Erasmus University Rotterdam
Erasmus School of Economics

# The Effect of Country Sustainability on the Pricing of Green Bonds

Jildou Merkus – 569783
Email: 569783jm@eur.nl

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Supervisor: Antti Yang
Second Assessor: Marshall X. Ma

## Abstract

Green bonds are seen as a potential means to increase funding for environmental-friendly projects, which are much needed in world where sustainability and climate change play a crucial role. This study focusses on the pricing of corporate green bonds, as contradicting results regarding this topic exist and results can have implications for the future growth of the green bond market. The pricing of green bonds reflects investors preferences, and it is expected that there is an existence of a willingness to pay for environmental sustainability, especially in countries where the level of sustainability is high. To test whether there is an effect of country sustainability on the pricing of green bonds, a matching methodology is used, in which green bonds are matched to a similar conventional non-green bond of the same issuer. By using a dataset of 223 EU corporate green bonds matched to their brown counterpart, the yield differential is determined, and a small but significant green bond premium of -1.4 bps is found. In addition, it is confirmed that in countries with a high Environmental Performance Index (EPI) this differential increases to -9 bps and in countries with a low EPI the green bond differential is +4 bps, which implies that green bonds are trading at a discount. In addition, a regression is performed and a significant negative relationship with a coefficient of -0.03 is found between the EPI and the green bond premium. These results highlight that the effect of pro-environmental preferences can be measured by the green bond premium. There exists a willingness to pay of investors for green bonds, and this increases in countries with high national environmental standards.

**Key words**

Sustainable finance; Green bonds; Socially responsible investing; Investment preferences; Corporate financial performance

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# 1. Introduction

In December 2015, the Paris Agreement was established in order to combat climate change. It describes that firms have to undertake investments to contribute to the transition of the world's economy to a low-carbon path, to reduce greenhouse gas concentration levels and to increase the ability of countries to deal with the impact of climate change. In order to fund large amounts of money needed for these investments, financial innovations are necessary (Hong and Karolyi, 2020). An example of such a financial innovation is a green bond. Green bonds are a form of debt financing whose proceeds are dedicated to finance environmentally friendly projects, such as renewable energy or green buildings (Flammer, 2020). Green bonds stimulate sustainability, by helping companies to obtain investors and setting up projects to contribute to the sustainable goals established in the Paris Agreement of 2015.

Green bonds are a relatively new financing instrument as they started emerging around 2015, but the market is exponentially increasing (Park, 2018). The COVID-19 pandemic slowed down the sales of green bonds in the beginning of 2020, but later the sales rose again as companies and governments found strong investor demand. The amount of green bonds sold in the first three quarters of 2020 exceeded $200 billion, which is approximately 12% more than the same period of 2019 (Bloomberg, 2020). It is expected that the total volume of green bonds which are for 100% dedicated to green assets has exceeded $1 trillion at the end of 2020 (Climate Bond Initiative, 2020a). The expectations of 2021 are that another $500 billion will be issued, which is also due to the fact that green bonds are perceived as a sustainable recovery from the COVID-19 pandemic. In addition, as the largest amount of green bonds issued is in the United States (Flammer, 2020), the installment of Joe Bidon is expected to positively influence the green bonds issuances, due to his more environmental and social approach than Donald Trump (Nauman, 2021). The fact that the market of green bonds is relatively new and growing at a rapid pace, provides a motivation to study this market.

Besides the increasing size of the green bond market, there is still a lot of room to grow for the green bond market. The largest amount of green bonds might be issued in the United States, but due to the enormous size of the total bond market in the United States, the green bond market accounts for only one-tenth of one percent of bonds outstanding (Chiang, 2017). In 2018, the size of the worldwide bond market is estimated at $102.8 trillion, and the green bond market around $95.7 billion. A reason for this relatively small portion of green bonds

could be that companies have to undergo third-party verification to establish that the proceeds are in fact funding project benefitting the environment. This increases the costs of issuing green bonds. In addition, proceeds of green bonds must solely go to green projects, which restricts firms' investment policies. However, by issuing a green bond a firm proves to its stakeholder that it cares about the environment and signals its commitment towards the environment (Flammer, 2021).

Cost of capital is a measure of investor's perceptions on what is value relevant. This would imply that increasing global interest in sustainability might be incorporated in the price of green bonds by investors (Gianfrate et al, 2021). It is expected that there is an existence of a willingness to pay for environmental sustainability (Bachelet et al, 2019), so investors are willing to trade off financial returns for societal benefits. This would lead to securities being priced with a so called "greenium" (Larcker and Watts, 2019). This green bond premium is defined as the yield differential between a green bond and an otherwise identical conventional bond (Zerbib, 2019).

Sustainability levels in countries differ across the world. In 2020, Denmark was the most sustainable country with a sustainability score of almost four times the score of the lowest ranked country, Liberia (Wendling et al, 2020). The trust of investors to green labels and the willingness to contribute to national environmental efforts could be high in countries with established environmental policy goals (Kapraun and Scheins, 2019). This makes it interesting to study, whether country sustainability influences the pricing of green bonds. In addition, this relationship regarding heterogeneity in the pricing of green bonds is only studied by Kapraun and Scheins (2019).

The future success of the green bond market in becoming an important contributor to financial markets and sustainable investments will, among others, depend on the pricing of green bonds (Hachenberg and Schiereck, 2018). This study contributes to the ongoing debate about the willingness of investors to pay a premium, thus accept lower yields, for a green bond compared to its equivalent brown bond. Past research has found contradicting results regarding the pricing of green bonds. Karpf and Mandel (2017) and Bachelet et al. (2019) find a green bond discount, while Hachenberg and Schiereck (2019), Larcker and Watts (2019) and Flammer (2021) find no significant difference between the pricing of green and brown bonds. On the other hand, Zerbib (2019) and Baker et al. (2018), among others, find a lower yield for

green bonds and thus a green bond discount. An interesting question arises why there is such difference with respect to results regarding the green premium. This study will zoom in on the pricing of green bonds by linking it to the level of country sustainability, such that the dependence of green bond pricing on the willingness to pay for environmentally friendly projects can be more closely studied. The main research question can be formulated as follows:

RESEARCH QUESTION:

*What is the effect of country sustainability on the pricing of green bonds?*

This question will be answered by using a matching methodology, in which 223 EU corporate green bonds are matched to an almost identical non-green bond of the same issuer. This methodology ensures that almost all characteristics of the bonds are identical, except for the yield and the use of proceeds. The bonds are matched based on their maturity, issue amount and difference in issue date. After the matching procedure, the yields of the green and similar non-green bonds can be compared, and it can be determined whether green bonds are priced at a discount compared to the non-green bonds. In addition, the Environmental Performance Index (EPI) is used to study the level of country sustainability. Based on this index, the sample is split up and it is investigated whether the pricing difference changes when the level of country sustainability changes. Finally, a regression analysis is performed, to investigate whether the pricing differential between the green and the equivalent brown bond is determined by the Environmental Performance Index, and thus, by the level of country sustainability.

This research finds a small significant negative green bond premium of -1.4 bps which indicates that green bonds are trading at a slightly lower yield than their matched non-green bonds. This confirms the prediction that investors are indeed willing to give up some return, in return for societal or environmental benefits and it indicates that there exists a high preference of investors for green bonds. In addition, this premium increases to -9 bps for countries with a high EPI and green bonds are trading at a discount of +4 bps in countries with a low EPI. Furthermore, the regression analysis confirms this negative relationship between the green bond premium and the EPI, as a significant coefficient of -0.03 is found. This indicates that the green bond differential will decrease as the EPI increases, which means that the green bond premium increases as the level of country sustainability increases. These results highlight the importance of the environmental efforts of a country in the pricing of corporate green bonds. Investors are willing to give up more of their return, in countries where the state of sustainability is high.

The research conducted in this paper contributes to the existing literature of climate finance, by studying the pricing or green bonds and the effect of country sustainability on this pricing. Green bonds are a relatively new tool of financing, and the market of green bonds is rapidly growing and expected to grow more in the future. More data has become available in the past two years, which no researcher has studied before. As the market is growing exponentially, these two years of additional data regarding green bonds will contain valuable information. Furthermore, previous literature regarding the pricing of green bonds is scarce, and the studies done find contradicting results. In addition, this study will focus on corporate green bonds, as mainly municipal green bonds were studied. Finally, this study sheds light on heterogeneity in the pricing of green bonds, as it is determined whether the state of sustainability in a country, influence the yield differential between a green and its similar non-green bond. Sustainability efforts are an unavoidable topic in current governments, so determining whether sustainable actions influence investor behavior is extremely relevant.

This paper starts with a literature review, which, in the first place, extensively describes the contradicting past literature regarding the pricing of green bonds. Secondly, the literature review includes a discussion of the past literature regarding the incorporation of country sustainability in the pricing of green bonds. In the following section, the data and research methodology of the research is described. This chapter starts with a description of de green bond dataset, which is followed by the explanation of the matching methodology used to study the pricing of green bonds. The final chapter of the data and methodology section, includes the methods and data used to study the effect of country sustainability. This includes an explanation of the EPI, a discussion of the division of the sample into high- and low-EPI countries and a description of the regression analysis. Thereafter, the results of the research are provided, which consists of the findings regarding the green bond premium and the findings regarding the effect of country sustainability. Next, the chapter including the discussion and conclusion is presented, which discusses the main findings, limitations of the paper, suggestions for further research and practical implications. This paper ends with the references and appendices.

