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Effect of green label on bond yields in the Eurozone

Abstract

Green bonds play a crucial role in financing environmentally-friendly projects that help to battle climate change. Although the demand for green bonds continues to grow, the evidence that investors are willing to accept lower yields for such bonds is mixed. This thesis examines if green bond premium, defined as the yield differential between green and non-green bonds, exists in the Eurozone bond market. For this, we construct a synthetic conventional bond for every 136 green bonds in our sample, and after controlling for residual liquidity, we perform a two-step regression. The findings suggest a significant negative premium of -3 basis points for the entire sample. The green bond premium is more pronounced in bonds that have lower ratings and are issued in the financial sector. We also find that bonds that are certified by Climate Bonds Initiative have an average premium of -6 basis points, which is larger than the premium identified for green bonds without such certificate in absolute terms.

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1. Introduction

Climate change is considered as one of the biggest threats in today's world. The Paris Climate Agreement, signed in 2015 to limit global average temperature to 2◦C above the pre-industrial level, is one of the initiatives created to address this. However, there is still a substantial gap in investments needed to reach the goals signed in the agreement. Green bonds, among other green assets, play a key role in raising funds and substantially reducing this gap.

Green bonds are a relatively new type of bond that are used to finance environmentally-friendly projects. They have the same characteristics as conventional bonds, with the only difference being labeled as "green". This label obliges the issuer to use the proceeds of the green bonds for projects that have environmental benefits. Since the European Investment Bank issued its first green bond in 2007, the green bond market has grown tremendously. Total green bond issuance is estimated to be over $250bn in 2019, representing a 51% growth on 2018 (CBI, 2020). However, it is still only a tiny fraction of the total debt market, indicating that there is still a lot of potential to grow. The only obstacle that could constrain this growth is the lack of established standards and regulations. At the moment, there is no universal definition that defines green bonds. This leads to a risk that the quality of the green label is different across the green bonds and creates information asymmetry between issuers and investors. Thus, ethical investors tend to rely on external information providers to reduce this information gap. The Climate Bonds Initiative (CBI) is an international organization that developed a trusted standard that identifies green bonds with the high quality of the green label. This means that CBI certification helps investors and governments in prioritizing their investments that contribute to environmental benefits.

It is essential to understand the pricing of green bonds for both investors and issuers. While the topic of green bonds is widely acknowledged by financial professionals, the economic literature on the pricing dynamics is very limited. Therefore, this thesis will contribute to the existing research by analyzing green bond premium, or in other words – greenium. Greenium is defined as a yield differential between green and non-green bonds with the same characteristics. More research is needed on this topic as existing papers do not provide clear proof of greenium existence. The empirical evidence is mixed: some studies have discovered a negative premium on green bonds relative to conventional bonds (Baker et al., 2018; Gianfrate and Peri, 2019; Zerbib, 2019), while other studies estimated a positive premium (Bachelet et al., 2019; Karpf and Mandel, 2018). Furthermore, the vast majority of the research focuses on the global or U.S. green bond market, usually ignoring other markets, such as Eurozone which will be analyzed in this thesis.

Eurozone is one of the biggest green bond issuers, issuing about a third of the global total. Germany, France, and the Netherlands are responsible for a third of the Eurozone's total issuance. Global green bond supply in 2019 was mainly driven by the Eurozone market – it accounted for more than 40% of it (CBI, 2018). Eurozone is expected to keep the leader's role in increasing the green bond market in the future too. Establishing an EU taxonomy for sustainable activities and the European Central Bank increasing its share in green bonds in its portfolio are accelerating the green bond supply. Thus, we consider Eurozone green bond market as the most suitable choice for our analysis.

In this thesis, the definition of green bonds is aligned with the one used in the Bloomberg terminal. Bloomberg tags bonds as "green" when an issuer self-labels its bond as green or complies with Green Bond Principles (GBP), under the secretariat of ICMA, on the use of proceeds (100% of the proceeds need to be aligned with GBP consistent green activities) (ICMA, 2017). There are some shortcomings with such definition and identification of green bonds: Bloomberg does not require additional reporting or external certification. As a result, some bonds might be labeled as green; however, sometimes, it can be challenging to assess how green it is, given uncertainty over regulation and inconsistent verification. This could lead to greenwashing – channeling the proceeds of the green bonds to activities that have no or even negative environmental benefits. The issue of some bonds being mislabeled as green might have a limited impact on the results of our analysis. If we expect green bonds to have a negative premium, a premium for our sample that might include bonds that are not entirely green could be less negative. Given that mislabeling occurs randomly, we cannot identify and exclude mislabeled bonds. However, there are other ways for investors to confirm the greenness of the bond. For instance, CBI certification is granted only to those bonds that have a verified post-issuance review which assures that the funds collected are distributed to green projects only.

In this paper, we want to examine if investors in Eurozone prefer green bonds and are willing to forgo their wealth to include such bonds in their portfolio. We compare each green bond with a conventional bond which has almost identical characteristics except for the greenness. Furthermore, a subsample of green bonds with approved external verifiers is analyzed to see if this verification has any additional impact on the pricing. Therefore, the goal of this thesis is to answer the following two research questions:
Research question 1: Do green labels affect bond yields in the Eurozone bond market?
Research question 2: Does additional third-party verification of green labels influence the market pricing of green bonds?

This study builds upon Zerbib (2019) and other related papers. For the analysis, we use a matching technique that requires that some of the variables (e.g., currency, bond structure, seniority, and coupon type) need to be exact matches between treated (green bonds) and control (non-green bonds) groups. Once the variables are matched, a pair of non-green bonds from the control group are extracted for each green bond. By interpolating or extrapolating the yields of the two conventional bonds, we construct a synthetic bond such that it has the same maturity as the green bond. In the next stage, after controlling for the residual difference in liquidity, we estimate a greenium with fixed-effects panel regression. To also analyze the main determinants of the greenium, we perform a cross-sectional regression. In the last stage, we use a subsample of matched bonds with evidence of approved third-party verification and perform the same regressions again.

The findings of our analysis confirm a significant negative premium of -3 basis points (bps) for green bonds in our sample, which is consistent with Zerbib's (2019) results. In addition to this, we find that green bonds with CBI certification have a much larger greenium (-6bps) relative to the bonds that don't have such certification in absolute terms.

The remainder of this thesis is structured as follows. The second section describes the theory, which includes a literature review and formulation of the hypothesis. Data analysis and preparation of the final matched bond sample are presented in section two. The empirical approach is described in section four, and the results are shown in section five. Section six offers the robustness checks run for our analysis, while section seven discusses overall results. Finally, the conclusions are summarized in section eight.

