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The relationship between Corporate Green Bond Yields and Firm Leverage

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Abstract

Green bonds, whose proceeds are used towards environmental-friendly projects, are still perceived as a relatively new financial instrument with the first Green bond being issued in 2007. However, the market is growing rapidly worldwide since its debut with almost 700 Green bonds and approximately $200bn issued in 2020.

Several authors have already conducted studies regarding Green bond premiums and pricing. They have focused their studies either on municipalities and corporations, like Flammer (2018), Baker et al. (2018), Tang and Zhang (2018), (Zerbib 2019) among others.

In this work we manually collect information on a large set of Green bond issuers and examine specifically Corporate Green Bonds and, more importantly, the relationship between the Yield to Maturity (YTM) of a Green Bond and the Leverage ratio of its issuer. For this, we have used a database composed by 2,054 Green Bonds and 37,771 Conventional Bonds for 956 unique issuers.

First, the results suggest that Green bonds have a negative premium i.e., the YTM of a Green bond is lower than the YTM of a Conventional bond: on average, the mean YTM is -0.971 basis points for Green Bonds.

When we look exclusively at Green Bonds and by studying the relationship between the YTM and the Leverage ratio from the issuer, our results shows that the YTM will be lower with a higher Leverage ratio from the issuer (-0.0850 basis points), meaning if the issuer has several issued bonds with a higher leverage, the YTM of a Green bond will be lower.

Keywords: green bonds, leverage, leverage ratio, sustainable finance, climate finance, socially responsible investment

JEL Classification: G12, G23, Q56

Resumo

As obrigações Verdes, cujos fundos serão usados em projetos sustentáveis para o ambiente, ainda são percecionadas como instrumentos financeiros recentes, com a primeira obrigação Verde emitida em 2007. No entanto, o mercado está a crescer de forma rápida a nível mundial, com quase 700 obrigações Verdes e aproximadamente $200 mil milhões emitidos em 2020.

Vários autores estudaram obrigações Verdes, desde o seu prémio ao preço. Outros autores focaram-se tanto em municípios como empresas, como podemos ver em Flammer (2018), Baker et al. (2018), Tang e Zhang (2018), (Zerbib 2019) entre outros.

Neste trabalho recolhemos manualmente informação sobre um vasto conjunto de emitentes de obrigações Verdes e, mais importante, estudamos especificamente as obrigações Verdes empresariais e a relação da *Yield to Maturity* de uma obrigação Verde com o endividamento do emitente. Para isto, usámos uma base de dados com 2.054 obrigações Verdes e 37.771 obrigações Convencionais de 956 emitentes únicos.

Os resultados sugerem que as obrigações Verdes têm um prémio negativo, a *YTM* de uma obrigação Verde é menor que a de uma obrigação Convencional: em média, a *YTM* média é -0,971 pontos percentuais menor numa obrigação Verde.

Quando analisamos exclusivamente obrigações Verdes e ao estudar a *YTM* com o rácio de endividamento do emitente, os resultados mostram que a *YTM* de uma obrigação Verde será menor com um maior rácio de endividamento (-0,0850 pontos percentuais), significando que se um emitente tiver várias obrigações e com isso um maior rácio de endividamento, a *YTM* de uma obrigação Verde será menor.

Palavras-Chave: obrigações verdes, rácio de endividamento, finanças sustentáveis, finanças climáticas, investimento socialmente responsável

Classificação *JEL*: G12, G23, Q56

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List of Abbreviations

CAB – Climate Awareness Bond

CBS – Climate Bonds Standard

CF – Cash–flow

CICERO – Center for International Climate Research

COP21 – 21st Conference of the Parties

COP26 – 26th Conference of the Parties

EIB – European Investment Bank

FV – Face value

GBP – Green Bonds Principles

ICMA – International Capital Market Association

IRR – Internal Rate of Return

NPV – Net Present Value

P – Price

PV – Present Value

S&P – Standard and Poor's

SEB – Skandinaviska Enskilda Banken

UK – United Kingdom

UNFCCC – United Nations Framework Convention on Climate Change

USD – United States of America Dollars

WACC – Weighted Average Cost of Capital

YTM – Yield to Maturity

1. Introduction

Earth's climate change is not something new, it has been happening since forever, but it is accelerating at a steady and dangerous pace since the increased human activity in mid-20th century and further rising at an unprecedented rate. There is scientific evidence on rapid climate change, with global temperatures rising, warming oceans, shrinking ice sheets, sea level rise, and others (NASA 2021).

On December 2015 in Paris, at the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC), 196 Parties adopted a legally binding international treaty on climate change, known as the Paris Agreement. The agreement's main goal is to limit global warming between 1.5 and 2 degrees Celsius when compared to pre-industrial levels. This was an historic agreement, as it made possible for several different countries to combine efforts in order to push back the rapid climate change. The agreement also claims that climate finance is needed as the projects to meet these demands require large-scale funding (UNFCCC 2016).

In order to support the needed large-scale funding, it was created a new financial instrument that was seen as a financial innovation in the sustainable finance area, as they facilitate and enable sustainable investing: Green Bonds (Maltais and Nykvist 2020).

According to Tang and Zhang (2018), Green bonds are fixed income instruments whose proceeds are directed to climate-related projects, such as renewable energy, green buildings, sustainable water management, among others.

Both Flammer (2018) and Maltais and Nykvist (2020), confirmed not only that the use of proceeds must be directed to climate-friendly endeavours, but also that Green Bonds are not structurally different from a Conventional bond. Although the proceeds of the Green bonds are channelled into specific green projects, the bonds are backed by the issuer's whole balance sheet, so it can provide additional guarantees to the investor (Tang and Zhang 2018). When issuing Green bonds, companies should certify them via third-party entities to make the issuance more credible and signal their commitment in the investment to both investors and the market.

There is no formal definition of what a Green bond is, although some guidance is provided by the International Capital Market Association (ICMA) in the Green Bonds Principles (GBP) where a voluntary process guideline for the issuance of Green Bonds exists with four core modules: use of proceeds; process for project evaluation and selection; management proceeds and reporting. All these modules are widely accepted by the market participants as this

promotes disclosure, transparency and reporting. The GBP also recommends external review from third-party entities.

The Center for International Climate Research is one of the third-party entities that assesses independently the issuers of Green bonds by attributing to their issuance a rating based on the "greenness" of the bond. This rating is called the "Shades of Green" and it has a direct relationship to how well does that issued Green bond promotes a low-carbon climate future.

Another concept of Green is provided by the Corporate Bonds Initiative (2018), where it "differs around the world. The Climate Bonds Initiative uses the Climate Bonds Taxonomy, which features eight categories: energy, buildings, transport, water, waste / pollution control, land use, industry and ICT".

When we first look at Green bonds they are not, in concept, structurally different from a Conventional bond. The only difference between Conventional and Green bonds is that the proceeds from Green bonds are committed to finance environmental and climate-friendly projects. These destinations can go from renewable energy, green buildings to pollution prevention and control, among others.

The world's first Green bond was issued in 2007 by the European Investment Bank (EIB), with an amount of 600€M and a maturity of 5 years (European Investment Bank 2021).

After this issuance, the market continued to gradually expand. It was almost non-existent in 2013, with only $21.2bn issued, but increased to a grand total of $1,110.7bn at the end of 2020. Green Bonds still represent a small share of the total fixed income market, as the total amount outstanding in the 2nd quarter of 2020 was $114tn across the world (Green Bonds represent approximately ~1% of total bond market) (SIFMA 2021).

Regarding sovereign issuances, France issued its first Green Bond instrument in 2017 while the United Kingdom is issuing its first instrument in 2021. We can see also an increase in the diversity of issuing countries and the number of issuances per country with a peak of 1,045 bonds and 54 unique issuing countries in 2020.

One of the main questions regarding Green bonds is if the proceeds-specific destination of Green bonds is sufficient to make them have different pricing from Conventional bonds.

There have been some studies regarding this topic. For the secondary market, Hachenberg and Schiereck (2018) only found limited evidence that Green bonds are priced significant differently from Conventional bonds. Zerbib (2019), for the bonds issued between 2013 and 2017, only found that for investment grade bonds there is a moderate premium for Green bonds when compared to ordinary ones. Regarding corporate bonds, Tang and Zhang (2018) documented a positive stock market reaction and a greater stock liquidity after the issuance and

announcement of Green bonds. Flammer (2018) not only confirmed a positive stock return but also finds evidence of improvements in both operating and environmental performances after the issuance of Green bonds.

For Modigliani and Miller (1958), leverage is the exposure of assets to financial risk and the leverage ratio is the proportion of Debt over its Equity. Adding more debt to the current structure will imply higher interest payments over debt issuance and therefore a higher leverage ratio of the company.

Our contribution to the already developed work in this field is to try to establish a relationship, if any, between the YTM of corporate Green Bond and the Leverage ratio of the issuer. With this, I intend to see if a corporate with a higher degree of leverage has a Green bond with a higher YTM for the investors when compared to a Conventional bond.

For this we have extracted a database from Refinitiv Eikon for all the active Corporate Green and Conventional bonds from 30th April 2012 until 28th February of 2021. With this search I have obtained a total of 2,054 Green bonds and 37,771 Conventional bonds. For the issuer's financial information, we have used not only Refinitiv Eikon but also recurred to the issuer's Investor Relations pages on their websites and contacted them by e-mail when the previous options were not sufficient to retrieve the required data.

Our findings establish a negative relation between the YTM of a bond and the bond being Green or not. The YTM is -0.971 basis points lower when compared to a Conventional bond. Our findings are small in economic terms and are also aligned to the ones in Flammer (2018), where there is a positive relation between these two factors with -0.019% between the yield at issue. Both findings state a close pricing between Green and Conventional bonds, consistent with Larcker and Watts (2019) findings for municipal bonds. By adding both a Green and Financial Sector dummy variables, the YTM of a bond will be lower if the bond is Green (-0.491 basis points) but with a positive relation if the issuer belongs to a Financial Sector (+1.247 basis points). When we study the Leverage ratio, the YTM will still be lower for a Green bond (-0.824 basis points) however with a higher Leverage ratio from the issuer, there will be a higher YTM but with a relatively low influence in economic terms (+0.0175 basis points). If we introduce both Financial Sector and Leverage Ratio variables, the YTM still has a negative premium if the issued bond is Green (-0.620 basis points) and will have a negative premium with a higher Leverage ratio (-0.0292 basis points) but there will be a positive premium and therefore a higher YTM if the issuer is in the Financial Sector (+1.551 basis points).

