Bank Green Bonds

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We analyze the characteristics of banks that issue green bonds to understand: (i) why some banks are more likely than others to resort to these funding instruments, and (ii) if the issuance of green bonds translates into 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 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 increase their environmental and emissions scores, and reduce lending to polluting sectors.

Keywords: Green bonds; Green banking; Environmental performance; Sustainable finance

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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 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. 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 and ultimately impacts their environmental performance.

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. 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

[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.

which banks have chosen this instrument and how this choice has affected their environmental footprint.

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. We build upon Flammer (2021) in assuming that banks issue green bonds mostly to signal their commitment to finance the green transition. Since the issuance of a green bond is a costly signal, we expect that banks will resort to green bond issuance after having released other signals, such as participating to sustainable finance initiatives or disclosing their environmental policies. Next, 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 use 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 less committed institutions that are mostly interested in sending an occasional signal to investors.

We test our hypotheses on the sample of all green bonds issued by banks globally between January 2013 and October 2020. The estimates from both duration models and Cox proportional hazard models support our predictions that large banks and banks that had already signaled their engagement towards sustainable finance are more likely to issue green bonds. We also 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 environmental footprint. It is reasonable to assume 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 performance using: (i) direct indicators such as the environmental score ("E") from ESG ratings and the emissions score which enters the calculation of the environmental score; (ii) 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: (i) an improvement in the issuer's emissions score and, to a lesser extent, in its general environmental score; (ii) a reduction in 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 and for relatively limited amounts. 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. Consistent with this explanation, we find that banks that issue green bonds in a sporadic manner are more likely to send other climate-friendly signals to investors, such as joining initiatives aimed at supporting the transition to a greener banking system.

This paper contributes to the fast-growing literature on corporate green bonds. Most studies on the topic revolve around two aspects: the reaction of equity investors to the issuance of green bonds (Tang and Zhang, 2020; Flammer, 2021) and the pricing of green bonds compared to conventional bonds i.e., the existence of a *greenium* (Hachenberg and Schiereck, 2018; Zerbib, 2019; Gianfrate and Peri, 2019; Tang and Zhang, 2020; Flammer, 2021; Fatica et al., 2021). The two papers most closely related to our work are by Flammer (2021) and Fatica et al. (2021). Flammer (2021) looks at corporate green bonds and argues that companies issue green bonds to send a signal regarding their commitment to the environment. Consistently, she finds positive abnormal returns for shareholders of green bond issuing corporations, no robust evidence of a greenium, and an improvement in the environmental performance of green bond issuers. 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 only study that looks at green bonds issued by banks is by Fatica et al. (2021), who find mixed results. Specifically, they show that only banks that had already signaled their environmental commitment issue green bonds at a premium. By investigating the lending decisions of green bond issuers towards European borrowers, they also document a contraction in the loans extended to more polluting

segments only when green bond issuers act as lead arrangers (but not as participants) in a syndicated loan. They interpret these findings as evidence of an environmental effort consistent with the issuance of green bonds. We complement the above studies by showing which banks are more likely to issue green bonds, by analyzing the heterogeneity of green bond issuers, and by providing a more comprehensive investigation of the impact of green bond issuance on the environmental performance of the issuing banks, both directly, in terms of environmental and emission scores, and indirectly, in terms of lending practices.

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 Agreement as an identification tool to explore changes in bank lending practices spurred by environmental concerns. Reghezza et al. (2021) 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 (2019) finds that French banks that declare their commitment to go green reduce lending to large corporates (but not SMEs) that belong to polluting sectors. 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

We assume that banks issue green bonds to signal their commitment to finance the green transition. This assumption has been validated by Flammer (2021) with reference to corporate 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 can be more expensive if a certification is sought. While at present there is no universal definition of green bonds, the Green Bond Principles issued by the ICMA and the Climate Bonds Taxonomy adopted by the Climate Bonds Initiative provide guidelines to issuers and investors to enhance transparency and verifiability in this segment and ensure that the proceeds are indeed allocated to climate-friendly projects. To provide further reassurance to investors that the use of proceeds is consistent with the goals of the Paris Climate Agreement, issuers

can have their green bonds certified by a third party at a cost.[4] While the direct certification cost can be offset by a lower borrowing cost in the form of a greenium, issuing a green bond remains typically 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.[5] Identifying the likely characteristics of these two bank groups (i.e., more committed or less committed) will help us draw predictions on which banks are more likely to issue green bonds. First, we predict that banks belonging to either group will have already attempted to signal their intention to go green to the market. As explained, issuing a green bond is a costly signal. Therefore, we expect that banks will resort to this after having issued other signals, such as participating to sustainable finance initiatives or disclosing their environmental policies. Hence, we articulate the following hypothesis:

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

Second, we predict that large banks are more likely to issue green bonds. 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. We see three

[4] See the Climate Bonds Standard and Certification Scheme at the Climate Bonds Initiative: https://www.climatebonds.net/certification.

[5] In this paper we do not investigate how the signal is perceived by investors. However, existing studies show that issuing green bonds is valuable to the issuers. Flammer (2021) documents that the issuance of corporate green bonds acts as a credible signal of the company's engagement to climate change for equity investors, and the increase in equity value is larger when the signal is more costly, and for first-time issuers. With reference to green bonds issued by financial institutions, the existence of a greenium is confirmed by Zerbib (2019) and Hachenberg and Schiereck (2018).

reasons for why this is the case. First, large banks can easily afford the certification cost. 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 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 effect of green bond issuance on environmental indicators is likely to be weaker on average for financial institutions than for other corporates. Nonetheless, it is reasonable to assume 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 performance. 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). Bloomberg's definition of green bonds includes all four types of bonds labelled as green according to the 2018 Green Bond Principles (i.e., Standard Green Use of Proceeds Bonds, Green Revenue Bonds, Green Project Bonds, Green Securitized Bonds) as well as other environmental, climate or themed bonds not necessarily aligned to the Green Bond Principles. 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. About 10% of bank green bonds (corresponding to about 19% of the total amount) have been certified by independent third parties, according to the information provided by the Climate Bonds Initiative database.[6] This percentage is in stark contrast with the higher average certification rate of 66% documented for corporate green bonds by Flammer (2021), suggesting that banks do not normally resort to certification. This observation is consistent with the above-mentioned difficulty in measuring in a direct and accurate manner the environmental benefits associated with green bonds issued by banks, and with the fact that banks may enjoy higher reputation than non-financial firms in the bond market, which can facilitate the placement even in absence of a third-party certification. Among the five largest issuing countries, China accounts for 33%

