How to Mitigate Greenwashing Concerns?
– Evidence from the Green Bond Market

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Current Draft: Oct 2022

Preliminary – please do not cite or circulate

Abstract

This study examines how high quality green bond issuers differentiate themselves from greenwashing issuers by bonding with two reputable institutions – the Climate Bonds Initiative (CBI) and the Luxembourg Green Exchange (LGX). Both institutions impose and enforce high transparency (i.e., disclosure and assurance) requirements, albeit different focuses. The CBI allows for private disclosure channels while putting more emphasis on post-issuance assurance and compliance with a green taxonomy. In contrast, the LGX requires public disclosure on a centralized platform while allowing for discretion in obtaining post-issuance assurance or complying with a green taxonomy. Consistent with the differences in focus, issuers bonding with the LGX (LGX Issuers) provide more public disclosure and more assurance, and allow easy access to their green bond documents. Nevertheless, issuers bonding with the CBI (CBI Issuers) only provide more assurance but tend to achieve larger environmental improvements. In the primary market, bonds listed on the LGX receive a larger green premium relative to the non-bonding green bonds, while the CBI certified bonds do not. Moreover, in the secondary market, the CBI or LGX Issuers that provide high post-issuance transparency enjoy a larger liquidity benefit, while those that fail to provide high post-issuance transparency suffer a liquidity penalty. Overall, the findings suggest that ex-ante certification from reputable institutions may not be enough to earn investors' trust. Instead, credible commitment of public post-issuance disclosure may be a more effective mechanism to mitigate investors' greenwashing concerns.

Keywords: Green Finance; Green Bond Standard; Transparency and Accountability

"Financial markets can help solve the climate challenge by meeting the growing demand for low-carbon projects around the world, from urban transit infrastructure to renewable energy facilities. New financial tools like green bonds are helping drive more capital to these projects, [...], clear standards and better market data will accelerate the use of green bonds by making them an even more attractive way to invest."

– Michael R. Bloomberg (OECD 2015)

1   Introduction

Recent years have seen a rapid expansion of the green bond market, a sub-market of ESG investing with growing importance. By 2025, the green bond is expected to reach $5 trillion USD in size, representing 9% of the total ESG asset under management (AUM) and about 3% of the total AUM of all assets (Bloomberg Intelligence 2021). However, due to the lack of regulatory standards that define "greenness" and mandate public reporting and assurance, green bond investors face significant greenwashing risks (Akerlof 1978).[1] This study examines how issuers of high-quality green bonds differentiate themselves from greenwashing issuers by bonding with reputable institutions that impose and enforce high disclosure and assurance requirements (Spence 1973; Jensen and Meckling 1976; Coffee Jr 2002), and whether the bonding mechanism effectively enhance issuers' environmental credibility.

I focus on two institutions (hereafter, Active Monitors) – the Climate Bonds Initiative (CBI) and the Luxembourg Green Exchange (LGX), for their prominent role in establishing and enforcing rules that promote green bond transparency (see, Appendix 6). Both of the Active Monitors require a detailed green bond plan (usually in the form of a Green Bond Framework), a pre-issuance external review that verifies the legitimacy (i.e.,

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[1]Anecdotal evidence underline the growing suspicion of the green bond label. For example, a recent The Financial Times article titled *"Investors probe ESG credentials of bond sellers on 'greenwashing' fears"* quoted research by NNI investment Partners which suggest that 15 percent of green bonds are issued by companies 'involved in controversial practices' (The Financial Times, Oct 28, 2020, available at `https://www.ft.com/content/1bcbad16-f69e-47db-82fa-0419d674bb53`). The same article also named the €1.3 billion green bond issued by Saudi Electricity Company for installation of smart grids, and the green bond issued by Mexico's government in 2018 for building a energy-efficient airport but failed to deliver as greenwashing.

whether the green bond plan aligns with selected standards) and feasibility (i.e., whether the issuer has the internal infrastructure to carry out the plan) of the green bond plan, and post-issuance reporting of the actual use of proceeds (UOP). Nevertheless, they have different focuses. By requiring alignment with a detailed green taxonomy and post-issuance assurance while allowing for private disclosure to existing bond holders, the CBI provides Active Monitoring with a focus on private communication and external certification.[2] In contrast, by mandating public disclosure of all relevant green bond documents on a centralized platform (i.e., the LGX website) while allowing for higher-level categories of eligible green projects and discretion in obtaining post-issuance assurance, the LGX provides Active Monitoring with a focus on transparency and visibility.[3] Issuers that fail to comply with the disclosure and assurance requirements will risk having their CBI certifications revoked or their green bonds removed from the LGX.