2. Theory

2.1. Literature review

Although the first green bond was issued 14 years ago, the academic literature examining this type of bond is relatively scarce. Many studies focus on a firm's corporate social responsibility (CSR) and investigate whether such companies can issue bonds at a lower cost. For instance, Ge and Liu (2015) found that U.S. firms with better CSR performance have lower costs of debt. Most of the studies presented similar results; however, there are some exemptions. For example, Stellner et al. (2015) did not find significant evidence that such companies are issuing bonds at a reduced cost, while Magnanelli and Izzo (2017) discovered better CSR performance is associated with even higher debt costs.

There is a limited amount of articles that specifically look into the green bond market and compare the yields of these bonds to the yields of conventional bonds. The majority of these papers analyze the global green bond market (Hyun et al., 2019; Loffler et al., 2021; Nanayakkara and Colombage, 2019). The second most common market studied for green bond premium is the U.S. (Partridge and Medda, 2019; Baker et al., 2018). There are also some specific markets investigated. For instance, Wensaas and Wist (2019) examine the green bonds of the Nordic secondary market, while Amundi (2021) has researched emerging market's green bonds. To the best of our knowledge, no papers are focusing on Eurozone's green bond market; however, few studies are searching for greenium in the European market. For instance, Gianfrate and Peri (2019) find that European green bonds are a cheaper alternative to raise funds than conventional bonds.

The papers analyzing the difference in yields between green bonds and conventional bonds differ not only in the scope of analysis but also in the results. CBI (2017), OECD (2017), and Larcker and Watts (2019) find no significant difference between two types of bonds in the primary and secondary markets, meaning that the investors are not willing to pay more for a bond that has a green label attached to it. Some studies have discovered a positive yield differential between green and non-green bonds (Bachelet et al., 2019, Karpf and Mandel, 2018). However, the majority of the researchers were able to find evidence for the existence of greenium (Ehlers and Packer, 2017; Zerbib, 2017; Partridge and Medda, 2019; Loffler et al., 2021; Larsson, 2018; Nanayakkara, 2019; Slimane et al., 2020; Lau et al., 2020). The magnitude of the identified green bond premium differs across the studies. Nanayakkara and Colombage (2019) examine the worldwide green bond market and find that investors are willing to pay significantly more for the green label than the bonds that don't have such label – they find a greenium of 63bps. Ehlers and Packer (2017) analyze 21 green bonds issued between 2014 and 2017 and discover a green bond premium of 18bps in the primary market. In Lau et al.'s (2020) paper, worldwide green bond data is examined, and a greenium of just 1bps is found.

Some studies find that the greenium is more pronounced while looking at the specific sub-samples separately. Zerbib (2019) discovers that the yield differential is much more significant for the bonds issued in the financial sector and the bonds with a lower rating. Larsson (2018) examines a sub-sample of bonds that are issued in green countries. He finds that such bonds also have lower yields compared to their conventional peers. Hyun et al. (2019) do not see a significant difference between green and non-green yields while analyzing the total sample; however, looking into green bond samples certified by external reviewers, they identify a robust greenium that ranges from 6bps to 15bps. Similarly to Hyun et al. (2019), Baker et al. (2018) examine U.S. corporate and municipal green bond market and find that the largest premium is identified for bonds that are externally certified as green.

As discussed above, existing papers do not provide clear proof of greenium existence as the empirical evidence is mixed. Therefore, further research on this topic is needed. This thesis makes three significant contributions to the existing literature. Firstly, there is limited research done on green bonds in the Eurozone market. Current studies that cover Eurozone green bonds are usually compared with other markets rather than focusing solely and comprehensively on Eurozone. Secondly, although we follow the matching technique used by Zerbib (2019), our analysis will retest the results presented in his study. It will show if the greenium detected previously still exists in more recent years with a more comprehensive sample of bonds. Finally, this thesis is one of the few that explicitly compare if and how green bonds with CBI certification differ in greenium from the bonds that don't have such approved certificates.

2.2. Hypothesis formulation

We can observe a potential explanation for the difference in the pricing of green bonds relative to conventional bonds in theory. Fama and French (2007) explain that investors' utility function includes not only the expected risk and return on their portfolios but also incorporates additional preferences. Several other pieces of research have also found that the investors' tastes have a significant impact on their investment strategy (Brodback et al., 2018; Hartzmark and Sussman, 2019). Since environmental, social, and governance factors are increasing in their importance for investors, green bonds are becoming a more popular instrument to invest in (Bernow et al., 2017). Accordingly, investors are willing to accept lower yields to include green bonds in their portfolios and support companies that issue bonds with environmental benefits.

Looking at this phenomenon from an economic perspective, the green bond market is much smaller than the conventional bond market. Also, there is a great demand by institutional investors for green assets, which creates a supply-demand imbalance. Such demand enables green bond issuers to adjust the terms of their issuance by paying out lower coupon rates. This leads to green bonds yielding lower yields than their conventional peers. Nevertheless, investors are still willing to pay a premium to become green bond holders because of the shortage of such bonds.

Moreover, third-party verification, such as Climate Bonds Initiative certification, might increase the green bond premium because of the potentially lower risk. Regular monitoring of the fund allocation of the green bond proceeds and confirmation of environmental benefits might reduce the probability of greenwashing and increase the reliability and transparency of green bonds. This potentially lower risk would reduce verified green bond yields relative to green bonds that do not have such verification.

These theoretical and economic arguments help us formulate two hypotheses:

H1: Green bonds have lower yields than conventional bonds issued by the same issuer in the Eurozone bond market.

H2: Green bonds certified by Climate Bonds Initiative have a larger greenium.

3. Data preparation

3.1. Data overview

The data is retrieved from the Bloomberg terminal. It includes details (issue date, maturity date, coupon type, coupon rate, seniority, bond type, issuer, country, rating[1], amount issued and outstanding, yield to maturity, and sector) on all green bonds issued in Eurozone up to 17 May, 2021, as well as all conventional bonds issued by the same green bond issuers. Our study focuses on EUR denominated bonds only, so all other currency denominated bonds are not included in the sample. The data cleaning process begins with a sample of 460 green bonds and 8,861 conventional bonds.

The extracted data is checked for missing values. First, 24 green bonds and 206 non-green bonds are removed because they are missing the ISIN code, maturity date, rating, outstanding amount, or yield to maturity. Next, to include only relevant data for the analysis, we remove structured notes, convertible and inflation-linked bonds, and bonds that have other than fixed coupon types. After cleaning the data, our sample consists of 409 green bonds and 5,071 conventional bonds. Full details on the data cleaning process and criteria are shown in Table 1.

