Greening the Financial Sector: Evidence from Bank Green Bonds

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Banks are expected to play a key role in assisting the real economy with the green transition process. One of the tools used for this purpose is the issuance of green bonds. We analyze the characteristics of banks that issue green bonds to understand: (i) which banks are more likely to resort to these funding instruments, and (ii) if the issuance of green bonds leads to an improvement in a bank's environmental footprint. We find that large banks and banks that had already publicly expressed their support for a green transition are more likely to issue green bonds. Conditional on being a green bond issuer, smaller banks tend to resort to green bonds in a more persistent manner and for relatively larger amounts, while larger banks issue green bonds on a more occasional basis and for smaller amounts. This heterogeneity is also reflected in our findings that only banks that issue green bonds more intensively improve their emissions and reduce lending to polluting sectors, thus contributing to the decarbonization of the financial sector.

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Turn green or lose 'licence to operate' - Deutsche Bank CEO Christian Sewing[1]

1. Introduction

The key role that banks are going to play over the next decades in assisting the transition towards a greener and more sustainable real economy is undisputed. Policymakers and investors increasingly expect banks to provide business and retail customers with funding and investment opportunities aligned with the goal of reducing the overall environmental footprint (see, e.g., European Banking Authority, 2021; Panetta, 2021). However, in the absence of common regulatory requirements, banks largely differ in the way they address these challenges. In this paper we focus on one specific instrument that banks can use to signal their commitment to green finance, namely the issuance of green bonds. By looking at the sample of all green bonds issued by banks worldwide between January 2013 and October 2020, we investigate the characteristics of the banks that choose to issue green bonds, and how this choice aligns with their stated intention to contribute to green finance.

Green bonds are fixed income securities that earn the label *green* because the issuer commits to allocate the proceeds to finance projects that carry environmental benefits. This restriction represents the key difference with respect to conventional bonds, which are unconstrained in the use of proceeds. Contrary to non-financial firms that can issue green bonds exclusively to finance their own climate-friendly projects, banks can use the proceeds of green bonds also to extend green loans or mortgages to businesses and retail customers. In this respect, green bonds represent an important tool available to financial institutions to facilitate green lending. In the 2013-2020 period, banks issued about 30% (by total amount) of all corporate (financial and non-financial) green bonds and 20% of all green bonds.[2] This confirms the relevant role played by the banking sector in the green bond market. Figure 1 compares the market share of green bonds (*x*-axis) and conventional bonds (*y*-axis) issued by banks (out of green and conventional

bonds issued by both banks and non-financial corporates), in countries where at least one green bond was issued by corporates over 2013-2020. Most entries lie around the 45-degree line, indicating that, in those countries, the participation of the banking sector in the green bond market mirrors its participation in the conventional bond market. Considering that banks are among the biggest issuers of corporate bonds in general,[3] and that both retail and institutional investors increasingly demand financial instruments that are aligned with sustainable and carbon-reduction targets (Krüger et al., 2020), the potential for the development of bank green bonds and for their contribution to green finance is substantial. Therefore, it is important to understand which banks choose this instrument and how this choice affects their environmental footprint.

[Figure 1 approximately here]

To this end, we develop several hypotheses relating to bank characteristics that enable us to differentiate: (i) between green bond issuers and non-green bond issuers; (ii) across green bond issuers of different types. In line with the existing literature (Flammer, 2021; Sangiorgi and Schopohl, 2021; Daubanes et al., 2022), we confirm that banks issue green bonds mostly to signal their commitment to finance the green transition. In this respect, we expect that banks that have already released other signals to go green, such as participating to sustainable finance initiatives launched before the emergence of the green bond market, are more likely to issue green bonds. The issuance of a green bond is more costly than that of a conventional bond because of the constraints in the use of proceeds, as well as of the costs associated with external reviews if the issue is certified. We hypothesize that the effort of issuing a green bond is unlikely to be the same across banks, and that large banks will find it easier to bear this cost. Thus, we predict that large banks are more likely to issue green bonds than small banks. Bank size may also be used to discriminate among different green bond issuers. Banks that are determined to improve their environmental performance are willing to bear the costs associated

with issuing green bonds, irrespective of their size. However, size should be relevant for banks that may be less committed to greening their policies, but still want to send a signal, since this will be easier to do for large banks, while small banks will find it too costly and abstain. As a result, we expect the proportion of green bonds over total bonds issued by larger banks to be smaller compared to the proportion issued by smaller banks, as the group of larger banks will also include institutions that are mostly interested in sending an occasional signal to investors.

We test our hypotheses on the characteristics of green bond issuers by means of multinomial logit models estimated on a panel of banks that have issued at least one bond (conventional or green) over the sample period 2013-2020. Estimates of the determinants of green bond issuance support our predictions that large banks and banks that had already signaled their engagement towards sustainable finance are more likely to issue green bonds. By focusing on the cross-section of green bond issuers, we find that smaller banks tend to resort to green bonds in a more persistent manner and for larger amounts, while larger banks issue green bonds on a more occasional basis and for smaller amounts.

We proceed by addressing an issue that has a direct bearing on the actual implementation of green finance and ask to what extent green bond issuers improve their direct and indirect environmental footprint. We hypothesize that banks that issue a relatively higher proportion of green bonds over total bonds will experience an improvement in their environmental performance. By contrast, the occasional issuance of green bonds may not have a meaningful impact on the issuer's environmental footprint. We test our hypothesis with a difference-in-differences approach. First, we derive a matched sample of treated banks that issue green bonds and control banks that do not issue green bonds but share similar characteristics with the treated banks pre-issuance. Second, we estimate the impact of green bond issuance on the issuer's environmental quality through a series of difference-in-differences specifications. We measure a bank's environmental footprint using: (i) the environmental score ("E") from its

Environmental, Social and Governance (ESG) score and the emissions score which enters the calculation of the environmental score; (ii) direct and indirect carbon dioxide (CO_2) emissions; (iii) a proxy for the proportion of the credit exposure stemming from business loans to polluting sectors. We find that a consistent and sizeable recourse to green bonds translates into an improvement in the issuer's emissions score and CO_2 emissions, and a contraction of lending to polluting sectors after issuing green bonds. Instead, we do not observe a post-issuance improvement in environmental quality for banks that issue green bonds occasionally. One explanation to our findings is that some banks may use green bonds primarily to send a signal to investors, which is not always followed by significant and immediate changes in their environmental practices.

This paper contributes to the fast-growing literature on corporate green bonds. Tang and Zhang (2020) and Flammer (2021) look at the value of issuing green bonds for corporates and find positive abnormal returns for shareholders around the announcement date. Flammer (2021) explains these results by arguing that companies issue green bonds to send a credible signal regarding their commitment to the environment. The signaling channel is formalized by Daubanes et al. (2022), who link it to the stock-price sensitivity of managers' pay and cross-country variations in carbon prices. A survey conducted by Sangiorgi and Schopohl (2021) on green bond issuers also points at reputational benefits, the market signaling power of green bonds and the desire to curb climate change as the main motives for green bond issuance. Several studies on green bonds focus on their pricing compared to conventional bonds (i.e., the existence of a *greenium*) and report mixed evidence. While some studies find the yield of green bonds to be significantly lower than that of conventional bonds (e.g., Hachenberg and Schiereck, 2018; Zerbib, 2019; Gianfrate and Peri, 2019), others do not observe consistent evidence of a greenium (Tang and Zhang, 2020; Flammer, 2021; Fatica et al., 2021). Only few papers analyze the actual impact of issuing green bonds on the environmental performance of

the issuers. Flammer (2021) documents an improvement in the environmental footprint of green bond issuing corporations. Fatica et al. (2021) investigate the lending decisions of banks issuing green bonds and observe a contraction in the loans extended to European borrowers in more polluting segments when those banks act as lead arrangers (but not as participants) in a syndicated loan.

Despite the active role that banks are expected to play in the decarbonization of the economy and their significant participation to the green bond market, the existing literature has focused on corporate green bonds in general, placing little emphasis on the distinctive features of bank green bonds. As mentioned, banks can issue green bonds to finance both internal projects and, more broadly, green lending. As such, the destination of proceeds can be perceived by investors to be less transparent and the impact of bank green bonds as less effective. We provide a first comprehensive study of bank green bonds by showing which banks are more likely to issue green bonds, by analyzing the heterogeneity of green bond issuers, and by providing a wide-ranging investigation of how green bond issuance relates to the environmental efforts of the issuing banks.

We also contribute to the strand of literature that investigates banks' effort in general (i.e., not limited to green bond issuers) towards the decarbonization of their loan portfolios. Most of these studies use the ratification of the Paris Climate Agreement as an identification tool to explore changes in bank lending practices spurred by environmental concerns. Reghezza et al. (2022) find that European banks relocate credit away from polluting sectors. Delis et al. (2021) document higher loan rates for fossil fuel firms especially after 2015. Similarly, Ehlers et al. (2021) find a loan risk premium associated with Scope 1 carbon emissions of borrowing firms. Degryse et al. (2021) show that green borrowers obtain cheaper loans from green lenders after the Paris Agreement. Müller and Sfrappini (2021) argue that banks reallocate credit to support the green transition in Europe but not in the U.S., Mésonnier (2022) finds that French banks

that declare their commitment to go green reduce lending to large corporates (but not SMEs) that belong to polluting sectors. Chen et al. (2021) document that banks charge worse lending terms to firms with higher levels of chemical pollution, and the effect is stronger for banks with higher corporate social responsibility scores. Our paper adds to this literature by showing how an intensive recourse to green bond financing can accelerate the decarbonization of bank lending.

2. Research hypotheses

Existing literature argues that the key driver behind the issuance of green bonds is the desire to signal the issuer's commitment to undertake and finance green projects (Flammer, 2021; Sangiorgi and Schopohl, 2021). For the signaling argument to be valid, the signal must have a value for the issuer. Looking at corporate green bonds in general, Flammer (2021) and Tang and Zhang (2020) verify that the signal is indeed valuable to the owners of the issuing firms, as green bond issuance triggers a positive response in stock prices. We confirm that this is also the case for green bonds issued by banks, by replicating Tang and Zhang (2020)'s event study around the announcements of bank green bonds in Appendix A. We document an increase in equity value for first-time green bond issuers, which confirms that the issuance of green bonds acts as a credible signal of the company's engagement to climate change for equity investors also in banks.

Building upon the signaling motivation for issuing green bonds, we develop our research hypotheses. First, we predict that green bond issuers will have already attempted to signal their intention to go green to the market. While the first sustainable finance initiatives have been available since the early 1990s, the corporate green bond market came into existence around 2013. Therefore, we expect that banks that issue green bonds will have already issued other

signals, such as participating to sustainable finance initiatives (see Zerbini, 2017, on how firms communicate their business conduct through participation to thematic initiatives, and Bauckloh et al., 2021, on how joining these initiatives affects the sustainability policies of the signatories). Hence, we articulate our first hypothesis:

> *H1*: Banks that have already released environmental-friendly signals have a higher propensity to issue green bonds.