As mentioned before, the aim of this thesis is to find any relationship between the YTM of a Green Bond and the Leverage of the issuer. The results show us that the YTM of a Green bond will be lower with a higher Leverage ratio of the issuer (-0.0850 basis points) but for a Conventional bond, it is the opposite: the YTM of a Conventional bond will be higher with a higher Leverage ratio from the issuer (+0.0233 basis points). When the Financial Sector dummy variable is added, the YTM of a Green bond will still be lower with a higher leverage from the issuer but if the issuer is operating in the Financial Sector, the YTM will be higher by 0.186 basis points. For Conventional bonds, the issuer's leverage ratio now has a negative effect on the bond YTM as it will decrease by -0.0288 basis points for a higher Leverage, however, the YTM will be higher if the issuer is in the Financial sector with a positive relation of +1.753 basis points.

Our humble contribution to the already studied subjects in the Green bond literature is the attempt to establish a relationship between the YTM of a Green bond and the issuer's Leverage.

Even though we found a negative relationship i.e., the YTM of a Green bond will be lower with a higher leverage ratio from its issuer (-0.0850 basis points), that is economically small, further research is required in order to confirm not only the trend but also the magnitude of this value.

When analysing bond issuances from the same firm, by using a different estimation technique, that is adding firm fixed effects, the YTM of a Green bond will be -0.296 basis points lower when compared to a Conventional bond with the same characteristics, from the same issuer.

By considering Leverage ratio and by only taking into account the top 50^{th} percentile, with a Leverage ratio above 15.96957, the market does not value the issuance of a Green bond, as it is statistically irrelevant. However, for the bottom 50^{th} percentile, there is now a premium for the YTM (-0.231 basis points) i.e., the market finds relevant that for a lower leverage issuer if the bond is Green or not.

If we add another issuer-only characteristic, as the Financial Sector, the Green variable is not statistically relevant for any company with a higher Leverage Ratio, regardless of whether it operates or not within the Financial Sector. This is also true for issuers that have a Leverage ratio below the median value and are not in the Financial Sector. Our final remark is that there will be a premium of -0.280 basis points for issuers that operate in the Financial Sector and that have a low Leverage ratio i.e., if the issued bond is Green, it will have a lower YTM when

compared to a Conventional bond from the same issuer if all the other characteristics are the same.

Everything discussed in the Introduction will be further detailed in the following sections. The remainder of this dissertation proceeds as follows. Section 2 presents the literature review on Green Bonds and Relationship between Leverage and Cost of Debt. Section 3 describes the Data and Methodology used. Section 4 presents and analyses our results. Our work has its remarking conclusions in Section 5, while References and Appendix being presented in both Section 6 and Section 7, respectively.

2. Literature Review

2.1. Green bonds

A Green bond is a fixed income financial instrument with the purpose of encouraging the financing of environmental-friendly projects, like renewable energy, whilst promoting social welfare (Tang and Zhang 2018) or climate-related sustainable activities (Fatica, Panzica and Rancan 2020), like sustainable water management.

When issuing Green bonds, companies should certify them via third-party entities to make the issuance more credible and signal their commitment to the investment. If it is a first-time issuance, companies may find the process costly, and the shareholders of the issuing firm should ask the benefits from that specific and more costly issuance (Tang and Zhang 2018). Curley (2014) affirms that issuing a Green bond reduces the debt financial expenses of a company.

According to Tang and Zhang (2018), even if the proceeds are directed to green projects, not only those assets will back the issuance but also the full amount of the balance sheet of the issuer will.

There is no formal definition of what a Green bond is. There is although some guidance offered in the Green Bonds Principles (GBP) by the International Capital Market Association (ICMA) where they define Green Bonds as "any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible Green Projects and which are aligned with the four core components of the GBP". A voluntary process guideline for issuing Green Bonds is also included in the GBP (ICMA 2018). Another concept of Green is provided by Corporate Bonds Initiative (2018), where it "differs around the world. The Climate Bonds Initiative uses the Climate Bonds Taxonomy, which features eight categories: energy, buildings, transport, water, waste / pollution control, land use, industry and ICT".

2.1.1. Green and Conventional Bonds – Are they Different?

A Green bond, in concept, is not structurally different from a Conventional bond. The only difference is that the proceeds from Green bonds are committed to finance environmental

and climate-friendly projects such as renewable energy, green buildings, pollution prevention and control, among others (Flammer 2018).

Are the proceeds specific destination sufficient to make Green bonds having different pricing from Conventional bonds?

A particular number of contributions have already analysed this issue with mixed results depending on the time frame, samples, and the type of market, if primary or secondary. For the secondary market, Hachenberg and Schiereck (2018) only found limited evidence that Green bonds are priced significant differently from Conventional bonds. Zerbib (2019), for the bonds issued between 2013 and 2017, only found that for investment grade bonds there is a moderate premium of Green bonds when compared to ordinary ones. Although it is not in the scope of this work, there are two contrasting studies regarding U.S. Municipal bonds: On a large sample of municipal Bonds in U.S., Karpf Mandel (2018) registered a Green bond discount on the secondary market; in a contrasting direction, for the primary market, Green bonds are issued with a premium when compared with Conventional bonds (Baker, et al. 2018).

Regarding corporate bonds, Tang and Zhang (2018) documented a positive stock market reaction and also a greater stock liquidity after the issuance and announcement of Green bonds. Flammer (2018) not only confirmed a positive stock return but also finds evidence of improvements in both operating and environmental performances after the issuance of Green bonds.

Our contribution to the already developed work in this field is to try to establish a relationship, if any, between the yield to maturity of a corporate Green bond and the firm's leverage ratio.

2.1.2. Green Bond Market

The world's first Green bond in the market was issued in 2007 by the EIB with an amount of 600€M and a maturity of 5 years. It was labelled a Climate Awareness Bond (CAB) (European Investment Bank 2021).

After this issuance, the market continued to expand, not only in issued amount, as shown in Figure 1 but also in the number of issuing countries and issuances per year as shown in Figure 2. As we can see in Figure 1, the market was almost non-existent in 2013 with only $21.2bn issued to a grand total of $1,110.7bn in the end of 2020. Green Bonds still represent a small share of the total fixed income market as the total amount outstanding in the 2nd quarter of 2020

was approximatly $114tn across the world (Green Bonds represent approximately ~1% of total bond market) (SIFMA 2021).

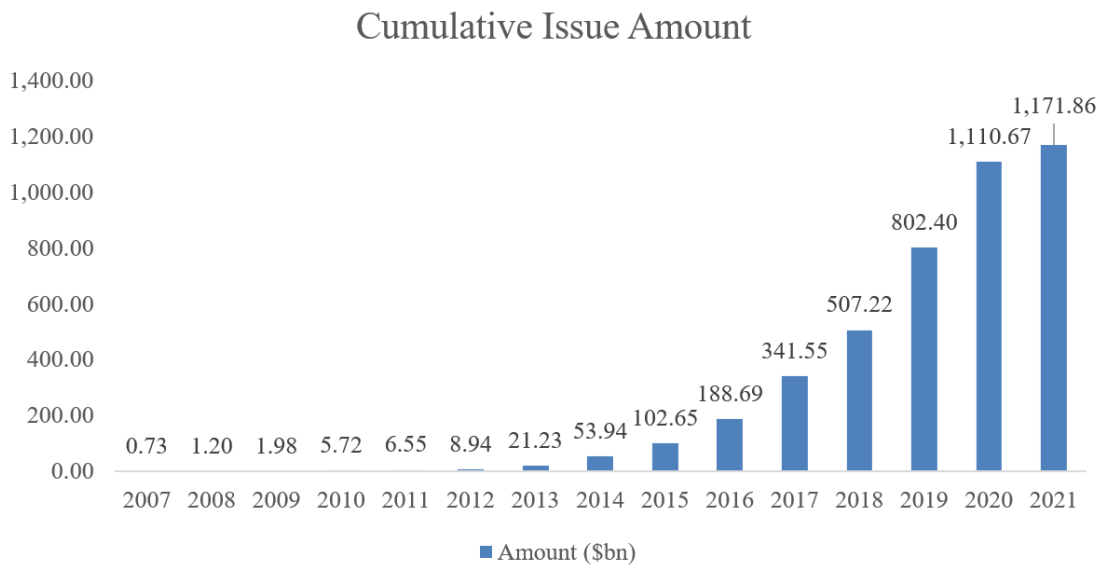

Figure 1 - Cumulative Issue Amount of Green Bonds. Source: Refinitiv Eikon

We can also see an increase in the diversity of both issuing countries and the number of issued Green bonds in Figure 2. The blue bars represent the number of Green Bonds issued per year and the red line represents the number of unique issuing countries per year, peaking a total of 1,045 bonds and 54 different issuing countries in 2020, despite the COVID-19 pandemic around the world. In the first 2 months of 2021, there were already issued 211 bonds by almost 30 different countries.