## 2. Literature Review and Hypotheses

This section will start with analyzing previous literature regarding the pricing of green bonds in comparison to their brown equivalent. Contradicting and varying results are found in the past regarding the existence of a green premium, so an overview of these findings is provided. The section ends with a hypothesis regarding this green bond premium, based on the findings in previous literature. In the second section, past literature about the impact of country sustainability on the difference in the pricing of green bonds with respect to their brown equivalent is discussed. Literature regarding this topic is still scarce, but the available literature argues that country sustainability does affect the pricing of green bonds, as the green-credibility increases, and thus the greenium (Kapraun and Schein, 2019). This section will end with the hypothesis regarding this relationship, which will be tried to reject in the remaining of the paper.

### 2.1. Pricing of Green Bonds

Researchers studying the pricing of green bonds find contradicting results. On the one hand, recent studies provide evidence that investors value sustainability and thus we would expect that green bonds are priced with a premium, or "greenium" and are traded at lower yields. However, on the other hand, studies have found no pricing differential between green and brown bonds or even a green bond discount, due to the uncertainty and relative novelty of the green bond market. It is argued that these results regarding the pricing of green bonds depend largely on the sample and the research methods used (Kapraun and Scheins, 2019). In addition, there are many types of green bond issuers, namely, supranationals, sovereigns, municipals, agencies, corporates and others. Each differs in target investor base, currency risks, and trading and institutional environment. For example, the U.S. municipal market is highly sensitive to tax features. So, if green municipal bonds are taxable, they are traded at higher yields, but in after-tax terms, they are actually sold for a premium, thus a lower yield (Baker et al, 2018).

#### *2.1.1 Green Bond Discount*

Karpf and Mandel (2017) find a green bond discount, namely a positive yield differential, by studying U.S. municipal green bonds. However, this spread can be largely explained by differences in mean characteristics of green and brown bonds. They argue that the market valuates green bonds in a less favorable manner than their matched brown bonds, because their expected mean return would be lower when the same coefficients as brown bonds

were used for the green bonds. As possible reason, Karpf and Mandel (2017) mention the skepticism or a lack of awareness on the side of the market with regard to green bonds. This problem might disappear in the future as the uncertainty in the market might gradually disappear. Flammer (2021) argues that Karpf and Mandel (2017) ignore the role of taxation in the municipal securities market, which biases the estimates to finding a green bond discount. Bachelet et al. (2019) find a similar outcome as Karpf and Mandel (2017) and conclude that green bonds in their sample enjoy a negative premium and may therefore be financed at a discount. As reason they mention that it can be due to the lower exposition to stakeholder risk of green investment.

### *2.1.2 Green Bond Premium*

On the other hand, Preclaw and Bakshi (2015) have found a green bond premium, which they attribute to opportunistic pricing based on strong demand from environmentally focused funds. In addition, Ehlers and Packer (2017) document that green bonds are priced at a premium at issuance relative to conventional bonds, while their performance is similar. They compared credit spreads of issuances of a cross section of 21 green bonds issued between 2014 and 2017. Nanayakkara and Colombage (2019), confirm this green bond premium by analyzing 82 green bonds for the period 2016 and 2017. These bonds were matched to their comparable conventional issues, based on credit spread, similar to Ehlers and Packer (2017). These results indicate that investors are willing to pay a premium for the acquisition of green bonds, which may have favorable effects in increasing the flow of private capital for green investments.

Baker et al. (2018) study approximately 2000 green municipal bonds issued between 2010 and 2016 in the United States and also find that they are issued at a premium, with lower yield by several basis points to otherwise similar ordinary bonds. They mention that the most natural explanation is that a subset of investors is willing to sacrifice some return to hold green bonds. In addition, they found that this pricing effect is stronger among bonds that are certified by external verifiers. In addition, Zerbib (2019) finds a small, negative green bond premium of two basis point. In this sample the yield of a green bond is lower than that of a conventional bond. These results highlight the low impact of investors' sustainable preferences on bond prices, which does not present a disincentive for investors to support to expansion of the green bond market, at the time of writing of the paper.

Hachenberg and Schiereck (2018) analyze the pricing of around 200 green bonds in comparison to conventional bonds and find that green bonds trade tighter in 2016. This implies that issuing a green bond is more expensive than issuing a non-green bond. However, this difference in pricing could make up for external costs that the issuer has to bear, like second-party opinion and a possible certification of the transaction. The study of Hachenberg and Schiereck (2018) also finds that government-related trade marginally wider than comparable non-green bonds. This might be due to the fact that government-related issuers actively promote the growth of the green bond market and they may fear that tight pricing of green bonds might hurt market growth. On the other hand, they find that financial green bonds trade tighter than non-green bonds.

By analyzing a sample of more than 1500 Green bonds, Kapraun and Scheins (2019) find that only certain types of green bonds trade at a premium (exhibit lower yields) relative to their conventional counterparts. Corporate bonds have on average higher yields than conventional bonds, so they suffer from the worse valuation of the green label on the secondary market. They state that bonds issued by governments or supranational entities, dominated in EUR or USD, or corporate bonds with very large issue sizes, have lower information asymmetry and therefore lower yields. These bonds and their issuers might be viewed as more credible in terms of a better implementation or a greater impact of the financed green project. Kapraun and Scheins (2019) therefore conclude that the most important determinant for the existence of a green premium is the perceived "green-credibility" of the corresponding bond and its issuer.

Finally, the main reason in favor of the existence of a green bond premium, is the large imbalance between the supply and demand of green bonds. This is due to the enormous appetite in green bonds from investors, due to the increasing interest in climate finance (Slimane et al., 2020). It is possible to issue green bonds with lower yields which investors are willing to accept, because the supply cannot keep up with this large demand of green bonds. As mentioned in the introduction, climate change is a large risk with financial implications, which drives investors' willingness for green investments. This makes investors more willing to pay for green investments, and is thus in favor of the existence of the green premium.

*2.1.3 No Pricing Differential*

Larcker and Watts (2019) question whether there is a pricing differential between green and non-green municipal securities and find little evidence in favor of this differential. Flammer (2021) confirms this finding for corporate green bonds. The most recent pricing report on green bonds of the Climate Bond Initiative (2020b), studies 21 green bonds issued in the first half of 2020, with a minimum size of $500 million. Of these, five showed evidence of a green bond premium. This does not provide clear evidence for a greenium. The results of surveys performed by Flammer (2020), Larcker and Watts (2019), and Chiang (2017) did not support the argument of a higher willingness to pay of investors for green bonds. Industry practitioners state firms would not accept a lower yield for a green bond, and they would not invest in green bonds if the returns were not competitive.

To conclude, these contradicting findings on the pricing of green bonds provide high motivation for further research. Based on these findings from previous literature regarding the pricing of green bonds, a hypothesis is formulated, which is tested in this research. It seems that environmental beneficial investments are perceived to have value for investors beyond the expected risk and return attributes of a security. Even though contradicting results still exists, the largest part of previous studies confirm this by stating that investors are willing to give up financial benefits to invest in green projects. This is mainly due to the growing trend of sustainability, which causes an increase in demand for green investments. This leads to the following first hypothesis, which I will try to reject in this research:

*H1: Green bonds are not traded at a premium in comparison to their equivalent brown bond*

**2.2. Country sustainability**

The pricing of green bonds is, among other things, reflected by the willingness to pay for sustainability of investors. As mentioned earlier, the findings regarding this pricing of green bonds compared to their brown counterpart, can vary by issuer type, sample or choice of method. Additionally, findings can also differ across geographies, as a number of country specific external variables play a role in explaining the price differential (Gianfrate et al, 2021). The effect of country-level factors on the greenium has not yet received much attention in previous literature regarding green bonds. In this section, the existing literature regarding the topic will be elaborated on.

Gianfrate et al. (2021) have surveyed the literature contributions that have investigated the relationship between environmental performance and firms' cost of capital. They conclude that most literature supports the existence of a negative relationship between environmental performance and cost of capital. However, several external factors such as national institutional and cultural frameworks seem to have an effect on this relationship. One of these factors they suggest is the role of country-level factors in moderating or strengthening the relationship between cost of capital debt and sustainability.

Cheung et al. (2016) investigate how the relationship between corporate social responsibility (CSR) and bank loan pricing is affected by the degree of national stakeholder orientation. They use a sample of approximately 1500 loan facilities issued by more than 600 firms in 20 countries. They argue that stakeholder groups have higher expectations regarding a firm's CSR performance and are more likely to publicly scrutinize a firm's CSR performance in more stakeholder-oriented countries. They use two measures to proxy for national stakeholder orientation. Firstly, one of the metrics developed by Dhaliwal et al. (2012) is used, which captures different dimensions of a country's institutions that influence CSR activities. Secondly, they use the country's ESG rating as developed by Bloomberg. More stakeholder-oriented countries are expected to be characterized by higher ESG ratings, as they perform better in promoting CSR-related matters. Cheung et al. (2016) find that the favorable effect of high CSR performance on bank loan spreads is greatly determined by the degree of a country's stakeholder orientation. This finding highlights the importance of national factors in determining the payoff of green investments.

Hoepner et al. (2016) study the relationship between corporate and country sustainability on the cost of bank loans, by looking into 470 loan agreements from 28 countries between 2005 and 2012. They find an economically and statistically significant relationship between country-level sustainability and cost of bank debt: an increase of one unit in a country's sustainability score is associated with an average decrease in the cost of debt by 64 basis points. The effect is mainly caused by the environmental performance, as this is twice as impactful as the social dimension. The conclusion of this paper is in line with the growing trend that recognizes the importance of sustainability in the valuation of asset classes. To measure the level of country sustainability, the Oekom Corporate and Country Rating Criteria is used, which is a rating based on 100 social and environmental criteria. Gianfrate et al (2021) mention that a

limitation of this sustainability measure is that it provides only a single rating and does lend itself to separating positive and negative performance.