The issuance of a green bond entails greater effort than that of a conventional bond. First, a green bond constrains the issuer in the use of the proceeds. Second, the issuance itself is more expensive when it complies with international green bond principles that entail the adoption of a green bond framework and the regular reporting on the use of proceeds. In the absence of a universal definition of green bonds, issuers can seek a second party opinion or have their green bonds certified at a cost to reassure investors that the use of proceeds is consistent with environmental goals. While the direct issuing costs can be partly offset by a lower borrowing cost in the form of a greenium, issuing a green bond typically remains more costly than issuing a conventional bond because of the binding constraint on the use of proceeds. If the cost associated with green bond issuance is sufficiently high, the signaling theory (Spence, 1973) predicts that only banks that are truly committed to pursue a green finance policy would be willing to bear this cost. However, the cost is unlikely to be the same across banks. Consequently, banks that find it less costly to tap the green bond market may still have an incentive to do so simply to send a signal to investors and policymakers, whether they are committed or not to undertake immediate actions to reduce their carbon footprint. Bank size is unlikely to be a determinant for the decision to issue green bonds for those institutions that are determined to improve their climate policies. Both large and small banks that want to send a strong signal to investors in this sense will be willing to bear the cost. On the other hand, size will be relevant for those institutions that may be less committed, but still want to send a signal,

as the cost of issuing a green bond will be relatively smaller for large banks. Sangiorgi and Schopohl (2021) document that large issuers are indeed less likely to perceive green bond funding as particularly costly. We advance three reasons for why this is the case. First, large banks can easily afford reporting and certification costs. Second, as they routinely issue several conventional bonds per year, the effort associated with an occasional green bond issuance will be less demanding than for small banks also with respect to the destination of proceeds. Finally, large banks normally attract a large number of equity and bond investors and therefore may cater more easily to the increasing demand for climate-friendly financial instruments. In line with our argument, we also expect larger banks to issue, on average, proportionally fewer green bonds compared to conventional bonds, than smaller banks. Smaller banks will issue green bonds if they are truly committed to become greener and, as such, will be willing to devote a non negligeable share of their bond financing to green lending. Instead, large banks will be of two types, those who intend to become greener and those who only want to send a signal. The former will behave like smaller banks, while the latter will presumably dedicate only a very marginal share of their bond financing to green bonds. On average, we expect the proportion of green bonds over total bonds issued by larger banks to be smaller compared to that issued by smaller banks. We formulate our second hypothesis in two steps as follows:

H2a: Larger banks have a higher propensity to issue green bonds.

H2b: The proportion of green bonds over total bonds issued by larger banks is smaller.

We complete our set of hypotheses by addressing a question that has a direct bearing on the actual transition to a more sustainable economy. Namely, to what extent do issuing banks improve their environmental footprint? Flammer (2021) shows that green bond issuers improve their environmental performance post-issuance. However, her sample includes all corporate green bond issuers (both financial and nonfinancial firms). As previously noted, bank green bonds can be used to finance a bank's own climate initiatives as well as to provide green

lending. In the latter case, the impact on the issuer's environmental performance can be less immediate and direct compared to the case where the proceeds are used to finance an internal green project. As a result, the overall effect of green bond issuance on environmental indicators is likely to be opaquer and more difficult to measure for financial institutions than for other corporates. Nonetheless, it is reasonable to hypothesize that banks that issue a relatively higher proportion of green bonds over total bonds are more committed to becoming greener and will see an improvement in their environmental quality. By contrast, the occasional issuance of green bonds may not result in a meaningful decrease of their environmental footprint. We express our third and final hypothesis as follows:

> *H3*: Banks that use green bonds more intensively experience an improvement in their environmental quality.

3. Bank green bonds and issuers: Univariate findings

We obtain our dataset of bank green bonds from Bloomberg, which labels as green bonds all "fixed income instruments for which the proceeds will be applied entirely towards green projects or activities that promote climate change mitigation, adaptation or other environmentally sustainable purposes" (Bloomberg, 2020). Other studies that use Bloomberg as a source for green bonds include Zerbib (2019), Flammer (2021), Tang and Zhang (2020). Our sample covers green bonds issued by banks between January 1, 2013 (there is no record of bonds issued by banks and labelled as green by Bloomberg before 2013) and October 31, 2020. We retrieve 617 bank green bonds for a total amount of $198 bn. Table 1 illustrates the evolution of the bank green bond market, that has displayed considerable growth over the past years, with an increase in the amount issued from $0.83 bn in 2013 (corresponding to 10 bonds) to nearly $33.43 bn in the first 10 months of 2020 (corresponding to 154 bonds). This is

consistent with the heightened interest expressed by investors in climate-friendly financial instruments. Green bonds span the entire maturity set, with 85% of bonds (which account for 95% of the total amount) having a short- or medium-term maturity. Nearly 90% of bank green bonds (by number and amount) have been reviewed by assurance providers for second party opinion, green bond auditing, green bond ratings or other certification. This percentage is higher than the average rate of 66% documented for corporate green bonds by Flammer (2021), suggesting that banks resort to external reviewing more often than other issuers. This observation is consistent with the above-mentioned fact that bank green bonds can be perceived to be less transparent and less effective than corporate green bonds. Among the five largest issuing countries, China accounts for 33% of the total amount issued (and 19% of the number of bonds), while France accounts for 28% of the bonds issued (and 8% of the amount). Together with the Netherlands, U.S. and Germany, these countries account for 60% of the total amount of bank green bonds.

[Table 1 approximately here]

Table 2 shows summary statistics on how intensively green bond issuers resort to green bonds. We restrict our analysis to the 177 banks that have issued green bonds and have financial data available in Moody's Analytics BankFocus, to enable us to later investigate the characteristics of green bond issuers. These 177 unique issuers account for 606 of the 617 green bonds in the original sample. The intensity of the recourse to green bonds is measured with four variables, at the issuer level: (i) the proportion of green bonds in relation to all bonds, by number of bonds, issued over the sample period; (ii) the proportion of green bonds in relation to all bonds, by amount of bonds, issued over the sample period; (iii) the proportion of green bonds in relation to the average amount of gross loans over the sample period; (iv) the proportion of green bonds in relation to the average amount of customer deposits plus long-term funding over the sample period. Ratios (i) and (ii) capture the weight of green bonds with respect to bond financing,

while (iii) and (iv) correct for potential differences across issuers in the access to the bond market. We observe great heterogeneity in the recourse to green bonds: on average, 15.98% of the bonds issued by a sample bank are represented by green bonds, with a median value of 7.69%, a bottom decile value of 0.32% and a top decile value of 50%. These findings remain essentially unchanged when considering the amount of bond issues instead of the number, and the heterogeneity across issuers is confirmed also when looking at green bond issuance in relation to the size of the loan portfolio and the issuer's funding needs. This variation is consistent with our hypotheses regarding which banks issue green bonds (i.e., from those that may only want to send a signal to those that fully engage in reducing their environmental footprint) and will be explored further in a multivariate setting.

[Table 2 approximately here]

For 104 out of these 177 issuers we could retrieve information on the actual use of proceeds from the documentation provided on their website. Use of proceeds falls within six categories: land, pollution prevention and waste management, water, green buildings, transport, energy. Figure 2 shows the proportion assigned to each category averaged across our sample banks, together with the minimum and maximum proportions. We see that bank green bonds are mostly used to finance renewable energy projects (48% of proceeds on average) and green buildings (34%), which include green mortgages. While some sample banks devote 100% of the proceeds to energy, green buildings, or transport, it is never the case that all proceeds are invested in the other three categories.

[Figure 2 approximately here]

We now provide some univariate evidence on the distinctive features of banks that issue green bonds. To this end, we consider the sample of all banks that have issued at least one bond (green or conventional) over the sample period according to Bloomberg, to ensure a meaningful comparison between green bond issuers and banks that do not issue green bonds but resort to

bond financing. We manually match these issuers with the information provided by Moody's Analytics BankFocus and only retain those banks with valid financial statements. Table 3 provides a comparison of the bank characteristics of green bond issuers (that have issued at least one green bond) and non-green bond issuers (that have issued only conventional bonds). All variables are computed at year-end 2012 i.e., before the issuance of the first bank green bond, to avoid reverse causality concerns.[4] We include a set of standard bank characteristics such as size, capital ratio, profitability (ROA), funding ratios (customer deposit ratio and long-term funding ratio) and loan ratio, as well as indicator variables for whether the issuer is publicly listed, or labelled as Global Systemically Important Banks (G-SIBs) by the Financial Stability Board. We also include an indicator variable that equals one if a bank is government-controlled to account for the fact that some governments may be channeling their environmental policies also through controlled banks. Since prior literature has shown that institutional investors are in general attentive to climate topics (Dyck et al., 2019; Krüger et al., 2020), we control for the percentage of institutional ownership in the bank.

[Table 3 approximately here]

We add a set of variables representative of the issuer's engagement in signaling its attention to sustainability and the environment. First, we use an indicator variable which equals one if the issuer has an ESG rating. The ESG ratings of our sample banks are retrieved from Thomson Reuter's Refinitiv. Refinitiv provides one of the most comprehensive ESG databases and has been widely used in the literature (see, e.g., Flammer 2021). Dedicated agencies compute ESG scores from publicly available information sources such as annual reports and other compulsory filings, corporate social responsibility reports, company websites, and news sources. Banks that want to signal their commitment to sustainability have an incentive to report and publicize their policies, since this information is a prerequisite to obtain an ESG score. One problem with using ESG ratings is that they are available only for publicly traded

banks or very large banks with publicly traded bonds, hence the presence of an ESG rating is highly correlated with bank size.[5] To overcome this issue, we complement this measure with another proxy for signaling a bank's attention to the environment, namely the participation to the United Nations Environmental Programme Finance Initiative (UNEP FI). The UNEP FI is a partnership between the United Nations Environmental Programme and the global financial sector aimed at mobilizing private sector finance for sustainable development. The initiative is the first of its kind and was launched in 1992, following the Earth Summit in Rio de Janeiro. By joining the initiative, financial institutions "openly recognize the role of the financial services sector in making our economy and lifestyles sustainable and commit to the integration of environmental and social considerations into all aspects of their operations".[6] At the time of writing, the UNEP FI counted 266 members, ranging from large publicly traded institutions to small regional banks. The UNEP FI membership represents an early manifestation of greenness and has been used in other studies (e.g., Fatica et al., 2021; Ehlers et al., 2021; Degryse et al., 2021), although it is not particularly taxing, since it does not require members to bind themselves to quantifiable decarbonization targets. Additional (and more binding) climate initiatives for the banking sector were launched only very recently. The UNEP FI was launched well ahead of the emergence of green bonds and is the most subscribed initiative worldwide by both green bond and non-green bond issuers, hence it is well suited for our analysis. As a third indicator of a bank's commitment to climate we employ, where available, the environmental score (i.e., the "E" component of the ESG Refinitiv score), which should provide a more direct measure of the effectiveness of the bank's green policies rather than its mere signaling efforts.