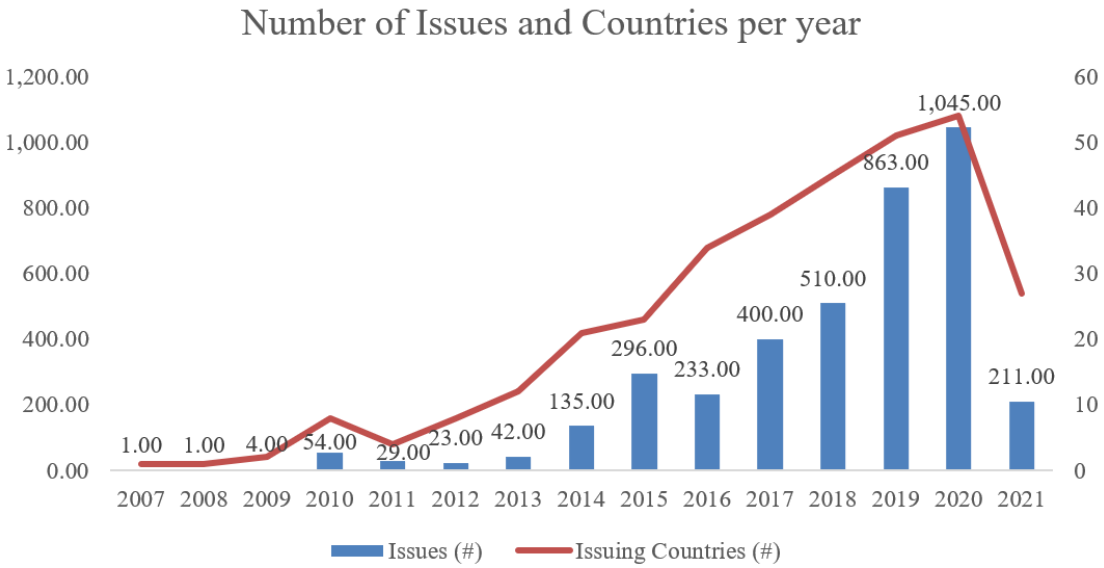

Figure 2 - Number of Issues and Countries per year. Source: Refinitiv Eikon

Regarding sovereign issuance, France issued its first Green Bond instrument in 2017 while the United Kingdom (UK) is only launching its first sovereign Green bond in 2021 for a yet to decide amount. This move comes ahead of UK's hosting the international climate summit in November, the COP26 (Financial Times 2021).

The market has slowed the number of issuances and amount in 2020 but the Swedish bank Skandinaviska Enskilda Banken (SEB) expects a turnaround in 2021 as investors and policymakers expect a recovery from COVID-19 pandemic originated crisis. SEB's projections are that corporates and Governments will issue a total of $500bn regarding Green bonds in 2021, about half of total issuance amount ($1.1tn issued amount since 2007 up until 2020) until the end of 2020 (Financial Times 2021).

In the first half of 2020 it was issued over $250bn in green debt while in 2019 the total issued amount was around $341bn according to the Climate Bonds Initiative (Climate Bonds Initiative 2020).

The types of issuers are also diversifying, ranging from Governments to Supranational Organizations, Banks, non-bank financial institutions, to Corporates.

Although the market is already expanding, Deschryver and de Mariz (2020) suggest four pillars for further expansion: standardization of the issue by developing a Green bond framework, an improved transparency and disclosure of the issuance with a creation of a task-force, distinguish the Green bond market from other green instruments alike such as transition bonds and easier mechanisms to invest in non-developed economies as they could prove to be a resourceful source for new issuances.

Another issue identified that limits the expansion of the Green bond market is that Green bonds are mostly used to refinance already existing projects, limiting its own growth (Bongaerts and Schoenmaker 2019). Bongaerts and Schoenmaker (2019) make a proposal to try to mitigate this limitation, by splitting Green bonds into regular Green Bonds and Green Certificates. This will enable a higher disclosure on the prices of the instruments while allowing more liquidity and promoting investments in new climate-friendly projects instead of refinancing already existing ones.

As mentioned before, there is still no formal definition of what a Green Bond is but there are some guidelines that we will explore in the next chapter.

2.1.3. Green Bond Principles & Climate Bonds Initiative Guidance

In 2014, a conglomerate of investment banks such as Goldman Sachs, JPMorgan Chase, HSBC, and others, created a guideline of voluntary best practices in the subject of Green Bonds issuance, called Green Bond Principles. Later, these principles transitioned to the supervision and development of an independent entity, the International Capital Markets Association who has issued the formal Green Bond Principles guide (Climate Bonds Initiative 2018).

According to ICMA (2018), the Green Bond Principles are a set of recommendations and guidelines for the best practices in the Green Bond Market, with a special focus in disclosure, transparency, and reporting. By requiring that the issuers report on the use of the proceeds, it promotes the transparency in the process of issuing and labelling a Green bond, allowing the investors to have more trust in this financial instrument and enables the tracking of the funds and where the proceeds are allocated.

Both United States and Europe are well represented in the executive committee with a minor participation from Asian countries.

The GBP have four core modules that are widely accepted by the market participants:

1- Use of proceeds

The issuer when applying for the issuance of a Green Bond must provide a description for the use of the proceeds in the legal documentation that is required. The GBP provides a non-exhaustive list of categories for eligible Green Projects which contribute to environmental objectives. This list, however, does not state which categories or projects have the most impact in climate change or which one is the best for environmental purposes, it serves only as a list for the issuer to choose where its project best fits in.

2- Process for Project Evaluation and Selection

Since transparency is one of the cornerstones of the GBP, the issuer of the Green Bond should clearly state the environmental sustainability objective, how did the issuer determined that the project was eligible in the proposed category, and the criteria for the project to be eligible and if applicable, any process that identified potential material environmental or social risks linked to the project.

3- Management of Proceeds

The net proceeds of the Green Bond should be segregated into a separate portfolio (ring-fencing of proceeds). It is also recommended to disclose the intended type of temporary investments for unallocated proceeds.

4- Reporting

There are two types of reporting the issuer should provide:

a) Use of proceeds reporting, where the information on projects benefiting from Green Bond allocations and reimbursements should be published on a yearly basis.

b) Impact reporting, where the issuer should provide the expectations on the environmentally sustainable impact and incorporate qualitative and quantitative key performance indicators.

GBP also recommends external review, such as verification, consultant review, certification, and rating.

Following this required external review or second opinion there are some independent third-party entities that provide assessments in this area.

The Center for International Climate Research (CICERO) Shades of Green is an independent company that provides assessments and shading, since 2015, to a company's revenues and investments, specifically in the Green Bonds area. This is a rating that can be assigned to a green project according to its "greenness", the so-called shades of green. These shades of green give information on how well a Green Bond promotes and is linked to a low-carbon climate future (CICERO 2015).

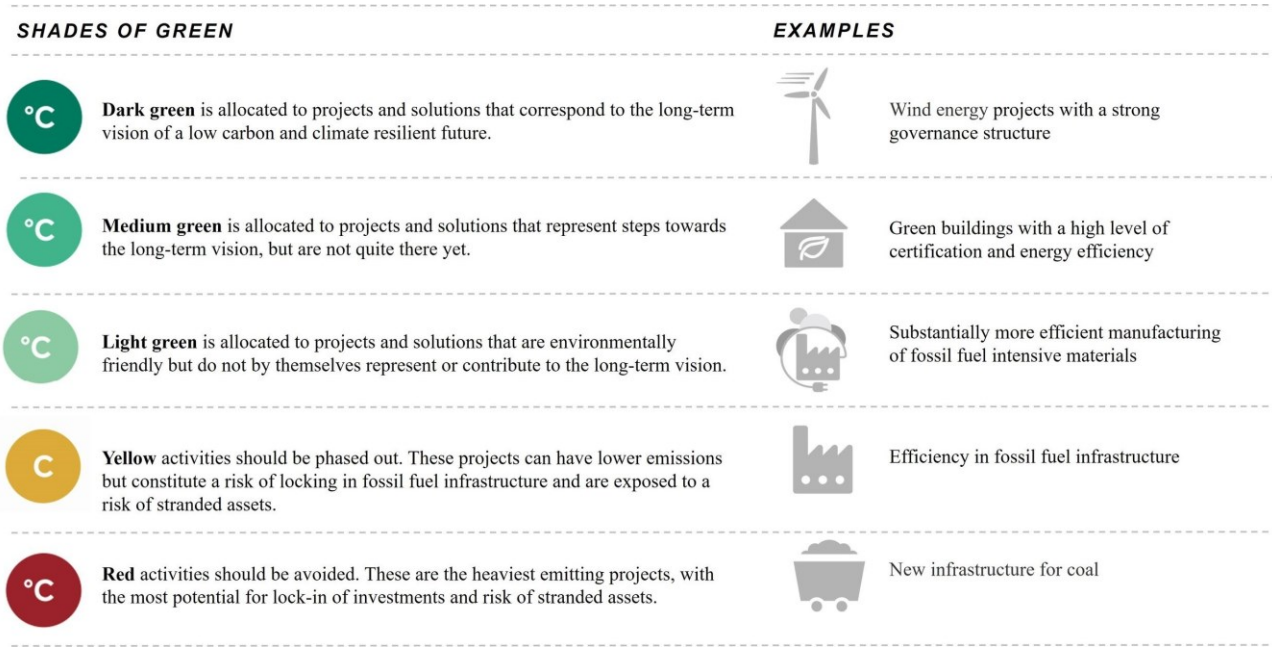

Figure 3 - Shades of Green (CICERO 2015)

Apart from ICMA with the GBP, Climate Bonds Initiative have also issued some guidance on the issuance of Green Bonds, with specific green taxonomy that features eight categories and also a ten sector criteria under the Climate Bonds Standard (CBS) that companies can assure in order for their bonds to be qualified as Green Bonds (Climate Bonds Initiative 2019).

Not only the issuers have to comply with the mentioned standard but they also must ensure that 95% of the proceeds must be allocated to green assets and projects aligned with CBS taxonomy (Climate Bonds Initiative 2018).

2.2. Relationship between Leverage and Cost of Debt

As seen in Modigliani and Miller (1958), leverage is the exposure of assets to financial risk and the leverage ratio is the proportion of Debt over its Equity.

When companies do not use equity as the only source of financing i.e., they use debt, they borrow funds from outside lenders and incur into interest expenses.

The cost of debt, present in the Weighted Average Cost of Capital (WACC) formula in Equation 1, is the rate at which the proportion of Debt over the total value of the firm will be multiplied, all discounted by tax effects.

$$WACC = \frac{E}{E+D} r_E + \frac{D}{E+D} r_D (1 - T)$$

Equation 1 - WACC (Berk and DeMarzo 2017)

Where E is the value of Equity, D is the value of Debt, r_E is the Cost of Equity, r_D is the Cost of Debt and T is the corporate tax rate.

To compute r_D, a company must use a rate of a risk-free bond that matches the duration of the term structure and then add a default premium (Berk and DeMarzo 2017).

By introducing external debt into their balance, companies tend to have a lower cost of capital when compared to lower-levered companies or only equity-financed companies by using the tax benefits as the interest payments can be deducted.

