

(In)-Credibly Green: Which Bonds Trade at a Green Bond Premium? *

Julia Kapraun[†] & Christopher Scheins[‡]

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Abstract

The most important determinant for the existence of a Green premium is the perceived “Green-credibility” of the corresponding bond and its issuer. We analyze a large sample of more than 1,500 Green bonds with respect to their pricing on the primary and secondary market. On both markets, only certain types of Green bonds trade at a Green premium (i.e., exhibit lower yields) relative to their conventional counterparts, namely those, which are issued by governments or supranational entities, denominated in EUR or USD, or corporate bonds with very large issue sizes. 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. For corporate issues, credibility of the Green label reveals to be of particular importance. Investors are more likely to consider a corporate bond as Green, i.e., be willing to pay a premium for it, when the bond is certified as such by a third party, or when the bond is listed on an exchange with a dedicated Green bond segment and tight listing requirements.

Keywords: Green bonds, Sustainable investing, Green premium, Green exchanges

JEL Classification: C33, G12, G14, G20, Q56

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[†]Corresponding author. Goethe University Frankfurt, Theodor-W.-Adorno-Platz 3, 60323 Frankfurt, email: julia.kapraun@hof.uni-frankfurt.de. Tel.: +49(0)69798 33728

[‡]Goethe University Frankfurt, Theodor-W.-Adorno-Platz 3, 60323 Frankfurt, email: christopher.scheins@hof.uni-frankfurt.de.

1 Introduction

*“There’s growing demand for Green bonds but no international standard to ensure their Greenness”.*¹

Green bonds, i.e., bonds which are supposed to finance environmentally sustainable projects, are seen as one of the key catalysts of the shift to a low-carbon global economy. Glomsrød and Wei (2018) and Flaherty et al. (2017) estimate that the diversion of capital from fossil industries to more sustainable sectors, in particular through Green bonds, will support economic sustainable growth, increase world GDP and drastically reduce greenhouse gas emissions. Although the market for Green bonds is still relatively small, it is by far no longer a niche segment, and Green bonds have been issued by governments and corporates in over 30 different currencies across the globe. Since the first Climate Awareness Bond was issued by the European Investment Bank in 2007, the cumulative issue volume has grown rapidly and is expected to reach \$1tn by the end of 2019.²

Our study is motivated by the ongoing debate about the willingness of investors to pay a *premium* (i.e., accept lower yields) for a Green bond compared to an otherwise identical conventional bond. Generally, recent studies provide evidence that investors value sustainability (Hartzmark and Sussman (2019), Ceccarelli et al. (2019), Ammann et al. (2019)) and are willing to pay for non-pecuniary characteristics of investments (Barber et al. (2018), Riedl and Smeets (2017), Bauer et al. (2019)). Furthermore, Green bonds are found to attract new investor clienteles, and the issuance of Green bonds tends to have positive effects on liquidity, institutional ownership and stock prices (e.g., Flammer (2018), Tang and Zhang (2018)). Yet, the results on the pricing implications for Green bonds are so far very mixed and depend largely on the sample and the methods applied in the course of the analysis. Some studies report Green bonds trading at lower yields (i.e., at a premium) than conventional bonds (see, e.g., Preclaw and Bakshi (2015), Ehlers and Packer (2017), Nanayakkara and Colombage (2018), or most recently, Zerbib (2019) and Baker et al. (2018)) by analyzing credit spreads, options data, or by using matching

¹www.marketwatch.com, published on Oct 14, 2019

²<https://www.ft.com/content/f9baa3b8-f51d-11e9-b018-3ef8794b17c6>

approaches in primary or secondary markets. However, other studies (e.g., Karpf and Mandel (2017), Hachenberg and Schiereck (2018), Larcker and Watts (2019)) document no significant difference in yields or even higher yields for Green bonds (Karpf and Mandel (2018), Bachelet et al. (2019)). Although most of these studies rely only on a very small set of bonds or focus on special types of bonds (e.g., US municipals) or markets (primary or secondary), they provide guidance for investors and Green bond issuers and are widely cited in practitioners' reports (e.g., by the Climate Bond Initiative, publications like "Institutional Money", or most recently in a Bundesbank report³).

With an increasing number of reports and studies on Green bonds providing conflicting evidence, an important question which arises among practitioners and researchers alike is *why* there is such a pronounced heterogeneity with respect to results concerning the existence of a Green premium. In this study, we shed more light on the pricing of Green bonds by linking the investors' valuation of the Green label to the "*Green-credibility*" attributes of the corresponding bond and its issuer.

The structure of the Green bonds market leaves room for different considerations, why investors might challenge or even doubt the Green-credibility of a bond. With the rapidly growing number of Green bond issues and issuers across the globe, the need for more transparency, regulation, and clear standards arises. The issuance of Green bonds is still an unregulated process, and each issuer and country can decide on the criteria making its bonds green. Although the ICMA Green Bond Principles⁴ have become the leading issuance framework for Green bonds, and the European Commission has made a proposal for EU Green Bond Standards, these guidelines are still voluntary, and there is no harmonized framework for the selection of eligible projects or reporting. Many investors are thus skeptical about Green marketing and "Greenwashing", i.e., misleading claims regarding Green credentials. Consequently, they have doubts concerning the Green-credibility of issuers, which have a reputation of being major polluters (e.g., from sectors such as transportation or nuclear energy). For example, most recently, a Green bond issued by

³See <https://www.bundesbank.de/de/publikationen/berichte/monatsberichte/monatsbericht-oktober-2019-811908>

⁴See <https://www.icmagroup.org/green-social-and-sustainability-bonds/green-bond-principles-gbp/> for the most recent guidelines

the shipping company Teekay Shuttle Tankers, failed to raise enough money to build fuel-efficient tankers.⁵ Although, so far, there are not many other such cases of Green bonds branded “oxymoronic”, these examples indicate that investors’ scrutiny grows, and that they do not blindly pay a premium to all bonds labeled Green.

Our main research questions can be formulated as follows: (a) Is there a *premium* for Green bonds, i.e., do Green bonds exhibit lower yields than their conventional counterparts? (b) Is there *heterogeneity* with respect to the yield differential across markets (primary vs. secondary), currencies, issuers, or other characteristics? (c) Are there any Green bonds, which appear to be more *Green-credible* and which, thus, trade at a premium on both markets?

To measure Green-credibility we consider several variables related to the characteristics of the bond, its issuer and its issue country, which might be relevant for investors’ acceptance of the Green label. At the issue level, we evaluate the effect of the specific project category financed by a Green bond, an additional external certification of the Greenness of the bond, reputational effects of the very first Green issue by a given issuer, and the listing of the bond on so-called “Green exchanges”, i.e., exchanges with a dedicated segment for Green bonds and additional listing requirements. At the issuer level, we distinguish between a corporate and a “more official” issuer type, such as governments, local governments, and supranationals. There might be of course also official entities issuing Green bonds from countries with rather low domestic sustainability efforts⁶ or large corporate issuers from green sectors such as renewable energy or sustainable transportation. Nevertheless, within the country of issue, Green bonds issued by more official entities might be viewed as more credible in terms of a better implementation and/or greater impact of the Green project to be financed by the bond. In the analysis of the corporate sample we further include a sustainability (ESG) rating of the corresponding issuer to account for heterogeneity across different sectors and to measure the effect of the overall sustainability reputation of the issuer on the acceptance of the Green label

⁵See e.g., <https://www.ft.com/content/b1d4201c-f142-11e9-bfa4-b25f11f42901>.

⁶For instance, Nigeria, which ranks #100 out of 180 countries based on the Environmental Performance Index developed at Yale University (see <https://epi.envirocenter.yale.edu/>) has issued two Green bonds.

by investors. For a general sentiment towards environmental trends and sustainability efforts in the corresponding issue country, we consider the Environmental Performance Index (EPI) developed at Yale University⁷, which ranks 180 countries on 24 performance indicators covering environmental health and ecosystem vitality. So for instance in 2018 ranking, while most European countries have scores around 80 and rank within top 20, China, being top 3 Green bond issuer, has a score of 50.74 and ranks #120 out of 180. According to the Yale methodology, low scores on the EPI indicate the need for national sustainability efforts with regard to several major environmental issues. The trust of investors to Green labels, and the willingness to contribute to national environmental efforts could be, thus, particularly high in countries with established environmental policy goals.

Finally, we also account for possible heterogeneity across currency markets by considering currency fixed effects and by splitting our sample by top three currencies in terms of issue volume (EUR, USD, CNY). Obviously, there may be other reasons than Green-credibility for the decision to issue in a specific currency. Still, since Green bonds are issued in over 30 different currencies, investors in some countries (e.g., Mexico) with rather low sustainability reputation might trust and value the label of Green bonds denominated in major currencies (EUR, USD) more than of those denominated in local currency.

To the best of our knowledge, we are the first to collect and analyze such a large and recent global data set on Green bonds with the majority of these bonds issued within the past two years. In our primary market analysis we consider over 1,500 Green and 200,000 conventional bonds, and find Green bonds to trade at *significantly lower yields* of around 18 bps, on average. This Green premium, however, *varies substantially* across currencies and issuer types. While investors accept 20–40 bps lower yields for bonds issued by governments, local governments or supranationals, or bonds denominated in top two major currencies (EUR and USD), the premia for small and medium-sized corporate Green bonds or bonds issued in other currencies are not significant. Particularly for the pricing of corporate Green bonds, an external certification of the bond’s “Greenness”

⁷<https://epi.envirocenter.yale.edu/>

proves to be of utmost importance.