Kapraun and Scheins (2019) argue that green credibility, as measured by, among others, characteristics of the issue country, might be relevant for investors' acceptance of the green label of a green bond. In their research, the effect of overall sentiment towards environmental trends and sustainability efforts in the corresponding issue country is measured by the Environmental Performance Index (EPI) developed at Yale University. As mentioned earlier, in their research, Kapraun and Scheins (2019) found a green premium and concluded that this premium is, as expected, largely determined by the green credibility of the corresponding bond and its issuer. They find that when the green bond is issued in a country with high national environmental standards, green bonds trade with a lower yield (-6 bps), and thus with a higher greenium. This would imply that in countries with high overall sustainability efforts, investors are willing to pay more for an environmentally friendly bond.

These findings are consistent with the view of Zerbib (2019), as he argues that the impact of pro-environmental preferences on bond prices can be isolated by comparing the pricing of a green bond to its similar non-green counterpart. The bonds are subject to the same financial risk once all their differences have been controlled. The effect of pro-environmental preferences can therefore most likely be measured trough a green bond premium.

To determine a countries' level a sustainability, a proxy is used which is elaborated on in section 3.3.1. Such a proxy is based on a country's sustainability efforts. Liang and Renneboog (2017) highlight an interesting determinant of the level of country sustainability. By examining 23,000 companies from 114 different countries, they find that the differences in corporate social responsibility ratings (CSR) across countries can be explained by a country's legal origin. A country's legal origin namely shapes country-level institutions and the firm-level contracting environment. In addition, a country's legal regime shapes the contracts between shareholder and other stakeholders through its effect on governance structures and the decision-making process. The two major legal systems are the common law system and the civil law system. A country with a common law system supports private market outcomes, places fewer restrictions on managerial behavior and favors shareholder protection. On the contrary, countries with a civil law system are characterized by state intervention in economic life through rules and regulations and a stakeholder view. Liang and Renneboog (2017) find that firms with a common

law origin score significantly lower on various CSR ratings than civil law firms. It appears that firms from the Scandinavian legal regime obtain the highest scores on most of the CSR ratings. French legal system has the second highest CSR ratings and the German and English origins the lowest. These findings are interesting for the research conducted in this paper, as it can partly explain why some countries have unexpected values of the level of country sustainability. This is elaborated on in section 3.3.2, in which all the countries including their sustainability score and legal system are listed.

The results in previous literature regarding the influence of country sustainability on the green bond premium suggest that the pricing of green bonds is most likely to be affected by country-level factors. In addition, as not much literature has been done regarding this topic, further investigation of the factors influencing the relationship between sustainability and the cost of debt is desirable. Based on the described previous literature, a negative relationship between sustainability and the green bond yield is expected and thus also a positive effect of country sustainability on the green bond premium. This makes sense as we would expect a higher willingness to pay of investors for sustainability, when the level of country sustainability is higher, as the perceived green-credibility is higher. This leads to the second hypothesis:

*H2: The green bond premium does not increase when country-sustainability increases*

To conclude, two hypotheses are established in this chapter, with the goal to be rejected in the remaining of the paper. In the next chapter, the methodology and data used to test the hypotheses will be discussed.

# 3. Data and Methodology

This section explains how the data used in this research is collected. In addition, a short summary of the data is provided. To analyze the collected data, a matching methodology is used, which will also be described extensively in this section. Finally, the methods and data used to test for the relationship between country sustainability and the yield differential are discussed. This entails a description of the Environmental Performance Index, an explanation of the high- and low-EPI category in the sample and, finally, a description of the regression analysis.

## 3.1 Green Bonds Dataset

For this research, a dataset with green bonds from the period of January 2013 until February 2021 is collected, which is extracted from the Bloomberg database. Only bonds labeled as "green bonds" are selected. This implies that in Bloomberg the "green bond indicator" should be "yes". Bloomberg provides important characteristics of green bonds, such as the amount issued, currency, maturity, coupon and credit rating. The raw dataset of green bonds contains 3909 green bonds.

For this research, the yield is needed in order to determine the pricing differential of the green bond relative to its brown counterpart. This yield is found by collecting the monthly prices of the green bonds with the Bloomberg Historical Data tool. These prices are merged with the green bond dataset, which results in a panel dataset including bonds and monthly yields over a period of 97 months, from January 2013 to February 2021. Not all bonds include prices in each month, as bonds might be issued after January 2013. However, no bond is already matured in February 2021. Only green bonds in months with non-missing values of yields are kept in the dataset, as this variable is necessary to answer the hypotheses.

## 3.2 Matching Methodology

In this paper, a matching methodology is used to study the pricing of green bonds. This method is chosen instead of a regression on suitable specification, because otherwise independent variables likely to explain bond spreads should be fully determined while ensuring the robustness of the specification. Matching green bonds to their similar ordinary bond provides a method that can substitute for the regression method, to determine the pricing differential, as most of the factors explaining the yield are identical for the matched bonds. The

only effective difference between a green bond and a non-green bond is the use of proceeds and the yield. This method is based on the matching methodology, or also known as a model-free approach, of Zerbib (2019). A green bond should be matched to a pair of securities with the same properties, except for the property whose effect is researched, in this case the yield. These matched bonds will be called “brown bonds” or “conventional bonds” in the remaining of this paper.

To obtain a dataset which consists of green bonds matched to their equivalent brown counterpart, the first step is to collect a dataset with potential brown bonds. These bonds are also collected from the Bloomberg database, similar to the green bonds dataset. Due to data collection restrictions, only European brown bonds could be collected from the Bloomberg database, so this limits the sample to only European green and brown bonds. In addition, the yields of the brown bonds are collected from the Bloomberg Historical data tool and are merged to the brown bond dataset. All months and bonds with missing yield values are again removed from the dataset.

The next step is to match the green bond with its brown equivalent using Zerbib’s (2019) matching methodology. A conventional bond needs to be found for each green bond with the closest maturity from the same issuer and having exactly the same characteristics, namely the same currency ratings, bond structure, seniority collateral and coupon type. To do this, the potential brown bonds are matched to the green bond dataset based on issuer and month level, as the green bond premium should be calculated for each bond, in each month. This results in green bonds being matched to multiple potential brown bonds.

Next, the most similar brown bond needs to be selected, such that each green bond is paired with its equivalent conventional bond. Several conditions are applied to remove brown bonds from the dataset that deviate too much in characteristics from the green bond. Firstly, the currency of the green and the brown bond should be the same, so bonds where these currencies do not match are removed from the sample. Secondly, only conventional bonds are kept in the sample that have a maturity that is neither two years shorter nor two years longer than the green bond’s maturity. Thirdly, the liquidity is accounted for. The liquidity of the green and brown bond is never equal, so a difference exists. However, this difference must be limited, as it can have effect on the yield level. To safeguard a fair approximation, several conditions must hold regarding the liquidity. The matched brown bond should have an issue amount of less than four

times the green bond's issue amount and greater than one-quarter of this amount. In addition, the matched brown bond should have an issue date that is at most six years earlier or six years later than the green bond's issue date. Finally, the bond with the closest maturity is selected. If there are still multiple potential brown bonds for a green bond, this implies that these brown bonds have the same (closest) maturity. In this case, the brown bond with the closest liquidity is selected as the brown counterpart.

This matching process of green and brown bonds results in a panel dataset with 223 EU corporate green bonds over a period of 97 months (from November 2013 to February 2021), including a similar brown counterpart. The descriptive statistics can be found in table 1. Note that the variables 'ask yield' and 'issue amount' for as well the green as the brown bonds are Winsorized at the top and bottom at 1 percentile to minimize the influence of outliers. The table shows that the maturity of the green and brown bond is almost similar. The green bond maturity is slightly higher (3.95 years) than the brown bond yield (3.80 years), but this indicates that the matching procedure was accurate, as this difference is only small. In addition, the issue amount of the green bonds is slightly lower (0.62 billion US Dollar) than the brown bonds issue amount (0.75 US Dollar). This also indicates that the matching based on liquidity was accurate, as the issue amounts do not differ largely.

**Table 1.** *Descriptive statistics of the 223 green and matched brown bonds in the sample.* This table reports the distribution of the several of the most important variables in all 223 pairs of bonds in the sample. The number of months per bond is the lengths of the time series for each pair of bonds. In addition, the distribution of the ask yield, the bond maturity, issue amount and coupon is provided. This allows to compare and determine the accuracy of the matching procedure.

| | Min | 1st Quart | Median | Mean | 3rd Quart | Max |
|---|---|---|---|---|---|---|
| # Months per bond | 2 | 7 | 15 | 21 | 31 | 87 |
| Ask yield of the green bond | -0.57 | -0.07 | 0.22 | 0.34 | 0.65 | 2.21 |
| Ask yield of the brown bond | -0.57 | -0.10 | 0.21 | 0.36 | 0.68 | 2.32 |
| Green bond maturity on 1 May 2021 (years) | -0.95 | 1.52 | 3.41 | 3.94 | 5.55 | 18.82 |
| Brown bond maturity on 1 May 2021 (years) | -1.29 | 1.72 | 3.43 | 3.80 | 5.72 | 17.87 |
| Green bond issue amount (USD bn) | 0.002 | 0.31 | 0.57 | 0.62 | 0.84 | 1.90 |
| Brown bond issue amount (USD bn) | 0.01 | 0.29 | 0.68 | 0.75 | 1.09 | 2.58 |
| Green bond coupon | 0 | 0.38 | 0.75 | 0.86 | 1.13 | 3.50 |
| Brown bond coupon | 0 | 0.63 | 1.25 | 1.86 | 2.50 | 7.13 |

In appendix 1, a list of the issuing companies in the sample can be found, including the number of green bonds issued per company. In addition, in appendix 2A and 2B a frequency plot of the issue year and the maturity year of the green bonds in the sample is provided.