[1] Bloomberg composition rating derived from Moody's, S&P and Fitch ratings.

Table 1: *Raw data cleaning process*

	Green	Conventional	Total
Raw data	460	8,861	9,321
Has maturity date	445	8,700	9,145
Has rating	445	8,681	9,126
Has ISIN code	436	8,657	9,093
Has amount outstanding	436	8,655	9,091
Has yield to maturity	430	8,638	9,068
Has fixed coupon type	414	5,784	6,198
Removed: convertible bonds, structured notes, infliation linked bonds	409	5,071	5,480

The majority of green bonds in the sample are corporate (91%) and have a seniority rank of senior unsecured (65%). They have 186 unique issuers from 16 different Eurozone countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Portugal, Slovenia, Slovakia, Spain, and the Netherlands, with Germany and France being the largest issuers. The rating of the green bonds in the sample ranges from AAA to CCC+ except for 51 non-rated bonds. 49% of the green bonds are issued by the financial sector, followed by the non-financial sector (42%) and the government (9%).

3.2. Matching method

In order to see how green bond yields differ from non-green bond yields, we first have to create pairs of bonds that are almost identical. To do this, we will match each bond from the treated group (green bonds) with the control group (conventional bonds) that are similar in relevant characteristics.

There are many matching techniques used in previous studies. For instance, Berg et al. (2016) use the correlation method where bonds are matched by calculating the correlation between treated and control groups with respect to the outcome variable. Gianfrate and Peri (2019) use the propensity score matching approach, which bundles all comparable characteristics in a single-index variable and then estimates how the treatment effect of getting a green label affects the yields. The methods also differ in how many bonds are selected as matches. In Helwege et al.'s (2014) study, only one closest conventional bond match is selected. However, it has been criticized in more recent studies that such matching might lead to a maturity bias. Zerbib (2019) overcomes this limitation by using two matches and creating a synthetic bond afterward. Another significant difference that can be observed in other studies is using matching with or without replacement. For example, Helwege et al. (2014) do not use the same bond if it has been already matched. Such an approach has a clear advantage of keeping control variables independent. Matching with replacement has its strong points too. Such a method ensures that created pairs do not depend on the bonds' ordering and are also more suitable for smaller samples. After reviewing the criteria and results of the matching methods used in the previous analysis, we decided to follow Zerbib's (2019) matching technique, where two peers are selected, and the replacement is allowed.

One of the most critical tasks is to decide which variables to use in the matching process and what criteria should be applied to them. Following Zerbib's (2019) approach, two conventional bonds have to be matched for each green bond in order to build a synthetic bond in the next stage. These bonds have to be closest in terms of maturity, but also have exact or similar other characteristics. This includes the same issuer, same currency, rating, instrument type, seniority, and coupon type. This thesis focuses on Eurozone's EUR-denominated bonds only, so the currency is not included in the matching variables. Since maturity cannot be precisely the same for different bonds (the sample would become too small), we apply a criteria which specifies that the maturity of a conventional bond peer cannot be shorter or longer more than two years than a green bond's maturity. Larsson (2018) has found in his paper that the results are much more reliable if the maturity of the green bond is in-between the maturities of the two conventional bonds. Therefore, to make our analysis even more robust, we introduce an additional rule: each green bond has to have one conventional bond peer with shorter maturity and the other one with longer maturity.

In order to account for the difference in liquidity, Zerbib (2019) defines two constraints on the difference in amount issued and issue date. In this study, we slightly modify this rule by using the amount outstanding instead of the amount issued. Although the difference between the two variables is insignificant, we believe that amount outstanding is more relevant as it is the current value of the bonds. The amount issued is subject to change due to bond buybacks or additional issues and is not as comparable as the amount outstanding. Thus, to control for the difference in liquidity, we limit conventional bond's amount outstanding to be less than four times of the green bond's amount outstanding and larger than a quarter of this amount, and we limit the issue date of the conventional bond to be less than six years earlier or later than green bond's issue date. Now that we have a complete list of matching criteria, any green bond with less than two conventional bond peers that satisfy these criteria is removed from the sample. The full list of matching variables and their criteria is presented in Table 2.

Table 2: *Summary of matching variables and their criteria*

Criteria	Matching type
Issuer	Exact
Instrument type	Exact
Currency	Exact
Amount outstanding (AO)	$\frac{1}{4}AO^{GB} \leq AO^{CB} \leq 4AO^{GB}$
Difference in issue date	< ±6 years
Difference in maturity	< ±2 years
Rating	Exact
Seniority	Exact
Coupon type	Exact
Country of issue	Exact

3.3. Creating synthetic bonds

After extracting two conventional bond peers for each green bond that satisfy the listed criteria in section 3.2., we need to create a synthetic bond. Following Zerbib (2019), a synthetic bond is constructed by using the interpolation method. By interpolating bond yields of conventional bonds CB_1 and CB_2 linearly, we get a synthetic bond (SB) with the same maturity as the green bond (GB). In other words, for each pair of conventional bonds, a linear function is defined that has an intercept α and slope β, passing through two points: ($Maturity_{CB1}$, $yield_{CB1}$) and ($Maturity_{CB2}$, $yield_{CB2}$), where *Maturity* is the remaining maturity at time *t* and *yield* is the ask yield at time *t*. The equation to calculate the yield for the synthetic bond is shown in equation 1.

(1) $$y_{SB} = \alpha + \beta * Maturity_{GB}$$

We finalize our database by calculating the yield spread between a green bond and matched synthetic bond. The equation is defined in 2.

(2) $$\Delta y_{i,t} = y_{i,t}^{GB} - y_{i,t}^{SB}$$

3.4. Liquidity proxy

The difference in liquidity has already been addressed by putting constraints on the amount outstanding and issue date; however, Zerbib (2019) argues that it is not enough to eliminate this difference entirely. In his study, he criticizes other papers (Baker et al., 2018; Karpf & Mandel, 2018) for not controlling for residual liquidity risk sufficiently. Following Zerbib (2019), our study will include an additional liquidity risk control variable – difference in bid-ask spread between green and matched synthetic bonds.

The bid-ask spread is collected from the Bloomberg terminal for each green bond and the two conventional bond peers. We will calculate the bid-ask spread by dividing the difference between the bid price and ask price by the average of bid and ask sum (Larsson, 2018), as shown in equation 3.