Adding even more debt to the current structure will imply higher interest payments over debt issuance and therefore a higher leverage ratio of the company.

The default premium will also increase as more debt is issued and it is on the company capital structure, as the risk rises, the total cost of debt, r_D, will increase as more debt exists in the company (Solomon 1963).

A more extensive Literature Review regarding Capital Structure and Bond Theory can be found in the Appendix, in sections 7.1.1. and 7.1.2. respectively.

3. Data & Methodology

To create the datasets for this work, I have extracted both Green and Conventional bonds databases from Refinitiv Eikon "Government and Corporate" universe in the "Advanced Search" application.

For the Green bond dataset, I have selected "Yes" in the already given field "Green Bond" from Refinitiv search parameters. The Green bonds in the dataset were defined by Refinitiv and validated in a partnership with Climate Bonds Initiative (Refinitiv 2020).

With the abovementioned search I have obtained a total of 3,865 Green bonds from July 2007 and February 2021. This dataset is the support for the data shown in both Figure 1 and Figure 2.

For this work my focus will be the active Green bonds issued by corporates.

Refinitiv provides a wide range of information for each issuance like the yield to maturity (which is the YTM to a given day, in this case, the date that I have extracted the information, 28th of February), coupon rate, maturity date, issue date, tenor, issued amount in United States Dollars (USD) and in the issuer's currency, coupon type, sector of activity, use of proceeds, among others. Besides not active bonds, I have also removed issuances that were already matured (maturity date prior to the extraction) but incorrectly stated as still active; bonds without the issuance amount; issuances without either coupon or yield to maturity. By applying these filters, I have obtained a total of 2,192 Corporate Green Bonds from April 2012 and February 2021.

To compile the Conventional bonds dataset, I have selected all bonds from the issuers in the Green bond database from April 2012 and February 2021 where the search field "Green Bond" was "No". This dataset is composed of 151,463 Conventional bonds. I have then applied the same database treatment procedure as the ones mentioned above. Again, I have removed observations that had already matured but that were listed as still active; that did not have either coupon, yield to maturity or the issuance amount, and got to a final Conventional Bond Dataset of 41,621 bonds.

I have also gathered information about the issuing companies' financials and further details. For this process I have used several methods and sources:

1. I have used mainly Refinitiv Eikon "Equities" universe in the "Advanced Search" application, where it was possible to gather information regarding "Total Assets", "Total Liabilities", "Shareholders Equity", "Debt-to-Equity" ratio and "Debt-to-Assets" ratio for 369 issuers;
2. For the remaining companies that was not possible to retrieve information in an automatic process in Refinitiv Eikon, I have conducted an exhaustive and extensive manual search on the Internet, more precisely on companies' websites, more specifically in their investor relations pages where I have retrieved the Annual Report, for a total of 139 companies;
3. For some companies it was possible to retrieve Balance Sheet information from Refinitiv in a manual procedure, where I had to search each company individually, access the page and extract manually the Balance Sheet information for 423 companies;
4. I have also contacted by e-mail one of the issuers to request financial information and it was provided by them.

After collecting all information for these companies, I have compiled the required financial information, company by company, in a different excel dataset. Even with this second method of search, it was not possible to retrieve financial information for 44 issuers in the database where I have removed them from both Green and Conventional Bond dataset.

My final sample is then composed by 2,054 Green Bonds and 37,771 Conventional Bonds. I will use this final database from this point forward in my work.

When dealing with large samples of data, it is usual to find extreme observations in it that would unbalance the analysis of the dataset. Winsor, in 1940, suggested to remove those observations of the dataset and balance them in a process called "winsorization", named in his honour. Winsorizing the sample *n* times, means that we replace each of the *n* lowest and each of the *n* highest observations and replace them by their nearest neighbours (Dixon and Yuen 1974).

For this work, as there were extreme values in some variables like the YTM and Leverage ratio, I have winsorized those two variables by transforming the 5% values in each tail. As a reference, in Table 1 there is a comparison of those two variables and the mean value of each one, winsorized or not:

Table 1 - Winsorized Variables mean values

Variable	Mean	Winsorized Mean
Yield to Maturity (YTM)	1,914.70	3.42
Leverage ratio	16.80	13.95

Table 2 shows the number of Corporate Bonds and the amount issued, in million US dollars, per year, since April 2012 until the end of February 2021 divided between Conventional and Green Bonds.

As we can see from the table below, Green bonds still have a reduced expression in the fixed income market but nonetheless, they are on the rise, representing roughly 7% of total bonds (Conventional + Green) and with almost 200$bn issued in 2020.

Despite the increase both in the number of Green bonds issuance and the issued amount since 2014, the average issuance amount has been decreasing since 2016, with an average of 448$M issued per Green bond to an average of 283$M issued per Green bond in 2020. Even with the COVID-19 pandemic, 2020 was still the year with more issued Green bonds since its debut and with the highest amount ever issued nonetheless a drop of 10% when comparing the average issuance amount vs. 2019.

Table 2 - Corporate Bonds over time

Year	# Bonds		Issued Amount ($M)	
	Conventional	Green	Conventional	Green
2012	572	1	192,344	37
2013	1,042	0	243,193	0
2014	1,681	17	538,109	7,316
2015	1,966	70	605,754	6,955
2016	3,129	97	949,608	43,504
2017	3,784	170	1,156,905	64,262
2018	5,838	309	1,442,245	98,490
2019	5,638	576	1,434,634	179,362
2020	9,170	688	1,519,625	194,637
2021	4,951	126	206,246	42,344
Total	**37,771**	**2,054**	**8,288,664**	**636,906**

Table 3 shows the number of Corporate Green Bonds and the amount issued, in million US dollars, per sector since April 2012 until the end of February 2021. Sector is shown according to the already existing data on Refinitiv Eikon database for the issuer. Financial and Banking sector is an aggregate of the following sectors: Banking, Financial – Other, Mortgage Banking, Life Insurance, Leasing, Property and Casualty Insurance.

Not surprisingly, financial and banking companies account for over of 50% of the total amount issued of Green bonds. This is mainly true due to issuance of Green bonds by banks but also some companies have subsidiaries that are registered as financial companies and are used to issue this type of instruments on behalf of the parent companies. The utility sector is the second largest issuer mainly due to green projects that have become a natural investment path for the future in this sector with an example being the wind farms and solar panels investments.

Companies within the Transportation sector, such as car manufacturers, might have an increase regarding issuance of Green bonds in the upcoming years as electric vehicles are on the rise and is a trend for the future. Those investments could be considered as eligible green projects by ICMA and their peers, allowing them to boost their investment in this area towards a green future and carbon-low climate environment.

Table 3 - Corporate Green Bonds by Sector

Sector	# Bonds	Issued Amount ($M)
Financial and Banking	984	375,263
Utility - Other	352	98,664
Service - Other	111	29,616
Transportation - Other	63	15,649
Oil and Gas	27	15,101
Home Builders	167	14,878
Real Estate Investment Trust	82	14,367
Electronics	28	13,384
Industrials - Other	41	9,890
Others	199	50,093
Total	**2,054**	**636,906**

Table 4 shows the number of Corporate Green Bonds and the amount issued, in million US dollars, per country of issuance since April 2012 until the end of February 2021.

China, being the most polluting country in the world accounting for 27.2% of Global Emissions (World Economic Forum 2019), has the largest issued amount to mobilize capital at the scale needed to meet climate investment needs in the country. Despite the decrease in CO_2 emissions in 2019, mainly due to the COVID-19 pandemic that started in the country (International Energy Agency 2020), the emissions in 2020 were already higher when compared to 2019. The increasing coal consumption is the main reason for the emission values to increase by an additional 6% in 2021 (International Energy Agency 2021).

These high levels of CO_2 consumptions will lead to an even larger gap between the issuing countries, as China is expected to issue, annually, between $424bn-$566bn from 2030 going forward just in green investments. This level of investment will also help China to meet the Paris Agreement target for CO_2 emissions reduction (Climate Bonds Initiative 2020).

Being the second most polluting country in the world, responsible for 15% of all emissions (World Economic Forum 2019), the United States are the second highest country regarding the issuance amount. This position should be consolidated by environmental-friendly policies by the Biden administration as they favour the climate agenda.

Netherlands is the third country regarding issued amount in Green bonds. This is true not only due to their investment in green projects and sustainability but also because some companies have their finance-specific subsidiaries based in the country, making it not possible to fully assess the investment levels of each country in a true and fair view.

Mexico, being the second most populated country in Latin America, is a key player regarding energy transition and reducing emissions in the area. The country could have an increase in green investments in the following years as Mexico City, the country's capital, is one of the cities in the world with the highest impact by pollution mainly caused by transportation. To improve the levels of pollution and to have a better life quality in its capital, Mexico has an opportunity to drive this change by channelling investments towards Green bonds to transition their transportation sector to a low-carbon and sustainable sector (Climate Bonds Initiative 2021).

Table 4 - Corporate Green Bonds by Country

Country	# Bonds	Issued Amount ($M)
China (Mainland)	491	118,392
United States	179	80,803
Netherlands	100	76,522
France	74	40,431
Germany	156	37,332
Sweden	255	25,135
Spain	34	21,121
United Kingdom	40	19,097
Japan	134	18,597
Norway	56	17,975
Others	535	181,501
Total	**2,054**	**636,906**

Table 5 shows the number of Corporate Green Bonds and the amount issued, in million US dollars, per Use of Proceeds since April 2012 until the end of February 2021. Use of Proceeds is shown according to the already existing data on Refinitiv Eikon database for the issue.

The top use of proceeds, Eligible Green Projects, is a very wide and non-specific term for use of proceeds, and therefore it is not possible to take any conclusion from it.

The next most selected use is Energy Efficiency, where windfarms and solar panel construction are amongst the destination of the issuance proceeds.

As mentioned before, if Mexico pursues the investment strategy for improving their transportation system, the Clean Transport destination of proceeds could have an increase not only in number of issued bonds but also in the issued amount.