Finally, the yield differential can be determined in order to test the first hypothesis, *green bonds are not traded at a premium in comparison to their equivalent brown bond*. The yield differential (green bond premium, $\Delta\tilde{y}_{i,t}$) is the difference between the green bond yield ($y_{i,t}^{GB}$) and the equivalent conventional bond yield ($y_{i,t}^{CB}$):

$$\Delta\tilde{y}_{i,t} = y_{i,t}^{GB} - y_{i,t}^{CB}$$

To test for heterogeneity in the green bond premium, it is tested whether the green bond premium differs in various sectors, for different credit ratings, in different years and for different issue amounts. Based on these results it can be concluded whether the first hypothesis, *green bonds are not traded at a premium in comparison to their equivalent brown bond*, holds for which groups. The sample is split up in groups based on the tested market segment, time period or type of bond, and the green bond premium is again determined in each sub-group, on the same method as described above.

### 3.3 Testing for Country Sustainability

#### *3.3.1 The Environmental Performance Index*

To measure the level of sustainability in the country of issuance of the green bonds, the Environmental Performance Index (EPI) is used. This index provides a data-driven summary of the state of sustainability around the world. It ranks 180 countries on environmental health and ecosystem vitality, using 32 performance indicators across 11 issue categories (Wendling et al, 2020). The indicators used to develop the EPI provide a determination at a national scale of how close countries are to established environmental policy targets. It could also be used as a practical guidance for countries that aspire to move toward a sustainable future (Wendling et al, 2020). In 2020, the top three countries were Denmark, Luxembourg and Switzerland, with a score of approximately 80 out of 100, while Liberia, Myanmar and Afghanistan were at the bottom with a score around 25 out of 100. Low scores on the EPI indicate the need for national sustainability efforts with regard to several major environmental issues such as the improvement of air quality and reduction of greenhouse gas emissions. In appendix 3, a graphical overview of the rankings in the 2020 Environmental Performance Index for the 180 countries can be found.

### *3.3.2 High- and Low-EPI Category*

To test the second hypothesis, *the green bond premium does not increase when country-sustainability increases*, the EPI is collected for all the countries in the sample. The first stage in testing this hypothesis, is comparing all the countries' EPI scores and green bond premia. Is there a higher green bond premium for countries with a high EPI score? This can be roughly determined by analyzing the descriptive of the green bond premium and the EPI score for each country. However, to further analyze the relationship more tests need to be done. Therefore, secondly, the sample of green bonds is split up in two groups based on the countries' EPI. In table 2, the countries present in the sample of green bonds are shown including their EPI score. The sample consists of bonds issued in 14 different countries, of which 13 are European countries and the other country is the United States. Note that this bond is issued by an American company (Digital Euro Finco LLC), but it is EU endorsed. The green bond is only offered in Europe and is not sold in the United States. This is the reason why it is included in the sample. The mean EPI score of the sample is 77.4 and the median is 77.2. To split the sample in two equal groups, the sample is divided based on whether the EPI score is higher or lower than 78. This results in two groups of 7 countries: the first group contains all the bonds issued in countries with an EPI lower than 78 and the second group contains bonds issued in countries with an EPI higher than 78. It is then tested whether the yield spread differs in these groups. A t-test can be performed, to check whether the yield difference between the mean yield in the high-EPI category and yield in the mean in the low-EPI category is significantly different from zero. Based on these results, it can be concluded whether the green bond premium is higher in high-EPI countries than low-EPI countries.

**Table 2:** *EPI Scores.* This table reports the countries in which the 223 green bonds in the sample are issued, including the EPI score and the legal origin of the country. The countries are separated in either the high-EPI category, when the EPI is higher than 78, or low-EPI category, when the EPI is higher than 78. The number of green bonds per country are also reported.

| Rank | Country | EPI | Category | Legal Origin | #GB |
|---|---|---|---|---|---|
| 1 | Denmark | 82.5 | High | Scandinavian | 1 |
| 2 | Luxembourg | 82.3 | High | French | 2 |
| 3 | United Kingdom | 81.3 | High | English | 3 |
| 4 | France | 80 | High | French | 40 |
| 5 | Austria | 79.6 | High | German | 3 |
| 6 | Finland | 78.9 | High | Scandinavian | 4 |
| 7 | Sweden | 78.7 | High | Scandinavian | 9 |
| 8 | Norway | 77.7 | Low | Scandinavian | 5 |
| 9 | Germany | 77.2 | Low | German | 102 |
| 10 | Netherlands | 75.3 | Low | French | 31 |
| 11 | Spain | 74.3 | Low | French | 9 |
| 12 | Belgium | 73.3 | Low | English | 1 |
| 13 | Italy | 71 | Low | French | 12 |
| 14 | United States | 69.3 | Low | English | 1 |
| | Mean | 77.4 | | | |
| | Median | 77.2 | | | |

When examining the low- and high-EPI category more closely, there are some unexpected countries in the low-EPI category. For example, the Netherlands is generally perceived as a country which pursues a high amount of sustainability efforts but is categorized in the low-EPI group. Firstly, this is due to the fact that the sample consists of countries with overall high EPI values. European countries generally have high EPI scores and within this group, the Netherlands has a relative low score. Secondly, based on the findings of Liang and Renneboog (2017), it can be concluded that the legal origin of a country influences the EPI score. Therefore, the legal origin of each country is retrieved from the article of Liang and Renneboog (2017) and is presented in table 2. As the Scandinavian legal system supports high EPI scores, this explains the ranking of those countries in the top 8. As the French Common Law system is not that supportive on sustainability efforts, this could explain the placement of the Netherlands on the 10$^{th}$ place.

### *3.3.3 Regression Analysis*

Besides the methodology described in section 3.3, the second hypothesis, *the green bond premium does not increase when country-sustainability increases*, can also be tested by regressing the green bond premium against the Environmental Performance Index (EPI). The regression can determine whether a change in the EPI will lead to a significant change in the green bond premium. The following Ordinary Least Squares regression model is developed:

$$Green\ bond\ premium = \beta_0 + \beta_1 EPI + \varepsilon$$

In this regression, the dependent variable is the '$green\ bond\ premium$', which is the difference between the yield of the green bond and its non-green counterpart, as described in section 3.2. The '$EPI$' is the Environmental Performance Index is the proxy for the level of country sustainability and is the independent variable in this regression. In section 3.3 this variable is thoroughly discussed. In table 7, the descriptive statistics and the correlation matrix of the variables in the regression analysis are provided.

**Table 3.** *Descriptive statistics and correlation matrix of the variables in the regression analysis.* This table shows the correlation of the variables in the regression, namely the green bond premium and the Environmental Performance Index. In addition, the minimum, mean and maximum for these variables is shown. Note that the correlation is not higher than 0.9 in absolute value, so no multicollinearity exists.

| Variables | Min | Mean | Max | (1) | (2) |
|---|---|---|---|---|---|
| (1) Green bond premium | -2.41 | -0.014 | 2.47 | 1.000 | |
| (2) EPI | 69.3 | 77.40 | 82.5 | -0.141 | 1.000 |

For the regression model, the OLS assumptions are sufficient. Normality is checked by the Jarque-Bera test, which lead to the conclusion that all variables are not normally distributed. This violates one of the OLM assumptions, but this assumption is optional. Collinearity is checked by analyzing the correlation matrix and it is concluded that no correlation is higher than 0.9, so no multicollinearity exists. In addition, the variance inflation factor is around 1, which does not indicate collinearity. Finally, the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity is performed, which concluded that there is heteroskedasticity. Therefore, robust standard errors are applied in the regression analysis.

To account unobserved factors in the regression, a fixed effects model is added to the regression, to account for time fixed effects. This is necessary, as it could be the case that the greenium or the EPI increases over time. By including these fixed effects in the regression, there is more focus on the cross-sectional variation, so the variation between countries. It reduces the change on biased results. Fixed effects are tested by using the least squares dummy variable model. One dummy variable is generated for each month, thus controlling for heterogeneity between months.

# 4. Results

This section will discuss the results of the research. Firstly, the results regarding the existence of a green bond premium are provided, as well as the variation of this premium across sectors, credit ratings, years and issue amounts. Next, the results regarding the effect of country sustainability on the green bond premium are given, which is divided in three parts. Firstly, the difference between the green bond yield and the brown bond yield is provided for each country. Next, the difference between the green bond premium in the high- and low-EPI category is provided. Finally, the results of the regression analysis between the green bond premium and the Environmental Performance Index are shown.

## 4.1 Green Bond Premium

To test the first hypothesis, *green bonds are not traded at a premium in comparison to their equivalent brown bond,* the green bond premium is determined. The yield differential is received from the matching methodology described in the previous section and is presented in table 4 and 5. As can be seen in these tables, the green bond yield (0.34) is slightly lower than the brown bond yield (0.36). This implies that there is a small negative green bond premium of -1.4 bps, which is significantly different from zero at the 5% level. The distribution of the green bond premium ranges from -241 bps to +247 bps with a mean and median value of -1.4 bps and -0.7 bps, respectively. A graphical format of the distribution of the green bond premium can be found in appendix 4.