Finally, we include two measures to account for heterogeneous country-specific climate policies. Our overview in Table 1 indicates that banks headquartered in certain countries may have a higher propensity to issue green bonds. This suggests a potential link between the environmental policies of a country and a bank's decision to issue green bonds. First, we use

the environmental performance index (EPI) score as an indicator of a country's environmental quality (Emerson et al., 2012; Hsu et al., 2014; Hsu et al., 2016; Wendling et al., 2018; Wendling et al., 2020). The EPI metric encompasses 32 indicators of environmental performance for 180 countries, based on their environmental health and ability to address environmental challenges and meet established environmental policy targets. Higher values of the EPI score are associated with higher environmental performance of a country. The EPI score is appropriate for our analysis as it covers a large panel of countries and years. Second, we follow Bolton and Kacperczyk (2021) and measure national progress on decarbonization commitments through their Nationally Determined Contributions (NDCs). The NDCs represent formal commitments made by countries after their ratification of the Paris Climate Agreement. We use the existence of NDC commitments as a proxy for the potential regulatory pressure banks may be exposed to in countries that must fulfill their commitment. It is worth noting that, since NDCs were issued after the Paris Climate Agreement, this variable cannot be included in Table 3, which refers to year-end 2012. All variables are defined in Appendix B.

We find that green bond issuers are significantly larger, less capitalized, and characterized by less traditional business models (as shown by lower customer deposit ratios and loan ratios) than non-green bond issuers. Consistently, the proportion of issuers that are publicly traded and labelled as G-SIBs is significantly larger among green bond issuers. Already at the beginning of the sample period, banks that will later become green bond issuers seem to be more active in signaling their commitment to the environment, as shown by the higher proportion of green bond issuers with an ESG rating and the higher participation rate to the UNEP FI among green bond issuers. Green bond issuers also show a higher environmental score on average compared to other issuers, suggesting an actual implementation of their green policies.

Interestingly, banks that issue green bonds are domiciled in countries with a worse EPI than that of countries of non-green bond issuers. In this respect, green bonds may be perceived as a

useful instrument to contribute to nationwide environmental plans and goals. Consistently, our univariate fundings also suggest that the proportion of banks whose global ultimate owner is the government is relatively higher among green bond issuers.

4. Which banks issue green bonds?

Moving beyond the univariate evidence, we formally test the determinants of the propensity of a bank to issue green bonds in a multivariate setting that enables us to control for bank characteristics, country features, and time trends. We adopt a multinomial logit approach, which allows us to estimate the likelihood that a bank issues a green bond in a particular year against two alternative outcomes i.e., the issuance of a conventional bond and the choice not to issue any bond at all. Multinomial logit models represent the most appropriate way to identify the characteristics underlying the choice to issue green bonds in the presence of multiple alternatives. We estimate the models on the panel of all sample banks that have issued at least one bond over the sample period 2013-2020. The multinomial logit regression has the following form:

$$Prob(B = 0, 1, 2) = \mathrm{F}(\beta_B X), \quad (1)$$

Where *B* is discrete dependent variable which can take three values: zero if the bank has issued no bonds in the year, one if it has issued conventional bonds only, and two if it has issued green bonds; F(·) is the logistic distribution; β_B is a vector of coefficients for outcome *B* where β_0 is zero and *X* is a vector of explanatory variables (all time-varying explanatory variables are computed at the beginning of the year). The estimates are reported in Table 4. The base outcome in Columns I, III and V (II, IV and VI) is not issuing a bond at all (issuing a conventional bond), so the estimates in the corresponding columns can be interpreted as the

impact on the probability of issuing a green bond vis-à-vis not issuing any bond at all (issuing a conventional bond).

The specifications in Columns I and II include in *X*: (i) standard bank characteristics (size, capital ratio, profitability, funding ratios, loan ratio); (ii) indicator variables for whether the issuer is publicly listed, is a G-SIB, is government-controlled, is a UNEP FI member and, as such, has publicly announced a commitment towards sustainable finance; (iii) the EPI of the country of domicile of the issuer, and an indicator variable for whether the country has already adopted an NDC. The sample for Columns I and II include all banks that have issued bonds during the sample period since, in principle, there are no limitations to the issuance of green bonds: any bank that is willing to use the bond proceeds for environmentally friendly projects can issue a green bond in place of a conventional bond.

In Columns III and IV we limit the sample to publicly listed banks to investigate the potential role of institutional investors in a bank's decision to issue green bonds, given that data on institutional ownership is only available for listed entities. To further enhance comparability between green and conventional bond issuers, we restrict our sample to publicly listed banks with an ESG rating in Columns V and VI. As discussed, those banks are typically very large and publicly listed, and all of them disclose information to the public with the intention to signal their sustainability. In these specifications, we add to *X* the bank's own environmental score to assess whether banks with a better environmental performance are more likely to issue green bonds. All models include year fixed effects and those in Columns I and II additionally control for country fixed effects.[7]

[Table 4 approximately here]

For a bank in need of funding with a regular access to the bond market, the natural alternative to issuing a green bond is issuing a conventional bond. Therefore, the results in Columns II, IV

and VI are the most informative in explaining the recourse to green bonds. We find that, across all samples, banks that have a higher propensity to issue green bonds are larger and more likely to be members of the UNEP FI. Thus, our findings support hypotheses *H1* and *H2a* that large banks and banks that had already publicly acknowledged the role of green finance in helping towards a sustainable transition are more likely to issue green bonds. We also observe that lower loan ratios are consistently associated with a higher likelihood of issuing green bonds versus conventional bonds. Instead, we do not find evidence that the environmental pressure from institutional investors or national regulators matters, since neither the percentage of institutional ownership, nor government ownership, nor the country EPI/NDC commitment are significant determinants of the decision to issue green bonds. These findings are also confirmed when comparing the likelihood of issuing green bonds to no bond issuance (Columns I, III and V).

To test hypothesis *H2b*, we now proceed to investigate the characteristics of the banks that choose to resort to green bonds more intensively and estimate the coefficients of the following OLS regression equation:

$$GREEN_i = \alpha + \beta X_{i,2012} + \varepsilon_i, \quad (2)$$

Where *GREEN* denotes one of the four measures presented in Table 2 for the intensity of recourse of bank *i* to green bonds i.e., the proportion of green bonds issued in relation to all bonds (by number and amount), average loans, and average funding needs (customer deposits plus long-term funding). *GREEN* is computed at the issuer level over the entire sample period, thus resulting in one observation per green bond issuer and the explanatory variables *X* are measured at year-end 2012 (before the first issuance of a bank green bond) to avoid endogeneity concerns.[8]

Results are reported in Table 5. The sample in odd-numbered columns includes all banks that issue at least one green bond, while it is restricted to the subset of listed banks in even-numbered columns. In line with hypothesis *H2b*, we see that issuer size has a negative impact on the intensity of recourse to green bonds in all but two specifications (Columns IV and VIII), which however refer to a small sample of 61 listed issuers. This confirms that larger banks seem to use green bonds on a more occasional basis and for small amounts, while smaller banks commit relatively larger amounts in a more persistent manner to this form of financing.

[Table 5 approximately here]

5. Does green bond issuance improve environmental performance?

We now address Hypothesis 3 and analyze whether the issuance of green bonds ultimately translates into an improved environmental performance of the issuing banks. We start by deriving a matched sample of green bond issuers and non-green bond issuers. The results from the previous section highlight how banks that issue green bonds are significantly different from banks that only issue conventional bonds along several dimensions that may be correlated to their environmental characteristics. Therefore, we need to build a sample of non-green bond issuers that are as close as possible to green bond issuers to study the effects of green bonds. For each bank that issues a green bond for the first time (*treated*) we find a match (*control*) among non-green bond issuers based on a set of characteristics measured at fiscal year-end before the green bond issuance. Specifically, we find the closest match that minimizes the Mahalanobis distance in terms of bank size, profitability, capital ratio, loan ratio, environmental score, and country's EPI.[9] Matching treated and control banks on their pre-issuance environmental score enables us to capture more accurately the effect of green bonds on the environmental measures of the treated group. To assess the goodness of the matching

procedure, we report in Appendix C the estimates of *t*-tests for difference in means across treated and control samples, which confirm that the two groups are well matched.

We proceed to estimate the impact of green bond issuance on the issuer's environmental quality by means of difference-in-differences specifications. We choose several environmental metrics for our analysis. First, we select two environmental indicators i.e., the environmental score and the emission score from the Refinitiv ESG rating of the bank. The environmental score comprises three categories (emissions, environmental innovation, and use of resources) and, in principle, should not be directly affected by the issuance of a green bond, given that this event is not included in any of the metrics used to derive the score. However, the attribution of the environmental score is not entirely objective and a green bond issuance may still influence the judgement of the rating analyst and ultimately translate into a higher environmental score. To mitigate this potential bias, we use the emission score of the issuer as a second environmental metric, which is essentially based on a series of emissions indicators and, hence, a more objective measure. Both environmental and emissions scores are expressed on a scale ranging between zero and 100 (from worst to best performance).

Second, we look at the CO_2 emissions of the banks in the matched sample, which arguably represent the most immediate and relevant measure of environmental performance. Given the subjectivity that characterizes ESG ratings and the resulting divergence in the scores provided by different ESG rating agencies (Berg et al., 2022), as well as recent evidence by Berg et al. (2020) of retroactive changes applied by Refinitiv to its ESG data, CO_2 emissions should provide a more objective metric of the quality of climate policies. We obtain from Refinitiv yearly data on Scope 1 and 2 emissions (reported jointly), as well as Scope 3 emissions. Scope 1 emissions are direct emissions of the bank from its own or controlled sources, while Scope 2 emissions are indirect emissions from purchased energy, and Scope 3 emissions include all indirect emissions stemming from the value chain of the bank's business activities, such as

investment and financial intermediation. Refinitiv labels carbon emission data as reported or estimated, based on whether they are directly reported by the company or estimated according to a model. We only consider carbon emission data reported by our sample banks and look at the yearly log growth rate in Scope 1 and 2, Scope 3, and Total emissions to measure a bank's progress in reducing its environmental footprint. We trim the log growth rates at the 5th and 95th percentile to correct for artificial variations due to changes in the methodology used by the bank to calculate its emissions.