Table 5 - Corporate Green Bonds by Use of Proceeds

Use of Proceeds	# Bonds	Issued Amount ($M)
Eligible Green Projects	969	329,174
Energy Efficiency	406	140,927
Clean Transport	174	67,595
Alternative Energy	82	18,918
Green Construction	76	14,354
Acquisition	23	12,628
Renewable Energy Projects	17	8,008
Environmental Protection Projects	15	7,568
General Purpose	65	6,727
General Purpose/Refinance	6	5,198
Others	221	25,809
Total	**2,054**	**636,906**

Table 6 shows the general Summary Statistics for the data collected, divided into Panel A for Bond Characteristics and Panel B for Issuer Characteristics, with panel A being split between Green and Conventional Bonds. Data is shown regarding the Mean, Median Standard Deviation, Minimum (Min), Maximum (Max) and N for the number of observations.

In Panel A, regarding bonds, *Amount* is the issuance amount in million USD. *Coupon* is the value in percentage of the coupon of the bond. *YTM* is the value in percentage of the Yield to Maturity. *Maturity* is the value in years of the tenor of the bond. *Callable* is a dummy variable equal to one if the bond is callable. *Putable* is a dummy variable equal to one if the bond is Putable. *Fixed Coupon* is a dummy variable equal to one if the coupon bond is fixed. *Perpetual* is a dummy variable equal to one if the bond is perpetual.

In Panel B, regarding issuers, *Leverage Ratio* is the value of the proportion of debt over equity. *Debt to Assets Ratio* is the value of the proportion of debt over assets. *Financial Sector* is a dummy variable equal to one if the issuer's sector is financial (financial sector is an aggregate of the following sectors: Banking, Financial – Other, Mortgage Banking, Life Insurance, Leasing, Property and Casualty Insurance).

By looking at Panel A we can see that Green Bonds have on average, a higher issuance amount ($310.08M for Green bonds vs. $219.45M for Conventional) although the highest issuance of Conventional bonds is almost six times higher than a Green bond ($25bn vs. $4,6bn), with a higher maturity than Conventional Bonds (9.92 years vs. 6.71). Conventional bonds on the other hand, have a higher coupon (3.10% vs. 2.76%) and YTM (3.47% vs. 2.50%).

Both Green and Conventional bonds coupons are predominantly fixed. There are a few number of bonds, either Green or Conventional, that are issued in perpetuity.

Regarding issuers, in Panel B, they are mostly companies within the financial sector with a Leverage ratio of 5.64 on average.

Table 6 - Summary Statistics

Summary statistics

Panel A. Bond characteristics

	Mean	Median	Std. Deviation	Min	Max	N
Green Bonds						
Amount (million $)	310.08	154.74	395.84	0.01	4,642.17	2,054
Coupon (percent)	2.76	2.38	2.20	-0.26	13.50	2,054
YTM (percent)	2.50	1.74	2.75	-5.23	22.95	2,054
Maturity (Year)	9.92	5.00	49.72	1.00	1,000.00	2,020
Callable (0/1)	0.23	0.00	0.42	0.00	1.00	2,054
Putable (0/1)	0.08	0.00	0.26	0.00	1.00	2,054
Fixed Coupon (0/1)	0.84	1.00	0.36	0.00	1.00	2,054
Perpetual (0/1)	0.02	0.00	0.13	0.00	1.00	2,054
Conventional Bonds						
Amount (million $)	219.45	24.15	625.41	0.00	25,000.00	37,771
Coupon (percent)	3.10	1.46	4.89	-0.50	192.00	37,771
YTM (percent)	3.47	1.05	6.53	-5.23	22.95	37,771
Maturity (Year)	6.71	5.00	8.16	1.00	1,000.00	37,223
Callable (0/1)	0.12	0.00	0.33	0.00	1.00	37,771
Putable (0/1)	0.02	0.00	0.12	0.00	1.00	37,771
Fixed Coupon (0/1)	0.60	1.00	0.49	0.00	1.00	37,771
Perpetual (0/1)	0.01	0.00	0.12	0.00	1.00	37,771

Panel B. Issuer characteristics

	Mean	Median	Std. Deviation	Min	Max	N
Leverage Ratio	5.64	2.44	6.01	1.19	24.08	956
Debt to Assets Ratio	0.73	0.70	0.15	0.54	0.96	956
Financial Sector (0/1)	0.51	1.00	0.50	0.00	1.00	956

4. Results

The first regression estimated is the following:

$$YTM = Constant\ i + \beta 1\ Green + \beta 2\ Financial\ Sector + \beta 3\ Leverage\ ratio + \varepsilon i$$

Equation 2 - Regression 1

In this regression, presented in Table 7, the YTM is the dependent variable. We consider three explanatory variables: *Green, Financial Sector and Leverage Ratio*. *Green* is a dummy variable equal to one if the bond is Green. *Financial Sector* is a dummy variable equal to one if the issuer's sector is financial (financial sector is an aggregate of the following sectors: Banking, Financial – Other, Mortgage Banking, Life Insurance, Leasing, Property and Casualty Insurance). *Leverage Ratio* is the value of the proportion of debt over equity.

In column (1) the relationship examined is that between YTM and Green; in (2) between YTM and Green and Financial Sector; in (3) between YTM and Green and Leverage Ratio and in (4) between YTM and Green. Financial Sector and Leverage Ratio. Robust standard errors are shown in parentheses and p values are as shown as follows: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

If we just consider the "Greeness" of a bond, the results show us in (1) that the YTM of a Green bond has a negative premium, although small in economic terms, when compared to a Conventional bond i.e., the YTM will be -0.971 basis points lower if the issued bond is Green.

In (2), the YTM of a bond will be lower if the bond is Green (-0.491 basis points) but there is a positive relation if the issuer belongs to a Financial Sector (+1.247 basis points).

When we introduce the Leverage ratio, in (3), the YTM will still be lower for a Green bond (-0.824 basis points). With a higher Leverage ratio from the issuer, there will be a higher YTM but with a relatively low influence (+0.0175 basis points).

Finally, in (4), by adding both Financial Sector and Leverage Ratio variables, the YTM still has a negative premium if the issued bond is Green (-0.620 basis points) and will have a negative premium with a higher Leverage ratio (-0.0292 basis points) but there will be a positive premium and therefore a higher YTM if the issuer is in the Financial Sector (+1.551 basis points).

Table 7 – The YTM of Green Bonds with issuer Leverage and Sector effects

	(1) YTM	(2) YTM	(3) YTM	(4) YTM
Green (0/1)	-0.971***	-0.491***	-0.824***	-0.620***
	(0.0694)	(0.0714)	(0.0691)	(0.0709)
Financial Sector (0/1)		1.247***		1.551***
		(0.0589)		(0.0718)
Leverage Ratio			0.0175***	-0.0292***
			(0.00285)	(0.00350)
Constant	3.471***	2.393***	3.220***	2.551***
	(0.0336)	(0.0484)	(0.0383)	(0.0470)
N	39,825	39,825	39,825	39,825
R-squared	0.001	0.006	0.001	0.006
Adjusted R-squared	0.001	0.006	0.001	0.006
Root-mean-square Deviation	6.389	6.374	6.388	6.372

For regression 2 the following equation is applied separately for green and conventional bonds:

$$YTM = Constant\ i + \beta 1\ Leverage\ ratio + \beta 2\ Financial\ Sector + \varepsilon i$$

Equation 3 - Regression 2

Table 8 presents the regression for Green bonds in columns (1) and (2) and Conventional bonds in columns (3) and (4), where the YTM is the dependent variable.

In columns (1) and (3) the relationship examined is between YTM and Leverage ratio and in columns (2) and (4) between YTM and the combination of both Leverage ratio and Financial Sector. Robust standard errors are shown in parentheses and p values are as shown as follows: * p<0.05, ** p<0.01, *** p<0.001.

The results show us that the YTM of a Green bond will be lower with a higher Leverage ratio of the issuer (-0.0850 basis points) but for a Conventional bond, it is the opposite: the YTM of a Conventional bond will be higher with a higher Leverage ratio from the issuer (+0.0233 basis points), meaning that there is a reaction from the market if the issuer has a higher leverage ratio depending on the issued instrument.

When the Financial Sector dummy variable is introduced in the regression, the YTM of a Green bond will still be lower with a higher leverage from the issuer but this variable is not statistically significant and therefore no conclusions can be made. For Conventional bonds, the issuer's leverage ratio now has a negative effect on the bond YTM as it will decrease it by -0.0288 basis points for a higher Leverage. However, the YTM will be higher if the issuer is in the Financial sector with a positive relation of +1.753 basis points being this variable what will mainly drive the value of YTM in a Conventional bond.

Table 8 – The YTM of Green and Conventional Bonds and the effect of Leverage ratio and Sector from the issuer

	(1)	**(2)**	**(3)**	**(4)**
	Green Bonds		**Conventional Bonds**	
	Leverage	**Leverage & Financial S.**	**Leverage**	**Leverage & Financial S.**
Leverage ratio	-0.0850***	-0.0918***	0.0233***	-0.0288***
	(0.00972)	(0.0123)	(0.00294)	(0.00366)
Financial Sector (0/1)		0.186		1.753***
		(0.153)		(0.0788)
Constant	3.008***	2.960***	3.136***	2.372***
	(0.0804)	(0.0837)	(0.0386)	(0.0496)
N	2,054	2,054	37,771	37,771
R-squared	0.042	0.043	0.001	0.006
Adjusted R-squared	0.042	0.042	0.001	0.006
Root-mean-square Deviation	2.696	2.696	6.527	6.508

For regression 3 the following equation is applied, adding fixed firm effects:

$$YTM = Constant\ i + \alpha_i + \beta 1\ Green + \varepsilon i$$

Equation 4 - Regression 3

Table 9 presents the regression where the YTM is the dependent variable and its interaction with the independent variable *Green* that is a dummy variable equal to one if the bond is Green.

In this model, we include another estimation technique: firm fixed effects, i.e., we test if for the same issuer there is a premium regarding the YTM for the bond if it is Green or Conventional (α_i). From the sample there were excluded 119 observations that only contained

either one Green or one Conventional bond issued. Robust standard errors are shown in parentheses and p values are as shown as follows: * p<0.05, ** p<0.01, *** p<0.001.