**Table 4.** *Green bond premium in the entire sample.* This table shows the mean and median of the ask yield for the green bonds and the matched brown bonds in the sample. The two rows at the bottom show mean and median, including the p-value, for the difference between the green and brown bond ask yield. This is the so called 'greenium'. The p-value is the result of a t-test and a quantile regression, for which I test when the null hypothesis that the greenium is equal to zero ($H_0$: $greenium = 0$) can be rejected. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

| | Ask yield | | |
|---|---|---|---|
| | # GB | Mean | Median |
| Green bond | 223 | 0.34 | 0.22 |
| Brown Bond | 223 | 0.36 | 0.21 |
| Difference | | -0.014** | -0.007*** |
| p-value (difference) | | 0.015 | 0.000 |

**Table 5.** *Distribution of the green bond premium.* This table summarizes the distribution of the green bond premium in the full green bond sample.

| Min | 1st Quart | Median | Mean | 3rd Quart | Max |
|---|---|---|---|---|---|
| -2.413 | -0.138 | -0.007 | -0.014 | 0.103 | 2.467 |

To determine heterogeneity in the green bond premium, the green bond premium is determined in different sectors, for different credit ratings, in different years and for different groups of issue amounts. The results can be found in table 6.

**Table 6.** *Green bond premia in different market segments.* This table shows the mean and median of the green bond premia in several sectors, for several credit ratings, for different years and for different groups of issue amounts. Note that the issue amount is provided in billion US Dollars. The groups are formed based on the distribution provided in table 1. In addition, the table shows the p-values for which we can reject the null hypothesis that the mean greenium is equal to zero ($H_0$: $greenium = 0$) and the number of green bonds in each sector, for each credit rating, in each year and for each group of bonds with a certain issue amount. A t-test for matched pair is used. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

| | | Greenium | | | |
|---|---|---|---|---|---|
| | | Mean | Median | p-value | # GB |
| Total | | -0.01** | 0.01 | 0.016 | 223 |
| Sector | Communications | -0.11*** | -0.11 | 0.000 | 2 |
| | Consumer Discretionary | -0.15*** | -0.09 | 0.000 | 3 |
| | Financials | -0.01** | -0.02 | 0.044 | 175 |
| | Health Care | -0.07*** | -0.05 | 0.000 | 1 |
| | Industrials | 0.14*** | 0.11 | 0.000 | 4 |
| | Materials | 0.004 | -0.06 | 0.685 | 2 |
| | Utilities | -0.001 | -0.01 | 0.853 | 36 |
| Credit rating | AAA | 0.03*** | 0.05 | 0.000 | 4 |
| | AA | -0.05*** | -0.01 | 0.001 | 2 |
| | AA- | 0.05*** | 0.02 | 0.005 | 7 |
| | A+ | -0.19*** | -0.09 | 0.000 | 7 |
| | A | -0.08** | 0.05 | 0.021 | 11 |
| | A- | -0.02 | -0.01 | 0.500 | 15 |
| | B+ | 0.00 | -0.07 | 0.685 | 2 |
| | BBB | 0.22*** | 0.06 | 0.000 | 24 |
| | BBB+ | 0.04*** | 0.005 | 0.000 | 21 |
| | BBB- | 0.05 | -0.10 | 0.252 | 6 |
| | No rating | -0.08*** | -0.04 | 0.000 | 124 |
| Year | 2013 | 0.01 | 0.01 | 0.213 | 1 |
| | 2014 | 0.08*** | 0.11 | 0.000 | 4 |
| | 2015 | -0.04** | -0.02 | 0.032 | 11 |
| | 2016 | -0.06** | -0.02 | 0.035 | 19 |
| | 2017 | -0.06*** | -0.06 | 0.000 | 41 |
| | 2018 | -0.06*** | -0.05 | 0.000 | 67 |
| | 2019 | -0.01 | -0.01 | 0.514 | 119 |
| | 2020 | 0.01 | -0.001 | 0.279 | 223 |
| | 2021 | -0.04* | -0.01 | 0.067 | 223 |
| Issue amount (bn$) | >0.84 | 0.05*** | 0.02 | 0.000 | 65 |
| | 0.57-0.84 | 0.05*** | 0.01 | 0.000 | 52 |
| | 0.53-0.57 | 0.09*** | 0.03 | 0.000 | 22 |
| | <0.53 | -0.18*** | -0.12 | 0.000 | 108 |

Firstly, regarding the different sectors, it appears that in the Communications, Consumer Discretionary, Financials and Health Care sector there exists a negative green bond premium, which is significantly different from zero at either the 1% or the 5% level. This implies that in these sectors there is a willingness to pay of investors for green investments. However, in the Industrials sector a positive yield differential exists, indicating a green bond discount, which is

significantly different from zero at the 1% level. This implies that in the Industrials sectors investors are not likely to sacrifice return for environmentally friendly investments. In the Utilities and Materials sector, the green bond premium is not significantly different from zero.

Secondly, looking at the green bond premia for different credit ratings, results vary. AA and A+ green bonds show a significant -5 bps and -19 bps premium, respectively, while the AAA and AA- bonds show a significant positive yield differential of +3 bps and +5 bps, respectively. The BBB and BBB+ and green bonds all have a significant positive yield differential, of +22 bps and +4 bps respectively. However, the majority of the green bonds in the sample (124/223) do not have a credit rating. Those exhibit a green bond premium of -8 bps, which is significantly different from zero at the 1% level.

Next, examining the results regarding the yield difference in various time periods, it can be seen that most yield differentials are significant and negative, except for the year 2013, 2014, 2019 and 2020. In the year 2014, the yield differential is +8 bps which is significantly different from zero. In the years 2013, 2019 and 2020 the yield differential is not significantly different from zero.

Finally, regarding the variation in the green bond premium for different issue amounts, it appears that only for bonds with an issue amount smaller than 530 million US Doller, the green bond premium exists. Bonds with an issue amount smaller than 530 million US Dollar namely show a green bond premium of -18 bps, which is significantly different from zero at the 1% level. In all the categories of issue amounts with bonds larger than 530 million US Dollar, a green bond discount of either +5 or +8 bps exists, which are all significant at the 1% level. This result indicates that the willingness to pay of investors for green investments mainly exists for green bonds smaller than 530 million, while investors in larger bonds do not want to sacrifice some of their return for green investments.

The green bond premium of -1.4 bps found in the entire sample of this research is consistent with the findings of Zerbib (2019), who found also found a small albeit significant green bond premium of -1.8 bps, who also used the same matching methodology. In addition, the heterogeneity in this green premium presented in table 6, is similar to a recent research of Actiam (2021). The article states that mainly green bonds with no credit rating and an issue amount lower than 500 million Euros have a higher change of a green bond premium, which is

confirmed by the results in table 6. This might be due to the fact that these bonds are less regulated and more prone to oversubscriptions. On the other hand, Kapraun and Scheins (2019), found in their research that particularly large green bonds that are high in demand trade at lower yields than midsize and small green bonds, which is contradicting to the findings in table 6. Furthermore, Kapraun and Scheins (2019) argue that corporate green bonds have on average higher yields, as they suffer from worse valuation of the green label on the secondary market. They state that this depends on the perceived 'green-credibility' of the bond and its issuer. 'Green-credibility' is influenced by the level of sustainability of a country. It will be tested in the next section, whether the yields of the bonds in the sample are influenced by the level of country sustainability, and thus whether this statement is supported by the data of this research.

To summarize this section regarding the green bond premium, it can be stated that the first hypothesis, *green bonds are not traded at a premium in comparison to their equivalent brown bond,* can be rejected when looking at the entire sample. The results show that green bonds do trade at a premium, which is significantly different from zero. This indicates a willingness to pay for investors and a trust in the green bond market. In the entire sample of green bonds, the bond yield is 1.4 bps lower than the bond yield of an equivalent brown. The lower the bond yield, the higher the price of the bond, which will save the issuer money, but will be more costly for the investor. In addition, the results also show that the green bond premium particularly exists in certain sectors, namely the Communications, Consumer Discretionary, Financials and Health Care sectors, which implies that the first hypothesis can particularly be rejected in these sectors. This indicates that in these sectors the demand for green investments is high and there is a willingness to pay of investors. In addition, the premium is mainly present for green bonds with no credit rating and an issue amount larger than 530 million US Dollar.

### 4.2 Effect of Country Sustainability

The second hypothesis, *the green bond premium does not increase when country-sustainability increases*, was tested by three approaches. The first approach compared the green bond premia in different countries. The results of this approach are elaborated on in the first section. Secondly, the sample is split up in two groups, the high-EPI and the low-EPI category, and it is tested whether the green bond premium in these two categories differs significantly. In the final section, the results of the regression analysis are displayed, which checked whether

the Environmental Performance Index influences the green bond premium. The results of the fixed regression analysis including the fixed effects are also presented.

### *4.2.1 Green Bond Premium Across Countries*

To test the second hypothesis, *the green bond premium does not increase when country sustainability increases*, the difference between the green bond yield and the brown bond yield is determined for each country. Table 7 reports the different green bond premia for all the countries in the sample. The table shows that all countries in the category high-EPI have a negative yield differential, ranging from -70 bps to -0.1 bps, except for Denmark and Luxemburg. All means of the green bond premia in the high-EPI category are significantly different from zero, except for The United Kingdom and Sweden. Furthermore, all countries in the category low-EPI have a positive yield differential, ranging from 2 bps to 38 bps, except for The Netherlands and Belgium. All the green bond premia in the low-EPI category are significantly different from zero at the 1% level.