To shed more light on possible heterogeneity in pricing between primary and secondary markets for Green bonds, we consider a secondary market data for a sample of Green bonds issued by companies and institutions, which offer both Green and conventional bonds. This allows us to disentangle the “Greenness” effect from other issuer specific yield drivers. Surprisingly, using the full sample, we find around 10 bps *higher yields* for Green bonds, on average, i.e., Green bonds trading at a *discount* compared to their conventional counterparts on the secondary market. Only Green bonds issued by governments or supranational institutions are traded at slightly lower yields (3 bps), while corporate bonds have on average 33 bps *higher yields* than conventional bonds. It is thus particularly corporate Green bonds, which suffer from the worse valuation of the Green label on the secondary market. This strong heterogeneity in pricing remains also when we consider only the data of the very active trading phase in the first week after issuance.

To investigate the drivers of the Green bond premium in greater detail, in our final analysis we analyze around 4,500 *matched bond pairs*. To this end, we compare Green bonds with conventional bonds of the *same issuer*, with the *same* rating, seniority, currency and bond type and with similar issue sizes and maturities. In addition to the bond’s attributes, which we found to be relevant in our primary analyses, the results of this study clearly emphasize the importance of the overall Green-credibility of the issue, the issuer and the issue country for the Green bond to be accepted as such by investors. The difference in yields is substantially lower for pairs with the Green bond listed on an exchange with a dedicated Green market segment with additional requirements on sustainable credentials (-7 bps), or for pairs where the Green bond is issued in a country with high national environmental standards (-6 bps). When considering the overall sustainability rating of the Green bond issuer, we find issuers ranked within the top 30% to benefit from a yield reduction of around 15 bps compared to corporations ranked in the middle 40%. This might be particularly driven by investors applying a top-down approach in their asset selection process, i.e., they first select the pool of eligible companies by considering only those firms with a top ESG rating, and then choose the corresponding

instruments. Interestingly, despite the few “oxymoronic” Green bonds not accepted by the markets, there are also investors who credit the overall impact of the Green bond project and reward also companies with very low sustainability ranking, but which try to reform their business through projects financed by Green products.

2 The Market for Green Bonds

For this study we collect a large amount of data on bonds which are classified as “Green” from three different sources: Climate Bonds Initiative (CBI), Bloomberg and Thomson Reuters Eikon. The initial data set contains around 2,000 Green bonds with a total issuance volume of \$487 bn.⁸ In 2007, the European Investment Bank pioneered the Green bonds market by issuing the first Climate Awareness Bond. 10 years later, more than 2,000 Green bonds have been issued in 30 different currencies worldwide. The majority of these bonds followed the Paris Agreement of 2015 with over 300 bonds issued yearly with increasing issuance volumes. Figure A.1 reports the yearly issuance volumes (in bn USD) split by issuer type.

–Insert Figure A.1 here–

A brief overview over some characteristics of the Green bonds in our data set can be found in Table A.1. Around 75% of all Green bonds in our sample have an issue volume below \$400m. The average Green bond has a maturity of 8.76 years, annual coupon of 3.28% and an issuance yield of 3.26%.

–Insert Table A.1 here–

21% of the Green bonds in our sample are traded on so-called Green exchanges. In the last few years many exchanges have launched dedicated segments exclusively for Green bonds, which have improved the liquidity and transparency of the Green bonds market

⁸We excluded more than thousand mortgage bonds issued by Fannie Mae with the average size of \$23m.

and provided access to different types of investors. More importantly, Green exchanges increase credibility of the Green label, since bonds listed in dedicated segments are usually required to meet certain standards with respect to reporting, external reviews etc. For instance, the Luxembourg Green exchange, one of the first dedicated Green bond platforms, requires issuers to follow the Green Bond Principles, the CBI Climate Bonds Standard eligibility taxonomy or other related frameworks⁹. Most recently, the London Stock Exchange tightened its Green bonds listing standards by introducing mandatory annual post-issuance reporting requirements for issuers, to “provide transparency to investors on the ongoing use of proceeds and demonstrate continued eligibility over the lifetime of the bonds”.¹⁰ Table A.2 provides an overview of Green bonds from our sample listed on such Green exchanges.¹¹

–Insert Table A.2 here–

In our sample we have in total 545 different issuers, which have issued over 2,000 Green bonds. Figure A.2 displays a histogram of the number of Green bonds per issuer. Around 50% of issuers have issued one single Green Bond so far, while 5% of issuers account for 50% of all Green bonds in our sample. Furthermore, 40.18 % of all issuers have issued only Green and no conventional bonds. This will be particularly relevant for our analysis of the secondary bond market, where we compare Green and conventional bonds of the same issuer and have, thus, to exclude these issuers.

–Insert Figure A.2 here–

While the first Green bonds were issued by supranationals¹², by the end of 2018, corporations from different sectors (e.g., energy, financials) and government entities are among

⁹See https://www.bourse.lu/sustainability_standards_and_labels for an overview of various Green bond standards.

¹⁰See <https://www.lseg.com/resources/media-centre/press-releases/london-stock-exchange-launches-green-economy-mark-and-sustainable-bond-market>.

¹¹Our list of exchanges with a Green bond segment is, however, not complete, as we only have information on the bonds in our sample per end of 2018 with existing information on the listing. Further exchanges, such as e.g., Frankfurt or Borsa Italiana with up to 150 Green bonds listed by the end of 2018, do not appear in our sample.

¹²European Investment Bank (EIB) and World Bank

the largest issuers. Table A.3 displays the top 10 Issuers with respect to the number of bonds issued and issuance volumes. Nearly half of the corporate Green bonds were issued by banks, followed by issues from the sectors “Corporate Financial Services” and “Electric Utilities”. Most of the Green bonds are issued to finance renewable energy projects, energy efficient buildings or used to finance clean transport and sustainable water management projects.

–Insert Table A.3 here–

Green Bonds are issued in every major currency across the globe, although there is a strong focus on the USD and EUR. Figure A.3 presents the number of bonds (right pie) and issue volumes (left pie) for different currency markets. Most and largest bonds are issued in USD (\$157bn), Euro (\$146bn), Chinese Yuan (\$75bn), and the Swedish Krona (\$23bn). Although there are more than twice as many Green bonds issued in USD compared to those issued in EUR, the USD bonds have lower issuance volumes, on average. With 16 per cent of the world’s Green bonds in terms of issue volume China is emerging as a key player in the Green bond market, though the Chinese guidelines on the Green bond issuance deviate from the international standard. In particular, only 50% of proceeds are required to be invested in sustainable projects, while it is the case for over 90% in Europe.¹³

–Insert Figure A.3 here–

3 Data and Green-Credibility Variables

3.1 Data collection

To collect all relevant data on Green and conventional bonds and their issuers, we first obtain a list of ISINs of Green bonds, by taking the union of a list provided by the

¹³See https://www.bourse.lu/sustainability_standards_and_labels for different Green bond standards.

Climate Bond Initiative (CBI), bonds that are classified as Green in Reuters and bonds with “Green” use of proceeds flag on Bloomberg. Over the last years, Fannie Mae, a US government-owned entity that provides a secondary market for home mortgages, issued a lot of Green bonds, however we could not obtain any trading characteristics for the most of them. In addition, these bonds are usually relatively small and, therefore, we excluded all of them for our analysis. Our final set consists of 2,114 Green bonds.

Next, we collect ISINs of conventional bonds with different coupon types, issued after 2009 and which started with all combinations that are present in the ISO 31661 alpha-2 list¹⁴. Though we focus on Fixed Coupon Plain Vanilla Bonds (FXPV) in our analysis, we also included other bond types for issuers, which also issued at least one Green bond. This gives us a universe of 408,997 Green and conventional bonds in total.

Finally, we downloaded main characteristics of these bonds, i.e., the issue date, maturity date, coupon, yield at issuance, amount issued, currency, sector, ratings from different agencies and others using Reuters and Bloomberg as our primary data sources. Summary statistics for the bonds used in our primary and secondary analyses can be found in Table B.1 and Table B.2 in the following sub-sections.

3.2 Primary Market Data

In the primary market analysis we consider only bonds with available data on either Issue Yield or Issue Price. We restrict our sample to Fixed Coupon Plain Vanilla Bonds, which allows us the exact calculation of the issue yield, using maturity, coupon rate and frequency, and issue price information. We end up with around 1,500 Green and 200,000 conventional bonds in total. In some specifications our sample is further reduced due to the unavailability of data on, e.g., rating or seniority. Table B.1 provides descriptive statistics for the Green and conventional bonds used for this analysis. The characteristics for Green bonds are very much similar to our full sample in Table A.1. The average Green

¹⁴The first two letters of any ISIN can be used to identify most countries of origin with the help of the ISO 31661 alpha-2 list, i.e. US is the two letter abbreviation for the United States and DE is the two letter abbreviation for Germany. We extended the list with XS, as this abbreviation is frequently used for international issues

bond in our sample has a maturity of 9 years, an issuance volume of around \$287m and is issued at prices slightly above par. The corresponding conventional bonds in Panel B have similar maturities and issue sizes but higher coupons and yields.