[6] https://www.climatebonds.net/certification/certified-bonds.

of the total amount issued (and 19% of the number of bonds), while France accounts for 28% of the bond 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 2 shows summary statistics on the proportion of green bonds in relation to all bonds issued over the sample period, at the issuer level. 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. We observe great heterogeneity in the recourse to green bonds: On average, 15.6% of the amount issued by a sample bank is represented by green bonds, with a median value of about 5.8%, a bottom decile value of 0.5% and a top decile value of 42.9%. These findings remain essentially unchanged when considering the number of bond issues instead of the amount issued. This heterogeneity 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.

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.[7] 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.

[7] 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.

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 Environmental, Social and Governance (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, covering above 70% of the global market capitalization with a historical coverage up to 20 years, 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. The 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.[8] 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."[9] In July 2021, the UNEP FI counted 266 members, ranging from large publicly traded institutions to small regional banks. As a third indicator of a bank's commitment to climate, we employ the environmental score (i.e., the "E" component of the ESG score), which should provide a more direct measure of the effectiveness of the bank's green policies rather than its mere signaling efforts.

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

[9] Statement available at: https://www.unepfi.org/about/unep-fi-statement/. 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, as 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 and, for this reason, cannot be used for our analysis. A more detailed analysis of different climate initiatives is provided in Section 6.

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. 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 well suited to our analysis as it covers a large panel of countries and years and is more informative than adding country fixed effects to our specifications. Finally, we include an indicator variable that equals one if a banks is government-controlled to account for the fact that some governments may be channeling their environmental policies also through controlled banks. All variables are defined in Appendix A.

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. Bolton and Kacperczyk (2021) find a similar negative relation between a country's commitment to the environment and the emission targets of publicly traded firms headquartered in that country. Consistent with our finding on the EPI, we note 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?

We formally test the determinants of the propensity of a bank to issue green bonds using two estimation methods. The first method is a duration model where we link the time it takes for a bank to issue a green bond to the bank characteristics measured at the beginning of the sample period. The time to the first green bond issuance is measured in months from January 2013, is naturally censored at zero, and is right-censored at 94 months for those banks that have not issued green bonds by October 2020. For banks that issue multiple green bonds over the sample period, the duration is measured as the number of months to the first green bond issuance. The model is estimated using a two-sided tobit regression (to account for both left- and right-censored observations), where the duration to first green bond issuance is regressed on a set of key bank characteristics measured at year-end 2012.

The second method is a Cox (1972) proportional hazard model, where we estimate the propensity of a bank to issue green bonds in any given year during our sample period, based on bank characteristics measured at the beginning of that year. Banks remain in the sample until the first green bond issuance, or throughout the sample period if they never issue a green bond. Compared to the duration approach, the Cox hazard model allows the estimates to account for a timelier adjustment of the propensity to issue green bonds to the time varying characteristics of banks over the sample period.

The estimates of the duration model and the Cox proportional hazard model are reported in Tables 4 and 5, respectively. Column I (in both tables) refers to a specification based on standard bank characteristics (size, capital ratio, profitability, funding ratios, loan ratio) and indicator variables for whether the issuer is publicly listed, is a G-SIB, and is government-controlled. Column II also includes the EPI of the country of domicile of the issuer, to account for the fact that the environmental performance of the country may have an impact on the propensity of a bank to issue green bonds.[10] Column III further includes a dummy variable for being a UNEP FI member and, as such, having publicly announced a commitment towards sustainable finance. Broadly in line with the univariate findings, we observe that banks that have a higher propensity to issue green bonds are larger, less capitalized, more profitable and have lower loan ratios than other banks. These banks are also more likely to be domiciled in

[10] For robustness, we have replaced the country EPI with country fixed effects. The results, available upon request, remain qualitatively unchanged.

countries with lower EPI scores and (limited to the Cox model) to be members of the UNEP FI.

The specifications in Columns I-III 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. To enhance comparability between green and conventional bond issuers, in Columns IV-V of Tables 4 and 5 we restrict our sample to banks with an ESG rating. As discussed, those banks are typically large and publicly traded, and they already disclose information to the public with the intention to signal their sustainability. On this restricted sample, we observe that large and publicly listed banks have a higher propensity to issue green bonds. The estimates from the Cox model confirm (at 10% confidence level) the negative impact of country EPI and the positive effect of being a UNEP FI member. The pre-issuance level of the environmental score, instead, is not significantly different across green and non-green bond issuers.

All in all, our findings from the duration and the Cox hazard analyses support our 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. Additionally, in line with the univariate findings, we find that the propensity to issue green bonds is higher for banks domiciled in countries with a lower environmental performance.

We now proceed to investigate the characteristics of the banks that choose to resort to green bonds more intensively. In Table 6 we look at the determinants of the proportion of green bonds over total bonds issued during the sample period. We restrict the analysis to those banks that issue at least one green bond. In Columns I and II (III and IV) the proportion of green bonds is computed on the number of bonds issued (on the amount in USD), at the issuer level over the entire sample period, thus resulting in one observation per green bond issuer. The model is estimated by OLS and the explanatory variables are measured at year-end 2012. In line with our hypothesis *H2b*, we see that issuer size has a negative impact on the proportion of green bonds issued both in terms of numbers of bonds and in terms of amount issued. 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. Furthermore, we document a negative relation between the intensity in the use of green bonds (by number of bonds issued) and the environmental performance of the country of domicile.

5. Green bond issuance and 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 choose two measures of environmental performance, one more directly linked to the bank's own environmental scores and one related to the exposure of the loan portfolio to carbon-intensive sectors.