**Table 7.** *Green bond premium per country including EPI.* This table shows the countries in the sample, including their EPI and in which category the country is ranked (either High or Low). The table also reports the green bond ask yield, the matched brown bond ask yield and the green bond premium for each country. In addition, the table shows the p-values for which we can reject the null hypothesis that the mean greenium in each country is equal to zero ($H_0$: $greenium = 0$). A t-test for matched pair is used. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

| | | | | Ask yield mean | | Greenium | | | |
|---|---|---|---|---|---|---|---|---|---|
| | H/L | | EPI | Green bond | Brown bond | Mean | Median | p-value | # GB |
| Total | | | 77.40 | 0.34 | 0.36 | -0.01** | -0.01 | 0.016 | 223 |
| Country | H | Denmark | 82.5 | 0.69 | -0.24 | 0.92*** | 0.82 | 0.000 | 1 |
| | H | Luxemburg | 82.3 | 0.61 | 0.41 | 0.20*** | 0.07 | 0.000 | 2 |
| | H | United Kingdom | 81.3 | 0.45 | 0.45 | -0.01 | 0.00 | 0.605 | 3 |
| | H | France | 80 | 0.42 | 0.51 | -0.09*** | -0.04 | 0.000 | 40 |
| | H | Austria | 79.6 | 0.27 | 0.97 | -0.70*** | -0.90 | 0.000 | 3 |
| | H | Finland | 78.9 | 0.24 | 0.36 | -0.12*** | -0.07 | 0.000 | 4 |
| | H | Sweden | 78.7 | 0.45 | 0.45 | -0.001 | 0.01 | 0.907 | 9 |
| | L | Norway | 77.7 | -0.08 | -0.10 | 0.02*** | 0.03 | 0.000 | 5 |
| | L | Netherlands | 75.3 | 0.43 | 0.45 | -0.02*** | -0.01 | 0.008 | 31 |
| | L | Germany | 77.2 | 0.13 | 0.08 | 0.05*** | -0.01 | 0.001 | 102 |
| | L | Spain | 74.3 | 0.47 | 0.33 | 0.14*** | 0.06 | 0.005 | 9 |
| | L | Belgium | 73.3 | 0.29 | 0.37 | -0.08*** | -0.08 | 0.000 | 1 |
| | L | Italy | 71 | 0.66 | 0.50 | 0.16*** | 0.06 | 0.000 | 12 |
| | L | United States | 69.3 | 0.91 | 0.53 | 0.38*** | 0.39 | 0.000 | 1 |

### *4.2.2 Green Bond Premium in High- and Low-EPI Category*

The second method to test the second hypothesis, *the green bond premium does not increase when country-sustainability increases*, compares the difference between the mean green bond premium in the high-EPI category and the mean green bond premium in the low-EPI category. Table 8 shows these means for both categories. It appears that the mean ask yield differential in high EPI countries is -9 bps and is significantly different from zero at the 1%. On

the contrary, the mean ask yield in countries with a low EPI is +4 bps and is also significantly different from zero at the 1% level. These results are in line with the results in table 7, as in both tables the yield differential is (mostly) negative for countries with a high-EPI, which indicates that in countries with high levels of sustainability, green bonds trade with a premium. This indicates that in countries who pursue relatively more sustainable efforts, the willingness to pay of investors is larger, as they are willing to accept a lower yield. On the other hand, in countries with a lower EPI, green bonds (mostly) trade at a discount as the yield differentials for these countries are positive. This implies that in those countries, investors are not willing to sacrifice return to invest in a green investment. To further investigate this relationship, the results of a regression analysis between the green bond yield differential and the EPI are discussed in the next section.

**Table 8.** *Differences in green bond premium for the high- and low-EPI category.* This table shows the green bond ask yield, the matched brown bond ask yield and the green bond premium in each EPI category. In addition, the table shows the p-values for which we can reject the null hypothesis that the mean greenium in each category is equal to zero ($H_0: greenium = 0$). A t-test for matched pair is used. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

| | Ask yield for high EPI countries | | | Ask yield for low EPI countries | | |
|---|---|---|---|---|---|---|
| | Obs. | Mean | Median | Obs. | Mean | Median |
| Green bond | 62 | 0.41 | 0.29 | 161 | 0.30 | 0.17 |
| Brown Bond | 62 | 0.50 | 0.37 | 161 | 0.26 | 0.12 |
| Difference | | -0.09*** | -0.03*** | | 0.04*** | 0.04*** |
| p-value (difference) | | 0.00 | 0.00 | | 0.00 | 0.00 |

### *4.2.3 Influence EPI Using a Regression Analysis*

To further test the second hypothesis, *the green bond premium does not increase when country-sustainability increases*, a regression analysis is performed. The results of the standard model and the model including month fixed effects are presented in table 9. Both regression analyses performed with the data, support the expected negative relationship between the EPI and the green bond yield differential. The EPI coefficient of the standard regression is -0.0259 and is significantly different from zero at the 1% level. If the EPI increases, the green bond yield differential will decrease with 0.0259, which leads to an increase in the green bond premium, as the yield of the green bond will then be lower than the brown bond yield. The R-squared is rather low, which indicates that the green bond premium is only for 2.4% explained by the EPI. Or in other words, the variance of EPI explains only 2.4% of the variance of the green bond premium. For the model including month fixed effects, the coefficient slightly decreases tot -0.0261, but this change is very small. This indicates that the month fixed effects do not influence the results that much, and the variables are not increasing over time. The R-

squared, however, does increase slightly to 3.4% which means that in the model including fixed effects the EPI explains the green bond premium slightly more.

**Table 9**. *Results regression analysis*. This table gives the results of the regression analysis performed, in order to study EPI as determinant of the green bond premium. The EPI is a measure for the level of country sustainability, which is explained is section 3.3. The model including month fixed effects is also presented in the table. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

| | Standard Model | | Including month fixed effects | |
|---|---|---|---|---|
| **Dependent variable: green bond premium** | Coefficient (Std. Dev.) | P-value | Coefficient (Std. Dev.) | P-value |
| Constant | 1.990** (0.881) | 0.024 | 2.059** (0.875) | 0.019 |
| EPI | -0.0259** (0.011) | 0.022 | -0.0261** (0.011) | 0.018 |
| # Observations | 4,625 | | 4,625 | |
| # Bonds | 223 | | 223 | |
| R-squared | 0.024 | | 0.034 | |

Based on these results, it appears that the finding of Kapraun and Scheins (2019) is confirmed. Their finding stated that the green premium is influenced by the 'green-credibility' of the bond and its issuer, which is determined by, among other things, the Environmental Performance Index. They found that when a green bond is issued in a country with high national environmental standards, the green bonds are traded with lower yields, and thus with a higher greenium. This finding is supported by the results of the research conducted in this paper, as the greenium enlarges when the level of country sustainability increases.

To summarize the results regarding the testing of the second hypothesis, *the green bond premium does not increase when country-sustainability increases*, it can be concluded that this hypothesis can be rejected. By comparing the green bond premium in different countries, by comparing the green bond premium in the high-EPI category and the low-EPI category and by performing a regression between the EPI and the green bond premium, it appeared that the green bond premium enlarges when the level of country sustainability increases. This indicates that if a country increases its sustainable efforts, and thus increasing its EPI by one unit, the green bond premium enlarges (becomes more negative) by approximately 3%. This means that investors are willing to give up more return in countries with a higher EPI. A possible reason for this could be that in countries with higher level of country sustainability, the demand for green investments is higher, so high that supply cannot preserve. Investors are keen to invest in green bonds such that they are willing to sacrifice a part of their return. This is beneficial for the issuer, as this saves the issuer money.

# 5. Discussion

The final section of this paper starts with a conclusion of the research, which includes a brief summary of the previous chapters. Next, the limitations of the research are addressed and suggestions for further research are provided. Finally, the practical implications which the results of this research could have are discussed.

## 5.1 Conclusion

We are living in a world where climate change and sustainability are unavoidable topics. The United Nations established goals regarding these topics in the Paris Agreement of 2005. The finance sector can play a significant role in achieving these goals, as funding is needed for projects that stimulate sustainability and combat climate change. For example, green bonds can serve as such means for funding and are a form of debt financing whose proceeds are dedicated to finance environmentally friendly projects. The green bond market is rapidly increasing and will probably keep increasing in the future, as there is still much room to grow. This study focusses on the pricing of corporate green bonds, as contradicting results regarding this topic exists and results can have implications for the future growth of the green bond market. The pricing of green bonds reflects investors preferences, and important implications can be drawn from the price differential between green bonds and their non-green counterpart. Although most literature argues that investors are generally willing to sacrifice some return to hold green bonds, evidence regarding the existence of a green bond premium have been mixed. In addition, the influence of country sustainability on the green bond premium has barely been studied. This research sheds more light on the existence of a green bond premium and aimed to identify the influence of country sustainability on the pricing of green bonds, relative to their equivalent non-green counterpart.

A qualitative analysis was performed, using a sample of 223 corporate European bonds, with yields in the period of November 2013 to February 2021. Those bonds were matched to their equivalent non-green counterpart, using Zerbib's (2019) matching methodology and the yields of these green and non-green bonds were compared. It can be concluded that on average green bonds have slightly lower yields (-1.4 bps) than their equivalent non-green counterpart, and thus trade at a premium. This result indicates that investors are willing to sacrifice some return to hold green bonds, which is also supported by literature (Baker et al. 2018, Zerbib., 2019). It appears that the market values green bonds and there is trust in the green bond market.

In addition, a potential reason for the green bond premium is that the demand for green bonds is increasing harder than the supply of green bonds. There is a growing trend of sustainable investors, which are willing give up some returns to invest in green investments. Moreover, although low, this premium demonstrates investors' appetite for green bond issues and supports the hypothesis that this instrument offers issuers the opportunity to broaden the debtholder base. Finally, from the supervisory authority perspective, while this negative premium underlines a certain buying pressure on green bonds, it does not yet reveal any substantial valuation discrepancy between green and conventional bonds.