–Insert Table B.1 here–

In a sub-sample analysis we consider bonds issued in different currencies to reveal possible differences across currency markets, and obtain 258 Green bonds in EUR, 392 Green bonds in USD and 180 Green bonds in CNY with available data on the issue yield. We further include an analysis for different issuer types such as corporates, government and supranational entities. Out of 1,513 Green plain vanilla bonds 781 are issued by corporates, 322 by supranationals such as, e.g., European Investment Bank, and 414 by government entities.

3.3 Secondary Market Data

In our secondary market analysis, we focus on the differences between the yields to maturity of Green and conventional bonds. To disentangle the Green effect from other issuer specific effects, we now only consider issuers with both types of bonds. This yields a sample of 769 Green bonds with at least one comparable conventional bond issued by the same company between 2009 and December 2018. Detailed statistics about the data used for the secondary market analysis are shown in Table B.2. Notably, Green bonds issued by companies which also issue conventional bonds, appear to have shorter maturities, much larger issuance volumes and are issued below par in contrast to the average Green bond from our primary analysis in Table B.1.

–Insert Table B.2 here–

3.4 Measuring Green-credibility

To measure Green-credibility we consider several variables related to the characteristics of the bond, its issuer and its issue country, which might be relevant for investors' acceptance

of the Green label.

While the first Green bonds were issued to finance projects from traditionally sustainable sectors, e.g., renewable energy, the list of eligible Green project categories has been extended over the last years.¹⁵ Now, also companies and countries contributing to global greenhouse gas (GHG) emissions can issue Green bonds to finance projects related to e.g., sustainable water-, energy- or waste management, or to build so-called green buildings. So for instance, in 2016, the Mexico City Airport trust issued a \$6bn Green bond in order to finance the construction of a new airport, which attracted significant public attention and discussions whether airports, being one of the biggest polluting industries, can be suitable for Green bonds projects. When assessing the value of a Green label, investors, therefore, might also take the related Green project into consideration. To evaluate the effect of the specific project category financed by a Green bond we include top 4 categories stated in the bond's prospectus: a rather general project category *Eligible Green Bond Project*, and more specific categories *Energy Efficiency*, *Alternative Energy* and *Clean transportation*.

The sustainability of the Green bond and its related project can be further certified by a third party. A large number of so-called approved verifiers (such as for instance, Sustainalytics, Cicero, Vigeo Eiris etc.) provide a pre- or post-issuance certification based on different Green bond standards. In particular, the use and management of proceeds as well as allocation and impact reporting are reviewed.¹⁶ To estimate potential differences in pricing of certified and non-certified Green bonds, in our primary and secondary market analyses, we include a dummy variable *Certified*, which is one for all Green bonds with a third party certification, and 0 otherwise.

Another confirmation of credibility of the Green bond and its label can be provided through a listing of the bond on exchanges with a dedicated Green bonds segment. As mentioned in Section 2, most of these exchanges have very tight listing standards with respect to additional certification and reporting over the lifetime of the bond. We expect,

¹⁵See for instance, the list of eligible Green project categories provided in the ICMA Green Bond Principles.

¹⁶An example for such a certification can be found for bonds listed on the Luxembourg Green exchange.

thus, bonds listed on such exchanges to appear more credible to investors, or at least, to suffer less from any Greenwashing concerns. To investigate the determinants of the Green bond premium, in our secondary market analysis we, therefore, include a dummy variable *GreenEx*, which is 1 for Green bonds traded on Green exchanges.

In our sample, we have issuers with so far only one Green bond and repeated issuers with 2 and more bonds. To evaluate the effect of the very first Green issue on the bond price, we include a dummy variable *FirstIssue*. While we, on the one hand, expect positive reputational effects for the very first Green bond (similar to the positive stock price reaction on the issue announcement date, documented e.g., by Flammer (2018)), issuers with a secondary and further issues might be viewed as more experienced or already verified as Green bond issuers by market participants, on the other hand.

In addition to the bond's attributes, we consider further variables related to the overall Green-credibility of the issuer and issue country. To this end, we include the Environmental Performance Index (*EPI*) developed at Yale university, which measures environmental trends and progress of the corresponding country. It ranks 180 countries on 24 performance indicators covering environmental health and ecosystem vitality.¹⁷ Figure B.1 displays EPI scores for 2018. The top three countries are Switzerland, France and Denmark, while Bangladesh and Burundi are at the bottom of the list. According to the Yale methodology, 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 GHG emissions. The trust of investors to Green labels, and the willingness to contribute to national environmental efforts could be, thus, particularly high in countries with established environmental policy goals.

–Insert Figure B.1 here–

Finally, we consider the overall sustainability (ESG) rating of the issuing entity provided by Sustainalytics. The Sustainalytics ESG Rating is a quantitative score on a scale of 1-100, measuring “how well issuers proactively manage the environmental, social and

¹⁷See <https://epi.envirocenter.yale.edu/> for more details on the calculation methodology.

governance issues that are the most material to their business”.¹⁸ It classifies firms in Laggards, Underperformers, Average Performers, Outperformers and Leader, with a score above 70 indicating Leaders and a score below 40 indicating Laggards.¹⁹

In our secondary market analysis we consider the effect of the sustainability rating for corporate issuers with available ESG scores. We obtain ESG scores for 161 issuers which account for around 35% of the corporate Green bonds in our sample. These issuers are located in over 30 different countries with around 50% coming from US (19 issuers), Japan (19), Germany (12), Taiwan (10) and Sweden (10). Also in terms of sectors is our sample well diversified, with issuers representing over 15 different sectors, such as e.g., “Transportation”, “Utilities”, “Financial services” or “Real Estate”. Interestingly, while most of the issuers in our sample have a solid reputation of sustainability in general (with an average ESG score of 68), there are several Green bonds issued by companies with rather low sustainability rankings (minimum score is 38). As illustrated in Figure B.2 nearly 25% of all issuers with available data on the rating have a score below 60, which indicate average and underperforming companies.

–Insert Figure B.2 here–

For this analysis, we include two dummy variables *ESGScoreLow* and *ESGScoreHigh*, which indicate companies ranked within the bottom and top 30% of the issuers. To this end, we want to investigate how investors evaluate the Green label of bonds, issued by companies with a very good and a very bad sustainability reputation compared to an average company. From a rational point of view, when looking at companies with top ESG ratings, there should be only a small, if at all, significant effect of the Green label on the bond price, since the conventional bonds of these companies already finance purely Green projects. On the other hand, institutional investors trying to avoid negative headlines due to possible Greenwashing issues or “shades of Green”²⁰ of bonds from other sectors,

¹⁸Please note that Sustainalytics adjusted its ESG methodology in 2019, with rating scale 100 being the most severe risk category. See <https://www.sustainalytics.com/> for more details.

¹⁹Exact thresholds for the cut-offs are industry-specific and can vary.

²⁰See e.g., <https://www.globalcapital.com/article/b1dpvkz9g111vw/light-green-bonds-throw-no-shade-on-the-dark-green-market>

would particularly demand for Green bonds issued only by companies with an excellent reputation. Interesting can be also the evaluation of Green bonds issued by companies with very low ESG scores. While such bonds are sometimes branded “oxymoronic”, and investors might question the sustainability of related projects, on the other hand, the so-called “impact investors” might particularly reward companies which try to improve their business practices, e.g., by significantly reducing GHG emissions, through projects financed by Green bonds.

Apart from the more obvious credibility variables related to bond’s and issuer’s attributes described above, we also include sub-sample analyses by splitting the sample on bond’s issue currency, issuer type and issue size. While the relevance of the latter might be more intuitive, since large bonds tend to be more liquid (and large Green bonds tend to be even more liquid than comparable conventional bonds, as documented by, e.g., Bachelet et al. (2019)), and the impact of the financed Green project is perceived to be larger, interpretations based on currency and issuer type effects should be stated more carefully.

At the issuer type level, we distinguish between a corporate and a “more official” entity, such as governments, local governments, and supranationals. There might be of course also official entities issuing Green bonds from countries with rather low domestic sustainability efforts (such as e.g., Nigeria or Mexico) or large corporate issuers from more sustainable sectors such as renewable energy or sustainable transportation. Yet, after controlling for the country of issue, Green bonds issued by governments and supranational entities tend to have larger issue sizes and might be viewed as more credible in terms of a better implementation, clearer documentation and a greater impact of the Green project to be financed by the bond.

Similar argumentation can be applied to the samples split by top three currencies in terms of issue volume (EUR, USD, CNY). Obviously, there may be other reasons than Green-credibility for the decision to issue in a specific currency. Still, since Green bonds are issued in over 30 different currencies, and some issuers do offer Green bonds in different currencies on the same markets (e.g., KfW or EBRD), investors in some countries (e.g., China or Mexico) with rather low sustainability reputation might trust and value the

label of Green bonds denominated in major currencies (EUR, USD) more than of those denominated in their local currency.