5.1. Environmental scores

In line with Flammer (2021), 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) and mapped into ratings (D for scores between zero and 25, C between 25 and 50, B between 50 and 75, and A between 75 and 100).

To assess the impact of green bond issuance on a bank's environmental indicators, we first derive 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. The methodology we follow is similar to the one in Flammer (2021). 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. These covariates are chosen to include the main determinants of a bank's propensity to

issue green bonds as well as a measure of environmental performance.[11] 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 Table 7 the estimates of *t*-tests for difference in means across treated and control samples, which confirm that the two groups are well matched.

We then proceed to estimate the impact of green bond issuance on the issuer's environmental metrics by means of difference-in-differences specifications. We use a panel of all bank-year observations of the treated and matched control banks from 2012 to 2020. In the first model we regress the environmental score and the emissions score in a given year on: (i) a dummy variable which equals one if the bank has ever issued green bonds over the sample period, and zero otherwise; (ii) year fixed effects; (iii) a dummy variable which equals one if the bank has already issued green bonds by that year, and zero otherwise. The latter is the variable of interest, as it indicates whether the environmental variables change following the issuance of green bonds. The findings, reported in Table 8, Columns I and V, suggest that, on average, the issuance of green bonds does not have a direct impact on the bank's environmental indicators, as the coefficients of the interaction variable are not statistically significant. The addition of country fixed effects in Columns II and VI, to control for potential residual differences at the country level, leaves the results qualitatively unchanged.

As previously discussed, 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 indicator variables that measure the intensity of recourse to green bonds. In Columns III and VII we add: (i) a dummy that equals one if, in the sample period, the bank has issued a proportion of green bonds over total bonds higher than the median computed across all green bond issuers, and zero otherwise; (ii) a dummy that equals one if an above-median green bond issuer has already issued green bonds by that year, and zero

[11] 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.

otherwise. The indicator variable in (ii) measures the additional impact on the environmental performance of high-intensity green bond issuers compared to other green bond issuers. The estimates show that, in line with hypothesis *H3*, high-intensity green bond issuers experience a significant increase in their environmental indicators following the issuance of green bonds in terms of both environmental score and emissions score. The economic effects are sizable. From Column III we see that their environmental score is increased by 9.3 percentage points, which corresponds to an increase in their pre-issuance environment score of 12%. Likewise, their emissions score is increased by 18.7 percentage points as reported in column VII, which translates into an increase in their pre-issuance emissions score of 24%. We also perform a Wald test on the sum of coefficients of the two interaction terms to assess whether the post-issuance environmental quality of high-intensity green bond issuers differs from that of non-green bond issuers, and we find the emissions score to be significantly larger post-issuance.

One may argue that in an attempt to send a stronger signal to the market, a bank may fraction a green bond issuance into several issuances of very limited amount. For robustness, we repeat the analysis using as an indicator of high-intensity green bond issuer a dummy variable that equals one if the proportion of the amount (instead of number) of green bonds issued over total bonds is above the median proportion computed across green bond issuers. The findings, reported in Columns IV and VIII, albeit slightly weaker, essentially confirm those discussed in the previous paragraph.

5.2. Lending to carbon-intensive sectors

A limitation of the previous analysis is that it is unlikely to 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).[12] As a result, the emissions score used in the previous analysis is unlikely to reflect any 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 measure. Quantifying the extent to which a bank lends to polluting sectors is 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 (2019) 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. (2021) 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

[12] 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.

classify an industry as carbon-intensive if it has been identified as major emission source by the Inter-governmental Panel on Climate Change (IPCC). The five industry sectors identified as major emission sources by the IPCC are: energy, transport, buildings, industry (such as chemicals and metals), and agriculture, forestry, and other land use. 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.[13]

We exclude banks that do not provide a necessary 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. These filters reduce the sample size to 32 pairs of green bond issuers and matched banks. We then re-estimate the difference-in-differences models of Subsection 5.1. by replacing the environmental or emissions scores with the proportion of a bank's credit exposure to carbon-intensive sectors (*Brown lending*). The results, reported in Table 9, are broadly consistent with the findings on the environmental indicators. Columns I and II show that, on average, green bond issuers do not significantly differ from their peer banks in terms of lending to brown sectors and the issuance of green bonds does not seem to play a role in reducing the credit exposure to these sectors. When we distinguish between low- and high-intensity green bond issuers based on the number of bonds issued, we find that, while high-intensity green bond issuers lend relatively more to polluting sectors, they significantly reduce their exposure after issuing green bonds. The economic effects are large. From Column III we see that brown lending decreases by a coefficient of 0.037, which corresponds to a decrease in the pre-issuance level of brown lending by 8%. Therefore, for these issuers, green bonds seem beneficial in redirecting lending to less carbon-intensive sectors.[14]

[13] 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 Subsection 5.1.

[14] For consistency we also investigate how green bond issuance affects the environmental and emission scores on this reduced sample of 32 pairs. The results, available from the authors upon request, yield the same conclusions as those drawn from the full sample of 69 pairs in Table 8.

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 lending policies, emissions score and, to a lesser extent, in its general environmental score. 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 quality of banks that issue green bonds occasionally and for limited amounts. One explanation may be that those issuers use green bonds mostly to send a signal to investors. Another explanation could be that those banks are less urged to improve their environmental performance, which is consistent with the higher (lower) pre-issuance emissions score (brown lending) observed in Table 8 (9) compared to high-intensity green bond issuers. It is worth noting that particular care must be taken when inferring a causal link between green bond issuance and changes in environmental quality, as it may be still too early to observe a general significant improvement in environmental variables as a result of green bond issuance. Table 1 indicates that nearly 70% of bank green bonds were issued since 2018 and that nearly 40% of those bonds have maturities ranging from 5 to 10 years. This does not invalidate our findings, to the extent that green bond issuance signals a more general commitment of the issuer to making the banking system greener.