(3)
$$BA_{i,t} = \frac{Ask_{i,t} - Bid_{i,t}}{\frac{Ask_{i,t} + Bid_{i,t}}{2}}$$

Since we do not have bid and ask prices for the synthetic bonds, we have to derive it from the two conventional bond peers. Therefore, the synthetic bond's bid-ask spread is calculated as a distance-weighted average of two conventional bonds' bid-ask spreads. To define it in the formula, d_1 represents the distance, which is calculated as the difference between green bond maturity and CB1 maturity, and d_2 is the difference between green bond maturity and CB2 maturity. Then the bid-ask spread of synthetic bond is calculated as shown in equation 4.

(4)
$$BA_{i,t}^{SB} = \frac{d_2}{d_1 + d_2} * BA_{i,t}^{CB1} + \frac{d_1}{d_1 + d_2} * BA_{i,t}^{CB2}$$

In the next stage, we calculate the difference between the bid-ask spread of a green bond and the bid-ask spread of a synthetic bond, as shown in equation 5. This difference will be used as a variable in our regression model to estimate the fixed-effects linear panel.

(5)
$$\Delta BA_{i,t} = BA_{i,t}^{GB} - BA_{i,t}^{SB}$$

3.5. Descriptive statistics

After constructing green bond and synthetic bond matches, three bond pairs were removed because they did not have bid-ask spreads. The other two bond pairs were eliminated from the sample due to extreme Δy values. This leaves us with the final sample of 136 green bonds and 99,894 EUR mil of the amount outstanding. This accounts for 33% of the total Eurozone's green bond market and 31% of the total outstanding amount of the original green bond sample.

All bonds in our sample have a fixed-coupon type and are EUR-denominated. 14 bonds are covered, and the majority of the unsecured bonds have a seniority rank of senior unsecured. Almost all of them are investment-grade bonds, except for one BB+ and one non-rated bond. The majority of bonds have either A-, BBB+ or AAA ratings. The sample has 63 unique issuers from 10 Eurozone countries, Germany and France being the largest. The most common sector is financial corporate with 88 bonds, followed by non-financial corporate with 39 bonds and government with 10 bonds. The most popular use of proceeds reported in the green bond frameworks is renewable energy, followed by green real estate and clean transport. More details on the statistics by country, rating, sector, and use of proceeds can be found in the Appendix (Tables A1, A2, A3, and Figure A1).

Table 3 provides statistics on how well green bonds were matched with their conventional peers. We see that the ask yields range from -0.55% to 2.1%, and the distribution is very similar for all samples. Maturity has more significant differences between the samples, with the average difference being around half a year shorter/longer maturity for the green bonds. The amount outstanding of the green bonds is around 30% smaller than that of non-green bonds on average. Another important statistic presented in the table, the difference in yield (Δy), is negative on average. The mean and median is -4bps and -2bps, respectively, and the overall distribution is skewed to the left, with 95 values out of 136 being negative.

Table 3: *Descriptive statistics of the green bonds, match conventional bonds and constructed synthetic conventional bonds*

	Min	1st quart	Median	Mean	3rd quart	Max
Ask yield of the GB (%)	- 0.551	- 0.185	0.063	0.095	0.326	1.916
Ask yield of the SB (%)	- 0.551	- 0.164	0.071	0.135	0.359	2.114
Ask yield of the CB1 (%)	- 0.548	- 0.249	0.003	0.066	0.329	1.872
Ask yield of the CB2 (%)	- 0.554	- 0.083	0.145	0.197	0.443	2.124
Yield difference (%)	- 0.378	- 0.063	- 0.020	- 0.040	0.003	0.246
Green bond maturity on 17 May, 2021 (years)	0.575	3.551	5.487	5.613	7.351	11.817
CB1 maturity (years)	0.353	3.047	5.253	5.043	6.975	10.897
CB2 maturity (years)	0.619	4.107	6.260	6.179	7.682	13.227
GB amount outstanding (EUR mil)	50	500	500	735	763	6,500
CB1 amount outstanding (EUR mil)	50	500	737	1,018	1,000	25,000
CB2 amount outstanding (EUR mil)	50	500	750	1,020	1,000	25,000

Table 4 shows the distribution of the difference in bid-ask spreads between green and synthetic bonds (ΔBA). We notice that it is concentrated around zero, which indicates that the controls for liquidity risk on the amount outstanding and issue date were successful.

Table 4: *Distribution of ΔBA*

	Min	1st quart	Median	Mean	3rd quart	Max	SD
ΔBA	-0.031%	-0.069%	-0.002%	-0.014%	0.079%	3.744%	0.560%

4. Empirical methodology

4.1. Identification of the greenium

After synthetic bond and liquidity proxy have been constructed, the final step is to estimate the green bond premium – the greenium. To do so, we will use fixed effect panel regression of yield difference, $\Delta y_{i,t}$, on the difference in residual liquidity, $\Delta BA_{i,t}$. This regression model is illustrated in equation 6, where p_i is the greenium, defined as a bond-specific, time-invariant unobserved effect, and $\epsilon_{i,t}$ is the error term. 1,299 monthly observations of 136 green bonds and their matched synthetic bonds have been used to run the regression.

(6) $$\Delta y_{i,t} = p_i + \beta * \Delta BA_{i,t} + \epsilon_{i,t}$$

Various tests are performed to see the quality of fit of the regression model for our analysis. Firstly, two individual effect tests are performed to verify that fixed effect estimator is preferred over pooled OLS, namely F-test and Breusch-Pagan test. Both tests reject the null hypothesis that there are no individual effects at less than a 1% significance level. To confirm that the fixed effect estimator is preferred over the random effect estimator, the Hausman test is performed. The hypothesis that a random-effect regression is a better fit for our analysis can be rejected at less than 1% significance level too. To test for autocorrelation in panel data, we perform the Wooldridge test, which confirms that serial correlation is present in our data. We find that there is also heteroscedasticity by conducting the Breusch-Pagan test. The presence of autocorrelation and heteroscedasticity suggests that there is cross-sectional and time-series dependence. To address this, we additionally perform an estimation of clustered standard errors for our regression model. Details on the tests mentioned above can be found in Table A4 of the Appendix.

The last test performed is the Wilcoxon test which ascertains if there is a significant green bond premium. In other words, the results of this test show if we can reject the null hypothesis that the mean of greenium is zero. It is applied to the whole sample of green bonds in the first stage, after which various subsamples are tested as well. This test plays a vital role in proving our analysis's second hypothesis: green bonds with a CBI certificate are awarded with larger greenium. After going through each issuer's green bond framework, we find nine bonds that are CBI certified. Bonds with such certificates are very diverse: they are issued by seven different issuers from 5 different countries. They are all corporate bonds with ratings ranging from AAA to BBB-. Wilcoxon test will determine if the green premium identified for this sub-sample is significant. The outcome of the test will be discussed in the results section.