The results below show us that a bond will have a lower YTM if the issued instrument is a Green bond with -0.296 basis points when compared to a Conventional one. This means that the market finds relevant, if for the same issuer the bond issued is Green, as it will have a premium and therefore it will have a lower YTM when compared to a Conventional bond with similar characteristics from the same issuer.

Table 9 – The YTM of Green Bonds with firm fixed effects

	(1) **YTM**
Green	-0.296* (0.150)
Constant	3.434*** (0.0265)
N	39,706
R-squared	0.382
Adjusted R-squared	0.369
Root-mean-square Deviation	5.082

For regression 4 the same equation is applied, but splitting the sample into high and low leverage firms:

$$YTM = Constant\ i + \alpha_i + \beta 1\ Green + \varepsilon i$$

Equation 5 - Regression 4

Table 10 presents the regression where the YTM is the dependent variable and its relationship with the independent variable *Green* that is a dummy variable equal to one if the bond is Green.

In this model, we include again firm fixed effects, i.e., we test if for the same issuer there is a premium regarding the YTM for the bond if it is Green or Conventional (α_i). This regression is applied in column (1) to the firms that have a Leverage ratio greater than the 50th percentile (Leverage ratio > 15.96957) and in column (2) to firms in the bottom 50th percentile, where their Leverage ratio is below 15.96957. From the sample, there were excluded 119 observations

that only contained either one Green or one Conventional bond issued. Robust standard errors are shown in parentheses and p values are as shown as follows: * p<0.05, ** p<0.01, *** p<0.001.

The regression below shows us firstly that for companies with High Leverage i.e., with a Leverage Ratio above the median value of 15.96957, although the YTM will be lower if the issued bond is Green, this variable is not statistically relevant and secondly that for a higher Leverage ratio, above the median value, it is not relevant for the market if the issued bond is either Green or Conventional i.e., there is not a premium in the YTM associated with the issuance for two bonds from the same issuer, with similar characteristics.

The regression for the Low Leverage firms i.e., with a leverage ratio in the bottom 50th percentile, it is now statistically relevant for the market if the bond is either Green or Conventional. The market will now consider a premium in the YTM of the issued bond, associated with the fact that it will be a Green bond. This YTM will be lower when compared to a Conventional bond, for the same issuer of -0.231 basis points.

Table 10 – The YTM of Green Bonds for high leverage firms

	(1) **High Leverage**	**(2)** **Low Leverage**
Green	-0.530	-0,231***
	(0.387)	(0,0868)
Constant	4.248***	2,211***
	(0.0402)	(0,0226)
N	23,820	15.886
R-squared	0.369	0,345
Adjusted R-squared	0.367	0,313
Root-mean-square Deviation	6.161	2,607

Table 11 presents several robustness exercises, always including firm fixed effects, i.e., we test if for the same issuer there is a premium regarding the YTM for the bond if it is Green or Conventional (α_i). In columns (1) and (2), we show issuers that have a Leverage ratio above the median value of 15.96957 and in columns (3) and (4) issuers that have low Leverage, meaning that they are below the 50th percentile regarding Leverage ratio. For columns (1) and (3) we present issuers that are not operating in the Financial Sector and in columns (2) and (4),

issuers that do operate in the Financial Sector. *Financial Sector* is a dummy variable equal to one if the issuer's sector is financial (financial sector is an aggregate of the following sectors: Banking, Financial – Other, Mortgage Banking, Life Insurance, Leasing, Property and Casualty Insurance).

From the sample there were excluded 119 observations that only contained either one Green or one Conventional bond issued. Robust standard errors are shown in parentheses and p values are as shown as follows: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

The regression below shows us that in column (1), for companies that do not operate in the Financial Sector and have a high Leverage ratio, the market does not value those factors in a Green bond as this variable is not statistically significant and no premium is associated with the issuance.

In column (2) we can see that this is also true but for companies that do operate in the Financial Sector and also have a high leverage, the market still does not find this relevant as the Green variable is again not statistically relevant.

For companies that have a low leverage ratio, meaning that they are below the 50^{th} percentile, and do not operate in the Financial Sector, the Green variable is again not statistically relevant making this irrelevant for the market and therefore they do not consider a premium for the issuance of Green bonds.

Finally in column (4), where we analyse companies that are operating in the Financial Sector and have a low leverage ratio, below the median value of 15.96957, there is a premium associated in the issued bond if it is labelled as Green, being the YTM of the Green bond -0.280 basis points lower than a Conventional bond issued by the same issuer with approximately the same characteristics. This issuance is now relevant for the market, as the Green variable is now statistically relevant, meaning that the market does find a premium associated with this issuance.

Table 11 – The YTM of Green Bonds with different Leverages and sectors

	(1)	(2)	(3)	(4)
	High Leverage Firms		Low Leverage Firms	
	Financial Sector = 0	Financial Sector = 1	Financial Sector = 0	Financial Sector = 1
Green	-0.525	-0.530	-0.187	-0.280*
	(0.00972)	(0.0123)	(0.00294)	(0.00366)
Constant	2.215***	4.259***	2.322***	2.142***
	(0.0980)	(0.0404)	(0.0466)	(0.0238)
N	135	23,685	5,997	9,889
R-squared	0.759	0.368	0.278	0.407
Adjusted R-squared	0.742	0.367	0.228	0.384
Root-mean-square Deviation	1.044	6.177	3.118	2.253

5. Conclusions

Our work added a new layer to the already existing studies by Flammer (2018), Baker et al. (2018), Tang and Zhang (2018), (Zerbib 2019) among others, as we introduced the Leverage ratio in the various analysis and regressions made.

The first result that we may find in this thesis is that for the whole sample the YTM of a Green bond will be -0.971 basis points lower when compared to a Conventional bond. When we add the Financial Sector variable and the Leverage ratio into the analysis, the YTM will be -0.620 basis points lower if the bond is Green, +1.551 basis points if the issuer operates in the Financial Sector and -0.0292 basis points if the issuer has a higher Leverage ratio.

When analysing exclusively Green bonds, the Leverage ratio will have an impact of -0.0918 basis points in the YTM while the Financial Sector variable is not statistically relevant in this sample. On the other hand, for Conventional bonds, Leverage ratio will decrease the YTM by -0.0288 basis points while if the issuer is operating in the Financial Sector, the YTM will be +1.753 basis points.

By introducing the firm fixed effects estimation technique, the YTM will be -0.296 basis points lower if the bond is Green when comparing to another bond from the same issuer with approximately the same characteristics.

Adding Leverage ratio and percentiles filtering to the above regression, the results show us that for a higher Leverage ratio (above the median value of 15.96957), the fact that the issued bond is Green it is not statistically relevant i.e., the market does not value if for the same issuer with a high leverage ratio the bond issued is Green or not. In opposite direction, when the issuer's Leverage ratio is in the lower 50^{th} percentile, there is now a premium (-0.231 basis points) for a bond issued by the same issuer with approximately the same characteristics.

The results vary if we do the same estimations by segregating the sample by their sector. If the firm does not belong in the Financial Sector, the variable Green is not statistically relevant despite the Leverage ratio from the issuer. It is also not statistically relevant for the YTM of a bond if the issuer is in the Financial Sector and with a Leverage ratio above the median value. When the firm is in the Financial Sector and with a Leverage ratio in the lowest 50^{th} percentile, the market values these factors and the YTM of a Green bond will have a premium of -0.280 basis points for the same issuer *ceteris paribus* when comparing to a Conventional bond.

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7. Appendix

7.1. Extended literature review

7.1.1. Capital Structure

A company's capital structure should be the one that maximizes the value of the firm. When a firm needs to raise new funds, that can be done either by financing with its own capital (equity) or by borrowing money (debt). The company can finance itself with equity alone through owner's equity, common stock, warrants, etc., or with a mixture of both equity and debt, through loans, bonds, or other financial instruments (Berk and DeMarzo 2017).

Instruments that assume characteristics of both equity and debt are called hybrid securities like convertible debt or preferred stock (Damodaran 2014).

The classical financial theory says that the investor should choose to maximize their investments with the portfolio that gives the highest expected return in a given time frame with a certain level of risk (Markowitz 1952).

Later, Professors Modigliani and Miller (1958) concluded that the capital structure has no impact in the firm's value.

The two factors that could influence the value were income from operations and risk of the underlying assets and for that to happen, the market should also be in perfect conditions.

The market can only be considered perfect if these conditions are met (Modigliani and Miller 1958):

- The same set of securities can be traded by both investors and firms at competitive market prices equal to their present value of the future cash flows.
- No taxes.
- No transaction costs.
- No bankruptcy costs
- No issuance costs.
- No agency costs.
- The generated cash flows are not affected by the firms investing decisions.

This led to the Modigliani-Miller Proposition I: “In a perfect capital market, the total value of a firm’s securities is equal to the market value of the total cash flows generated by its assets and is not affected by its choice of capital structure”.

7.1.1.1. Trade-Off Theory

The Modigliani and Miller Theory was challenged later by Kraus and Litzenberger (1973) with their trade-off theory regarding the optimal level of financial leverage.

This theory also states that the capital structure of a firm is not relevant. It weighs the benefits of debt that result from shielding the cash flows from taxes against the costs of financial distress that comes with leverage.

The total value of a levered firm equals the “value of the firm without leverage plus the present value of the tax savings from debt, less the present value of financial distress costs” (Kraus and Litzenberger 1973).

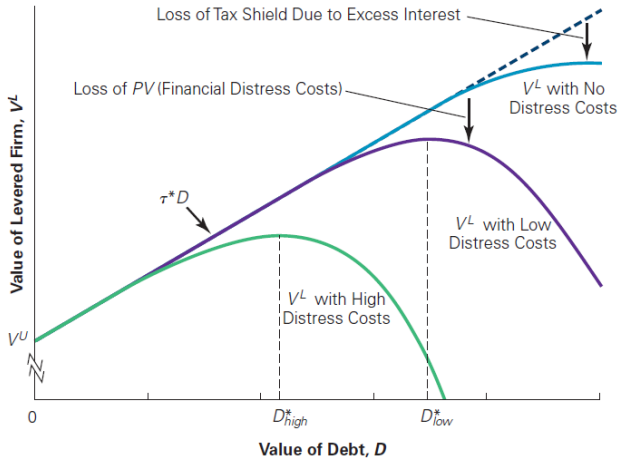

Figure 4 - Optimal Leverage with Taxes and Financial Distress Costs (Berk and DeMarzo 2017)

7.1.1.2. Pecking Order Theory

In 1984, Myers (1984) Capital Structure Puzzle paper introduced extra layers of analysis to previous capital structure and trade-off theory: Market asymmetry exists; there are financial distress costs alongside with agency issues regarding firm specific risks and financial structure information.