Third, we investigate lending to carbon-intensive sectors. The analyses conducted so far are unlikely to fully capture the potential effect of the issuance of green bonds on the loan portfolio of the issuing banks. As explained, bank green bonds can be used to finance banks' own climate-friendly initiatives as well as to decarbonize their loan portfolio. The reduction in emissions coming from the decarbonization of the loan portfolio should translate in a reduction of banks' Scope 3 emissions. This category of emissions, according to the Greenhouse Gas Protocol, should include indirect emissions from business travel, paper, waste, office equipment, etc., as well as the emissions related to the main business of financial intermediation. In practice, given the complexity of measuring the downstream emissions stemming from lending and investment activities, banks typically exclude these emissions from their Scope 3 measure (ECB, 2019).[10] As a result, the emissions score and the Scope 3 emissions are unlikely to fully reflect the potential change in the lending behavior of banks following the issuance of green bonds.

To address this limitation, we attempt to derive a direct measure of the brownness of a bank's loan portfolio and test whether the issuance of green bonds has had an impact on this variable. This measure has the added benefit of being entirely free from the subjectivity of ESG metrics. It has been documented (see e.g., Iovino et al., 2021) that brown firms are more reliant on debt financing compared to green firms, hence there is indeed potential for banks to reduce their

brown lending if they so desire. Quantifying the extent to which a bank lends to polluting sectors is however a challenging task in the absence of standardized reporting requirements on the composition of the loan portfolio by industry sector. To deal with this issue, existing papers have followed different approaches. Fatica et al. (2021) focus on syndicated loans to retrieve information on the sector of economic activity and the location of borrowers, which is then matched to the Eurostat dataset on GHG emissions by country and sector. Mésonnier (2022) and Degryse et al. (2020) also use the Eurostat GHG emission data (matched with the French and the Belgian credit registers, respectively) to analyze changes in the lending attitude of banks to polluting sectors. Reghezza et al. (2022) exploit a confidential ECB dataset to match the largest individual counterparties (in terms of loan exposures) of Eurozone banks to their carbon emissions from Refinitiv. These methods are not well suited to investigate the lending practices of our sample of green bond issuers and matched banks for a number of reasons. First, restricting the analysis to syndicated loans may be representative of the loan portfolio for very large banks, but our sample also includes mid-sized banks who are unlikely to participate to the syndicated loan market. Second, the Eurostat GHG emission dataset is only relevant to borrowers in Europe, while our sample includes banks (and borrowers) from all continents.

We propose a novel approach to estimate a bank's exposure to carbon-intensive sectors. We download annual reports and, where available, Pillar 3 reports, for all treated and control banks in our matched sample from 2012 to 2020, and we manually search for information on the segmentation of the loan portfolio or credit exposure by industry. The disclosure of the credit concentration by industry varies greatly across the sample banks: while some banks only report a very coarse classification (e.g., loans to governments, banks, businesses, and retail) or none, others provide a detailed composition of their loan portfolio. Following Choi et al. (2020), we classify an industry as carbon-intensive if it has been identified as major emission source by the Inter-governmental Panel on Climate Change (IPCC). To refine our classification, we refer

to both the full list of IPCC subcategory codes as reported in the Annex II of the IPCC's Fifth Assessment Report, issued in 2014 (Krey et al., 2014) and the mapping between these codes and industry names provided by Choi et al. (2020) in their Internet Appendix.[11] We exclude banks that do not provide a sufficient level of detail to enable us to derive a meaningful estimate of the proportion of loans to polluting sectors, as well as those banks that changed their reporting standards during the sample period. The variable *Brown lending* is computed as the proportion of a bank's credit exposure to carbon-intensive sectors.

Table 6 reports estimates of the difference-in-differences specifications for all environmental measures, *ENVIR*. We use a panel of all bank-year observations of the treated and matched control banks from 2012 to 2020, where the matched samples differ in size according to the availability of the outcome variables. In the odd-numbered columns we regress those variables on: (i) a dummy variable which equals one if the bank has already issued green bonds by that year (*GBI post issuance*), and zero otherwise; (ii) bank fixed effects; (iii) year fixed effects:[12]

$$ENVIR_{i,t} = \beta GBI\ post\ issuance_{i,t} + BANK_i + YEAR_t + \varepsilon_{i,t}\ , \qquad (3)$$

where β is the coefficient of interest, as it indicates whether the environmental measures change following the issuance of green bonds. Standard errors are clustered at the country level. Our estimates suggest that, on average, the issuance of green bonds does not have a direct impact on the bank's environmental indicators.

As previously discussed in reference to Tables 2 and 5, banks are heterogeneous in their recourse to green bonds, which represent a sizeable share of bond financing for some banks, and marginal for other banks. To the extent that green bond issuance reflects a bank's commitment to undertake climate-friendly policies, we would expect to observe a stronger improvement in the environmental performance of the former group of banks than of the latter. To test whether this is the case, we enrich our specification by adding an indicator variable that

measures the intensity of recourse to green bonds. In the even-numbered columns of Table 6 we add a dummy (*IGBI post issuance*) that equals one if an intense green bond issuer has already issued green bonds by that year, and zero otherwise:

$$ENVIR_{i,t} = \beta GBI\ post\ issuance_{i,t} + \gamma IGBI\ post\ issuance_{i,t} + \\ + BANK_i + YEAR_t + \varepsilon_{i,t}, \tag{4}$$

where the intense green bond issuer, *IGBI*, is defined as a bank that has issued a proportion of green bonds over total bonds higher than the median computed across all green bond issuers, consistently with the first measure from Tables 2 and 5.[13] The coefficient γ of the new dummy measures the additional impact on the environmental performance of high-intensity green bond issuers compared to other green bond issuers. We also perform a Wald test on the sum of coefficients of the two dummies to assess whether the post-issuance environmental quality of high-intensity green bond issuers improves compared to their pre-issuance levels.

The estimates show that, compared to low-intensity green bond issuers, high-intensity green bond issuers experience a significant increase in both their environmental score and emissions score from ESG ratings, following the issuance of green bonds. The Wald test confirms that the emissions score for those banks is significantly larger post-issuance. Compared to low-intensity green bond issuers, high-intensity green bond issuers also reduce both their Scope 1 and 2 and their Scope 3 emissions significantly after the issuance of green bonds. Although the coefficient estimate for Total scope is insignificant, all the three Wald tests indicate that each post-issuance scope measure of high-intensity green bond issuers improves compared to their pre-issuance levels. We conclude that also these results on CO_2 emissions are in line with hypothesis *H3*. Finally, we find that high-intensity green bond issuers significantly reduce their exposure to polluting sectors after issuing green bonds. Therefore, for these issuers, green bonds seem beneficial in redirecting lending to less carbon-intensive sectors.

All in all, our results on the link between green bond issuance and environmental performance suggest that a consistent and sizeable recourse to green bonds translates into an improvement in the issuer's emissions scores and a greening of its lending policies. In line with the stated objective of a green bond issuance, these banks take important measures to reduce their environmental footprint. Instead, we do not observe a post-issuance improvement in the environmental measures or lending practices of banks that issue green bonds occasionally and for limited amounts. One may argue that the differential post-issuance impact on the environmental footprint in banks that use green bonds more or less intensively could be explained by the timing of the first green bond issuances. Specifically, if banks that use green bonds more (less) intensively have issued green bonds earlier (later) in the sample period, one may worry that it may be too early to observe a general significant improvement in environmental variables for low-intensity issuers. However, this is not the case in our sample: a *t*-test on means and a Wilcoxon test on medians of the year of the first green bond issuance for high- and low-intensity issuers indicate no significant differences across the two groups, with 2016 being the first mean and median year for both types.

[Table 6 approximately here]

6. The role of certification and use of proceeds

We conclude our analysis by exploring whether certification and the use of the proceeds from the issue play a role in improving the environmental footprint of green bond issuers. Previous literature suggests that external review/certification strengthens the signal that green bond issuers send to investors in the corporate sector (Flammer, 2021; Daubanes et al., 2022), and contributes to increasing the environmental quality of the issuers (Flammer, 2021). As discussed with reference to Table 1, nearly 90% of our green bonds have been subject to some form of assurance provision, hence testing the value attached to external review is unfeasible

since we do not have enough bonds that have not been reviewed or certified. Given that 97% of green bonds in our matched sample obtained assurance provision, the lack of statistical significance of the coefficient of *GBI post issuance* in equation (3) and Table 6 (odd columns) suggests that, on average, external validation is not a predictor of a significant improvement in the environmental footprint of banks issuing green bonds. These findings are indeed consistent with our research hypotheses: external review is commonplace in banks as it is requested by both smaller banks (for whom it is relatively more costly) that intend to use green bonds more intensively and larger banks (for whom it is relatively cheaper) that intend to issue more sporadically. Since both groups resort to assurance provision, on average its impact on the environmental output of the issuers is not statistically significant and only becomes sizeable for the subgroup of banks that resort to green bonds more intensively.

To further explore the role of certification, we focus on one particular type of certification, which is aimed at assuring compliance with the Climate Bonds Standard adopted by the Climate Bonds Initiative (CBI). The CBI's Climate Bonds Standard establishes sector specific eligibility criteria to assess an asset's low carbon value and consistency with the 1.5 degrees Celsius warming limit of the Paris Agreement. This certification scheme (used also by Baker et al., 2022) is arguably more rigorous than a generic second party opinion but significantly costlier, given that it requires both pre-issuance and post-issuance verifications.[14] About 13% of the green bond issuers in our matched sample have obtained a CBI certification, which enables us to test its information value on the issuer's commitment to contribute to the green transition. To this aim, we replicate our difference-in-differences analysis to single out the potential impact of certified green bond issues on our environmental metrics and estimate the following regression on our panel of treated and control banks:

$$ENVIR_{i,t} = \beta GBI\ post\ issuance_{i,t} + \gamma CBI\ Certified\ GBI_{i,t} + \\ + BANK_i + YEAR_t + \varepsilon_{i,t}, \tag{5}$$

where *ENVIR* denotes the environmental measures as in Equations (4) and (5), *GBI post issuance* is a dummy variable which equals one if the bank has already issued green bonds by that year, and zero otherwise; *CBI Certified GBI* is the interaction of a dummy variable which equals one if the issuer has obtained certification to the Climate Bond Standards and *GBI post issuance*; *BANK* and *YEAR* denote bank fixed effects and year fixed effects, respectively. Our main variable of interest is *CBI Certified GBI*, which measures the incremental effect of CBI certification (over and above non-CBI certified green bond issuances) on the environmental performance of the issuer. The results of this analysis are reported in Table 7. As before, we perform a Wald test on the sum of coefficients of the two dummies. We find that issuers that resort to CBI certification significantly reduce their Scope 3 and Total CO_2 emissions compared to other issuers, as well as in comparison to their own pre-issuance levels. Instead, we do not observe a significant effect of CBI certification on the remaining environmental measures. The estimates in Column III suggest that Scope 1 and 2 emissions increase in certified issuers compared to non-certified ones, but the Wald test reveals that this does not translate into an increase in emissions with respect to pre-issuance levels. The lack of consistent results (which could be partly explained by the low statistical power associated with the low CBI certification rate) confirms that certification does not seem to play a role in predicting the issuer's engagement in green policies for bank green bonds, while the intensity of recourse to green bonds is a much stronger predictor of the intention to go green.