My sample includes 698 corporate green bonds issued between November 1, 2013 and December 31, 2020 by 326 public corporations from 40 countries.[4] In my sample, the top three countries by issuance size are China, France, and United States; the top three currencies are Euro (EUR), US Dollar (USD), and Chinese Yuan (CNY); and finally, the top three sectors are Financials, Utilities, and Real Estate. The average green bond in my sample has an issuance size of $346 million, a credit rating of S&P equivalent of A, and an average maturity of 7 years. The average public corporate green bond issuer is of the size of $192.3 billion and a leverage ratio of 0.36, suggesting that it is relatively experienced in the corporate bond market.

I start by examining the factors that drive issuers' choices to bond with the Active Monitors. Consistent with prior studies suggesting that firms choose bonding to signal

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[2]After December 2019, CBI certified green bonds complying with the Climate Bond Standard (CBS) Version 3.0 are required to publicly disclose post-issuance reporting.

[3]The relevant green bond documents includes Green Bond Framework, pre-issuance external review reports, post-issuance report, and if available, post-issuance assurance. See Figure 1 for an example.

[4]I limit my sample to green bonds issued by public corporations to allow collection of data on green bond post-issuance transparency.

their superior quality (e.g., Klein and Leffler 1981; Ippolito 1990; Titman and Trueman 1986; Coffee Jr 2002; Stulz 1999), I find that issuers that are the environmental leaders of an industry and those with existing ESG reporting and auditing practices are more likely to bond with the Active Monitors to signal the greenness of their bonds. The finding corroborates with the idea that such issuers enjoy lower marginal costs when delivering high greenness because of their access to better environmental technology or better ESG reporting and auditing technology. On the other hand, consistent with the notion that the marginal benefit from bonding with external monitors is higher when the information asymmetry problem is severe (e.g., Jensen and Meckling 1976; Fama 1980; Leftwich, Watts, and Zimmerman 1981; Datar, Feltham, and Hughes 1991; Chow 1982; Simnett, Vanstraelen, and Chua 2009), I find that the demand for Active Monitoring is higher when the issuers belong to industries or countries with poor environmental performance. Finally, I study issuers' choices to bond with either the CBI or the LGX and find interesting differences. While issuers' environmental performance and existing ESG reporting and assurance practices are more important factors for bonding with the LGX, the domicile country's environmental performance tends to be an important determinant of bonding with the CBI. The differential findings in determinants of bonding could be associated with the differential transparency requirements the CBI and the LGX impose.

Next, I examine whether the issuers that bond with the Active Monitors (hereafter, the Actively Monitored Issuers) demonstrate higher greenness ex-post. Since the provision of reliable post-issuance information is essential for investors to assess the greenness of the bond (e.g., Chiang, 2017; Sangiorgi and Schopohl, 2021), I first investigate whether the Actively Monitored Issuers tend to provide more detailed post-issuance disclosure and obtain more comprehensive post-issuance assurance in comparison to issuers that are not under Active Monitoring (hereafter, Non-Actively Monitored Issuers). Using hand-collected data on green bond post-issuance disclosure and assurance (hereafter, post-issuance transparency), I find that relative to the Non-Actively Monitored Issuers, the Actively

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Monitored Issuers provide significantly more post-issuance transparency. Moreover, when examining issuers that bond with the CBI (CBI Issuers) and the LGX (LGX Issuers) separately, I find that the CBI Issuers provide more post-issuance assurance than the Non-Actively Monitored Issuers. On the contrary, the LGX Issuers provide more disclosure and assurance and are more likely to establish a dedicated green bond website to allow easy access to the green bond documents. This finding is consistent with the fact that the CBI allows disclosure of post-issuance information through private channels for the majority of the sample period, whereas the LGX requires public disclosure on the LGX website.