The abovementioned sources of financing are now valued differently by managers and investors to what is called, the "pecking order":

1- Firms prefer internal funding.

2- They would adapt their target dividends according to the investment opportunities that may arise

3- External financing:

   a. Debt

   b. Hybrid securities such as convertible bonds

   c. Equity

In this theory, there is no target debt-to-equity ratio since there are two types of equity, both internal and external (Myers 1984).

There is also another pecking-order theory, from (Myers and Majluf 1984), called the issue-invest decision process where the firm's managers have superior information:

1- Safer securities are preferred over riskier ones. Bond markets should be the choice for external capital but raise equity by retention if possible. External financing by debt is better than issuing capital and financing through equity.

2- When a firm's investment opportunities surpass operational cash-flows and it has used up all their low-risk debt issuance ability, it is preferred to pursue this investment rather than proceed with riskier securities to finance the needs, in the interest of existing shareholders.

3- When investment opportunities are not very demanding, firms can restrict their dividend pay-out to investors, generating some financial slack. The retained cash is held both as marketable securities or reserve borrowing power.

4- If the company has to sell some stock or risky securities in order to generated cash to payback dividends, they should not pay dividends.

5- When managers have superior information and stock is issued to finance investments, stock price will fall, *ceteris paribus*.

7.1.1.3. Leverage Ratio

In a broader picture, companies decide to have leverage due to two benefits over equity: the tax benefit where interest payments on debt are tax-deductible and cash-flows originated from equity are not; and debt adds discipline to managers as they have to make debt payments, or the company can become bankrupt (Damodaran 2014).

These two benefits must be weighted and considered in the firm's leverage ratio:

$$Leverage\ Ratio = \frac{Total\ Debt}{Total\ Equity}$$

Equation 6 - Leverage Ratio

7.1.2. Bond Theory

As mentioned before companies can choose debt to finance themselves, specifically through fixed income securities.

Fixed income securities are financial obligations that the issuer promises to pay a specified amount of money to the buyer at a specific date in the future. There are two fixed income securities categories: Debt Obligations and Preferred Stock. We will focus on debt obligations.

In debt obligations, that can assume the form of a bond amongst other type of securities, the issuer is referred as the borrower and the investor who buys the security is called as the lender or creditor. The promised cash-flows from the issuer are both the interest (coupon payments) and the principal (face value), that represents the repayment of funds borrowed (Fabozzi 2007).

Not only companies or firms can issue bonds. Supranational Organizations like the World Bank, Governments like German Government, Agencies like Freddie Mac, Municipalities like the State of Washington can also issue bonds just like firms (Brealey, Myers and Allen 2016)

When a company issues bonds, it comes with several advantages: The first is that bonds usually have a more favourable financing structure and terms than equivalent bank debt, largely because the risk is split amongst a larger number of investors; the second is that bond issues might have some special features that the regular bank debt could not, for example, bonds can be convertible into common stock.

When borrowing money and issuing bonds, the company has to make several choices with the issuance, namely the maturity of the bond (short term or long term); whether the debt should have fixed interest payments or an interest rate tied to market rates (fixed and floating rates) or even if it will be a zero-coupon bond where no interest is paid during the contract and is fully paid at maturity alongside with principal; the nature of the security offered to those buying the bonds (secured versus unsecured) and how the debt will be repaid over time (Damodaran 2014) (Fabozzi 2007).

Bond maturities have influence in many aspects of the bonds: with long-term bonds, usually there is a higher interest rate associated. Also, prices of the long-term bonds are more sensitive to fluctuations rather than short-term ones.

The interest rate that a company can issue a bond cannot be as low as the one in Government bonds, being the latter a benchmark for interest rates and the so-called risk-free interest rate. When these risk-free interest rates rise or decline, firm's interest rates will adjust accordingly too proportionally.

Since corporations have a higher default probability than Governments and less liquidity in their securities these two effects will have an impact in the spread between corporate bonds interest and Government bond interest rates (Brealey, Myers and Allen 2016).

Nonetheless, bonds are considered a safe investment as creditors will get the money invested at maturity unless the company goes bankrupt.

If the bond is kept until maturity, the investor knows exactly what the return will be at least on the face value of the bond, as the interest will depend if it is fixed or floating and the latter depends on three factors: inflation; market rate; and issuer credit rating.

Credit rating is assessed by an independent third-party agency that evaluates how well you are capable to fulfil your obligations (Fabozzi 2007) (Berk and DeMarzo 2017).

7.1.2.1. Secured vs. Unsecured Bonds

Bonds or other types of corporate debt obligations may be either secured or unsecured obligations. When we talk about Secured Debt this means that there is some collateral (properties, machinery, or other income stream) that will secure the payment of the debt. On the contrary, unsecured debt does not have that collateral pledge and therefore there are no guarantees on the payment of debt.

With Secured Debt, the investor has the right to claim the issuer's assets in event of default to try to recover his money back. Even with these pledged collaterals there is no guarantee that the investor will get his full investment back as the issuers ability to generate cash flows to payback its obligations may not be enough.

When there are claims on a weak borrower, the value recovered is often below par.

Even though Unsecured Debt or debenture bonds are not secured by a specific collateral, that does not mean that the investors have no claim in the issuer's assets or earnings. They have the right to claim general assets that are not pledged to secured debt (Fabozzi 2007).

7.1.2.2. Bond Ratings

There is a direct relationship between default risk of the issuers and its bond ratings.

Since it would be very difficult and inefficient for the individual investor to identify and evaluate every bond and company default risk, the safety of most corporate bonds is assessed by independent third-party firms like Moody's; Standard and Poor's (S&P); and Fitch.

The ratings are split between two major categories: Investment Grade that range from AAA to BBB- (S&P rating notation) and Junk/Speculative Bonds/High-Yield Bonds (BB+ to D, in S&P rating notation).

The bonds with the highest rating are the least likely ones to default. When investors check this information, they can easily assess the company creditworthiness and specifically of that bond; the risk of bankruptcy; the bondholder's ability to lay claim to the firm's assets in the event of default (Berk and DeMarzo 2017).

	Moody's	S&P	Fitch	Meaning
Investment Grade	Aaa	AAA	AAA	Prime
	Aa1	AA+	AA+	High Grade
	Aa2	AA	AA	
	Aa3	AA-	AA-	
	A1	A+	A+	Upper Medium Grade
	A2	A	A	
	A3	A-	A-	
	Baa1	BBB+	BBB+	Lower Medium Grade
	Baa2	BBB	BBB	
	Baa3	BBB-	BBB-	
Junk	Ba1	BB+	BB+	Non Investment Grade Speculative
	Ba2	BB	BB	
	Ba3	BB-	BB-	
	B1	B+	B+	Highly Speculative
	B2	B	B	
	B3	B-	B-	
	Caa1	CCC+	CCC+	Substantial Risks
	Caa2	CCC	CCC	Extremely Speculative
	Caa3	CCC-	CCC-	In Default w/ Little Prospect for Recovery
	Ca	CC	CC+	
		C	CC	In Default
			CC-	
	D	D	DDD	

Figure 5 - Bond Rating Credit Table (Waring 2012)

7.1.2.3. Bond Pricing

An investor that owns a bond is entitled to a set of cash-flows until maturity (assuming that the bond is not a zero-coupon bond). Every year until the bond ends, the investor is entitled to collect regular interest payments (coupon). At maturity he will receive not only the final coupon payment but will also get back the face value, or principal, of the bond (Brealey, Myers and Allen 2016).

The basic principle for valuing a bond is that the value must be equal to the present value of its expected cash-flows, where it is first needed to estimate the cash-flows; estimate the rates and then compute the estimated cash-flows using those rates (Fabozzi 2007).

Since we are using a coupon bond as example, its price will be the present value of the coupon payments and the face value discounted at the competitive market rate:

$$P = PV\ (Bond\ Cashflow) = \frac{CF_1}{(1+YTM)^1} + \frac{CF_2}{(1+YTM)^2} + \cdots + \frac{CF_N}{(1+YTM)^n} + \frac{FV}{(1+YTM)^n}$$

Equation 7 - Price of a Coupon Bond (Berk and DeMarzo 2017)

Where P is Price, PV is Present Value, CF is the cash-flow (bond coupon payment), YTM is the yield to maturity of a zero-coupon bond with the same maturity as the coupon one, and FV is the face value of the bond.

When the bond is traded at a price above the face value (FV) it is called premium; if it is traded at a lower price than FV it is traded at a discount and if it is traded at FV it is called that it is traded at par (Berk and DeMarzo 2017).

7.1.2.4. Bond Yields

When evaluating bond returns several yield measures could be computed as a percent return, rather than a dollar return like coupon rate: current yield, yield to maturity, yield to call, amongst others. We will focus only on Yield to Maturity.

Internal Rate of Return (IRR) is the discount rate that the Net Present Value (NPV) of the cash-flows of the project are equal to zero. If compared to zero-coupon bonds, it is called the Yield to Maturity: "The yield to maturity of a bond is the discount rate that sets the present value of the promised bond payments equal to the current market price of the bond" (Berk and DeMarzo 2017)

This measure of yield is by far the most used in the bond market where the expected cash-flows are determined and then the interest rate that will make the PV of the cash flows equal to the market price plus accrued interest. With this calculation we get the YTM of the bond, with the assumption that the bond is held to maturity.

There is a relationship between Coupon Rate and YTM for when the bond is trading at par, with a discount or on a premium:

Table 12A - Relationship between Coupon Rate and YTM, adapted from Fabozzi (2007)

Bond Selling at:	**Relationship**
Par (P=FV)	Coupon Rate = YTM
Discount (P<FV)	Coupon Rate < YTM
Premium (P>FV)	Coupon Rate > YTM

To compute the YTM we can adapt Equation 7 and solve in order of YTM:

$$P = \frac{CF_1}{(1+YTM)^1} + \frac{CF_2}{(1+YTM)^2} + \cdots + \frac{CF_N}{(1+YTM)^n} + \frac{FV}{(1+YTM)^n}$$

Where P is a given Price, CF is the cash flow (bond coupon payment), and FV is the face value of the bond (Fabozzi 2007).