Secondly, the Environmental Performance Index was collected for the countries of the bonds and issuers in the sample. By using several approaches, it was tested whether the green bond premium is affected by the level of country sustainability. This study found that in countries with a high Environmental Performance Index (EPI) the yield differential increases to -9 bps and in countries with a low EPI the green bond differential is +4 bps, which implies that green bonds are trading at a discount in low-EPI countries. In addition, a regression was performed and a significant negative relationship with a coefficient of -0.03 is found between the EPI and the green bond premium. This implies that as the Environmental Performance Index increases, the level of country sustainability increases, the green bond differential becomes more negative, thus increasing the green bond premium. These results highlight that the effect of pro-environmental preferences can be measured by the green bond premium. There exists a willingness to pay of investors for green bonds, and this increases in countries with high national environmental standards. Thus, to return to the research question of this paper, *what is the effect of country sustainability on the pricing of green bonds?*, it can be concluded that country sustainability affects the pricing of green bonds, by lowering the yield of the green bond in comparison to its non-green equivalent. This most likely due to the increasing perceived "green-credibility" in countries with high-EPI and therefore a larger demand for green bonds.

### 5.2 Limitations and Further Research

Further research is needed to determine the effects of country sustainability on the pricing of green bonds on a larger scale. In this sample, the green bond dataset only consists of European bonds, with an EPI ranging from 69.3 to 82.5, while it could be very interesting to examine yields when the Environmental Performance Index differs more between countries. For example, including bonds issued in African or Asian countries with a lower EPI, and compare these with the EU green bonds in this sample. However, this research contributes to

the existing literature of climate finance, by analyzing the effects of country sustainability on the pricing of green bonds on a small scale. As this field of study is relatively new and literature is scarce, this research is a foundation for further research. The level of country sustainability could also be measured by other proxies in future research, as this would make the results more robust. In addition, as the green bond market is expected to grow, larger samples could be used in the future.

### 5.3 Practical Implications

As mentioned earlier, the pricing of green bonds can have important implications for the growth of the green bond market. The fact that a green bond premium exists, proves that there is a large demand for green bonds. However, supply cannot keep up with this demand. Therefore, an important practical implication from the issuer point of view, is to start issuing more green bonds in countries with a high sustainability score, to meet de high demand for green bonds. On the other hand, it is necessary for issuers to start issuing green bonds in countries with a low sustainability score. In these countries, investors are not willing to sacrifice return (based on the findings of this paper), which makes it less interesting for issuers to issue bonds in these countries. However, the need for environmentally friendly projects is large, especially in those countries with a low sustainability score, as much can be attained in order to achieve the goals established in the Paris Agreement. However, as a green bond discount exists in countries with low sustainability efforts, government intervention might be necessary to stimulate the growth of the green bond market, as issuers are not saving money by issuing green bonds.

From the investor point of view, an important practical implication is regarding the investor's choice of issuing country when making the decision in which green bond to invest in. It appears that in countries with high sustainability levels the return on green bonds is lower compared to a country with a lower sustainability score. Therefore, if investors have a choice, and the goal is to achieve the highest return, an investor will rather invest in countries with a low sustainability score, as it is not necessary to sacrifice return in order to invest in green bonds in those countries. Moreover, if investors are not just profit-driven but also have other-regarding motives, such as the caring about the environment, investors should also choose to invest in projects issued in countries with a low sustainability score, as the need for environmental projects is large.

## References


Actiam (2021). Greenium: uitruil van rendement en duurzaamheid? Retrieved on 7 June 2021: https://www.actiam.com/nl/beleggingsoplossingen/greenium-uitruil-van-rendement-en-duurzaamheid/

Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability, 11*(4), 1098.

Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018). Financing the response to climate change: The pricing and ownership of US green bonds (No. w25194). *National Bureau of Economic Research.*

Bloomberg. (2020). Why Bonds Good for the Earth Now Carry a 'Greenium'. Retrieved on 22 February 2021, from: https://www.bloomberg.com/news/articles/2020-10-30/why-bonds-good-for-the-earth-now-carry-a-greenium-quicktake

Cheung, Y. L., Tan, W., & Wang, W. (2016). National stakeholder orientation, corporate social responsibility, and bank loan cost. *Journal of Business Ethics, 150*(2), 505-524.

Chiang, J. O. H. N. (2017). Growing the US green bond market. *California State Treasurer, California*.

Climate Bonds Initiative. (2020a). Green Bonds Market Summary – Q3 2020. Retrieved from: https://www.climatebonds.net/system/tdf/reports/cbi_q3_2020_report_01c.pdf?file=1&type=node&id=54810&force=0

Climate Bonds Initiative. (2020b). Green Bond Pricing in Primary Market – Q1-Q2 2020. Retrieved from: https://www.climatebonds.net/system/tdf/reports/cbi-pricing-h1-2020-21092020.pdf?file=1&type=node&id=54353&force=0

Dhaliwal, D., Li, O. Z., Tsang, A., & Yang, G. Y. (2011). Voluntary nonfinancial disclosure and the cost of equity capital: The initiation of corporate social responsibility reporting. *The Accounting Review, 86*(1), 59–100.

Ehlers, T., & Packer, F. (2017). Green bond finance and certification. *BIS Quarterly Review September.*

Gianfrate, G., Schoenmaker, D., & Wasama, S. (2021) Working paper. Retrieved from: https://www.rsm.nl/fileadmin/Images_NEW/Erasmus_Platform_for_Sustainable_Value_Creation/11_04_Cost_of_Capital.pdf

Hachenberg, B., & Schiereck, D. (2018). Are green bonds priced differently from conventional bonds? *Journal of Asset Management*, *19*(6), 371-383.

Hoepner, A., Oikonomou, I., Scholtens, B., & Schröder, M. (2016). The effects of corporate and country sustainability characteristics on the cost of debt: An international investigation. *Journal of Business Finance & Accounting, 43*(1-2), 158-190.

Hong, H., Karolyi, G. A., & Scheinkman, J. A. (2020). Climate Finance. *The Review of Financial Studies*, *33*(3), 1011–1023.

Nanayakkara, M., & Colombage, S. (2019). Do investors in Green Bond market pay a premium? Global evidence. *Applied Economics*, *51*(40), 4425-4437.

Nauman, B. (2021). Analysts expect as much as $500bn of green bonds in bumper 2021. *Finacial Times*. Retrieved from: https://www-ft-com.eur.idm.oclc.org/content/021329aa-b0bd-4183-8559-0f3260b73d62

Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*.

Kapraun, J., & Scheins, C. (2019, March). (In)-Credibly Green: Which Bonds Trade at a Green Bond Premium?. In Proceedings of Paris December 2019 Finance Meeting EUROFIDAI-ESSEC.

Karpf, A., & Mandel, A. (2017). Does it Pay to Be Green? *Unpublished working paper. Pantheon-Sorbonne University*.

Karpf, A., & Mandel, A. (2018). The changing value of the ‘green’ label on the US municipal bond market. *Nature Climate Change, 8*(2), 161-165

Larcker, D. F., & Watts, E. M. (2019). Where's the greenium? *Journal of Accounting and Economics, 69*(2-3), 101312.

Liang, H., & Renneboog, L. (2017). On the foundations of corporate social responsibility. *The Journal of Finance*, *72*(2), 853-910.

Park, S. K. (2018). Investors as regulators: green bonds and the governance challenges of the sustainable finance revolution. *Stan. J. Int'l L., 54,* 1.

Preclaw, R., & A. Bakshi (2015). The Cost of Being Green. *Tech. rep., Barclays research.*

Slimane, M. B., Da Fonseca, D., & Mahtani, V. (2020). Facts and Fantasies about the green bond premium.

Wendling, Z. A., Emerson, J. W., de Sherbinin, A., Esty, D. C., et al. (2020). 2020 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy. epi.yale.edu

Zerbib, O. D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance*, *98*, 39-60.