I then investigate the environmental improvement at the issuer level post green bond issuance. Within the sample of green bond issuers, I find that the CBI Issuers experience the largest percentage reduction in carbon intensity relative to the Non-Actively Monitored Issuers. In a matched sample consisting of green bond issuers and comparable conventional (i.e., brown) bond issuers, I find that the Actively Monitored Issuers achieve a larger reduction in carbon intensity by 13% relative to matched brown bond issuers, which is a significantly larger relative improvement in comparison to the Non-Active Monitored Issuers. Further analysis shows that both the CBI Issuers and the LGX Issuers perform better than the the Non-Actively Monitored Issuers.[5] Overall, the findings of superior post-issuance transparency and larger percentage carbon intensity reduction among the Actively Monitored Issuers are consistent with the bonding theory, which predicts that in equilibrium, the Actively Monitored Issuers should provide higher environmental quality for their green bonds.

Next, I revisit the green premium puzzle and examine whether green bonds under Active Monitoring (hereafter, Actively Monitored green bonds) obtain a larger green premium than those that are not under Active Monitoring (hereafter, Non-Actively

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[5]Nonetheless, the non-finding of larger environmental improvements at the issuer level among the Non-Actively Monitored Issuers does not provide sufficient evidence to reject the null hypothesis that these issuers have invested their green bond proceeds in environmental projects with positive environmental impact.

Monitored green bonds). Assuming that bonding with the Active Monitors conveys a credible signal of the green bond's environmental quality, the Actively Monitored Green Bonds should attract more green investors who are willing to pay premium for high greenness (Merton et al. 1987; Coffee Jr 2002; Fama and French 2007; Friedman and Heinle 2016). Moreover, a larger green premium is necessary to sustain the bonding equilibrium where the Actively Monitored Issuers find bonding attractive. Adopting a pooled-fixed effects model (Baker et al. 2018; Wang and Wu 2022; Caramichael and Rapp 2022), I find a green premium of 13 to 17 basis points (bps) only among the Actively Monitored green bonds. Moreover, when further dividing Actively Monitored green bonds into the CBI certified green bonds and the LGX listed green bonds, I find that the green premium is mainly driven by the LGX listed green bonds. The findings suggest that listing on the LGX provides a stronger signal of greenness, perhaps due to its high standard of post-issuance transparency.[6] The green premium among Actively Monitored green bonds is robust, yet smaller (7 bps) in a matched sample with stringent matching criteria (Larcker and Watts 2020). Taking the estimate of 7 bps as a baseline, for the median Actively Monitored green bond in my sample with the size of $450 million USD, the green premium of 7 bps per year would translate into roughly $315,000 USD in savings, which is economically significant.

Finally, consistent with the notion that post-issuance transparency is important to mitigate information asymmetry and facilitate liquidity (Diamond and Verrecchia 1991; Kim and Verrecchia 1994; Leuz and Verrecchia 2000; Leuz and Wysocki 2016), I find that green bonds with high post-issuance transparency enjoy liquidity benefits in the secondary market. More importantly, the Actively Monitored green bonds with high post-issuance transparency enjoy additional liquidity benefits, while the Actively Monitored green bonds with low post-issuance transparency suffer lower liquidity even when compared to the

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[6]Sangiorgi and Schopohl (2021) survey European Asset Managers about the factors that make green bond investments more attractive and find that investors rate having high transparency, post-issuance reporting of actual UOP, and impact reporting critical for making the green bond more attractive. In contrast, having a CBI certification is not rated important.

Non-Actively Monitored green bonds with low post-issuance transparency. The findings are consistent with the idea that in equilibrium, bonding issuers that deliver high transparency are rewarded with a liquidity premium, whereas bonding issuers that fail to deliver high transparency suffer a liquidity cost.