4.2. The determinants of the greenium

Now that the regression model for the green bond premium has been defined in the previous sub-section, the next step is to identify key characteristics that may show where and to what extent the greenium is present. Having Zerbib's (2019) paper as our starting point, variables that we consider are rating, maturity, sector, and the natural logarithm of the amount outstanding. This selection slightly differs from Zerbib's (2019) as he uses the issue amount instead of the amount outstanding and includes currency as an additional determinant. The choice of the amount outstanding is explained in the matching method section, and we do not include currency because all the bonds in our sample are EUR-denominated. Moreover, we include collateral type as an additional independent variable in our analysis to see if it has any explanatory value. We will use cross-sectional OLS regression, which is defined in equation 7. Non-financial sector and unsecured type are chosen as reference categories for sector and collateral type variables, respectively. The number of specific categories is determined by how many bonds belong to that category – each of them must have at least five bonds to be included in the model.

(7) $$p_i = \beta_0 + \beta_1 Rating + \beta_2 Maturity + \beta_3 \log(Amount\ outstanding) + \sum_{j=1}^{N_{Collateral\_type}-1} \beta_4, Collateral\_type_j 1 Collateral\_type_j + \sum_{j=1}^{N_{Sector}-1} \beta_5, Sector_j 1 Sector_j + \epsilon_j$$

Differently from Zerbib's (2019) analysis, a rating is converted to numeric ordinal values, following Ge & Liu (2015). Thus, the new rating interpretation ranges from 1 as AAA to 14 as non-rated, as shown in table 5.

Table 5: *Conversion of Bloomberg rating to ordinal measure*

Rating	Ordinal measure
AAA	1
AA+	2
AA	3
AA-	4
A+	5
A	6
A-	7
BBB+	8
BBB	9
BBB-	10
BB+	11
BB	12
BB-	13
NR	14

To see if there are additional characteristics that determine green bond premium, we will run two additional regression models by adding more variables to the original equation 7. Since we are interested in CBI certification to prove one of the hypotheses, the first modified model includes CBI certified bonds category. The reference category is the bonds that do not have such certification. The equation for this new regression model is defined in equation 8.

(8) $$p_i = \beta_0 + \beta_1 Rating + \beta_2 Maturity + \beta_3 \log(Amount\ outstanding) + \sum_{j=1}^{N_{Collateral\_type}-1} \beta_4, Collateral\_type_j 1 Collateral\_type_j +$$

$$\sum_{j=1}^{N_{Sector}-1} \beta_5 , Sector_j 1Sector_j +$$

$$\sum_{j=1}^{N_{CBI\_certified}-1} \beta_6 , CBI\_certified_j 1CBI\_certified_j + \epsilon_j$$

The final regression model that is used in our analysis includes countries as additional determinants of the greenium. In the original equation 7, we assume that all the countries in Eurozone do not differ in terms of significance, sign, and magnitude of green bond premium. The following regression model is run to see if different Eurozone countries have significant explanatory value in addition to the existent variables. The new model is defined in equation 9. There are four countries that have more than five bonds in our sample, namely Germany, France, Italy, and Spain, with Germany being used as the reference category.

(9) $$p_i = \beta_0 + \beta_1 Rating + \beta_2 Maturity + \beta_3 \log(Amount\ outstanding) +$$

$$\sum_{j=1}^{N_{Collateral\_type}-1} \beta_4 , Collateral\_type_j 1Collateral\_type_j +$$

$$\sum_{j=1}^{N_{Sector}-1} \beta_5 , Sector_j 1Sector_j +$$

$$\sum_{j=1}^{N_{CBI\_certified}-1} \beta_6 , CBI\_certified_j 1CBI\_certified_j +$$

$$\sum_{j=1}^{N_{Country}-1} \beta_7 , Country_j 1Country_j + \epsilon_j$$

In order to see if there are any multicollinearity problems in any of the regression models defined in equations 7, 8, and 9, generalized variance inflator factors (GVIF) are calculated. Test results prove that there are no multicollinearity issues with any of the specifications. In addition to this, the Breusch-Pagan test is run for heteroskedasticity, which results in all three models having heteroskedasticity. To address this problem, robust standard errors are used in all models. More details on the tests can be found in Table A5 of the Appendix.

5. Results

5.1 The greenium

The discussion of the results will start with a regression model defined in equation 6. The model is based on a matched green bond sample of 136 bonds and their 1,299 monthly observations. We find that the estimate of residual liquidity estimator, ΔBA, is negative and highly significant. The results, presented in Table 6, show that a 1bps increase in bid-ask spread differential results in a -1.16bps drop in yield differential, $\Delta y_{i,t}$. This is the case for both regressions with estimated clustered standard errors (b) and without (a). It shows that such additional control for liquidity has large explanatory power, although the R^2 is only 1.2%.

Table 6: *The results of fixed-effects regression. Specification (a) estimates coefficients without clustered standard errors estimation, while specification (b) estimates coefficients using clustered standard errors*

	Dependent variable: $\Delta y_{i,t}$	
	(a)	(b)
ΔBA	-1.158***	-1.158**
	(0.315)	(0.488)
Observations	1,299	1,299
R^2	0.012	0.012
F statistic	18.56***	18.56***

*p<0.1; **p<0.05; ***p<0.01.

The distribution of fixed effects p_i, representing individual green bond's premium, is presented in Table 7. It ranges from -25bp s to 24bps, with mean and median being -3.1bps and -1.2bps, respectively. The mean of -3.1bps is equal to around 20% of the green bonds' average ask yield. 62% of the sample's green bond premium is negative, which indicates it has a longer left tail.

Table 7: *Distribution of the estimated green premium*

	Min	1st quart	Median	Mean	3rd quart	Max	SD
p_i (bps)	-25.402	-5.683	-1.216	-3.119	0.991	23.588	7.368

Finally, we look at the results of the Wilcoxon signed-rank with continuity correction test that has been applied to the whole sample and several subsamples: sector, collateral type, country, and rating. The test shows if the green bond premium estimated for the sub-sample is significantly different from zero. In addition to this, we calculate the mean and median per sub-sample. The results are presented in Table 8. It shows that the total sample's average premium of -3.1bps is highly significant at a 99% confidence level. The financial corporate sector with a mean premium of -3.8bps and the non-financial corporate sector with a mean of -2.1bps are significantly different from zero at 99% and 95% confidence levels, respectively. Out of 10 country subsamples, France, Germany, and Italy have a negative green bond premium significant at 99%, 95%, and 90% confidence levels. Also, A-, BBB+ and BBB green bonds have a -5.8bps, -3.8bps, and -4.8bps, respectively, all significant at a 99% confidence level. Although the mean and median of the remaining categories are not statistically significant, the majority (72%) of them are negative.