4 Empirical Analysis

4.1 Primary market analysis

To reveal possible differences in yields of Green and conventional bonds, in this section we focus on yields at issue following the regression model applied by Baker et al. (2018):

$$Y_{i,t,b} = FE_{i,t,b} + \beta \cdot Green_{i,t,b} + \epsilon_{i,t,b}, \quad (1)$$

where $Y_{i,t,b}$ is the yield at issuance of bond b , issued by the issuer i in month t . FE are issuer, year-month, currency, seniority and issue country fixed effects. We further include maturity bucket and issue size bucket fixed effects, where maturity buckets are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to maturity, and issue size fixed effects are the deciles of the issue volume (in USD) in comparison to all other issues that occurred before or in the same month as the issue. The dummy $Green_{i,t,b}$ is the main variable of interest and is equal to 1 if the bond is labeled as Green, and 0 otherwise.

Table C.1 presents our main results for the full sample. After accounting for year-month, issuer and currency fixed effects, regression in specification (1) reveals that Green bonds are issued at a lower yield of around 15 basis points than comparable conventional bonds. For primary market, we can thus, conclude that Green bonds trade at a significant Green premium. Controlling for other relevant bond characteristics in columns (2) and (3), further highlights the value of the Green label: The coefficient on the *Green* dummy variable increases to 18 bps in our main specification (3).

–Insert Table C.1 here–

In specification (4) we consider pricing effects on bonds financing different types of Green projects, and find these to be mostly insignificant, although we observe that a rather general category *Eligible Green Bond Project* seems to be less accepted than more specific projects from categories *Energy Efficiency* or *Alternative Energy*.

To shed more light on the different currency and issuer type effects, in Table C.2 we present the results of specification (3) of Table C.1 for different sub-samples. First, in columns (1) to (4) in Table C.2 we observe a significant heterogeneity in premia across currencies. While Green bonds denominated in major currencies, EUR and USD, trade at a significant premium of up to 39 bps, bonds issued in other currencies, such as e.g., CNY, appear to be less attractive and trade at similar yields as their conventional counterparts. This might be an indication that Green bonds, which follow European or acknowledged international (and not, e.g., local Chinese) Green Bond Principles are more recognized among investors.

–Insert Table C.2 here–

In columns (5) and (6), we consider Green bond premia for different types of issuers. After controlling for different fixed effects (particularly, for issue size and maturity buckets), we find very high premia of around 31 bps for Green bonds issued by governments and supranationals, while the premia for corporate Green bonds are not statistically different from zero. Investors thus, rely more on the Green label and strict implementation of Green projects by official entities rather than by corporations.

In our final analysis of the primary market, we investigate, which characteristics of a corporate Green bond might improve its pricing compared to a conventional one. For better comparison, we display the base result for the full corporate sample in specification (6) of Table C.2 in column (1) of Table C.3. Specifications (2–3) present results for the sub-samples split by the issue size of the bond. Here, we first consider very large Green bonds (*Corp+Large* sample), defined as bonds within the top 30% of the issue size in comparison to all other bonds in our sample, issued before or in the same month, and find these bonds to trade at significant premia of 19 bps similar to our full sample

analysis. However, if we restrict our analysis to rather small issues, here with an issue size below median in comparison to all other bonds (*Corp+Small* sample), we observe a significantly positive and large coefficient on the *Green* dummy variable and, thus, higher yields for these Green bonds.²¹ For a corporate Green bond, the issue size has, obviously, a huge impact on the yield at issuance. Investors are willing to pay a premium for corporate Green bonds only when the related Green project reaches a certain size and has, consequently, a larger environmental impact.

Another important attribute of the corporate bond for the acceptance of its Green label, i.e., lower yields, reveals to be an additional external review confirming its sustainability credentials.²² Specification (4) shows that corporate Green bonds which are certified as Green, trade at significantly lower yields of around 22 bps than Green bonds without a certification.

Finally, in our last specification we investigate the pricing of the issuer's very first Green bond. While one could expect some positive effects of the issuer's experience on the second and further issues (i.e., Green bonds for which our dummy variable *FirstIssue* is 0), we could not verify this in our full and sub-sample analysis. On the contrary, corporate Green bonds benefit from reputational effects of being first-time Green issues by a given issuer. In column (5) of Table C.3 we observe a significant yield reduction of around 18 bps for very first corporate Green bonds.

–Insert Table C.3 here–

To summarize, the results of this section reveal significant premia for Green bonds on primary markets, on average. However, the willingness of investors on primary markets to pay higher prices for Green bonds depends on bonds and issuers specific characteristics. In particular, investors accept lower yields for bonds denominated in major currencies, issued by a government or a supranational entity, or for corporate bonds with large issue size and external certification.

²¹The coefficient is even larger if we consider only bonds within the bottom 30% of the issue size.

²²Such reviews, or second party opinions, are provided by e.g., vigeo eiris, CICERO or Sustainalytics.

4.2 Secondary market analysis

Our results from the primary market analysis are based on a broader sample of Green and conventional bonds coming from companies issuing only Green, only conventional, or both types of bonds. In this section we want to disentangle the effect of the Green label from other possible effects on the bond price. To this end, we focus only on those Green and conventional bonds, which are issued by companies with both types of bonds, and end up with 769 Green and 3,389 conventional bonds for this analysis. We have already seen in Table B.2 that these bonds have usually much larger issue volumes than the average Green or conventional bond in our total sample.²³

4.2.1 Yield to Maturity Analysis

Having now 769 Green and 3,389 conventional bonds, we redo our analysis from Section (4.1), where we now regress the *Yield to Maturity* on the *Green* dummy variable. Here we also include the corresponding Bid-Ask spread as a liquidity control (*BidAsk*), as this is particularly important on the secondary market. We further include all fixed effects specified in sub-section 4.1. Column (1) in Table C.4 presents our main result of the analysis, while specifications (2)–(6) present our sub-sample analyses. In contrast to our main result from the primary market (column (3) in Table C.1) with a significant negative coefficient on the *Green* variable, we now find the coefficient for the *Green* dummy to be significantly positive for the full sample. On the secondary market, Green bonds trade at 10 bps *higher* yields than comparable conventional bonds. Also bonds listed in major currencies trade at significant discounts (sub-samples in columns (2)–(4)), though there is a smaller discount for USD than for EUR and CNY denominated bonds. The Green label on the secondary market seems to be less attractive than on primary markets or is even totally undesirable. This struggling finding might indicate that investors on the secondary market have either much lower demand for Green investments, or have additional requirements on the issuer, or do not trust the Green label in general.

²³Results from primary analysis for this sub-sample can be found in Table C.7. In line with our results on the relevance of the issue size in previous subsection, we find even stronger results from primary analysis for this sub-sample.

–Insert Table C.4 here–

Another explanation might be that most attractive Green bonds, which are usually heavily oversubscribed on the primary market, have only few pricing quotes or do not trade on the secondary markets at all, and the result is, thus driven, by less attractive or less liquid Green bonds. We have, however, did not find any significant relationship between the number of observations obtained for Green bonds and the corresponding coefficient on the *Green* dummy variable. To further compare primary and secondary market results, Figure C.1 depicts the percentage of Green bonds trading at a premium on both markets (31%) vs. those which trade at a premium on the primary but at a discount on the secondary markets (31%) and the other two combinations. The red lines represent the means of the *Green* dummy coefficient on the corresponding market. Also from this result we cannot conclude that only less attractive Green bonds trade on the secondary markets.

–Insert Figure C.1 here–

In columns (5) and (6) in Table C.4 we again split our sample based on the issuer type and find now significant difference in terms of pricing across the two groups (Corp vs. Sovr+Supr). Here only Green bonds issued by governments or supranational entities are traded at a small but significant premium of around 3 bps, while corporate bonds have on average 33 bps *higher* yields than conventional bonds. It is, thus, particularly corporate Green bonds, which suffer from the lower demand or appear to be less credible on the secondary market and trade, thus, at significant discounts.

One possible concern with our secondary market data might be the fact that bonds (Green and conventional) are usually actively traded only in the first couple of weeks after issuance, so it might be liquidity issues which drive our results (although we control for differences in Bid/Ask spreads in our analysis). Furthermore, there might be large investors, which are not allowed or willing to buy a bond on the primary market, but, having strong preferences for Green bonds, seize the opportunity as soon as the bond is

tradable, i.e., within the first days after its issuance. To shed light on this issue, we redo our analysis using only the first 1, 2, 3, or 4 weeks of trading. Table C.5 shows the results based on the first week of trading.²⁴ Surprisingly, the value of the Green label seems indeed to decrease significantly over the lifetime of the bond. We find that also shortly after issuance, Green bonds trade at significantly lower yields (4 bps) than their conventional counterparts (column (1)), on average. However, similar to the primary market analysis, we observe a strong heterogeneity in premia across different currencies and issuer types (columns (2)–(6)). So for instance, bonds issued in Chinese Yuan still trade at a huge discount, while EUR and USD denominated bonds have similar prices as their conventional counterparts. Most importantly, here again, we find the Green label to be valuable only for bonds issued by government and supranational entities, with the Green premium being still high at around 13 bps. In contrast to the primary market, however, where corporate Green bonds trade at similar yields as their conventional counterparts, even in the very active trading phase on the secondary market, these bonds trade at a significant discount of 5 bps.