[Table 7 approximately here]

Finally, we investigate whether the environmental performance of green bond issuers is somehow affected by the way in which green bond proceeds are used. While we do not have

priors as to which use of proceeds would be most efficiently associated with an improvement in the issuer's footprint, we believe it may still be informative to see whether such a link exists. We consider the three main uses of proceeds as discussed in connection to Figure 2, namely renewable energy, green buildings, and transportation separately, and we group together the other uses (land, water, waste management and pollution prevention) as the fourth category. We construct a dummy variable for each category that takes the value of one (zero) if part of the proceeds has (has not) been used for that category and estimate the following regression model:

$$ENVIR_{i,t} = \beta GBI\ post\ issuance_{i,t} + \gamma Buildings_{i,t} + \delta Transport_{i,t} + \\ + \theta Energy_{i,t} + \tau Other_{i,t} + BANK_i + YEAR_t + \varepsilon_{i,t}, \quad (6)$$

where the environmental variables (*ENVIR*) of our panel of treated and control banks are regressed on: the $GBI\ post\ issuance$ dummy variable which equals one if the bank has already issued green bonds by that year, and zero otherwise; four dummy variables (*Buildings*, *Transport*, *Energy*, and *Other*) which result from the interaction of the use of proceeds and $GBI\ post\ issuance$; bank fixed effects; year fixed effects.

Our findings, reported in Table 8, do not allow us to identify a use of proceeds which is consistently superior to others for improving the environmental quality of the issuing bank along the different measures. Investing in transportation seems to have positive environmental effects, as it is associated to a decrease in Scope 3 emissions. By contrast, using green bond proceeds for green buildings is linked to a worsening of the environmental footprint in terms of a reduction in the emissions score and an increase in Scope 3 emissions. To the best of our knowledge, we are the first to collect information on the use of green bond proceeds and our findings provide some novel insights on how different uses can impact a bank's environmental metrics. However, we remain cautious in the interpretation of the results, as more homogeneous

and detailed data on use of proceeds are needed. The adoption of common regulation on green bonds will represent an important step forward in this respect.

[Table 8 approximately here]

7. Conclusions

In this paper we analyze the characteristics of banks that issue green bonds with the aim of understanding why some banks resort to green bonds and not others, and to learn if green bond issuance ultimately translates into an improvement of the issuer's environmental footprint. Our analysis is performed both within the group of green bond issuers as well as by contrasting them with non-green bond issuers.

We find that large banks and banks that had already publicly acknowledged the importance of transitioning to a greener banking sector are more likely to issue green bonds. However, conditional on issuing green bonds, the intensity of recourse to this form of financing is higher for smaller banks than for larger banks. These results can be understood through the lens of signaling. Although both large and small banks want to issue green bonds as a signal to shareholders of their engagement for a climate-friendly transition, the costs of doing so are relatively larger for smaller banks. This heterogeneity in the green commitment of issuers is also reflected in our findings that banks that issue green bonds more frequently experience an increase in their environmental quality following the issuance of green bonds and a decrease in their credit exposure to polluting sectors, while we find no such evidence for other green bond issuers.

These results carry relevant implications. While bank green bonds account for a large share of the corporate green bond market, they are still generally perceived by investors as being opaquer than green bonds issued by non-financial firms, given the lower level of detail

concerning the destination of the proceeds and the higher complexity in monitoring the issuing banks. This leads to mixed results when analyzing the impact of bank green bonds in general (e.g., Tang and Zhang, 2020; Fatica et al., 2021). Our findings show that even green bond certification is not consistently associated with an improved environmental quality of the issuing banks. We suggest that looking at the characteristics of green bond issuers together with the intensity with which they resort to green bonds can provide useful insights to: (i) distinguish among different issuers and (ii) help identify those that are more likely to undertake a tangible and immediate commitment to reduce their environmental footprint. All in all, we provide evidence that shows how bank green bonds can indeed represent a key instrument to achieve a climate alignment within the banking sector, provided they are used consistently and in a sizeable manner.

[1] Olaf Storbeck, "Turn green or lose 'licence to operate', says Deutsche Bank chief," *Financial Times*, May 20, 2021.

[2] Authors' calculations based on Bloomberg data.

[3] The banking sector accounted for 43% of all corporate bonds issued globally in 2020. Authors' calculations based on Bloomberg data.

[4] The number of green bond issuers reported in Table 3 (120) is smaller than the one reported in Table 2 (177), since Table 3 only refers to banks that have financial data available at year-end 2012, while Table 2 includes all green bond issuers that have financial data available at any point during the sample period.

[5] The correlation between bank size and presence of an ESG rating is equal to 48% in our sample.

[6] Statement available at: https://www.unepfi.org/about/unep-fi-statement/.

[7] Our specifications in Columns III-VI do not include country fixed effects since the multinomial logit models suffer from the curse of dimensionality issue when dealing with a large number of fixed effects for these sample sizes, and fail to converge to a solution. This is also the reason why we are unable to include bank fixed effects or country-year fixed effects in our specifications, which could otherwise have served as effective controls for any

time-varying environmental policies in different countries. However, the inclusion of country EPI and NDC already contains key information on the countries' environmental and regulatory specificities.

[8] In an unreported robustness check, we replaced country EPI with country fixed effects, and the results are essentially unchanged.

[9] We exclude from the pool of potential control banks those that never issue green bonds but belong to the same banking group of the treated banks and, as such, share the same environmental measures. Those banks would otherwise be classified as non-issuers even though they could potentially benefit, at a group level, from the green bond issuance of other institutions in the group.

[10] Guidance on how to measure and disclose emissions from lending and investment activities has been detailed in the Global GHG Accounting and Reporting Standard for the Financial Industry only in November 2020. In February 2021, the European Banking Authority proposed the disclosure of banks' green asset ratio, that is the share of a credit institution's environmentally sustainable balance sheet exposures versus its total eligible exposures.

[11] Some sample banks report the proportion of loans granted to green companies in their sustainability reports. We decide against using this information mainly because information on green lending has been provided for a sufficient number of years only by very few sample banks. Additionally, sustainability reports are a key input used by rating agencies to derive ESG ratings, hence any information on green lending included in sustainability reports is most likely embedded in the environmental measures used in Section 5.

[12] We use bank fixed effects instead of country fixed effects to better control for any bank specific feature that may have not been captured by the matching.

[13] For brevity, we proxy the intensity of green bond issuance only with this measure, given that all measures are positively and significantly (at 1% level) correlated and, as shown in Table 5, share the same explanatory factors.

[14] See the Climate Bonds Standard and Certification Scheme at the Climate Bonds Initiative: https://www.climatebonds.net/certification. The list of green bonds that have obtained CBI certification is retrieved from https://www.climatebonds.net/certification/certified-bonds.

Appendix A: Event study around green bond announcements

In this appendix we perform an event study to test the stock price reaction of green bond issuers around the announcement of the issuance of green bonds. Our sample covers all green bonds issued by publicly listed banks worldwide between January 1, 2013 and October 31, 2020. The announcement dates of green bond issuances as well as the issuers' daily stock prices are retrieved from Bloomberg. We use a one-factor market model to estimate the "normal" relation between stock and market returns since previous literature has shown that short-horizon event studies are not sensitive to the benchmark specification (Kothari and Warner, 2007):

$$R_{it} = \alpha_i + \beta_i \cdot R_{mt} + \varepsilon_{it}$$

where R_{it} is the daily return on the common share of bank *i* on day *t* and R_{mt} is the daily return on the MSCI World total return index on the same day. In line with Tang and Zhang (2020), the market model is estimated from 300 calendar days to 50 calendar days prior to the event date $t = 0$, which coincides with the announcement date. We derive daily abnormal stock returns AR_{it} as the difference between raw returns and returns estimated from the market model:

$$AR_{it} = R_{it} - \left(\hat{\alpha}_i + \hat{\beta}_i \cdot R_{mt}\right)$$

As in Tang and Zhang (2020) and Flammer (2021), we then compute cumulative abnormal returns CAR_i for bank *i* around each event date by aggregating AR_{it} from 5 days before to 10 days after (5 days before to 5 days after) the announcement date. The table reports the average CARs computed across the two event windows separately for first-time issues and subsequent issues, with *t*-statistics in parenthesis. Consistently with the findings from previous studies on corporate green bonds in general, we document, also in banks: (i) a positive stock price response following the announcement of the first green bond issuance; (ii) no stock price response following the announcement of subsequent green bond issuances. This is in line with the signaling argument, as the market learns about the bank's commitment to green lending

with the first-time issue, while the information content of subsequent issues is likely to resemble that of conventional bond issues (see the discussion in Tang and Zhang, 2020, and Flammer, 2021).

	First-time issues		Subsequent issues	
	[-5, 5]	[-5, 10]	[-5, 5]	[-5, 10]
	I	II	III	IV
CAR	1.276**	1.506*	-0.622	-0.986
	(1.982)	(1.952)	(-1.089)	(-1.412)
Observations	78	78	89	87

∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level,

Appendix B: Variable definitions

Variable	Definition	Source
Brown lending	The proportion of a bank's credit exposure to carbon-intensive sectors	Carbon-intensive industries are classified by the Inter-governmental Panel on Climate Change (IPCC). Information on lending to such industries is obtained from annual reports and Pillar 3 reports
Buildings	Dummy variable taking the value 1 (0) if green bond proceeds were (not) used for green buildings	Documentation provided on the banks' websites
Capital ratio	Ratio of equity over total assets	Moody's Analytics BankFocus
CBI Certified GBI	Dummy variable taking the value 1 (0) if an issuer who obtained a third-party certification of compliance with the Climate Bonds Standards of the Climate Bonds Initiative has (has not) already issued a green bond by the current year	Climate Bonds Initiative
ΔCO_2 emissions: Scope 1 & 2	Yearly log change in reported Scope 1 and 2 emissions	Thomson Reuter's Refinitiv
ΔCO_2 emissions: Scope 3	Yearly log change in reported Scope 3 emissions	Thomson Reuter's Refinitiv
ΔCO_2 emissions: Total scope	Yearly log change in the sum of reported Scope 1, 2 and 3 emissions	Thomson Reuter's Refinitiv
Customer deposit ratio	Ratio of total customer deposits over total assets	Moody's Analytics BankFocus
Emissions score	The bank's emissions score	Thomson Reuter's Refinitiv
Energy	Dummy variable taking the value 1 (0) if green bond proceeds were (not) used for renewable energy purposes	Documentation provided on the banks' websites
Environmental score	The bank's environmental score	Thomson Reuter's Refinitiv
EPI country score	The Environmental Performance Index score of the country where the bank is headquartered	The EPI is computed by Yale University and available at: https://epi.yale.edu/
Government controlled	Dummy variable taking the value 1 (0) if the bank's global ultimate owner is (is not) a public authority, state, or government	Moody's Analytics BankFocus
Green bond issuer (GBI)	Dummy variable taking the value 1 (0) if a bank has (has not) issued a green bond during the sample period	Bloomberg
GBI post issuance	Dummy variable taking the value 1 (0) if a GBI has (has not) already issued a green bond by the current year	Bloomberg