6. Green bonds and other green signaling initiatives

Throughout our study, we have assumed that, by issuing a green bond, a bank signals to investors its intention to reduce its environmental footprint. Green bonds represent only one of several initiatives that banks can undertake to favor the transition to a more climate-friendly banking system. In this section, we look at how green bond issuers relate to those other initiatives compared to non-green bond issuers, to see to what extent green bond issuance is part of a more general strategy aimed at improving the issuer's environmental quality. As of July 2021, there existed seven major global climate initiatives directly focused on how banks can contribute to the decarbonization of the economy. These initiatives are fully detailed in Appendix B and range from more lenient ones like the UNEP FI or the Task Force on Climate-Related Financial Disclosure (TFCD) which are "voluntary and aspirational", to more stringent

ones like the Net-Zero Banking Alliance (NZBA) agreement or the Science-Based Target initiative (SBTi) that require members to set credible plans to achieve zero-emission targets.[15]

The two histograms in Figure 1 indicate that it is much more likely that a bank that has issued green bonds is a member of one or more of these initiatives compared to a bank that has not issued green bonds. The underlying sample includes all banks that have issued at least one bond (green or conventional) over the sample period and have financial data available in Moody's Analytics BankFocus. In Panel A of Table 10 we contrast the participation of the sample of non-green bond issuing banks with the participation of the green bond issuing banks. We do so by comparing both the total number of initiatives joined as well as by looking into each of the seven individual initiatives.

Following our observations from Figure 1 it is not surprising to find large differences between the two groups. While the average green bond issuer has joined two initiatives, the average participation for a non-green bond issuer is only about one-half initiative. For both groups it is the case that the UNEP FI is the most joined initiative, as it is the oldest attempt to encourage the transition towards a more sustainable finance, and one of only two initiatives to have been in place before the starting date of our study. The fact that the initiative was launched well ahead of the emergence of green bonds and that it is the most subscribed initiative by both green bond and non-green bond issuers are the reasons why it was chosen as the representative initiative for the analysis in Tables 4 to 6. The findings in Table 10 confirm the validity of our choice. Unsurprisingly, we also note that the participation rate goes down as the commitment required to join an initiative becomes more stringent. The arguably toughest initiative, together with the above mentioned SBTi and the NZBA, is the Collective Commitment to Climate Action (CCCA), which requires signatories to report annually on their progress in achieving set targets to reduce their portfolio exposure to carbon-intensive sectors. This initiative is the least represented among our sample banks. We note that, with respect to the individual initiatives, green bond issuers have a participation rate that is around three times that of non-green bond issuers. These statistics suggest a consistent behavior of green bond issuers and reinforce our conclusions from the previous analysis, namely that these banks are more likely to signal to the market their commitment to the climate cause than other banks. In the last rows

[15] The list of initiatives that we consider is by no means exhaustive, as we focus on initiatives that are open to any bank, irrespective of size or geographic location, and mostly endorsed by independent bodies such as the United Nations or the Financial Stability Board.

of Panel A, we examine whether green bond issuers typically join climate-related initiatives before or after they issue their first green bond. We find no significant difference in the prevalence of joining an initiative and then becoming a green bond issuer as opposed to the reverse order of events. These results, however, should be interpreted with care, given that five out of the seven initiatives considered in our study were launched after the first bank green bonds were launched.

In Panel B of Table 10 we focus on green bond issuers and investigate whether there are differences in the participation rate to climate initiatives between those banks that issue green bonds more intensely compared to those that issue green bonds occasionally and for smaller amounts. Again, we categorize green bond issuers into high-intensity and low-intensity issuers based on the proportion (USD amount) of green bonds over total bonds issued over the sample period compared to the median. Panel B shows that an average low-intensity bank joins about three times as many initiatives compared to a high-intensity bank. Figure 2 (a) and (b) display the respective distributions of initiatives joined by these two groups. We note that it is considerably more likely that a low-intensity green bond issuer is a member of one or more of these initiatives compared to a high-intensity green bond issuing bank. It is interesting to reflect upon these findings together with the results from Tables 8 and 9, where we document that only banks that issue green bonds frequently and for sizeable amounts experience a significant increase in their environmental performance. It thus seems to be the case that occasional green bond issuers are instead relatively more focused on sending signals on their climate commitment by joining initiatives and consider the issuance of green bonds as one of the main tools available for this purpose. By contrast, the high-intensity green bond issuers spend less time on joining initiatives but overall seem more successful in reducing their environmental footprint. Our findings thus constitute further evidence that points to the importance of bank green bonds as a key, perhaps necessary, instrument to achieve a climate alignment within the banking sector.

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 stakeholders 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 and for larger amounts 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 more opaque 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 (Tang and Zhang, 2020; Fatica et al., 2021). 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.

References

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

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

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

Cox, D.R. (1972). Regression models and life-tables. *Journal of the Royal Statistical Society. Series B (Methodological)* 34, 187–220.

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.

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*, 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*, 142, 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., Levy, M. A., et al. (2016). 2016 Environmental Performance Index: Global Metrics for the Environment. New Haven, CT: Yale Center for Environmental Law & Policy.

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.

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. (2019). Banks' climate commitments and credit to brown industries: New evidence for France. Banque de France Working Paper #743.

Müller, I. and Sfrappini, E. (2021) Climate change-related regulatory risks and bank lending, IWH- Halle 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. (2021). Do banks fuel climate change? ECB Working Paper No 2550.

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., et al. (2018). 2018 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy.

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

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.

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
Certified		
No	555	161.27
Yes	62	36.77
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. *Certified* indicates whether a green bond obtained a third-party certification according to the Climate Bonds Initiative.