–Insert Table C.5 here–

4.2.2 Determinants of the Yield Differential

In our final analysis we investigate the determinants of the difference in yields between Green and conventional bonds in greater detail by analyzing differences in yields to maturity of *matched* bond pairs.

One of the challenges in this analysis is to properly define the relevant sample of Green and conventional bonds. To this end, for every Green bond we look for conventional bonds, issued by the *same issuer*, with the same rating, same seniority, same currency and same bond type and similar maturity and issue sizes. We restrict the list of comparable conventional bonds to contain at most 10 bonds for each Green bond in order to have a similar weighting of small issuers and issuers with several thousand bonds in our sample²⁵.

²⁴Results for first 2, 3, 4 weeks trading data are similar and available upon request.

²⁵The biggest issuer in our sample has issued 16k bonds, with less than 1% of them classified as Green.

Previous approaches (e.g., used in Zerbib (2019) or Helwege et al. (2014)) compare Green bonds yields to synthetic conventional yields created based on the data of two comparable conventional bonds. The requirement of having at least two conventional bonds per issuer, however, significantly reduces the sample.²⁶ In contrast, our methodology allows us to compare up to 4,546 Green-conventional bond pairs and to control for differences in characteristics we could not match exactly.

For this analysis, we use the mid quotes of both bonds in each pair and calculate the yield spread between the Green and conventional bond, henceforth called *GMC*. We then regress the *GMC* on a number of controls (*C*) and Green-credibility variables (*GC*) described in Section 3.4:

$$GMC_{i,t,p} = \alpha + \beta \cdot GC_{itp} + \gamma \cdot C_{itp} + \epsilon_{i,t,p} \quad (2)$$

As controls we include the differences in bid-ask spreads for Green and conventional bonds, as well as the differences with respect to maturity, coupon, and issue size.

Table C.6 presents our results. In line with our findings in the previous subsection (see Table C.4), in all specifications, the difference in yields is significantly positive, i.e., Green bonds have higher yields than their conventional counterparts. Columns (2)–(4) highlight the relevance of the external certification, the positive reputational effect of the very first Green bond issue, and the type of the issuing entity. Furthermore, in column (5), we observe a considerable impact of the listing of the Green bond. The difference in yields for pairs of Green bonds, listed on the exchanges with a dedicated Green market segment, is significantly lower by around 7 bps. Green exchanges, such as for instance, in Luxembourg or London, provide, thus, higher visibility and transparency for those bonds and increase the reliability of the overall Green bonds market.

–Insert Table C.6 here–

²⁶Around 300 issuers in our sample have issued only one Green bond and no conventional bonds.

Intuitively, also the overall environmental sentiment in the country of issue plays an important role for the acceptance of Green investment products. An increase in the EPI index by 1 reduces the yield differential by around 6 bps (column (6)), which is huge considering the large differences between scores across countries. The trust of investors to Green labels and the willingness to pay a premium for sustainable investments is therefore higher in countries with established environmental policy goals.

One of most interesting results of our last analysis on the determinants of the yield differential is presented in column (7). Here, we consider a sub-set of Green-conventional bond pairs (35% of the full sample) issued by corporate institutions with available data on ESG ratings, and find the sustainability reputation of bond issuers to be highly important for Green bonds' pricing. More specifically, compared to corporations ranked in the middle 40% based on the Sustainalytics ESG score, top 30% rated issuers benefit from a yield reduction of around 15 bps. This might be particularly driven by investors, who apply a top-down approach in their asset selection process, and specify, thus, first the pool of suitable companies by considering only top rankings, and then the corresponding instruments. Also an investment decision for these companies requires less due-diligence as perceived reputational or Greenwashing risks are potentially low.

Nevertheless, there are also Green bond investors who reward companies, rated in the bottom 30%, but which try to improve their emissions through projects financed by Green bonds. The reduction in the yield differential for such companies in comparison to medium ranked corporations is similar to that of the top rated firms (19 bps). Though the few cases of Green bonds failing to raise enough capital signal growing investors' scrutiny of which projects can be reasonably labeled sustainable, Green bonds are still viewed as helpful instruments to move companies in a cleaner direction.

The results of this analysis are similar when we consider only the Environmental Score of the corresponding issuer. Interestingly, the impact of the sustainability reputation becomes less significant when we include more companies from the middle, e.g., top vs bottom 40 %. This is well in line with previous findings by e.g., Hartzmark and Sussman (2019), that investors mostly react to extreme ratings.

5 Conclusion

With booming Green bonds market, the need for more transparency, uniform standards regarding eligibility of Green projects, external certification, and reporting becomes more urgent. Many investors become skeptical about Green credentials of bonds issued by certain companies or countries, and do to trust Green labels without additional verification. Though there is evidence that investors generally value sustainability and are willing to pay for non-pecuniary characteristics of investments, the existing results on so-called Green bond premium are mixed. In this paper, we shed more light on the existence of the Green premium by linking the investors' valuation of the Green label to the “*Green-credibility*” attributes of the corresponding bond and its issuer.

Using data on more than 1,500 Green and 200,000 conventional bonds we reveal about 18 bps *lower* yields at issuance for Green bonds. This premium varies, however, substantially across currencies and issuer types. It is high and significant for bonds issued by official entities such as governments or supranationals, or for bonds denominated in major currencies USD or EUR. For corporate Green bonds, however, additional certification of Green credentials is required. This is true also for secondary markets, where we consider over 4,500 matched Green-conventional bond pairs of the same issuer. In particular we find the Green-credibility of the bond, indicated e.g., by a listing on a Green exchange, the overall environmental sentiment in the country of issue, as well as the sustainable reputation of the bond issuer significantly reducing the Green-conventional yield differential.

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Appendices

A The Market for Green Bonds

Figure A.1: Volume of Green bonds by issuer type

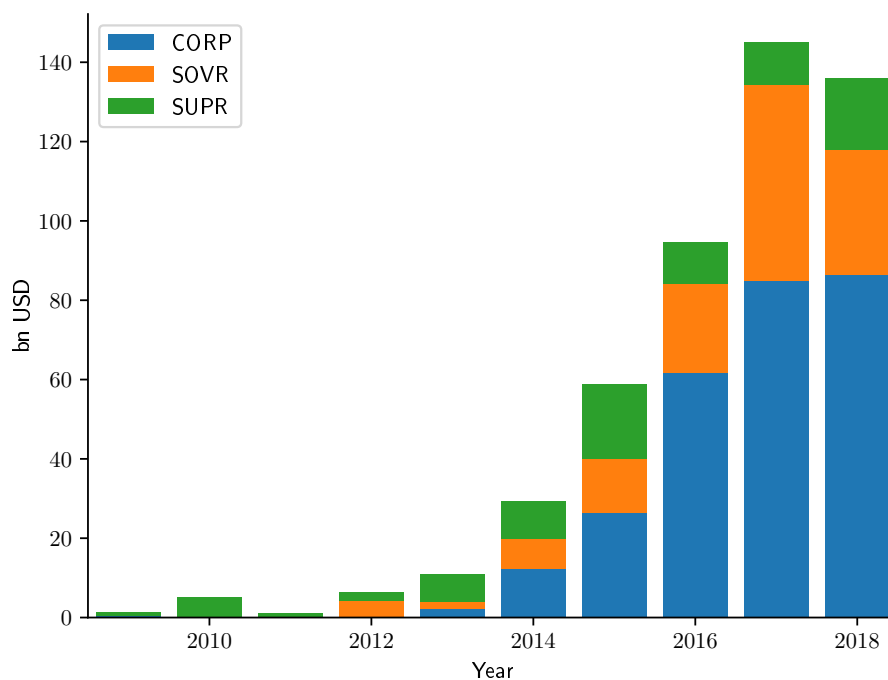


Table A.1: Descriptive statistics for Green bonds.

	5%	25%	50%	Mean	75%	95%	N
Coupon(%)	0.20	1.37	3.12	3.28	4.90	7.76	1,808
Issue Price	98.95	99.86	100.00	100.40	100.00	111.03	1,828
Issue Yield	0.21	1.50	3.01	3.26	4.68	7.80	1,780
Maturity(Years)	2.48	4.00	5.01	8.76	10.01	29.84	1,815
Volume(\$Million)	1.63	13.59	80.34	260.01	390.50	1,000.00	1,826

Coupon (%) is the size of the annual coupon of the bonds; *Issue Price* is the price of the bond at issuance; *Issue Yield* is the yield to maturity of the bond at issuance, which is computed if no data was provided by Reuters; *Maturity (Years)* is the difference between the Issue Date and Maturity Date in Years; *Volume (\$Million)* is the issue volume of the bond converted in million USD.

Table A.2: Green Bonds traded on the Green Exchanges

Exchange	Number	bnUSD
Luxembourg Stock Exchange	113	56.22
Frankfurt Stock Exchange	89	53.44
Milan Stock Exchange	39	34.40
London Stock Exchange	59	11.17
Stockholm Stock Exchange	61	4.24
Oslo Stock Exchange	12	2.13
Taipei Exchange	15	1.33

Number is the number of Green bonds in our sample listed on the corresponding exchange; *bnUSD* is the issue volume of the bond converted in billion USD.