If the bond is a zero-coupon bond, its YTM would be the competitive market interest rate for a risk-free investment with a maturity equal to the zero-coupon bond as seen above.

7.2. Tables

Table 13A presents the regression where the YTM is the dependent variable and its interaction with the other independent variables. *Green* is a dummy variable equal to one if the Bond is Green. The rest of the variables are the country of issuance of a bond, in a total of 56 unique countries. The R-Squared is 0.2962 and the Root-mean-square Deviation is 5.3664 for a total of 39,825 observations.

Table 13A - Regression 7 by Country of Issuance

Variable	Coefficient	Robust Std. Error	t	P>|t|	[95% Conf.Interval]	
Green (0/1)	-0.046	0.065	-0.700	0.482	-0.174	0.082
Austria	0.172	0.102	1.690	0.092	-0.028	0.372
Belgium	0.826	0.353	2.340	0.019	0.135	1.517
Bermuda	4.168	0.074	55.990	0.000	4.022	4.314
Brazil	2.417	0.208	11.610	0.000	2.009	2.825
British Virgin Islands	1.268	0.107	11.870	0.000	1.059	1.478
Canada	0.087	0.066	1.320	0.188	-0.042	0.216
Cayman Islands	2.288	0.273	8.370	0.000	1.752	2.824
Chile	0.791	0.159	4.960	0.000	0.479	1.104
China (Mainland)	3.966	0.053	74.670	0.000	3.862	4.070
Colombia	1.970	0.360	5.470	0.000	1.264	2.675
Denmark	1.418	0.215	6.600	0.000	0.996	1.839
Finland	1.421	0.295	4.820	0.000	0.843	1.998
France	1.083	0.094	11.480	0.000	0.898	1.268
Georgia	6.004	0.057	106.170	0.000	5.893	6.115
Germany	-0.126	0.041	-3.040	0.002	-0.207	-0.045
Greece	2.025	0.799	2.540	0.011	0.460	3.591
Guernsey	2.302	0.467	4.930	0.000	1.388	3.217
Hong Kong	1.483	0.117	12.720	0.000	1.254	1.711
Iceland	0.092	0.278	0.330	0.741	-0.453	0.637
India	5.983	0.147	40.840	0.000	5.696	6.271
Indonesia	5.044	0.244	20.660	0.000	4.565	5.522
Ireland	1.243	0.282	4.400	0.000	0.689	1.796

Italy	0.046	0.077	0.600	0.546	-0.105	0.197
Japan	-0.252	0.041	-6.100	0.000	-0.332	-0.171
Jersey	-0.192	0.113	-1.700	0.089	-0.413	0.029
Latvia	-0.641	0.103	-6.220	0.000	-0.843	-0.439
Lithuania	-0.160	0.171	-0.930	0.350	-0.496	0.176
Luxembourg	1.366	0.381	3.580	0.000	0.618	2.113
Macau	0.522	0.245	2.130	0.033	0.042	1.002
Malaysia	3.346	0.094	35.750	0.000	3.163	3.530
Mauritius	3.256	0.135	24.120	0.000	2.991	3.521
Mexico	3.780	0.140	26.960	0.000	3.505	4.055
Namibia	5.540	0.785	7.060	0.000	4.001	7.079
Netherlands	0.449	0.086	5.220	0.000	0.280	0.617
New Zealand	0.862	0.234	3.680	0.000	0.402	1.321
Nigeria	2.384	0.037	64.100	0.000	2.311	2.457
Norway	0.069	0.066	1.040	0.296	-0.061	0.200
Panama	2.825	0.243	11.610	0.000	2.348	3.302
Peru	2.142	0.508	4.210	0.000	1.145	3.138
Philippines	2.000	0.474	4.220	0.000	1.071	2.928
Poland	0.260	0.233	1.120	0.264	-0.196	0.717
Portugal	5.071	3.162	1.600	0.109	-1.126	11.268
Russia	22.109	0.037	594.500	0.000	22.036	22.182
Singapore	0.796	0.154	5.170	0.000	0.494	1.098
Slovenia	-0.719	0.048	-15.100	0.000	-0.812	-0.626
South Africa	5.597	0.186	30.150	0.000	5.233	5.961
South Korea	0.494	0.040	12.320	0.000	0.415	0.573
Spain	0.167	0.113	1.480	0.140	-0.055	0.389
Sweden	0.155	0.080	1.950	0.052	-0.001	0.311
Switzerland	-0.569	0.100	-5.700	0.000	-0.765	-0.374
Taiwan	0.002	0.076	0.030	0.978	-0.147	0.152
Thailand	1.458	0.192	7.600	0.000	1.082	1.834
Turkey	7.593	0.910	8.340	0.000	5.810	9.377
Utd Arab Emirates	1.193	0.148	8.060	0.000	0.903	1.483
United Kingdom	8.784	0.112	78.130	0.000	8.564	9.004
United States	1.457	0.080	18.190	0.000	1.300	1.614
Constant	0.836	0.037	22.490	0.000	0.763	0.909

Table 14A presents the regression where the YTM is the dependent variable and its interaction with the other independent variables. *Green* is a dummy variable equal to one if the Bond is Green. *Leverage Ratio* is the value of the proportion of debt over equity. The rest of the variables are the country of issuance of a bond, in a total of 56 unique countries. The R-Squared is 0.2963 and the Root-mean-square Deviation is 5.3659 for a total of 39,825 observations.

Table 14A - Regression 8 with Leverage ratio by Country of Issuance

Variable	Coefficient	Robust Std. Error	t	P>|t|	[95% Conf.	Interval]
Green	-0,112	0,064	-1,740	0,082	-0,238	0,014
Leverage ratio	-0,019	0,003	-5,440	0,000	-0,026	-0,012
Austria	0,040	0,107	0,370	0,708	-0,170	0,251
Belgium	0,828	0,343	2,410	0,016	0,156	1,500
Bermuda	4,101	0,077	53,130	0,000	3,950	4,252
Brazil	2,274	0,211	10,770	0,000	1,860	2,689
British Virgin Islands	1,077	0,112	9,610	0,000	0,857	1,296
Canada	0,185	0,067	2,760	0,006	0,053	0,316
Cayman Islands	2,219	0,274	8,110	0,000	1,683	2,755
Chile	0,718	0,155	4,620	0,000	0,413	1,022
China (Mainland)	3,831	0,060	64,320	0,000	3,714	3,948
Colombia	1,875	0,361	5,200	0,000	1,168	2,581
Denmark	1,561	0,212	7,370	0,000	1,146	1,976
Finland	1,458	0,295	4,950	0,000	0,880	2,036
France	1,232	0,095	12,980	0,000	1,046	1,418
Georgia	5,847	0,060	97,620	0,000	5,729	5,964
Germany	-0,016	0,046	-0,340	0,731	-0,106	0,075
Greece	1,996	0,798	2,500	0,012	0,432	3,559
Guernsey	2,510	0,468	5,360	0,000	1,593	3,428
Hong Kong	1,320	0,121	10,920	0,000	1,083	1,557
Iceland	-0,120	0,280	-0,430	0,669	-0,669	0,429
India	5,903	0,149	39,750	0,000	5,612	6,195
Indonesia	4,848	0,243	19,980	0,000	4,372	5,323
Ireland	1,062	0,283	3,750	0,000	0,507	1,617
Italy	0,017	0,078	0,220	0,825	-0,136	0,170
Japan	-0,319	0,044	-7,270	0,000	-0,406	-0,233
Jersey	-0,389	0,115	-3,390	0,001	-0,614	-0,164
Latvia	-0,793	0,110	-7,220	0,000	-1,008	-0,578
Lithuania	-0,329	0,160	-2,060	0,039	-0,643	-0,016
Luxembourg	1,400	0,379	3,690	0,000	0,656	2,143
Macau	0,440	0,247	1,780	0,075	-0,045	0,925
Malaysia	3,257	0,098	33,350	0,000	3,066	3,449
Mauritius	3,133	0,138	22,700	0,000	2,862	3,403
Mexico	3,660	0,147	24,840	0,000	3,371	3,949
Namibia	5,444	0,785	6,930	0,000	3,905	6,983
Netherlands	0,447	0,086	5,210	0,000	0,279	0,615
New Zealand	0,712	0,238	2,990	0,003	0,245	1,178
Nigeria	2,350	0,038	62,420	0,000	2,276	2,424
Norway	-0,018	0,068	-0,270	0,788	-0,151	0,115
Panama	2,733	0,242	11,290	0,000	2,258	3,207
Peru	2,056	0,560	3,670	0,000	0,959	3,153
Philippines	1,909	0,470	4,060	0,000	0,988	2,831
Poland	0,264	0,233	1,130	0,257	-0,193	0,721
Portugal	4,924	3,147	1,560	0,118	-1,244	11,092

Russia	22,007	0,042	529,300	0,000	21,926	22,089
Singapore	0,678	0,158	4,300	0,000	0,369	0,987
Slovenia	-0,838	0,050	-16,840	0,000	-0,935	-0,740
South Africa	5,593	0,186	30,100	0,000	5,229	5,957
South Korea	0,322	0,051	6,260	0,000	0,221	0,423
Spain	0,214	0,114	1,880	0,060	-0,009	0,436
Sweden	0,061	0,084	0,720	0,469	-0,104	0,226
Switzerland	-0,626	0,101	-6,180	0,000	-0,825	-0,428
Taiwan	-0,051	0,079	-0,640	0,520	-0,205	0,103
Thailand	1,274	0,196	6,500	0,000	0,890	1,659
Turkey	7,504	0,909	8,250	0,000	5,722	9,285
Utd Arab Emirates	1,100	0,149	7,400	0,000	0,809	1,391
United Kingdom	8,853	0,113	78,380	0,000	8,631	9,074
United States	1,392	0,083	16,750	0,000	1,229	1,554
Constant	1,077	0,058	18,630	0,000	0,964	1,190