Table 2: Green bonds over total bonds: Green bond issuers

	By number of bond issues	By amount issued (USD bn)
Mean	15.98%	15.57%
Standard deviation	21.41%	21.86%
10th percentile	0.32%	0.54%
25th percentile	1.22%	1.72%
Median	7.69%	5.84%
75th percentile	23.08%	20.18%
90th percentile	50.00%	42.89%
Number of issuers	177	177

This table reports summary statistics on the proportion of green bonds over total bonds issued between Jan 2013 and Oct 2020, 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	1349	18.703	1.736	120	-19.450***
Capital ratio	0.114	0.126	1349	0.083	0.106	120	3.024***
ROA	0.007	0.023	1349	0.008	0.010	120	-1.114
Customer deposit ratio	0.570	0.217	1349	0.523	0.243	120	2.048**
Long-term funding ratio	0.130	0.132	1349	0.118	0.123	120	1.009
Loan ratio	0.617	0.193	1349	0.506	0.197	120	5.957***
Listed	0.243	0.429	1349	0.492	0.502	120	-5.255***
G-SIB	0.007	0.081	1349	0.117	0.322	120	-3.727***
Government controlled	0.070	0.255	1349	0.150	0.359	120	-2.400**
Has ESG rating	0.231	0.421	1349	0.558	0.499	120	-6.982***
UNEP FI member	0.083	0.276	1349	0.325	0.470	120	-5.551***
EPI country score	61.994	9.119	1332	56.935	11.587	118	4.618***
Environmental score	45.243	34.425	311	60.742	30.491	67	-3.685***

This 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 A. Column VII 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 a green bond: Duration analysis

	Duration in months to first green bond issuance				
	I	II	III	IV	V
Ln(Assets)	-17.992***	-17.222***	-16.473***	-19.548***	-19.804***
	(1.579)	(1.613)	(1.607)	(2.760)	(3.036)
Capital ratio	98.180*	96.130*	88.665*	13.124	22.120
	(57.681)	(53.376)	(51.925)	(50.234)	(50.818)
ROA	-545.325**	-396.762*	-366.683*	-139.719	-84.822
	(251.599)	(222.055)	(215.825)	(234.056)	(238.298)
Customer deposit ratio	-17.971	-1.441	-7.327	10.690	28.721
	(19.794)	(19.396)	(19.497)	(27.505)	(32.543)
Long-term funding ratio	-31.295	-30.810	-37.499	-9.963	1.104
	(30.470)	(30.286)	(30.678)	(39.918)	(42.157)
Loan ratio	38.305**	33.126**	35.820**	-20.049	-23.205
	(17.074)	(16.055)	(15.516)	(23.465)	(24.509)
Listed	-5.009	-2.080	-2.484	-15.593**	-14.760*
	(5.531)	(5.584)	(5.554)	(7.020)	(7.544)
G-SIB	-2.008	-6.261	-4.090	0.591	-2.487
	(11.808)	(11.575)	(11.653)	(11.614)	(12.020)
Government controlled	-6.663	-5.587	-6.458	25.182**	29.254**
	(8.225)	(8.896)	(8.828)	(11.112)	(11.346)
UNEP FI			-9.234		0.534
			(6.357)		(9.381)
EPI country score		0.856***	0.889***		0.534
		(0.285)	(0.283)		(0.416)
Environmental score					0.069
					(0.145)
Constant	453.986***	380.391***	370.015***	502.941***	461.254***
	(35.387)	(41.918)	(41.232)	(59.008)	(65.119)
Observations	1,469	1,450	1,450	378	368
Pseudo R-squared	0.145	0.152	0.153	0.111	0.118
Sample	Full	Full	Full	ESG banks	ESG banks

This table analyzes the characteristics of bank green bond issuers, by showing estimates of duration models to first green bond issuance. The models are estimated by using two-sided Tobit regressions. The dependent variable is the time to the first green bond issuance measured in months from January 2013 (naturally censored at zero, and right-censored at 94 months for those banks that have not issued any green bonds by October 2020). Bank characteristics are measured at year-end 2012. All variables are described in Appendix A. The sample in Columns I-III includes all banks that have issued at least one bond (green or conventional) over the sample period. The sample in Columns IV-V includes only banks with an ESG rating available at year-end 2012. Robust standard errors in parentheses. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

Table 5: Propensity to issue a green bond: Cox proportional hazard models

	Hazards to first green bond issuance				
	I	II	III	IV	V
Ln(Assets)	0.624***	0.620***	0.596***	0.720***	0.678***
	(0.047)	(0.049)	(0.049)	(0.092)	(0.104)
Capital ratio	-3.496***	-3.314**	-3.076**	-2.085	-1.317
	(1.356)	(1.396)	(1.370)	(1.730)	(1.610)
ROA	13.595***	10.966**	10.967**	8.526	6.189
	(4.815)	(5.486)	(5.355)	(9.791)	(9.743)
Customer deposit ratio	-0.626	-0.927*	-0.689	-0.971	-0.674
	(0.518)	(0.527)	(0.550)	(0.882)	(1.030)
Long-term funding ratio	-0.065	0.051	0.279	0.193	0.472
	(0.887)	(0.890)	(0.905)	(1.366)	(1.458)
Loan ratio	-1.154**	-1.083**	-1.165**	-0.103	-0.164
	(0.490)	(0.501)	(0.502)	(0.831)	(0.922)
Listed	0.326*	0.212	0.254	0.718***	0.900***
	(0.179)	(0.189)	(0.194)	(0.275)	(0.324)
G-SIB	0.126	0.221	0.149	0.157	0.054
	(0.276)	(0.278)	(0.284)	(0.334)	(0.352)
Government controlled	0.164	-0.079	-0.006	-0.366	-0.584
	(0.242)	(0.290)	(0.290)	(0.406)	(0.450)
UNEP FI			0.373*		0.519*
			(0.208)		(0.310)
EPI country score		-0.023***	-0.025***		-0.021*
		(0.007)	(0.007)		(0.011)
Environmental score					0.003
					(0.005)
Observations	14,911	14,762	14,762	3,763	3,687
Pseudo R-squared	0.151	0.156	0.158	0.150	0.163
Sample	Full	Full	Full	ESG banks	ESG banks

This table analyzes the characteristics of bank green bond issuers, by showing estimates of Cox proportional hazard models with time-varying covariates at the bank-year level. All variables are described in Appendix A. The sample in Columns I-III includes all banks that have issued at least one bond (green or conventional) over the sample period. The sample in Columns IV-V includes only banks with an ESG rating available. Robust standard errors in parentheses. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