Table 8: *Mean, median, and significance level of the green premium per sub-section*

		Mean (p_i)	Median (p_i)	$p_i \neq 0$	#GB
Total		-3.119	-1.216	***	136
Sector	Financial Corporate	-3.833	-1.235	***	88
	Non-financial Corporate	-2.148	-1.788	**	39
	Government	-0.342	0.382		9
Collateral type	Covered	0.012	0.249		14
	Unsecured	-3.478	-1.922	***	122
Country	AT	-7.928	-7.928		2
	BE	-5.237	-5.237		2
	DE	-3.354	-0.674	**	67
	ES	0.539	0.464		8
	FI	-1.145	-0.992		4
	FR	-3.076	-2.502	***	36
	IE	-0.424	-0.424		1
	IT	-5.200	-4.710	*	10
	NL	-2.487	-2.303		3
	PT	-0.764	-1.219		3
Rating	AAA	-0.369	0.249		20
	AA+	0.112	0.382		13
	AA	1.135	1.121		7
	AA-	-1.355	-0.913		3
	A+	-3.698	-2.388		6
	A	0.066	-2.303		3
	A-	-5.761	-3.593	***	37
	BBB+	-3.836	-4.169	***	21
	BBB	-4.815	-4.696	***	17
	BBB-	0.108	4.104		7
	BB+	-19.455	-19.455		1
	NR	-5.906	-5.906		1

*p<0.1; **p<0.05; ***p<0.01.

The identified greenium of -3.1bps confirms our first hypothesis H_1*: Green bonds have lower yields than conventional bonds issued by the same issuer in the Eurozone bond market.* It proves that investors value socially responsible investing and thus prefer investing in green bonds, as discussed in the theory section. Estimated greenium is also consistent with the results of previous studies, which also evaluate a significant negative green bond premium. For instance, Zerbib (2019), Partridge and Medda (2019), and Loffler et al. (2021) all identify a greenium of -2bps, -5bps, and -15bps, respectively.

5.2. CBI certified bonds

Since green bonds with CBI certificates are of particular interest in this thesis, we will look at how the distribution of the CBI-certified bond premiums differs from the distribution of total sample premiums. As shown in Table 9 the average (median) premium of this specific sub-sample is -6.3bps (-5.0bps), with 89% of the premiums being negative. The greenium identified for the CBI-certified bonds is twice as large as for the entire sample in absolute terms. Although the sample is relatively small, a Wilcoxon signed-rank test with continuity correction shows that the estimated greenium is significantly different from zero at a 95% confidence level.

Table 9: *Distribution of green premium for CBI certified bonds sample*

	Min	1st quart	Median	Mean	3rd quart	Max	SD
p_i (bps)	-14.125	-11.790	-4.971	-6.303	-2.303	3.037	5.920

The result that CBI-certified bonds have a negative premium, which is significant and twice as large compared to the full sample in absolute terms, is in line with our second hypothesis *H_2: green bonds certified by Climate Bonds Initiative have a larger greenium.* In addition, the results are in line with Hyun et al.'s (2019) study, which finds that bonds certified by an external reviewer have a significant negative premium. This is also consistent with the theoretical argument raised in the theory section, which states that socially responsible investors are more likely to invest in green bonds if an approved external reviewer has reviewed the bonds.

5.3. The determinants of the greenium

The results of the cross-sectional OLS regression are shown in Table 10. Three different regression specifications are considered, as discussed in the empirical methodology section. Specification (a) represents equation 7, specification (b) – equation 8, and specification (c) – equation 9. In specification (c), we have some countries that have less than five bonds and thus are not included in the regression. To have the results more reliable, we exclude the bonds that are not represented by a country in our analysis, therefore the sample for regression specification (c) is smaller. Also, since there is a heteroscedasticity problem, we use robust standard error estimations for all three specifications.

Table 10: *The results of cross-sectional regression. Specification (a) represent equation 7, specification (b) – equation 8, and specification (c) – equation 9*

	Dependent variable: p_i		
	Cross-sectional regressions with robust standard errors		
	(a)	(b)	(c)
Intercept	4.356	5.506	8.580
	(12.261)	(12.315)	(13.771)
Rating	-0.893***	-0.899***	-1.118***
	(0.263)	(0.266)	(0.394)
log(Amount Outstanding)	0.149	0.139	-0.024
	(0.833)	(0.836)	(0.930)
Collateral type: covered	0.132	0.168	-0.191
	(0.957)	(0.968)	(1.126)
Maturity	-0.201	-0.297	-0.213
	(0.267)	(0.271)	(0.344)
Sector Financials	-4.477***	-4.707***	-5.257***
	(1.626)	(1.619)	(1.939)
Sector Government	-2.232	-2.503	-4.048*
	(1.752)	(1.735)	(2.263)
CBI certified		-4.261**	-5.967***
		(1.798)	(1.986)
Country FR			0.109
			(1.431)
Country IT			-0.086
			(2.925)
Country ES			3.870
			(3.257)
Observations	136	136	121
R^2	0.133	0.152	0.175

*p<0.1; **p<0.05; ***p<0.01.

The R^2 ranges from 13% to 18% for the three specifications. In the first model (a), we find that two variables are statistically significant: rating and financial sector. The sign of rating coefficient is negative for all three specifications and ranges from -0.89bps to -1.12bps, meaning that a lower rating yields a higher premium in absolute terms. The results are significant at a 99% confidence level. This aligns with Zerbib (2019) and Larsson (2018), who also find a significant negative relationship between rating and green bond premium.

The financial sector coefficient is also negative and highly significant for all three models, ranging from -4.5bps to -5.3bps with respect to the non-financial sector. This means that the greenium is larger for the bonds issued in the financial sector compared to the non-financial sector. The government coefficient also has a negative coefficient; however, it is significant only in the specification (c) at a 90% confidence level. The coefficient of -4bps is smaller than that of the financial sector, meaning that the greenium is smaller for bonds issued by the government compared to the financial sector. The results for sector subsamples are consistent with Zerbib (2019) and Larsson (2018).

Similar to Zerbib (2019), maturity and amount outstanding have insignificant explanatory power of the premium. This holds for all three specifications. The collateral type was added as an additional variable to the ones used by Zerbib (2019), as we expected it to affect the premium significantly. We find that collateral type is an insignificant variable in all three models, too, with coefficient being positive in (a) and (b) and negative in (c) specification.

