matching

unique value to our premium, and in fact, this shows the complexity of performing this estimation. Moreover, making tougher or laxer the restrictions of the possible match determines the outcome of the result.

For the second part of the analysis, the novelty of the market produces that we do not have many bonds completed their outstanding period. Because of this, we do not have a clear image of the number of companies that have failed to achieve their sustainability performance targets. So, we do not have in our sample firms that face a step-up or a punishment according to the bond's structure.

Unfortunately, the data collection process is complex due to the lack of reporting and few information sources available. To overcome this challenge, we complemented our data set with information from different sources, such as Bloomberg and Refinitiv, for the information regarding bond's yield; however, there are many SLBs that we do not find the precise SPT that they followed.

This data availability problem natural of a novelty of the market that is still in development could generate a sample bias, and the results presented in this research should be critically analyzed and with the time and growth of the market could change.

To make a meaningful regression analysis and explore the different impacts of the chosen SPT, we needed to relax and expand the previous match made. The last could introduce noise to our regression coefficients; however, this problem was considered, and we robust checked all the results under various specifications to reduce it.

IX. Further discussion

The literature on sustainability-liked bonds has been scarce since the SLB market recently started. This should be an incentive to research further to understand the dynamics surrounding SLBs and, in this way, finds ways to improve this mechanism to make it a trustfully alternative to finance the transition to a greener economy.

As in this research, we explore the existence of a premium that reduces the cost of debt for enterprises that chose SLB to finance their operations. It would be interesting to explore closely if these firms are more profitable than the rest. In the same line, as the cost of debt is cheaper than their pairs, future research could analyze these firms' leverage levels.

Another future research possibility is to explore the size of firms using this instrument and

whether small or large firms dominate the sustainability-linked bond environment. Nevertheless, this instrument appears to be an exciting source of financing for smaller enterprises, as its objective is to engage the firm on a whole level and not only on a project level as green bonds. Finally, one crucial future research is to explore the issuing cost of this instrument and the effort and time expended in the certification process that must be conducted to be able to put this instrument on the market. An enormous disincentive for the SLB market's growth is that the instrument is still unknown, and the certification process is still complex. The last introduces a huge entry barrier to enterprises with insufficient resources or professionals to issue and place this instrument in the market.

X. Bibliography

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XI. Appendix

A. Equity vs bond market comparison

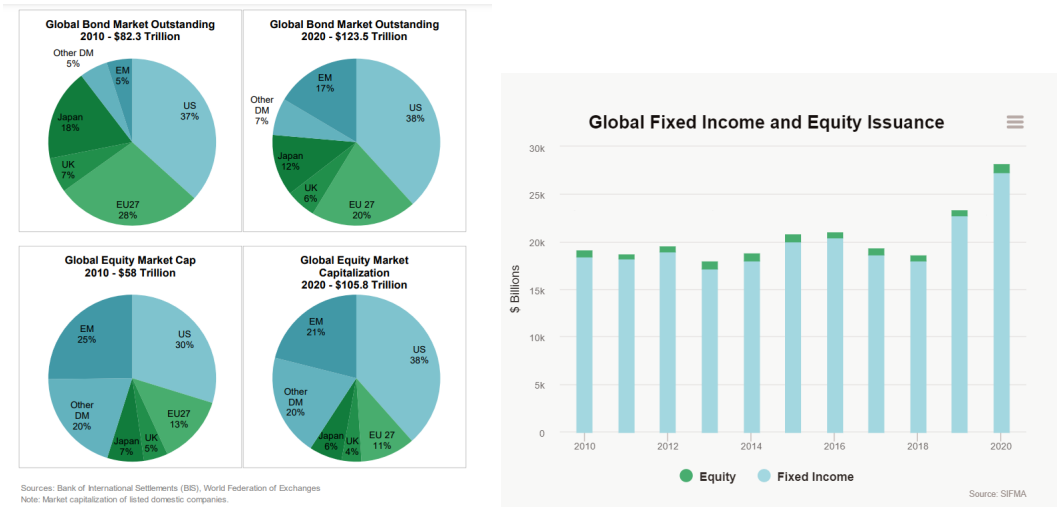

Figure 12: Source: BIS & SIFMA

B. ODS Objectives

Figure 13: Source: United Nations

C. Amounts issued by area of green and sustainable linked bonds

Table A.1: SLBs classified by industry type

Issuer Industry	Number of bonds	Amount Issued in M USD
GOVT AGENCY	3	186.21
GOVT REGIONAL	3	144.15
GOVT NATIONAL	1	2 000.00
INDUSTRIAL	323	141 680.09
FINANCIAL	61	20 332.78
UTILITY - ELEC	54	40 364.34
SPECIAL PURPOSE	35	23 066.43
TELEPHONE	6	2 619.31
TRANS - NON RAIL	5	1 596.11
BANK	4	2 051.39
GAS TRANSMISSION	3	2 207.16

Table A.2: SLBs classified by continent

Continent of the issuer	Number of bonds	Amount Issued in M USD
Afrique	5	212
América	43	25 032
Europe	327	163 924
Asia	81	17 911
North america	33	26 092
Oceania	9	3 077

Table A.3: Green bonds classified by industry

Issuer Industry	Number of bonds	Amount Issued in M USD
SUPRA-NATIONAL	286	102 498.04
INDUSTRIAL	1000	201 656.71
BANK	1071	277 131.24
SPECIAL PURPOSE	196	69 934.59
FINANCIAL	1062	187 569.95
UTILITY - ELEC	634	174 298.27
TELEPHONE	10	6 336.57
GOVT NATIONAL	59	171 708.10
GOVT AGENCY	277	85 748.03
TRANS - NON RAIL	13	2 118.92
GOVT REGIONAL	218	74 424.78
TRANS - RAIL	24	6 633.20
UTILITY - GAS	9	1 498.94

Table A.4: Green bonds classified by continent

Continent of the issuer	Number of bonds	Amount Issued in M USD
Afrique	48	11 208
América	122	33 183
Europe	2467	829 690
Asia	1583	289 440
North america	587	182 585
Oceania	52	15 452

D. Descriptive analysis of conventional sample

Table A.5: Conventional bonds classified by industry

Issuer Industry	Number of bonds	Amount Issued in M USD
FINANCIAL	1447	1 262 350
INDUSTRIAL	4065	3 677 332
SPECIAL PURPOSE	1009	825 701
BANK	1217	1 450 225
UTILITY - ELEC	326	229 591
GAS TRANSMISSION	74	65 334
TELEPHONE	171	198 116
TRANS - NON RAIL	67	77 972
SUPRA-NATIONAL	107	285 124
UTILITY - GAS	17	10 510
TRANS - RAIL	41	32 453
US TAXABLE MUNI	1	16
GOVT NATIONAL	46	358 590
GOVT REGIONAL	4	344

Table A.6: Conventional bonds by Maturity type

Maturity type	Number of bonds	Amount Issued in M USD
CALLABLE	5928	5 609 374.83
PERP/CALL	328	311 011.66
AT MATURITY	2042	2 339 558.51
CONVERTIBLE	99	55 734.41
SINKABLE	72	73 380.30
CALL/SINK	65	60 341.86
CONV/PUT	34	15 979.88
CALL/PUT	4	1 414.90
CONV/PUT/CALL	5	2 763.75
PUTABLE	7	1 745.32
CONV/CALL	4	637.60
EXTENDIBLE	1	209.19
SINK/EXT	1	741.46
CALL/EXT	2	765.48