Table 6: Intensity of recourse to green bonds

	By number of bond issues (%)		By amount issued (%)	
	I	II	III	IV
Ln(Assets)	-0.034***	-0.028***	-0.032***	-0.026**
	(0.009)	(0.010)	(0.010)	(0.012)
Capital ratio	-0.036	-0.006	-0.142	-0.132
	(0.128)	(0.148)	(0.148)	(0.152)
ROA	0.333	-0.631	2.022	1.312
	(1.392)	(1.522)	(1.717)	(1.708)
Customer deposit ratio	0.312***	0.227***	0.310***	0.234***
	(0.068)	(0.080)	(0.073)	(0.088)
Long-term funding ratio	0.144	0.154	0.177	0.181
	(0.194)	(0.191)	(0.200)	(0.199)
Loan ratio	-0.151	-0.087	-0.123	-0.070
	(0.098)	(0.099)	(0.098)	(0.107)
Listed	-0.001	-0.019	-0.004	-0.017
	(0.023)	(0.023)	(0.025)	(0.025)
G-SIB	0.045	0.057	0.081	0.092
	(0.053)	(0.053)	(0.066)	(0.068)
Government controlled	-0.002	-0.001	0.045	0.047
	(0.041)	(0.039)	(0.049)	(0.048)
UNEP FI		-0.021		-0.025
		(0.030)		(0.037)
EPI country score		-0.003*		-0.002
		(0.001)		(0.002)
Constant	0.622***	0.714***	0.554***	0.619***
	(0.158)	(0.176)	(0.187)	(0.224)
Observations	120	118	120	118
Adjusted R-squared	0.268	0.289	0.233	0.239

This table shows the determinants of the intensity of recourse to green bonds. The dependent variable is, for each green bond issuer, the proportion of green bonds over total bonds issued between Jan 2013 and Oct 2020, measured on number of bonds issued (Columns I and II) and amount of bonds issued (Columns III and IV). The sample includes only banks that have issued green bonds. Bank characteristics are measured at year-end 2012. All variables are described in Appendix A. The models are estimated using OLS regressions. Robust standard errors in parentheses. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

Table 7: *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
Emissions score	67.80	28.08	69.66	24.10	0.42
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 A. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Table 8: Green bond issuance and environmental indicators: Difference-in-differences

	Environmental score				Emissions score			
	I	II	III	IV	V	VI	VII	VIII
Green bond issuer (GBI)	2.501	5.285	6.531	7.726	1.284	5.067	8.044*	8.146*
	(4.896)	(4.308)	(4.782)	(4.762)	(4.997)	(4.002)	(4.362)	(4.216)
GBI post issuance	-1.153	-1.080	-4.007*	-3.232	-1.003	-0.868	-6.716***	-5.985***
	(1.988)	(2.027)	(2.178)	(2.221)	(2.530)	(2.579)	(2.212)	(2.265)
GBI above median (by number of bond issues)			-4.686				-11.228	
			(7.306)				(8.149)	
GBI above median (by number of bond issues) post issuance			9.333**				18.661***	
			(3.893)				(5.626)	
GBI above median (by amount issued)				-9.327				-11.780*
				(7.075)				(7.162)
GBI above median (by amount issued) post issuance				7.362*				17.380***
				(3.872)				(5.800)
Constant	52.844***	24.545***	24.566***	24.034***	58.428***	48.372***	48.251***	48.060***
	(3.644)	(6.381)	(6.466)	(6.054)	(3.777)	(3.277)	(3.291)	(3.180)
Observations	1,114	1,114	1,114	1,114	1,114	1,114	1,114	1,114
Country FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.206	0.206	0.220	0.215	0.211	0.211	0.248	0.243
χ-test: GBI + GBI above median = 0			0.07	0.06			0.18	0.28
χ-test: GBI post issuance + GBI above median post issuance = 0			2.31	1.42			5.03**	4.33**

This table reports estimates from difference-in-differences panel models of environmental quality after the issuance of green bonds. The sample includes all available observations from treated banks (green bond issuers) and control banks (non-green bond issuers). The dependent variable in Columns I-IV (V-VIII) is the bank's environmental (emissions) score provided by Refinitiv. All variables are described in Appendix A. Standard errors are clustered at the bank level. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

Table 9: Green bond issuance and brown lending: Difference-in-differences

	Brown lending			
	I	II	III	IV
Green bond issuer (GBI)	0.067*	-0.010	-0.091***	-0.056*
	(0.040)	(0.037)	(0.024)	(0.032)
GBI post issuance	-0.005	-0.005	0.010	-0.004
	(0.011)	(0.012)	(0.014)	(0.012)
GBI above median (by number of bond issues)			0.262***	
			(0.066)	
GBI above median (by number of bond issues) post issuance			-0.037**	
			(0.016)	
GBI above median (by amount issued)				0.126*
				(0.067)
GBI above median (by amount issued) post issuance				-0.003
				(0.019)
Constant	0.353***	0.171***	0.171***	0.171***
	(0.027)	(0.010)	(0.010)	(0.010)
Observations	480	480	480	480
Country FE	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adjusted R-squared	0.0802	0.0802	0.100	0.0803
χ-test: GBI + GBI above median = 0			6.88***	1.24
χ-test: GBI post issuance + GBI above median post issuance = 0			3.51*	0.14

This table reports estimates from difference-in-differences panel models of lending to carbon-intensive sectors after the issuance of green bonds. The sample includes all available observations from treated banks (green bond issuers) and control banks (non-green bond issuers) where information on the industry composition of the loan portfolio is available. The dependent variable is the proportion of a bank's credit exposure to carbon-intensive sectors (*Brown lending*). All variables are described in Appendix A. Standard errors are clustered at the bank level. $*$, $**$, and $***$ denotes significance at the 10%, 5%, and 1% level, respectively.