In specification (b), we have added an additional variable of CBI certification. We find that CBI-certified bonds have a negative and highly significant coefficient of -4.3bps and -6.0bps for specifications (b) and (c), respectively. This is consistent with our theoretical argument that CBI certification yields a much larger greenium with respect to the bonds that don't have such a certificate. In specification (c), country variables have been added. France and Spain have positive coefficients, while Italy – negative; however, none of them significantly affect the premium.

6. Robustness checks

To assess the quality of the methodology used, three robustness checks are performed. One of the main concerns in our analysis is whether the matching method and the extrapolation of synthetic bond yields yielded reliable results. We need to ensure that the difference in liquidity levels of two conventional bonds compared to green bonds was not too large. To test this, more stringent criteria on liquidity variables are applied in the matching process. Firstly, a conventional bond's amount outstanding must be less than two times of the green bond's amount outstanding instead of four, and it has to be at least more than half of this amount instead of a quarter. The issue date of a conventional bond cannot be earlier or later than two years of the green bond issue date instead of six years. Lastly, the difference in maturity between conventional and green bonds must be no more than one year instead of two years. After all these stringent criteria are applied, we end up with a sample of 18 green bonds. The distribution of the green premium p_i for the sample with stringent criteria, as well as for the original sample, is presented in Table 11.

Table 11: *Distribution of green premium for the sample with stringent criteria, compared to the distribution of the original sample*

p_i (bps)	Min	1st quart	Median	Mean	3rd quart	Max	SD	# GB
Stringent criteria	-19.571	-2.806	0.604	0.303	3.037	26.432	9.484	18
General criteria	-25.402	-5.683	-1.216	-3.119	0.991	23.588	7.368	136

We can see that the distribution is similar in extreme values, with larger differences being present in mean and median. The average and median of the original sample are -3.1bps and -1.2bps, respectively, while for the specific sample we are interested in, they are 0.3bps and 0.6bps, respectively. We find such values are not significant since results of the Wilcoxon signed-rank test with continuity correction show that we cannot reject the null hypothesis of the mean being zero for a more stringent sample. Such an outcome of the Wilcoxon test might be due to a very small sample size of only 18 bonds. Thus, applying more stringent criteria on liquidity variables results in lower quality of the estimations.

Another concern that should be addressed is whether the estimated greenium for the matched green bond sample represents the whole Eurozone's green bond market. Figure A2 of the Appendix shows the comparison of the distribution of green bonds between two samples by sector and rating - the main determinants of the premium as found in the results section. We see that the proportions of bonds in each sub-section are almost identical in both samples, meaning that the bonds in our analysis are representative of the bonds in the Eurozone market.

We perform the final robustness check to confirm if the green premium identified for CBI-certified bonds is indeed due to CBI certification. To do this, we have studied what criteria need to be met for the bond to be certified. One of the fundamental rules that the issuers need to meet is to have pre- and post-issuance reviews by an approved verifier. After going through each green bond framework of the bonds in our sample, we found 54 green bonds with pre- and post-issuance reviews by CBI-approved verifiers. They have 27 unique issuers from 9 different countries, with Germany and France being the largest. All of them are corporate bonds, except for two bonds that are issued by the government. The majority of them are senior unsecured, with a rating ranging from AAA to BB+.

We have run both fixed-effects and cross-sectional regressions with the sample of bonds that have pre- and post-issuance verifiers. The results are presented in Table 12 and Table 13. The distribution of the green premium of this sample is compared to the distribution of the premiums of the CBI-certified sample. We can see that the value of the premium for the pre- and post-issuance verified sample is twice as small as for the bonds with a CBI certificate. The average premium of such a sample is -2.8bps, compared to the average of -6.3bps for certified bonds. Cross-sectional regression results also show pre- and post-issuance reviews having a lower influence on the green premium than CBI certification. The coefficient of this new variable is 0.07, compared to -4.3 for CBI-certified bonds. Applying Wilcoxon signed-rank test with continuity correction results in a p-value of 0.001, meaning that the hypothesis of the average premium being zero can be rejected at a 99% confidence level. The results indicate that investors value CBI certification and are willing to accept lower yield to hold such bonds.

Table 12: *The distribution of green premium for pre- and post-issuance reviewed bonds sample, compared with the distribution of CBI certified bonds sample*

p_i (bps)	Min	1st quart	Median	Mean	3rd quart	Max	SD	# GB
Pre&Post Issue Review	-23.239	-5.126	-1.519	-2.804	0.671	8.115	5.747	54
CBI certificate	-14.125	-11.790	-4.971	-6.303	-2.303	3.037	5.920	9

Table 13: *The results of cross-sectional regression for the pre- and post-issuance reviewed bonds sample*

	Dependent variable: p_i
	Cross-sectional regression with robust standard errors
Intercept	-0.018
	(11.557)
Rating	-0.896***
	(0.270)
log(Amount Outstanding)	0.141
	(0.831)
Covered	0.103
	(1.020)
Maturity	-0.200
	(0.268)
Sector Non-Financials	4.460***
	(1.651)
Sector Government	2.248
	(1.240)
Pre&Post Issue Review	0.071
	(1.100)
Observations	136
R^2	0.133

*p<0.1; **p<0.05; ***p<0.01.

7. Discussion

This paper examines how a green label affects the pricing of green bonds relative to conventional bonds. We show that investors prefer green bonds even when their returns are lower. They are willing to forgo additional returns to be able to contribute to environmentally-friendly projects. The results are even more substantial for CBI-certified bonds with the implication that higher quality of green label increases investors' trust to invest in such bonds. This is consistent with Fama and French (2007), who show that investors care not only about risk and return on their portfolio but also take into account their tastes and preferences.

The -3bps average green bond premium has various implications for different market players. From investors' perspective, such a magnitude of premium should not discourage ethical investors from investing in green bonds. In other words, the extra wealth that the investors are giving up in order to include green bonds in their portfolios is not too immense. This explains the supply-demand imbalance – the supply of green bonds is currently not able to keep up with the demand coming from socially responsible investors (S&P Global, 2018). When it comes to the issuers, green bonds are more financially beneficial to issue. Although green bonds are usually more expensive to issue due to continuous monitoring and reporting, the identified greenium of -3bps covers these costs and even generates some savings. For instance, CBI bonds have to pay a fee of 0.1bps of the issue amount to receive a certification of a green label, which is much lower than the average green bond premium that the issuers are saving (Gianfrate and Peri, 2019). Lastly, our results have clear implications for policymakers too. We find that there is a great demand for green bonds, and it is still growing. Given that currently there are no common international standards, this should incentivize supervisors to take more action in providing clear guidance in the definition of green bonds.