Figure A.2: Number of Green Bonds per Issuer

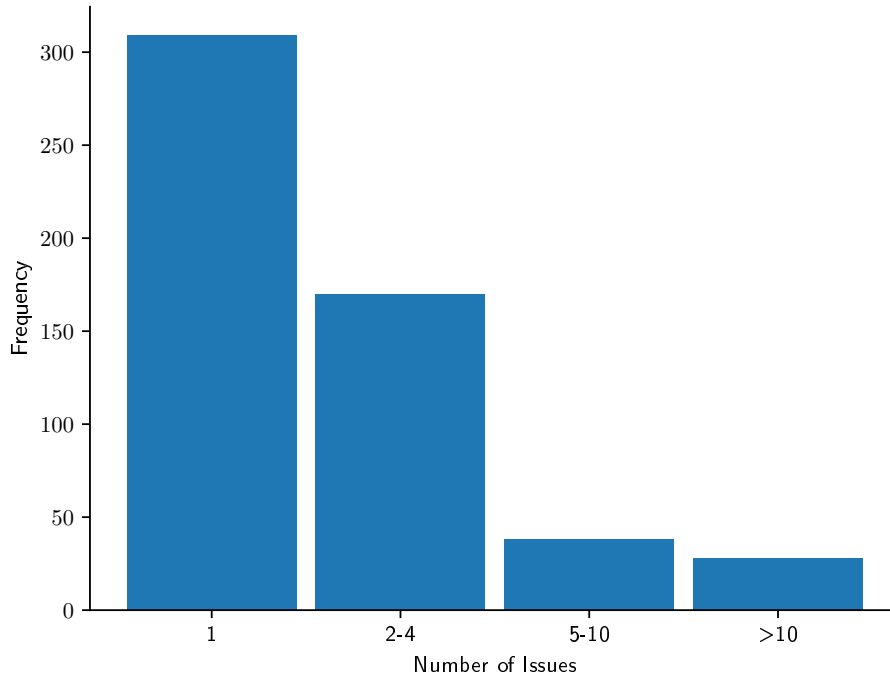
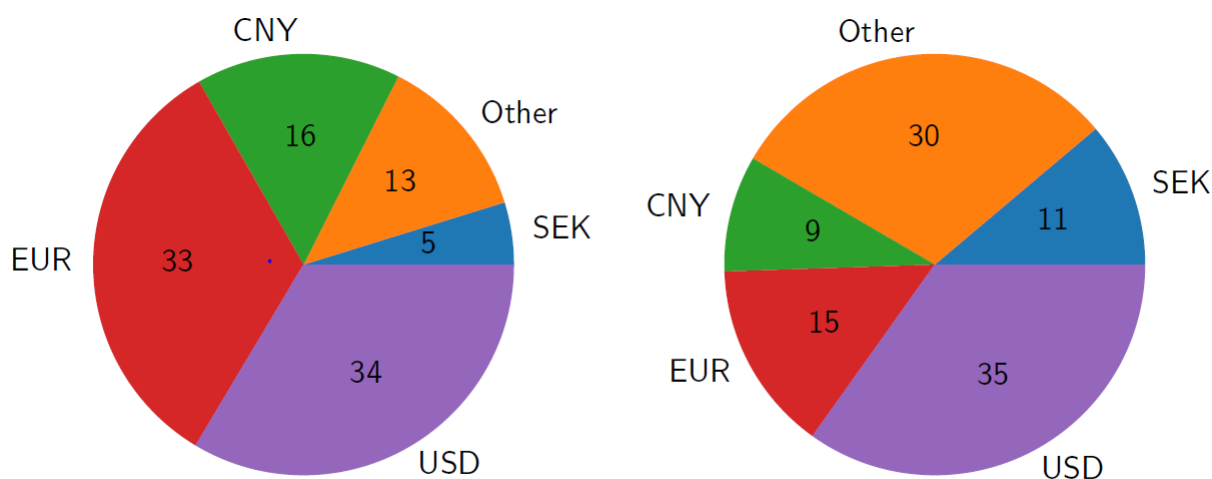


Table A.3: Top 10 Green Bond Issuer per end of 2018

Issuer	bnUSD	# Issued	Sector
European Investment Bank	40.19	49	Banking Services
WindMW GmbH	29.37	80	Electric Utilities & IPPs
Électricité de France S.A.	26.19	18	Multiline Utilities
IBRD	17.00	158	Banking Services
Industrial Bank Co Ltd	16.93	7	Banking Services
KfW	14.74	18	Banking Services
Mexico City Airport Trust	12.00	8	Collective Investments
International Finance Corp	8.46	77	Investment Banking & Investment Services
NRW Bank	7.86	10	Banking Services
Shanghai Pudong Development Bank Co Ltd	7.59	3	Banking Services

Issuer is the most frequently used name for each Parent Identifier, *bnUSD* is the USD equivalent issue volume, *# Issued* is the number of Green Bonds issued by the Parent Identifier, *Sector* is the most frequently named sector for each Parent Identifier.

Figure A.3: Shares of Green Bonds issued by currency



Shares of Green bonds in % of total issue volume (left pie) and total number of bonds (right pie) issued in different currencies per end of 2018.

B Data

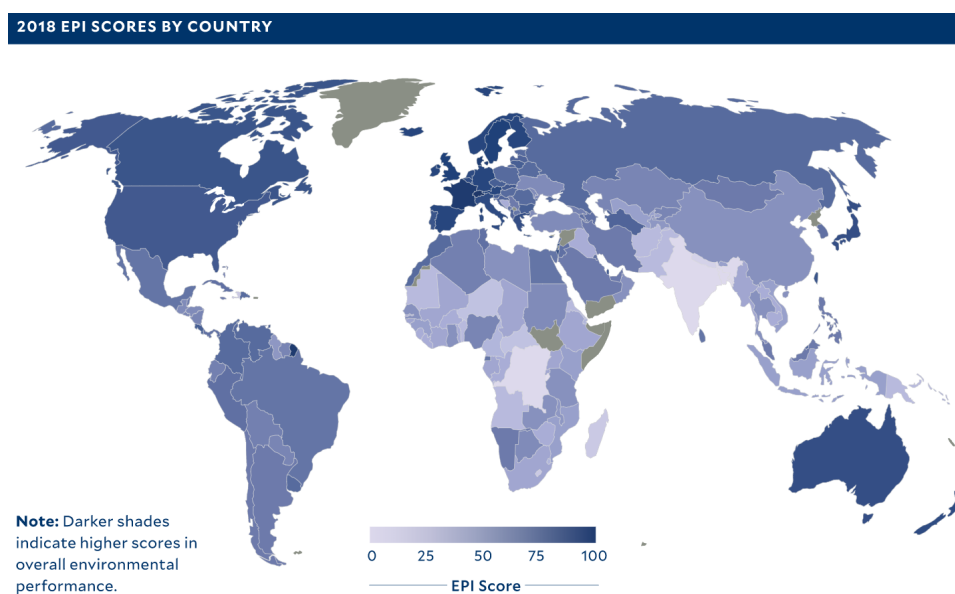
Table B.1: Descriptive statistics for bonds in primary markets

<i>Panel A: Green Bonds</i>							
	5%	25%	50%	Mean	75%	95%	N
Coupon(%)	0.38	1.60	3.40	3.49	5.00	7.75	1,513
Issue Price	98.90	99.79	100.00	100.67	100.00	112.86	1,513
Issue Yield	0.34	1.60	3.16	3.37	4.70	7.72	1,513
Maturity(Years)	2.52	4.00	5.25	9.05	10.01	29.91	1,513
Volume(\$Million)	1.89	15.00	100.00	286.80	426.69	1,000.00	1,511

<i>Panel B: Conventional Bonds</i>							
	5%	25%	50%	Mean	75%	95%	N
Coupon(%)	0.38	1.85	3.33	5.00	3.60	7.90	198,267
Issue Price	99.20	100.00	100.00	100.00	101.51	115.20	198,267
Issue Yield	0.35	1.65	2.95	4.40	3.36	7.96	198,267
Maturity(Years)	1.48	3.01	5.50	10.01	7.59	20.01	198,228
Volume(\$Million)	0.57	12.00	47.14	198.41	469.09	1,119.92	197,822

Coupon (%) is the annual coupon; *Issue Price* is the price of the bond at issuance; *Issue Yield* is the yield to maturity of the bond at issuance; *Maturity (Years)* is the difference between the Issue Date and Maturity Date in Years; *Volume (\$Million)* is the issue volume of the bond converted in Million USD.

Figure B.1: Environmental Performance Index



Environmental Performance Index developed by the Yale university, which measures environmental trends and progress of the corresponding country in 2018. Source: <https://epi.envirocenter.yale.edu/>.