Table 10: Climate initiatives joined by green bond and non-green bond issuers

Panel A	Non-green bond issuers			Green bond issuers			
	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	*t*-stat.
Total initiatives joined	0.538	1.406	2,235	1.966	2.164	174	-8.562***
UNEP FI	0.134	0.340	2,235	0.425	0.496	174	-7.617***
Equator Principles Financial Institutions	0.085	0.280	2,235	0.385	0.488	174	-7.997***
TFCD	0.095	0.293	2,235	0.385	0.488	174	-7.736***
SBTi	0.035	0.184	2,235	0.155	0.363	174	-4.326***
CCCA	0.029	0.167	2,235	0.098	0.298	174	-3.023**
Principles for Responsible Banking	0.119	0.324	2,235	0.385	0.488	174	-7.071***
Net-Zero Banking Alliance	0.042	0.200	2,235	0.132	0.340	174	-3.471***
Green bonds issued before joining				0.948	1.255	174	-0.668
Green bonds issued after joining				1.017	1.301	174	

Panel B	GBI below median			GBI above median			
	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	*t*-stat.
By number of bond issues	3.080	2.102	87	0.826	1.551	87	8.062***
By amount issued	2.886	2.194	87	1.023	1.680	87	6.297***

Panel A reports summary statistics of participation to climate initiatives for: (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). Panel B reports summary statistics of participation to climate initiatives for Green bond issuers based on whether they have over the sample period issued a proportion of green bonds below or above the median. Information on climate initiative participation is taken as of July 2021. All initiatives are described in Appendix B. Column VII reports the *t*-test for the difference in means. ∗, ∗∗, and ∗∗∗ denotes significance at the 10%, 5%, and 1% level, respectively.

Figure 1 Distribution of climate initiatives joined by sample banks

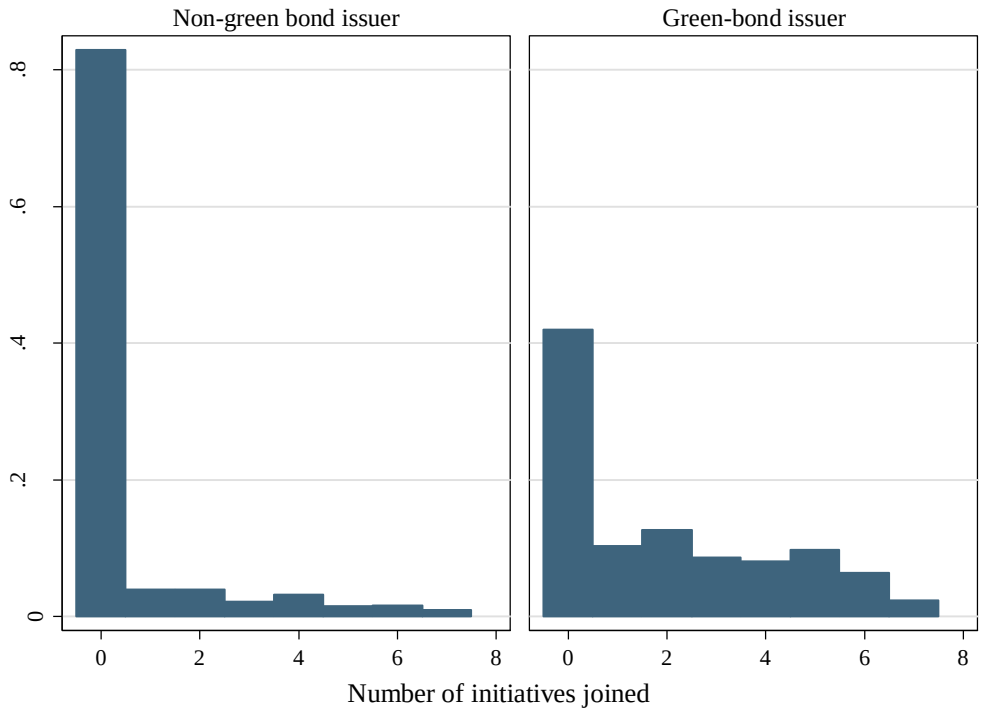
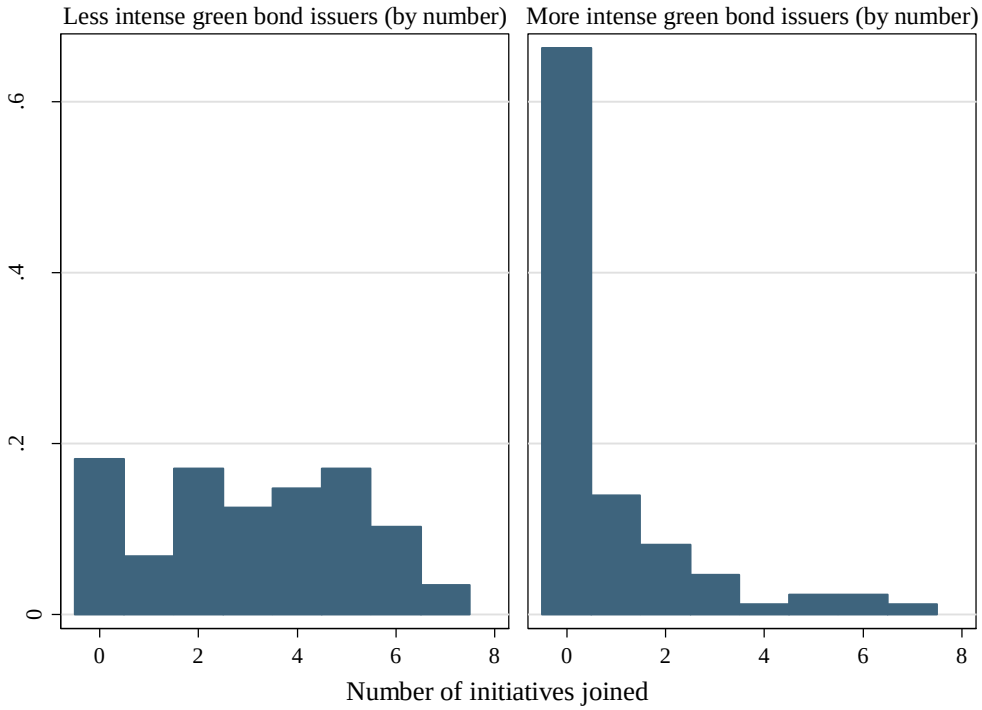
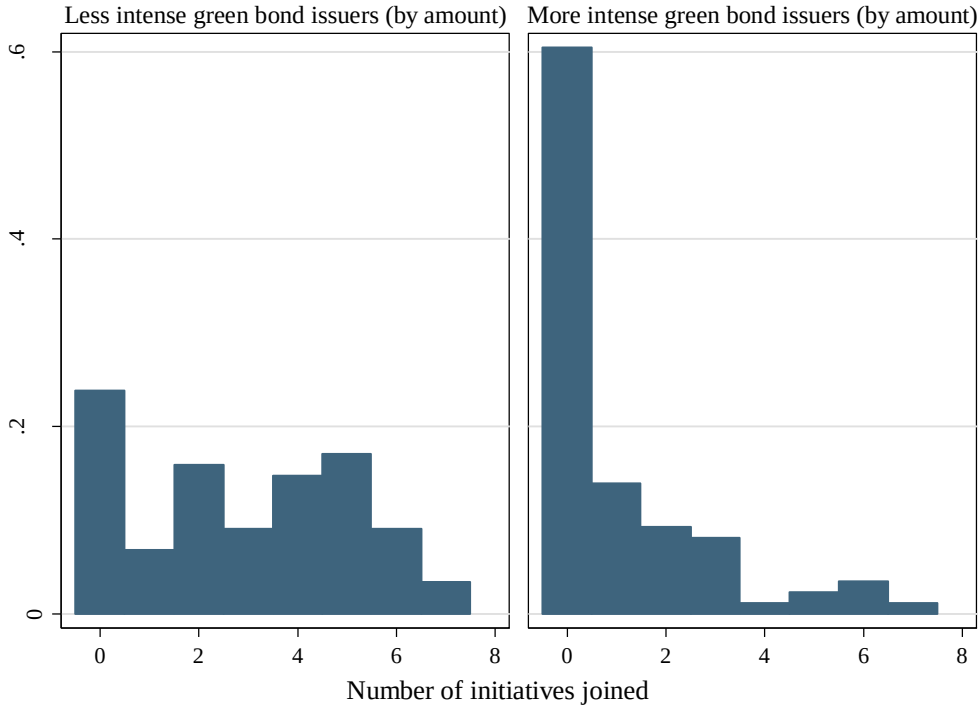