Focusing on the Eurozone, the supply of green bonds is expected to grow substantially. Eurozone is already a leader in the growth of the global green bond market; however, recent developments might increase the pace of the issuance even more. In March 2018, the European Commission adopted the action plan on sustainable finance, which includes establishing an EU taxonomy for green activities, creating an EU green bond standard, and many other actions (European Commission, 2018). A common European legal framework will be beneficial not only for the issuers to get better financial results but also for the investors as such framework will reduce the risk of greenwashing. Another European organization, the European Central Bank, has also contributed to the higher growth of the green bond market in the Eurozone. Recently it has increased the purchases of green bonds in their asset purchase programs and plans to increase the share of such bonds in their portfolio even further in the future (European Central Bank, 2018). Such actions by European institutions will help to increase the supply of environmentally-friendly projects.

8. Conclusion

This thesis examines what impact green labels have on bond pricing and answers two research questions: *Do green labels affect bond yields in the Eurozone bond market?*, and *Does additional third-party verification of green labels influence market pricing of green bonds?*. This paper aims to find a green bond premium, which is defined as the yield difference between green and conventional bonds. We construct synthetic conventional bonds that have almost identical characteristics to each green bond in our sample, and, after controlling for residual liquidity, we perform a two-step regression. We discover a significant negative green bond premium of -3bps for the whole green bond sample, which is consistent with Zerbib (2019) and confirms our theoretical argument that investors care about their preferences when investing, which is in line with Fama and French (2007). The greenium is more pronounced in low-rated and financial bonds. We also find that the green bond premium is larger in absolute terms for CBI-certified bonds relative to bonds that don't have such certification.

There are two main limitations to our analysis. Firstly, the definition of green bonds that we use has no proof that the bonds that self-label themselves as green are actually green. This might lead to some bonds in our sample misusing this label. A common international legal framework is needed to provide a proper definition of green bonds for the analysis to be improved. Another limitation is related to the technical part of the thesis. A matching technique that we use follows Zerbib's (2019) method. Some bond characteristics are not identical matches; instead, certain thresholds are applied to make these characteristics as similar as possible. This might lead to estimated yield differences being a result of the slight differential in the variables that are not identical matches and not proof of greenium.

Further research could focus on two following areas. Instead of using a matching method that relies on not always exact matches, more general matching techniques could be used, for example, propensity scores matching. Such a method would most likely overcome the limitation discussed in our thesis. Finally, other sustainable assets, such as social bonds, could also be analyzed and compared to green bonds to see which type of assets have the biggest premium.

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10. Appendix

Table A1: *Descriptive statistics of the green bond sample by country*

Country	# of GB	Amount Outstanding (EUR mil)
Austria	2	500
Belgium	2	1,000
Finland	4	2,250
France	36	27,094
Germany	67	49,950
Ireland	1	700
Italy	10	8,100
Netherlands	3	2,250
Portugal	3	1,950
Spain	8	6,100

Table A2: *Descriptive statistics of the green bond sample by rating*

Rating	# of GB	Amount Outstanding (EUR mil)
AAA	20	34,500
AA+	13	6,550
AA	7	5,600
AA-	3	1,550
A+	6	3,300
A	3	1,500
A-	37	11,250
BBB+	21	18,194
BBB	17	12,250
BBB-	7	4,550
BB+	1	500
NR	1	150

Table A3: *Descriptive statistics of the green bond sample by sector*

Sector	# of GB	Amount Outstanding (EUR mil)
Financial Corporate	88	57,844
Non-Financial Corporate	39	30,750
Government	9	11,300

Table A4: *Tests performed for the fixed-effects regression, defined by equation 6. The results are presented in terms of P-values and their interpretations*

	Panel: Δy controlled by ΔBA		
	Test	P value	Conclusion
Fixed vs. Random effect	Hausman	0.0044	Fixed effect
Individual effect	F-test	< 0.00001	Individual effect
	Breusch-Pagan test	< 0.00001	Individual effect
Serial correlation	Wooldridge test	< 0.00001	Serial correlation
Heteroscedasticity	Breusch-Pagan test	< 0.00001	Heteroscedasticity

Table A5: *Tests performed for the cross-sectional regressions, defined by equations 7,8 and 9*

		p_i		
		(a)	(b)	(c)
Breusch-Pagan	P value	> 0.0001	> 0.0001	> 0.0001
Multicolinearity test	Rating	2.28	2.28	2.86
	log(Amount Outstanding)	1.54	1.54	1.76
	Covered	1.42	1.42	1.53
	Maturity	1.19	1.25	1.51
	Sector Financial	2.00	2.01	2.15
	Sector Government	1.47	1.48	1.52
	CBI certified		1.06	1.12
	Country FR			1.40
	Country IT			1.50
	Country ES			1.65

Figure A1: *Top 5 types of use of proceeds in the green bond sample. The percentage represents a share of issuers that mention a particular type of use of proceeds in their green bond framework*

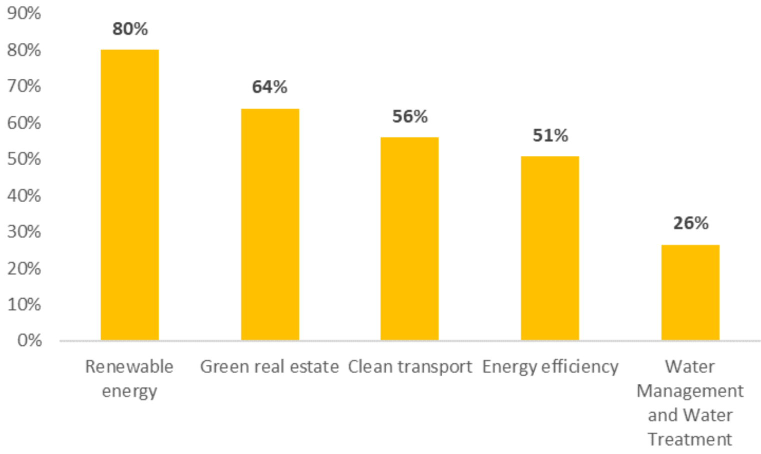

Figure A2: *The comparison of the distribution of green bonds between the green bond sample in our analysis (Matched GB) and green bonds in the Eurozone (Total GB sample). Charts on the left represent comparison by sector, while charts on the right represent comparison by rating. Top charts show the comparison of proportions of number of green bonds, while bottom charts – proportions of their amount outstanding.*