G-SIB	Dummy variable taking the value 1 (0) if the bank is (is not) a global systemically important bank	The yearly lists of G-SIBs are obtained from the website of the Financial Stability Board: https://www.fsb.org
Has ESG rating	Dummy variable taking the value 1 (0) if the bank has (has not) an ESG rating	Thomson Reuter's Refinitiv
Institutional ownership	Percentage of total institutional ownership of the bank	Bloomberg
Intense GBI	Dummy variable taking the value 1 (0) if a bank has issued in the sample period a proportion of green bonds over total bonds higher (lower) than the median	Bloomberg
Intense GBI post issuance	Dummy variable taking the value 1 (0) if an Intense GBI by number of bonds has (has not) already issued a green bond by the current year	Bloomberg
Listed	Dummy variable taking the value 1 (0) if a bank is (is not) publicly listed	Moody's Analytics BankFocus
Ln(Assets)	Natural log of total assets in million USD	Moody's Analytics BankFocus
Loan ratio	Ratio of gross loans over total assets	Moody's Analytics BankFocus
Long-term funding ratio	Ratio of long-term funding over total assets	Moody's Analytics BankFocus
NDC	Dummy variable taking the value 1 (0) for each year a country in which a bank is headquartered has (has not) a Nationally Determined Contribution in place	https://www.climate-resource.com/tools/ndcs
Other	Dummy variable taking the value 1 (0) if green bond proceeds were (not) used for land, water, or pollution prevention and waste management	Documentation provided on the banks' websites
ROA	Ratio of net income over total assets	Moody's Analytics BankFocus
Transport	Dummy variable taking the value 1 (0) if green bond proceeds were (not) used for green transport projects	Documentation provided on the banks' websites
UNEP FI	Dummy variable taking the value 1 (0) if the bank is (is not) a member of the United Nations Environment Programme Finance Initiative	Member lists obtained from: https://www.unepfi.org/members

Appendix C: *t*-tests on treated and control samples

	Treated		Control		
	Mean	St. dev.	Mean	St. dev.	*t*-stat.
Environmental score	65.19	25.53	64.59	24.82	-0.14
Ln(Assets)	19.09	1.58	18.63	1.27	-1.90
Capital ratio	0.11	0.17	0.11	0.11	-0.08
ROA	0.01	0.01	0.01	0.03	0.87
Loan ratio	0.50	0.21	0.49	0.23	-0.25
EPI country score	70.48	13.92	70.09	13.73	-0.17
Observations	69		69		

This table reports summary statistics and *t*-tests for difference in means for treated (green bond issuers) and control (non-green bond issuers) banks from a matched sample. The matching is based on bank characteristics of bond issuers at year-end before the first green bond was issued. All variables are described in Appendix B. $*$, $**$, and $***$ denotes significance at the 10%, 5%, and 1% level, respectively.

References

Baker, M., Bergstresser, D., Serafeim, G., and Wurgler, J. (2022). The pricing and ownership of U.S. green bonds. *Annual Review of Financial Economics*, forthcoming.

Bauckloh T., Schaltegger S., Utz S., Zeile, S., and Zwergel B. (2021). Active first movers vs. late free-riders? An empirical analysis of UN PRI signatories' commitment. *Journal of Business Ethics*, forthcoming.

Berg, F., Fabisik, K., and Sautner, Z. (2020). Is history repeating itself? The (un)predictable past of ESG ratings. ECGI Finance Working Paper No. 708-2020.

Berg, F., Kölbel, J.F., and Rigobon, R. (2022). Aggregate confusion: The divergence of ESG ratings, *Review of Finance*, forthcoming.

Bloomberg (2020). Guide to green bonds on the terminal.

Bolton, P., and Kacperczyk, M. (2021). Firm commitments. Working Paper.

Chen, I.J., Hasan I., Lin, C.-Y., and Nguyen, T. (2021). Do banks value borrowers' environmental record? Evidence from financial contracts. *Journal of Business Ethics* 174, 687–713.

Choi D., Gao, Z., and Jiang W. (2020). Attention to global warming. *Review of Financial Studies* 33, 1112–1145

Daubanes, J.X., Mitali, S.F., and Rochet, J.-C. (2022). Why do firms issue green bonds? Swiss Finance Institute Research Paper No. 21-97.

Degryse H., Roukny T., and Tielens J. (2020). Banking barriers to the green economy. Working paper.

Degryse H., Goncharenko R., Theunisz C., and Vadasz, T. (2021). When green meets green. Working paper.

Delis, M., de Greiff, K., Iosifidi, M., and Ongena, S. (2021). Being stranded with fossil fuel reserves? Climate policy risk and the pricing of bank loans. Swiss Finance Institute Research Paper Series No 18-10.

Dyck, A., Lins, K.V., Roth, L., and Wagner, H.F. (2019). Do institutional investors drive corporate social responsibility? International evidence. *Journal of Financial Economics* 131, 693–714.

Ehlers, T., Packer, F., and de Greiff, K. (2021). The pricing of carbon risk in syndicated loans: Which risks are priced and why? *Journal of Banking and Finance*, 136, 106180.

Emerson, J. W., Hsu, A., Levy, M. A., de Sherbinin, A., Mara, V., Esty, D. C., and Jaiteh, M. (2012). 2012 Environmental Performance Index and Pilot Trend Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy.

European Banking Authority (2021). Advice to the Commission on KPIs and methodology for disclosure by credit institutions and investment firms under the NFRD on how and to what extent their activities qualify as environmentally sustainable according to the EU taxonomy regulation. EBA/Rep/2021/03.

European Central Bank (2019). Financial Stability Review: Climate risk-related disclosures of banks and insurers and their market impact. November.

Fatica, S., Panzica, R., and Rancan, M. (2021). The pricing of green bonds: Are financial institutions special? *Journal of Financial Stability* 54, 100873.

Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, 12, 499–516.

Gianfrate, G., and Peri, M. (2019). The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production* 219, 127–135.

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

Hsu, A., Emerson, J. W., Levy, M. A., de Sherbinin, A., Johnson, L., Malik, O. A., Schwartz, J. D., and Jaiteh, M. (2014). 2014 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy.

Hsu, A., Esty, D. C., de Sherbinin, A., and Levy, M. A. (2016). 2016 Environmental Performance Index: Global Metrics for the Environment. New Haven, CT: Yale Center for Environmental Law & Policy.

Iovino, L., Martin, T., and Sauvagnat, J. (2021) Corporate taxation and carbon emissions. Working paper.

Krey V., Masera, O., Blanford, G., Bruckner, T., Cooke, R., Fisher-Vanden, K., Haberl, H., Hertwich, E., Kriegler, E., Mueller, D., Paltsev, S., Price, L., Schlömer, S., Ürge-Vorsatz, D., van Vuuren, D., and Zwickel, T. (2014). Annex II: Metrics & methodology. In Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., and Minx, J.C. (eds.), *Climate change 2014: Mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, UK: Cambridge University Press.

Kothari, S.P., and Warner, J.B. (2007). 'Econometrics of event studies' in E. Eckbo (ed), Handbook of Corporate Finance, pp. 3-36. Amsterdam, The Netherlands: Elsevier.

Krüger, P., Sautner, Z., and Starks, L. T. (2020). The importance of climate risks for institutional investors. *Review of Financial Studies* 33, 1067–1111.

Mésonnier, J.-S. (2022). Banks' climate commitments and credit to carbon-intensive industries: New evidence for France. *Climate Policy* 22, 389–400.

Müller, I. and Sfrappini, E. (2021) Climate change-related regulatory risks and bank lending. Working paper.

Panetta, F. (2021). A global accord for sustainable finance. The ECB Blog, Frankfurt am Main, 11 May 2021.

Reghezza, A., Altunbas, Y., Marques-Ibanez, D., Rodriguez d'Acri, C., and Spaggiari, M. (2022). Do banks fuel climate change? Journal of Financial Stability 62, 101049.

Sangiorgi, I. and Schopohl, L. (2021). Explaining green bond issuance using survey evidence: Beyond the greenium. *British Accounting Review*, 101071.

Spence, M. (1973). Job market signaling. *Quarterly Journal of Economics* 87, 355–374.

Tang, D. Y. and Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance* 61, 101427.

Wendling, Z. A., Emerson, J. W., Esty, D. C., Levy, M. A., de Sherbinin, A. (2018). 2018 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy.

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

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

Zerbini, F. (2017). CSR initiatives as market signals: A review and research agenda. *Journal of Business Ethics*, 146, 1–23.

Table 1: Bank green bonds

	Number of bond issues	Amount issued (USD bn)
Year of issuance		
2013	10	0.83
2014	27	1.39
2015	24	7.50
2016	52	32.86
2017	87	27.41
2018	123	47.26
2019	140	47.37
2020 (Jan-Oct)	154	33.43
Maturity at issuance		
0-5 years	282	90.32
5-10 years	244	98.61
>10 years	91	9.10
Assurance provision		
Yes	543	174.61
No	74	23.42
Top 5 countries of issuer (by amount)		
China	116	65.11
Netherlands	22	16.39
France	174	15.62
U.S.	21	12.24
Germany	68	9.63

This table reports the number and total issuance amount (in USD bn) of green bonds issued by banks over the period January 2013-October 2020. The sample includes bonds issued by banks and labelled as green bonds by Bloomberg. *Assurance provision* indicates whether a green bond has been reviewed by assurance providers for second party opinion, green bond auditing, green bond ratings or other certification.

Table 2: Intensity of recourse to green bonds: Univariate

	Mean	Standard deviation	10th percentile	Median	90th percentile	Number of issuers
By number of bond issues	15.98%	21.41%	0.32%	7.69%	50.00%	177
By amount of bonds issued	15.57%	21.86%	0.54%	5.84%	42.89%	177
By loans	2.79%	4.65%	0.11%	1.24%	5.87%	177
By funding	2.23%	5.97%	0.09%	0.80%	4.10%	177

This table reports summary statistics on the proportion of green bonds in relation to: (i) all bonds issued by number of bonds; (ii) all bonds issued by amount of bonds; (iii) the average amount of gross loans; (iv) the average amount of customer deposits plus long-term funding. The variables are computed over the sample period at the issuer level. The sample includes banks that issued green bonds and have financial data available in Moody's Analytics BankFocus.