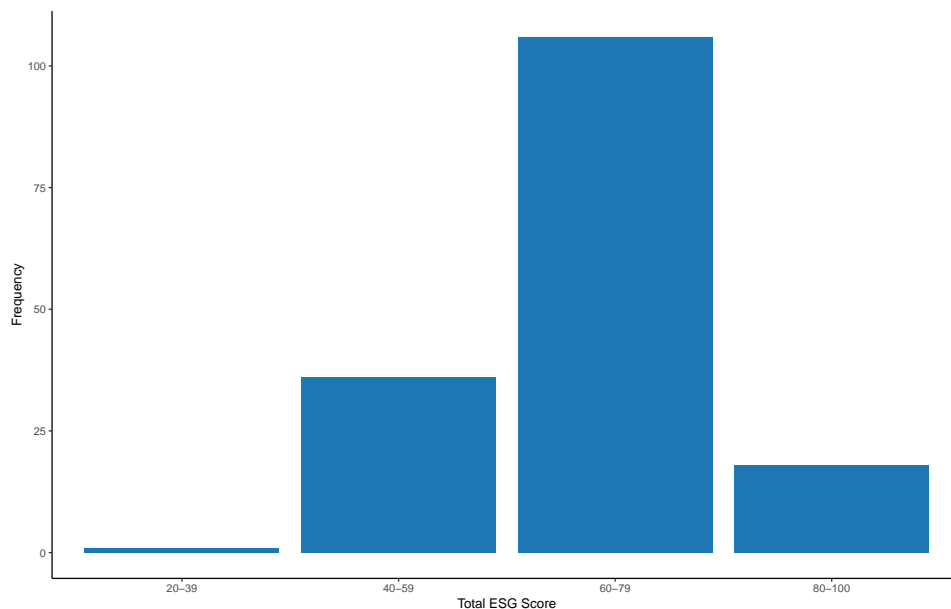
Table B.2: Descriptive statistics for bonds in secondary markets

<i>Panel A: Green Bonds</i>							
	5%	25%	50%	Mean	75%	95%	N
Coupon(%)	0.25	0.99	2.00	2.50	3.51	6.22	639
Issue Price	98.97	99.55	99.87	99.50	100.00	100.00	639
Issue Yield	0.21	1.00	2.16	2.55	3.55	6.20	639
Maturity(Years)	3.00	5.00	5.04	7.33	10.01	15.01	638
Volume(\$Million)	3.85	115.54	419.11	445.22	520.98	1,250.00	639

<i>Panel B: Conventional Bonds</i>							
	5%	25%	50%	Mean	75%	95%	N
Coupon(%)	0.05	1.12	2.33	3.62	2.62	6.25	2,703
Issue Price	98.12	99.51	99.89	100.00	99.33	100.16	2,707
Issue Yield	0.18	1.34	2.52	3.80	2.78	6.25	2,701
Maturity(Years)	2.06	5.00	7.01	10.01	8.84	28.89	2,705
Volume(\$Million)	8.50	66.94	393.76	977.45	1,055.59	3,876.03	2,707

Coupon (%) is the annual coupon; *Experienced* is a dummy variable that is one if the bond is issued not on the same day as the first Green bond of this issuer; *greenEX* is a dummy variable that is one if the bond is listed on a Green exchange; *Issue Price* is the price of the bond at issuance; *Issue Yield* is the yield to maturity of the bond at issuance; *Maturity (Years)* is the difference between the Issue Date and Maturity Date in Years; *Volume (\$Million)* is the issue volume of the bond converted in Million USD.

Figure B.2: Sustainability ratings of Green bonds issuer



Histogram of Sustainalytics sustainability (ESG) scores per December 2018 for a sample of corporate issuers with available data (161 issuer which account for around 35% of the full sample).

C Empirical results

Table C.1: *Primary Market Analysis (Full Sample)*

	IssueYield			
	(1)	(2)	(3)	(4)
Green	-0.150*** (0.056)	-0.156** (0.061)	-0.181*** (0.060)	-0.360*** (0.120)
Energy Efficiency				0.008 (0.157)
Alternative Energy				0.153 (0.168)
Eligible Green Bond Projects				0.276** (0.131)
Clean Transport				0.289 (0.198)
FE	YM, I, FX	+S, M, IS	+C	All
Green Bonds	1,513	1,321	1,321	1,165
Observations	199,765	161,482	161,482	52,980
R ²	0.658	0.692	0.720	0.792
Adjusted R ²	0.638	0.670	0.699	0.773

The table shows results of the regressions of Yield at issuance for Green and conventional bonds. The Issue Yield of Green and conventional fixed coupon plain vanilla bonds is regressed against a *Green* dummy variable, which is 1 if the bond is a Green bond and 0 otherwise. We include Issuer (I), YearMonth (YM), Currency (FX), Seniority (S), Maturity (M) and Issue size (IS) buckets, and Issue country (C) fixed effects, to take into account substantial differences between issuers, the yield curve, and different interest rate environments in different countries. The Maturity fixed effects are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to maturity. The Issue Size fixed effects are the deciles of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue. *Energy Efficiency*, *Alternative Energy*, *Clean Transport* and *Eligible Green Bond Project* are dummy variables indicating the Green project category of the corresponding bond.

Table C.2: *Primary Market Analysis (Sub-samples)*

	IssueYield					
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.205*** (0.052)	-0.389*** (0.073)	-0.009 (0.053)	0.171 (0.144)	-0.310*** (0.094)	0.028 (0.066)
Subsample	EUR	USD	CNY	OTH	SOVR+SUPR	CORP
FE	ALL\FX	ALL\FX	ALL\FX	ALL\FX	All	All
Green Bonds	258	392	180	398	540	781
Observations	32,133	48,852	21,353	58,183	61,408	100,074
R ²	0.704	0.805	0.765	0.734	0.740	0.720
Adjusted R ²	0.676	0.790	0.736	0.712	0.736	0.687

The table shows results of the regressions of Yield at issuance for Green and conventional bonds. The Issue Yield of Green and conventional fixed coupon plain vanilla bonds is regressed against a *Green* dummy variable, which is 1 if the bond is a Green bond and 0 otherwise. We include Issuer (I), YearMonth (YM), Seniority (S), Maturity (M) and Issue size (IS) fixed effects in Models 1–4, as well as Currency (FX) fixed effects in Models 5–6. The Maturity fixed effects are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to Maturity. The Issue Size fixed effects are the deciles of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue.

Table C.3: *Primary Market Analysis for Corporate Bonds*

	IssueYield				
	(1)	(2)	(3)	(4)	(5)
Green	0.028 (0.066)	-0.191*** (0.055)	0.745* (0.383)	0.120* (0.072)	-0.073 (0.054)
Certified				-0.219* (0.132)	
FirstIssue					-0.184* (0.107)
Subsample	CORP	CORP+Large	CORP+Small	CORP	CORP
FE	All	All	All	All	All
Green Bonds	781	432	209	781	781
Observations	100,074	41,793	33,441	100,074	100,074
R ²	0.720	0.844	0.596	0.720	0.720
Adjusted R ²	0.687	0.817	0.549	0.687	0.687

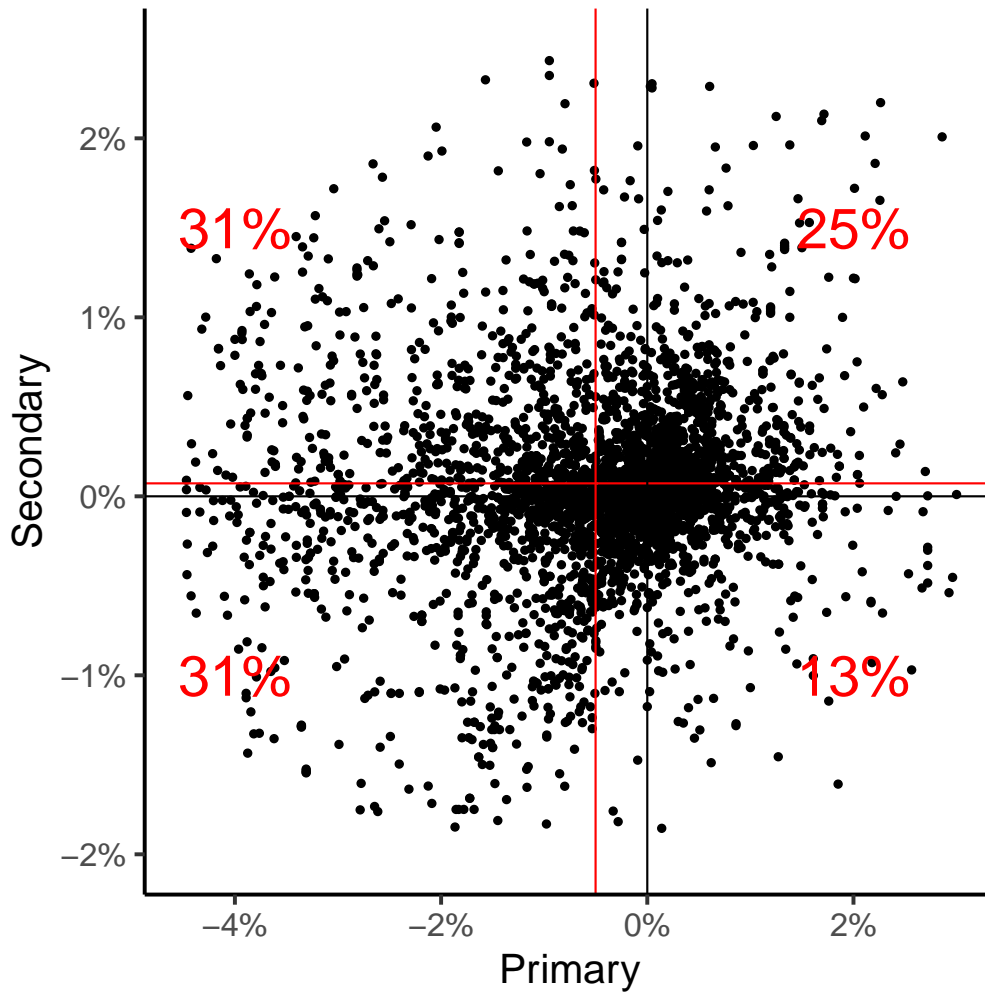
The table shows results of the regressions of Yield at issuance for Green and conventional bonds. The Issue Yield of Green and conventional fixed coupon plain vanilla bonds is regressed against a *Green* dummy variable, which is 1 if the bond is a Green bond and 0 otherwise. Sub-samples *Corp+Large* (*Corp+Small*) indicate corporate bonds with the issue size within the top 30% (below median) of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue. *Certified* is a dummy variable, which is 1 for Green bonds certified by a third party. *FirstIssue* is a dummy variable, which is 1 if the bond is the first Green issue of this issuer. We include Issuer (I), YearMonth (YM), Currency (FX), Seniority (S), Maturity (M) and Issue size (IS) buckets, and Issue country (C) fixed effects, to take into account substantial differences between issuers, the yield curve, and different interest rate environments in different countries. The Maturity fixed effects are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to maturity. The Issue Size fixed effects are the deciles of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue.