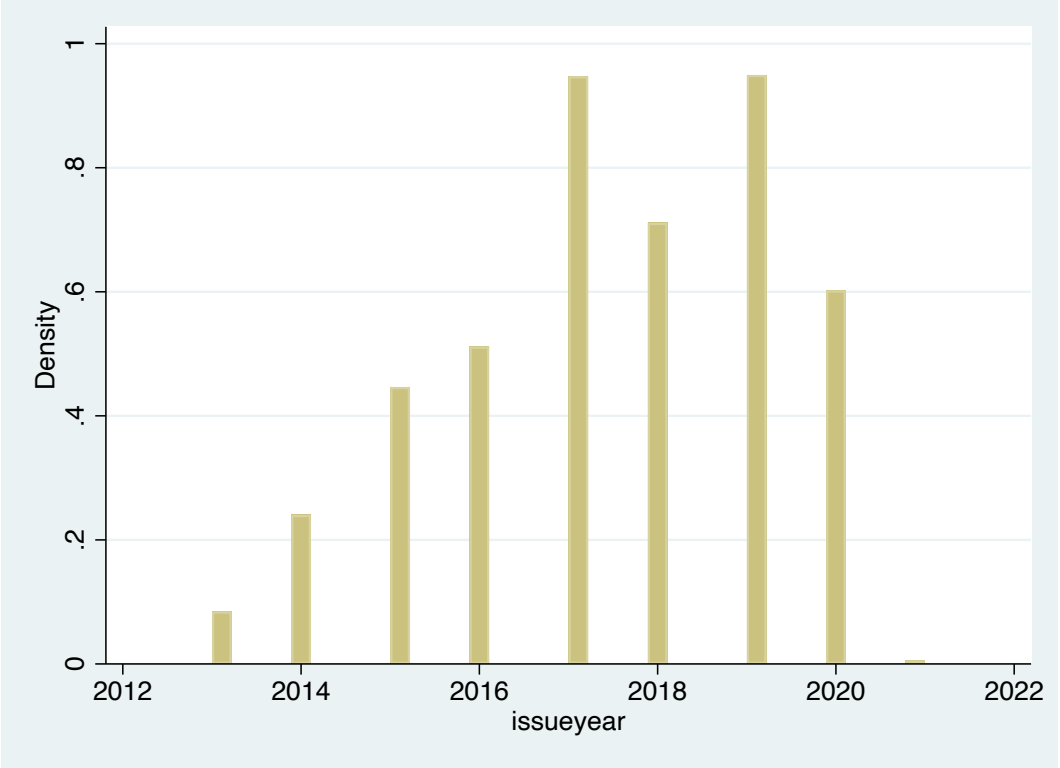
# Appendix

**Appendix 1**: List of issuers including number of green bonds

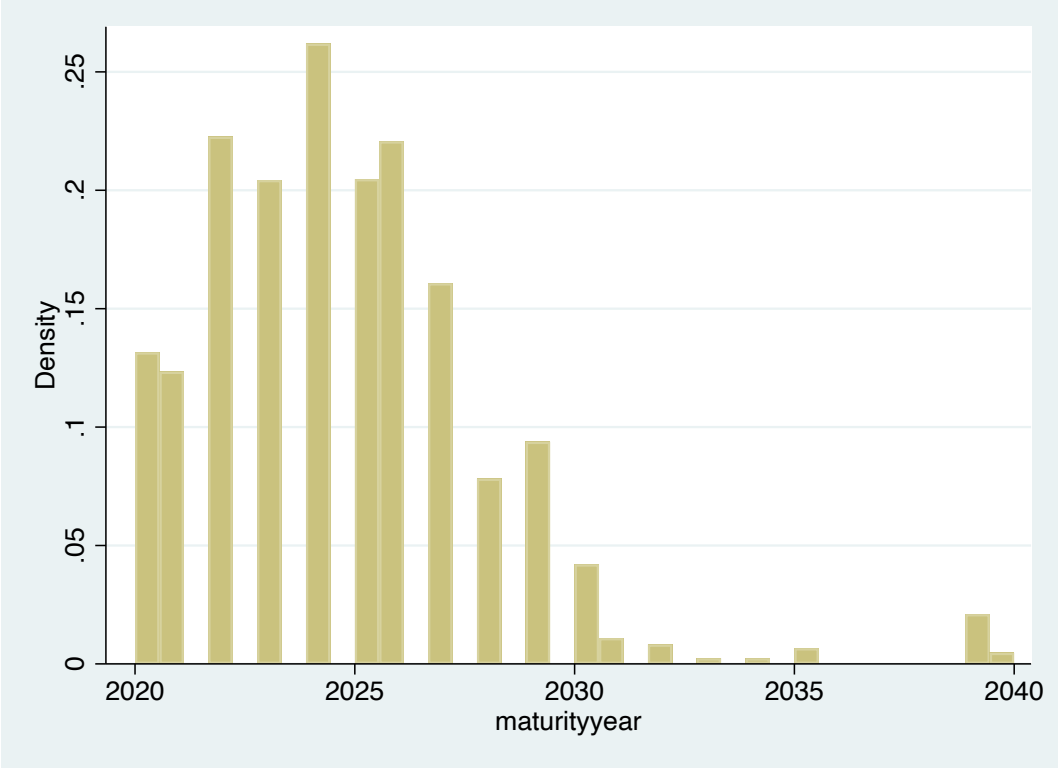
| Issuer Name | # GB |
|---|---|
| A2A SpA | 1 |
| ABN AMRO Bank NV | 4 |
| ACCIONA Financiacion Filiales SA | 1 |
| ALD SA | 1 |
| Assicurazioni Generali SpA | 1 |
| BNP Paribas SA | 3 |
| BPCE SA | 2 |
| Banco Bilbao Vizcaya Argentaria SA | 2 |
| Banco Santander SA | 2 |
| Bankinter SA | 1 |
| Berlin Hyp AG | 11 |
| CPI Property Group SA | 1 |
| Commerzbank AG | 1 |
| Cooperatieve Rabobank UA | 2 |
| Covivio | 2 |
| Credit Agricole Corporate & Investment Bank SA | 8 |
| Credit Agricole Home Loan SFH SA | 1 |
| Credit Agricole SA | 1 |
| Credit Agricole SA/London | 1 |
| DNB Boligkreditt AS | 1 |
| DZ Bank AG Deutsche Zentral-Genossenschaftsbank Frankfurt Am Main | 2 |
| Danske Bank A/S | 1 |
| Deutsche Hypothekenbank AG | 17 |
| Deutsche Kreditbank AG | 2 |
| Digital Dutch Finco BV | 2 |
| Digital Euro Finco LLC | 1 |
| E.ON International Finance BV | 1 |
| E.ON SE | 5 |
| EDP Finance BV | 1 |
| Electricite de France SA | 1 |
| Enel Finance International NV | 3 |
| Engie SA | 9 |
| Ferrovie dello Stato Italiane SpA | 2 |
| Fingrid Oyj | 1 |
| HSBC Continental Europe SA | 1 |
| Hypo Vorarlberg Bank AG | 1 |
| ICADE | 1 |
| ING Bank NV | 1 |
| ING Groep NV | 1 |
| Iberdrola Finanzas SA | 1 |
| Iberdrola International BV | 3 |
| Intesa Sanpaolo SpA | 2 |
| Iren SpA | 2 |
| KBC Group NV | 1 |
| Koninklijke Philips NV | 1 |
| La Banque Postale SA | 1 |
| La Poste SA | 1 |
| Landesbank Baden-Wuerttemberg | 59 |
| LeasePlan Corp NV | 2 |
| Muenchener Hypothekenbank eG | 5 |
| NORD/LB Luxembourg SA Covered Bond Bank | 1 |
| National Grid Electricity Transmission PLC | 1 |
| Naturgy Finance BV | 1 |
| Nexity SA | 1 |
| Nordea Bank Abp | 2 |
| OI European Group BV | 2 |
| OP Corporate Bank plc | 1 |
| PostNL NV | 1 |
| Raiffeisen Bank International AG | 2 |
| Red Electrica Financiaciones SAU | 1 |
| Royal Schiphol Group NV | 1 |

| | |
|---|---|
| SR-Boligkreditt AS | 1 |
| SSE PLC | 1 |
| Skandinaviska Enskilda Banken AB | 1 |
| Snam SpA | 1 |
| Societe Generale SA | 2 |
| Societe Generale SFH SA | 2 |
| SpareBank 1 Boligkreditt AS | 2 |
| Sparebanken Soer Boligkreditt AS | 1 |
| Stedin Holding NV | 1 |
| Svenska Handelsbanken AB | 2 |
| Swedbank AB | 1 |
| Telefonica Emisiones SA | 1 |
| Terna Rete Elettrica Nazionale SpA | 2 |
| Unibail-Rodamco-Westfield SE | 2 |
| Unione di Banche Italiane SpA | 1 |
| Vasakronan AB | 5 |
| Vesteda Finance BV | 1 |
| Vodafone Group PLC | 1 |
| de Volksbank NV | 3 |
| Total | 223 |

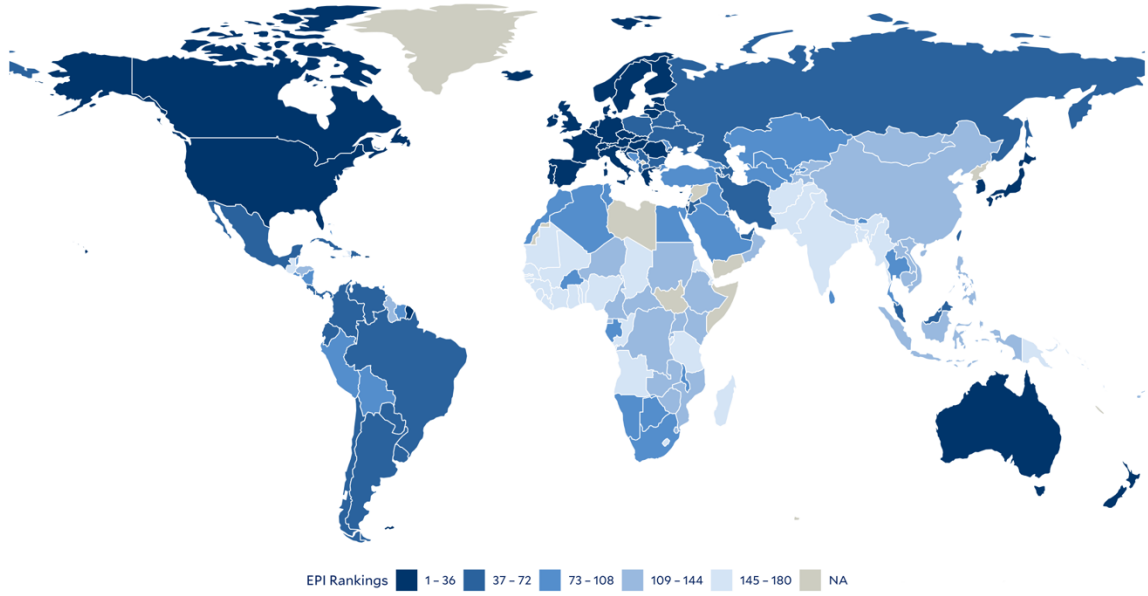
**Appendix 2A**. Issue year of green bonds




**Appendix 2B. Maturity year of the green bonds**



**Appendix 3.** Rankings in the 2020 Environmental Performance Index for 180 countries



**Appendix 4.** Graphical display of the distribution of the green bond premium