Table 3: Bank characteristics of green bond and non-green bond issuers

	Non-green bond issuers			Green bond issuers			
	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	*t*-stat.
Ln(Assets)	15.444	2.001	1,349	18.703	1.736	120	-19.450***
Capital ratio	0.114	0.126	1,349	0.083	0.106	120	3.024***
ROA	0.007	0.023	1,349	0.008	0.010	120	-1.114
Customer deposit ratio	0.570	0.217	1,349	0.523	0.243	120	2.048**
Long-term funding ratio	0.130	0.132	1,349	0.118	0.123	120	1.009
Loan ratio	0.617	0.193	1,349	0.506	0.197	120	5.957***
Listed	0.243	0.429	1,349	0.492	0.502	120	-5.255***
G-SIB	0.007	0.081	1,349	0.117	0.322	120	-3.727***
Government controlled	0.070	0.255	1,349	0.150	0.359	120	-2.400**
Institutional ownership	0.465	0.321	384	0.502	0.243	68	-1.089
Has ESG rating	0.231	0.421	1,349	0.558	0.499	120	-6.982***
UNEP FI member	0.083	0.276	1,349	0.325	0.470	120	-5.551***
Environmental score	45.243	34.425	311	60.742	30.491	67	-3.685***
EPI country score	61.994	9.119	1,332	56.935	11.587	118	4.618***

The table reports summary statistics for bank characteristics of: (i) banks that have issued at least one bond over the sample period, but no green bonds (non-green bond issuers); (ii) banks that have issued at least one green bond over the sample period (green bond issuers). Bank characteristics are measured at year-end 2012. All variables are described in Appendix B. The last column reports the *t*-test for the difference in means. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Table 4: Propensity to issue green bonds: Multinominal logit models

	Green bond issuance					
Base issuance outcome	No bond	Conventional bond	No bond	Conventional bond	No bond	Conventional bond
	I	II	III	IV	V	VI
Ln(Assets)	0.882***	0.484***	1.093***	0.696***	1.265***	0.710***
	(0.070)	(0.070)	(0.098)	(0.096)	(0.134)	(0.125)
Capital ratio	-0.105	0.149	-0.793	1.043	0.761	1.617
	(1.138)	(1.133)	(1.411)	(1.359)	(1.763)	(1.669)
ROA	11.025	5.685	1.089	-10.853	-2.237	-14.194
	(7.352)	(7.197)	(8.564)	(8.198)	(11.883)	(11.264)
Customer deposit ratio	-1.457**	-0.597	-1.572*	1.486*	0.115	2.132*
	(0.603)	(0.595)	(0.883)	(0.839)	(1.381)	(1.277)
Long-term funding ratio	2.560***	-0.790	6.709***	1.218	5.991***	2.062
	(0.860)	(0.821)	(1.384)	(1.230)	(1.733)	(1.506)
Loan ratio	-1.504***	-1.645***	-0.345	-2.267***	-1.450	-3.006***
	(0.558)	(0.551)	(0.768)	(0.743)	(1.159)	(1.090)
Listed	0.423**	0.188				
	(0.201)	(0.198)				
G-SIB	0.548	-0.206	1.121*	-0.258	0.545	-0.281
	(0.390)	(0.295)	(0.654)	(0.345)	(0.689)	(0.376)
Government controlled	0.269	0.371	0.332	-0.118	0.726	-0.048
	(0.268)	(0.264)	(0.344)	(0.327)	(0.460)	(0.399)
Institutional ownership			-0.603	-0.372	-1.506***	-0.658
			(0.428)	(0.420)	(0.582)	(0.557)
UNEP FI	0.737***	0.909***	0.858***	1.100***	0.969**	1.193***
	(0.232)	(0.229)	(0.288)	(0.264)	(0.382)	(0.327)
EPI country score	0.011	-0.002	0.005	-0.014	0.003	-0.019
	(0.021)	(0.021)	(0.010)	(0.010)	(0.014)	(0.013)
NDC	-0.596	0.276	-0.211	0.065	-0.812	-0.539
	(0.411)	(0.401)	(0.509)	(0.498)	(0.590)	(0.543)
Environmental score					0.007	0.002
					(0.006)	(0.006)
Constant	-19.707***	-12.991***	-24.899***	-17.570***	-28.106***	-17.629***

	(1.909)	(1.909)	(2.384)	(2.338)	(3.255)	(3.058)
Observations	15,080	15,080	3,794	3,794	1,847	1,847
Of which Y= 0	7,190	7,190	1,804	1,804	733	733
Of which Y= 1	7,653	7,653	1,866	1,866	1,013	1,013
Of which Y= 2	237	237	124	124	101	101
Country FE	Yes	Yes	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.194	0.194	0.217	0.217	0.253	0.253
Sample	Full	Full	Listed	Listed	ESG banks	ESG banks

This table analyzes the likelihood of issuing bank green bonds by means of multinomial logit models. The dependent variable equals zero (one) [two] in bank-years where a sample bank does not issue any bond (issues conventional bonds only) [issues green bonds]. The base outcome is not issuing any bond (issuing a conventional bond) in Columns I, III and V (II, IV and VI). All control variables are described in Appendix B. Time-varying controls are computed at the beginning of the year. The sample in Columns I-II (III-IV) [V-VI] includes all banks that have issued at least one green or conventional bond over the sample period 2013-2020 (which are also listed) [which are listed and have an ESG rating]. Robust standard errors in parentheses. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Table 5: Intensity of recourse to green bonds: Determinants

	By number of bonds		By amount of bonds		By loans		By funding	
	I	II	III	IV	V	VI	VII	VIII
Ln(Assets)	-0.028***	-0.012*	-0.026**	0.002	-0.008***	-0.005**	-0.004**	-0.004
	(0.010)	(0.006)	(0.012)	(0.010)	(0.002)	(0.002)	(0.002)	(0.003)
Capital ratio	-0.001	0.085	-0.126	0.032	-0.103*	0.057	0.260*	0.313**
	(0.148)	(0.111)	(0.151)	(0.126)	(0.052)	(0.104)	(0.137)	(0.137)
ROA	-0.670	-0.759	1.272	0.656	0.488	-0.186	0.674	0.601
	(1.518)	(0.985)	(1.698)	(1.278)	(0.332)	(0.333)	(0.985)	(1.131)
Customer deposit ratio	0.230***	0.296***	0.237***	0.296**	0.017	0.022	-0.030	-0.053
	(0.080)	(0.099)	(0.087)	(0.122)	(0.012)	(0.020)	(0.023)	(0.054)
Long-term funding ratio	0.156	0.044	0.184	0.122	0.039	0.046	-0.089	-0.215**
	(0.191)	(0.116)	(0.199)	(0.148)	(0.025)	(0.031)	(0.059)	(0.106)
Loan ratio	-0.088	-0.156	-0.071	-0.078	-0.055***	-0.053***	-0.025	-0.004
	(0.098)	(0.116)	(0.106)	(0.155)	(0.013)	(0.018)	(0.019)	(0.046)
Listed	-0.020		-0.017		0.002		0.003	
	(0.023)		(0.025)		(0.004)		(0.005)	
G-SIB	0.056	0.012	0.092	0.045	0.004	-0.003	-0.033*	-0.048**
	(0.053)	(0.056)	(0.067)	(0.083)	(0.005)	(0.007)	(0.018)	(0.023)
Government controlled	-0.001	0.067	0.047	0.097	0.011	-0.001	0.018**	0.028*
	(0.039)	(0.050)	(0.048)	(0.079)	(0.008)	(0.004)	(0.007)	(0.016)
Institutional ownership		0.026		0.024		-0.000		-0.009
		(0.044)		(0.063)		(0.008)		(0.017)
UNEP FI	-0.021	0.012	-0.024	-0.014	0.004	0.006	0.004	0.012
	(0.029)	(0.029)	(0.037)	(0.042)	(0.005)	(0.008)	(0.007)	(0.014)
EPI country score	-0.003*	-0.002	-0.002	-0.002	0.000	-0.000	0.001	0.001*
	(0.001)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)
Constant	0.712***	0.315*	0.616***	-0.029	0.186***	0.113**	0.071	0.044
	(0.176)	(0.183)	(0.225)	(0.280)	(0.032)	(0.047)	(0.045)	(0.066)
Observations	118	61	118	61	118	61	118	61
Adjusted R-squared	0.357	0.444	0.240	0.262	0.314	0.155	0.565	0.656

This table shows the determinants of the intensity of recourse to green bonds. The dependent variable is the proportion of green bonds in relation to: (i) all bonds issued by number of bonds (Columns I and II); (ii) all bonds issued by amount of bonds (Columns III and IV); (iii) the average amount of gross loans (Columns V and VI); (iv) the average amount of customer deposits plus long-term funding (Columns VII and VIII). The variables are computed over the sample period at the issuer level. The sample in Columns I, III, V, VII (II, IV, VI, VIII) includes only banks that have issued green bonds (and are listed). Bank characteristics and other independent variables are measured at year-end 2012. All variables are described in Appendix B. The models are estimated using OLS regressions. Robust standard errors in parentheses. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Table 6: Green bond issuance and environmental indicators: Difference-in-differences

	Environmental score		Emissions score		ΔCO_2 emissions						Brown lending	
					Scope 1 & 2		Scope 3		Total scope			
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
GBI post issuance	-1.377	-4.301*	-1.273	-7.163***	-0.023	-0.014	-0.012	-0.005	-0.036	-0.034	-0.005	0.010
	(2.508)	(2.466)	(2.487)	(2.395)	(0.021)	(0.023)	(0.060)	(0.062)	(0.040)	(0.041)	(0.011)	(0.013)
Intense GBI post issuance		9.354**		18.840***		-0.055**		-0.175*		-0.046		-0.037**
		(4.092)		(4.819)		(0.026)		(0.091)		(0.040)		(0.017)
Observations	1,114	1,114	1,114	1,114	753	753	646	646	646	646	480	480
No. of banks	138	138	138	138	124	124	106	106	106	106	64	64
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-sq.	0.206	0.220	0.211	0.249	0.090	0.092	0.279	0.281	0.063	0.063	0.080	0.100
χ-test: GBI post issuance + Intense GBI post issuance = 0		0.93		7.43***		10.43***		4.87**		8.13***		3.19*

This table reports estimates from difference-in-differences panel models of environmental performance after the issuance of green bonds for low-intensity and high-intensity green bond issuers (GBI). The sample in Columns I-IV [V-X] {XI-XII} includes all available observations from treated banks (GBI) and control banks (non-green bond issuers) [where information on CO_2 emissions is available] {where information on the industry composition of the loan portfolio is available}. The dependent variable in Columns I-II (III-IV) [V-VI] {VII-VIII} <IX-X> «XI-XII» is the bank's environmental score (emissions score) [log growth rate in Scope 1 and 2 emissions] {log growth rate in Scope 3 emissions} <log growth rate in Scope 1, 2 and 3 emissions> «the proportion of a bank's credit exposure to carbon-intensive sectors». All variables are described in Appendix B. Standard errors are clustered at the country level. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Table 7: Green bond issuance and certification: Difference-in-differences