Table C.4: *Secondary Market Analysis*

	Yield to maturity					
	(1)	(2)	(3)	(4)	(5)	(6)
Green	0.101*** (0.002)	0.243*** (0.002)	0.073*** (0.003)	0.238*** (0.006)	0.334*** (0.004)	-0.025*** (0.002)
Sub-sample	FULL	EUR	USD	CNY	CORP	SOVR+SUPR
FE	All	ALL\FX	ALL\FX	ALL\FX	All	All
Number Green bonds	769	190	303	49	408	361
Obs. Green bonds	390,693	92,691	160,600	13,552	192,188	198,505
Number conventional bonds	3,389	1,094	1,161	163	1,697	1,692
Obs. conventional bonds	2,195,218	829,713	693,971	23,764	1,047,988	1,147,230
Total Obs.	2,585,911	922,404	854,571	37,316	1,240,176	1,345,735
R ²	0.852	0.785	0.732	0.705	0.819	0.885
Adjusted R ²	0.852	0.785	0.732	0.704	0.819	0.885

The table shows results of the regressions of Yield to maturity for Green and conventional bonds. The Yield to maturity of Green and conventional fixed coupon plain vanilla bonds is regressed against a *Green* dummy variable, which is 1 if the bond is a Green bond and 0 otherwise. We include Issuer fixed effects, YearMonth fixed effects, Currency fixed effects (Models 1, 5–6), Seniority, Maturity and Issue size fixed effects, to take into account substantial differences between issuers, the yield curve, different interest rate environments in different countries and the influence of ratings on the yield at issuance. The Maturity fixed effects are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to Maturity. The Issue Size fixed effects are the deciles of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue. We use the corresponding *BidAsk* spread as a control.

Figure C.1: Green Dummy Coefficients in Primary and Secondary Markets



Percentage of Green bonds (red numbers) trading at a premium on primary but at a discount on secondary markets (upper left quadrant), at a premium on both markets (lower left quadrant), at a discount on both markets (upper right quadrant), and at a discount on primary but at a premium on secondary markets (lower right quadrant). Black dots are the coefficients on the *Green* dummy variable in the corresponding regressions, while red lines represent the means of the *Green* dummy coefficient on the corresponding market.

Table C.5: *Secondary Market Analysis: First Week of Trading*

	Yield to maturity					
	(1)	(2)	(3)	(4)	(5)	(6)
Green	-0.044*** (0.016)	-0.012 (0.014)	-0.022 (0.016)	0.270*** (0.084)	0.052*** (0.018)	-0.127*** (0.026)
Sub-sample	FULL	EUR	USD	CNY	CORP	SOVR+SUPR
FE	All	ALL\FX	ALL\FX	ALL\FX	All	All
Number Green bonds	534	180	190	20	276	258
Obs. Green bonds	2,989	1,064	1,072	63	1,537	1,452
Number conventional bonds	1,976	673	716	100	972	1,004
Obs. conventional bonds	10,710	3,856	3,975	369	5,197	5,513
Total Obs.	13,699	4,920	5,047	432	6,734	6,965
R ²	0.891	0.906	0.932	0.937	0.912	0.898
Adjusted R ²	0.888	0.902	0.929	0.928	0.909	0.895

The table shows results of the regressions of Yield to maturity for Green and conventional bonds. The Yield to maturity of Green and conventional fixed coupon plain vanilla bonds is regressed against a *Green* dummy variable, which is 1 if the bond is a Green bond and 0 otherwise. We include Issuer fixed effects, YearMonth fixed effects, Currency fixed effects (Models 1, 5–6), Seniority, Maturity and Issue size fixed effects, to take into account substantial differences between issuers, the yield curve, different interest rate environments in different countries and the influence of ratings on the yield at issuance. The Maturity fixed effects are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to Maturity. The Issue Size fixed effects are the deciles of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue. We use the corresponding *BidAsk* spread as a control.

Table C.6: *Determinants of the Green bond premium*

	GMC						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	0.057*** (0.001)	0.070*** (0.001)	0.073*** (0.001)	0.074*** (0.001)	0.085*** (0.001)	0.081*** (0.006)	0.210*** (0.003)
Certified		-0.019*** (0.001)					
FirstIssue			-0.050*** (0.001)				
SovSupra				-0.028*** (0.001)			
GreenEX					-0.069*** (0.001)		
EPI						-0.062*** (0.008)	
ESGScoreLow							-0.191*** (0.003)
ESGScoreHigh							-0.151*** (0.003)
Subsample	FULL	FULL	FULL	FULL	FULL	FULL	CORP
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Green Bonds	641	641	641	641	641	278	235
Pairs	4,546	4,546	4,546	4,546	4,546	2,086	1,630
Observations	1,589,012	1,589,012	1,589,012	1,589,012	1,589,012	672,232	548,688
R ²	0.302	0.302	0.303	0.303	0.305	0.338	0.355
Adjusted R ²	0.302	0.302	0.303	0.303	0.305	0.338	0.355

The dependent variable Green-minus-Conventional (GMC) is the mid yield spread between the pairs of Green and conventional bonds. *Certified* is a dummy variable, which is 1 if the bond has an external review confirming its sustainability credentials; *FirstIssue* is an indicator which is one, if the Green bond is the very first Green issue of the issuer; *SovSupra* is an indicator which is one, if the Green bond is issued by a government or a supranational entity; *GreenEX* is an indicator which is one, if the Green bond in the pair is traded at a Green exchange; *EPI* is the Environmental Performance Index between 1 and 100 (here scaled by 100), which measures environmental trends and progress of the corresponding country; *ESGScoreHigh* is an indicator which is one, if the issuers' Sustainalytics ESG Score is within the top 30% of all issuers; *ESGScoreLow* is an indicator which is one, if the issuers' Sustainalytics ESG Score is within the bottom 30% of all issuers. As controls we use differences in percent between the Green and conventional bonds coupons; differences in years between the Green and conventional bonds time to maturity; differences between the Green and conventional bonds issue size; and the difference between the bid-ask-spread for Green and conventional bonds.

Table C.7: *Primary Market Analysis for bonds traded on the secondary markets*

	IssueYield			
	(1)	(2)	(3)	(4)
Green	−0.300*** (0.077)	−0.244*** (0.077)	−0.256*** (0.077)	−0.223 (0.158)
Energy Efficiency				0.065 (0.188)
Alternative Energy				0.082 (0.186)
Eligible Green Bond Projects				−0.235 (0.197)
Clean Transport				−0.087 (0.204)
FE	YM, I, FX	+S, M, IS	+C	All
Green Bonds	701	701	701	657
Observations	3,274	3,274	3,274	1,841
R ²	0.597	0.632	0.650	0.695
Adjusted R ²	0.549	0.587	0.604	0.627

The table shows results of the Fixed Effects regressions of bonds Yield at Issuance for Green and conventional bonds. The Issue Yield of Green and conventional fixed coupon plain vanilla bonds is regressed against a *Green* indicator, which is 1 if the Bond is a Green bond and 0 otherwise. *Experienced* is a dummy variable that is one if the bond is issued not on the same day as the first Green bond of this issuer; *Energy Efficiency*, *Alternative Energy*, *Clean Transport* and *Eligible Green Bond Project* are dummy variables indicating the use of proceeds for the corresponding bond. We include Issuer, Year-Month, Currency, Seniority, Maturity and Issue size buckets, and Issue country fixed effects, to take into account substantial differences between issuers, the yield curve, and different interest rate environments in different countries. The Maturity fixed effects are three buckets for short-term (less than 5 years), medium (between 5 and 10 years) and long term (more than 10 years) time to Maturity. The Issue Size fixed effects are the deciles of the issue (in USD) in comparison to all other issues that occurred before or in the same month as the Issue.