Figure 2: Distribution of climate initiatives joined by green bond issuers

(a)



(b)



Appendix A: 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
Capital ratio	Ratio of equity over total assets	Moody's Analytics BankFocus
Customer deposit ratio	Ratio of total customer deposits over total assets	Moody's Analytics BankFocus
Emissions score	The bank's emission score	Thomson Reuter's Refinitiv
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
GBI above median (by amount issued)	Dummy variable taking the value 1 (0) if a bank has issued in the sample period a proportion of green bonds over total bonds (by USD amount) higher (lower) than the median	Bloomberg
GBI above median (by number of bond issues)	Dummy variable taking the value 1 (0) if a bank has issued in the sample period a proportion of green bonds over total bonds (by number of bonds issued) higher (lower) than the median	Bloomberg
GBI above median (by amount issued) post issuance	Dummy variable taking the value 1 (0) if a GBI above median by amount has (has not) already issued a green bond by the current year	Bloomberg
GBI above median (by number of bond issues) post issuance	Dummy variable taking the value 1 (0) if a GBI above median by number of bonds 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
Listed	Dummy variable taking the value 1 (0) if a bank is (is not) publicly listed	Moody's Analytics BankFocus
Ln(Assets)	Natural logarithm 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
ROA	Ratio of net income over total assets	Moody's Analytics BankFocus
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 B: Climate initiatives for the banking sector

Initiative	Established	Stated objective	Source
UNEP FI	1992	The United Nations Environment Programme Finance Initiative (UNEP FI) lists several sustainability principles that should be implemented at all levels of operations in financial institutions. The principles are voluntary and aspirational and membership is obtained by paying a nominal fee.	https://www.unepfi.org
Equator Principles Financial Institutions	2003	The Equator Principles is a risk management framework for determining, assessing and managing environmental and social risk in project finance. Financial institutions commit to not provide project finance or project-related corporate loans to projects where the client will not comply with the Equator Principles reporting standards.	https://equator-principles.com
TFCD	2015	The Task Force on Climate-Related Financial Disclosures (TCFD) is an organization with the goal of developing a set of voluntary climate-related financial risk disclosures which can be adopted by companies to inform investors and other members of the public about climate change risks.	https://www.fsb-tcfd.org
SBTi	2015	The Science Based Targets initiative (SBTi) defines best practice in science-based target setting and provides companies with a specification how much and how quickly they need to reduce their greenhouse gas emissions. Participants report emissions and their progress to reach their targets annually.	https://sciencebasedtargets.org
CCCA	2019	The Collective Commitment to Climate Action sets out concrete and time-bound actions that banks will take to scale up their contribution to and align their lending with the objectives of the Paris Agreement on Climate. Banks must set and publish sector-specific targets for aligning their portfolios with a well-below 2 degrees and striving for 1.5 degrees Celsius trajectory. Signatories report annually on their progress in implementing the commitment and achieving set targets.	https://www.unepfi.org/banking/bankingprinciples/commitments/ccca
Principles for Responsible Banking	2019	The Principles for Responsible Banking constitute a framework to align signatory banks' strategies and practices with the Sustainable Development Goals and the Paris Climate Agreement. The principles are voluntary and aspirational although signatories have an obligation to report on the extent to which they implement the principles through the annual Reporting and Assessment process.	https://www.unepfi.org/banking/bankingprinciples
Net-Zero Banking Alliance	2021	The Net-Zero Banking Alliance brings together banks committed to aligning their lending and investment portfolios with net-zero emissions by 2050. Signatories must set 5-year targets from 2030 to 2050 on emission reductions. The progress in reaching the targets must be disclosed annually.	https://www.unepfi.org/net-zero-banking