	Environmental score	Emissions score	ΔCO₂ emissions			Brown lending
			Scope 1 & 2	Scope 3	Total scope	
	I	II	III	IV	V	VI
Green bond issuer (GBI) post issuance	-0.338	-1.605	-0.027	0.017	-0.024	-0.005
	(2.722)	(2.490)	(0.022)	(0.066)	(0.041)	(0.013)
CBI Certified GBI	-6.832	2.182	0.042**	-0.228**	-0.095*	-0.000
	(6.808)	(8.524)	(0.020)	(0.089)	(0.057)	(0.012)
Observations	1,114	1,114	753	646	646	480
Number of banks	138	138	123	105	105	64
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.210	0.211	0.091	0.285	0.064	0.080
χ-test: GBI post issuance + Certified GBI = 0	1.43	0	0.85	9.71***	3.65*	0.22

This table reports estimates from difference-in-differences panel models of environmental performance after the issuance of green bonds for non-CBI certified and CBI certified green bond issuers (GBI). The sample in Columns I-II [III-V] {VI} includes all available observations from treated banks (GBI) and control banks (non-green bond issuers) [where information on CO_2 emissions is available] {where information on the industry composition of the loan portfolio is available}. The dependent variable in Columns I (II) [III] {IV} <V> «VI» is the bank's environmental score (emissions score) [log growth rate in Scope 1 and 2 emissions] {log growth rate in Scope 3 emissions} <log growth rate in Scope 1, 2 and 3 emissions> «the proportion of a bank's credit exposure to carbon-intensive sectors». All variables are described in Appendix B. Standard errors are clustered at the country level. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

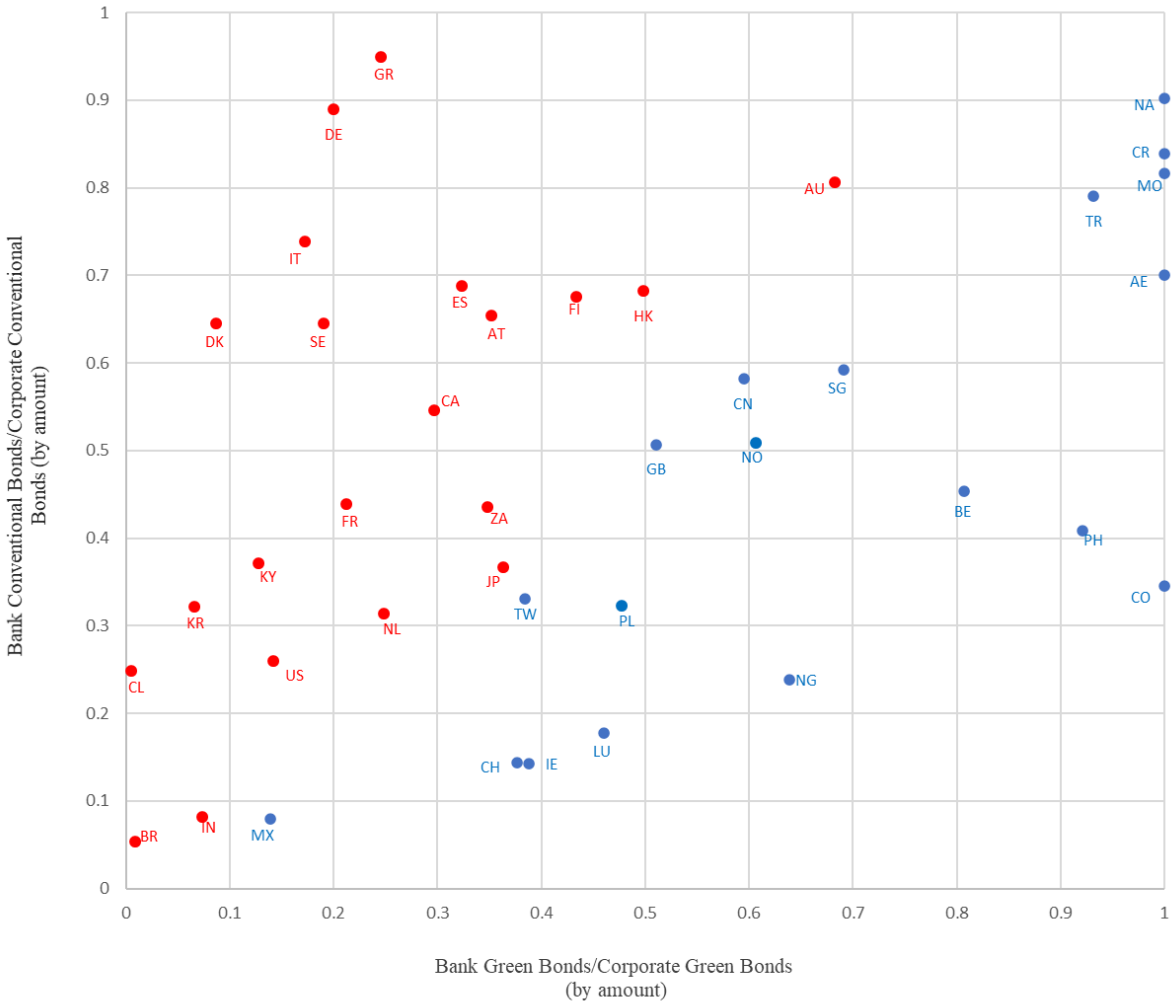
Table 8: Green bond issuance and use of proceeds: Difference-in-differences

	Environmental score	Emissions score	ΔCO₂ emissions			Brown lending
			Scope 1 & 2	Scope 3	Total scope	
	I	II	III	IV	V	VI
Green bond issuer (GBI) post issuance	-6.844	-7.071	-0.024	0.338	0.190	-0.003
	(6.978)	(9.816)	(0.050)	(0.501)	(0.196)	(0.029)
Buildings	-4.686	-9.113*	-0.012	0.433***	0.037	0.026
	(4.324)	(4.746)	(0.040)	(0.166)	(0.081)	(0.019)
Transport	0.670	0.655	0.033	-0.236*	-0.027	0.011
	(5.040)	(8.157)	(0.036)	(0.125)	(0.061)	(0.016)
Energy	5.170	9.447	0.005	-0.600	-0.300	-0.024
	(6.780)	(11.126)	(0.048)	(0.493)	(0.194)	(0.017)
Other	0.183	-0.891	-0.021	-0.014	0.076	-0.007
	(5.318)	(12.020)	(0.036)	(0.151)	(0.062)	(0.012)
Observations	843	843	604	536	536	399
Number of banks	102	102	97	84	84	53
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.180	0.187	0.094	0.315	0.093	0.071

This table reports estimates from difference-in-differences panel models of environmental performance after the issuance of green bonds with respect to different use of proceeds. The sample in Columns I-II [III-V] {VI} includes all available observations from treated banks (GBI) and control banks (non-green bond issuers) [where information on CO_2 emissions is available] {where information on the industry composition of the loan portfolio is available}. The dependent variable in Columns I (II) [III] {IV} <V> «VI» is the bank's environmental score (emissions score) [log growth rate in Scope 1 and 2 emissions] {log growth rate in Scope 3 emissions} < log growth rate in Scope 1, 2 and 3 emissions> «the proportion of a bank's credit exposure to carbon-intensive sectors». All

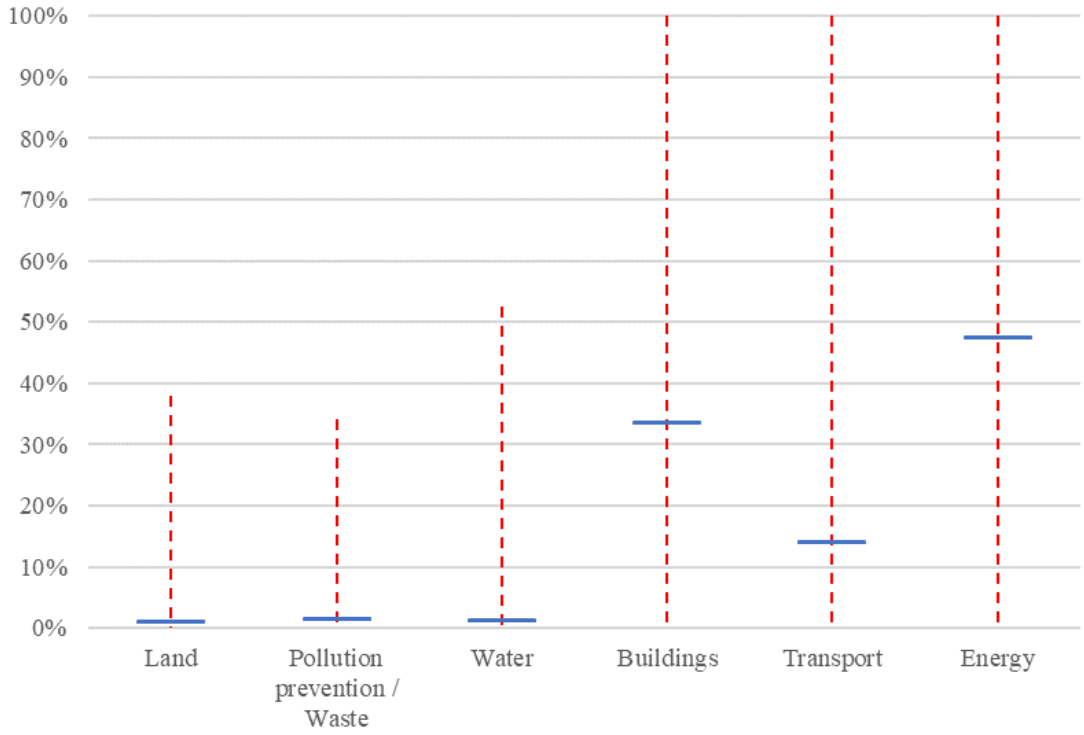
variables are described in Appendix B. Standard errors are clustered at the country level. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Figure 1: Bank bonds and corporate bonds



This figure compares the market share of green bonds (*x*-axis) and conventional bonds (*y*-axis) issued by banks (out of green and conventional bonds issued by banks and non-financial corporates) at country level. Sample period: January 2013-October 2020. Entries in blue (red) denote countries where the market share of bank green bonds is higher (lower) than that of bank conventional bonds.

Figure 2: Use of proceeds



This figure shows the use of proceeds of bank green bonds. The blue marks indicate the proportion invested in each category, averaged across green bond issuers. The vertical red lines represent the minimum and maximum proportion invested in each category by any of the green bond issuers.