This study contributes to the ESG literature in the following ways. First, by investigating the role of the Active Monitors in stipulating green bond transparency, this study adds to the prior literature on the role private institutions (e.g., GRI, SASB) play in promoting voluntary ESG disclosure (Christensen, Hail, and Leuz 2019; Grewal and Serafeim 2020).[7] Second, by documenting the link between Active Monitoring and green bond premium, this study adds to the debate on investors' willingness to sacrifice financial returns for socially responsible assets (Fama 1980; Friedman and Heinle 2016; Larcker and Watts 2020; Barber et al. 2021; Riedl and Smeets 2017). Furthermore, by providing evidence on the liquidity benefits enjoyed by high-transparency green bond issuers, especially the Actively Monitored Issuers, this paper extends the stream of literature on the liquidity consequences of ESG disclosure (Cormier and Magnan 1999; Barth, Cahan, Chen, and Venter 2017; Grewal, Hauptmann, and Serafeim 2021; Riordan and Nerlinger 2022) and provides evidence on how high post-issuance transparency reinforces issuers' ex-ante signal of high quality. Finally, the findings in this study contributes to the discussion of an effective ESG standard. Specifically, the findings in this study suggest that the credible ex-ante commitment to **public disclosure** and the ex-post fulfillment of the reporting promise are critical to mitigate investors' greenwashing concerns.

This study extends the green bond literature by examining the determinants and consequences of issuers' choices to bond with the Active Monitors to signal their environmental quality. Specifically, while prior studies consider the issuance of green bonds as a credible environmental signal and only discuss the governance role of the CBI and the

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[7]Even more broadly, this study relates to Leftwich et al. (1981) which investigate NYSE's role as an external monitor that imposes stringent disclosure requirements.

green exchanges (e.g., Flammer 2020; Lu 2020), this study compares the differential requirements of the CBI and the LGX and investigates how the differences could affect issuers' bonding choices, post-issuance disclosure and assurances practices, as well as environmental credibility. Moreover, to my knowledge, this is the first academic study that examines the status of green bond post-issuance disclosure and assurance.[8] Utilizing hand-collected data, this study documents the heterogeneity of green bond reporting and assurances (e.g., Christensen et al. 2019), and underlines the lack of disclosure of quantitative impact, impact methodologies, and post-issuance assurance in the current green bond market.

Finally, this study provides timely empirical evidence with potential policy implications for the design of a green bond standard. Recently, the European Commission proposed a regulation on European Green Bond Standard (EUGBS), a voluntary standard that aims to provide uniformity for all participants in the green bond market. The EUGBS provides a detailed taxonomy for eligible green projects and requires issuers to obtain pre-issuance external reviews, publish post-issuance disclosure on the use of proceeds, and obtain post-issuance assurance. Additionally, during the life of the bond, issuers are required to publish at least one report on the overall environmental impact (EUGBS 2021). Although the industry acknowledges the EUGBS's potential to rise as a de-facto global standard, some express concerns that the detailed definition of green projects and the stringent requirements on reporting and external verification may deter issuers (Fitch, 2021). While acknowledging the cost of compliance, the findings in this study underline the importance of credible commitment to public disclosure and assurance and the role of external monitors/enforcers in fostering trust and improving liquidity of the green bond market.

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[8]Some industry reports have also examined the status of post-issuance reporting (e.g., CBI 2019, Climate Bonds Initiative, 2021). Although the industry reports may be based on more detailed proprietary data, they tend to be very descriptive.

2 Institutional Background

2.1 The Green Bond Market and Greenwashing Risks

Green Bonds have become a prominent finance innovation to combat climate change (Reuters, 2021). Since the European Investment Bank (EIB) issued the first green bond in 2007, the green bond market has grown exponentially. According to industry estimates, the green bond market is expected to grow to $ 5 trillion USD by 2025, accounting for 9% of the total ESG asset under management (AUM) and about 3% of the total AUM of all assets (Bloomberg Intelligence 2021).

Despite the hype, investors seeking environmentally-friendly assets face risks of greenwashing in the green bond market. To start with, there is no universal definition of what makes a bond green. For example, before May 2020, clean coal projects are eligible as green in the Chinese green bond market but not elsewhere. Second, issuers' promise to use green bond proceeds on environmental projects is often not contractually enforceable. For example, in the risk factor analysis related to greenwashing risks from Apple's 2019 Green Bond Prospectus Supplement, Apple cautions its potential investors that it provides no assurance that the greenness of the invested projects will meet investors' expectations, neither does it guarantee that the green investments will be free of adverse environmental or social impacts (see Figure 2). Thirdly, due to the lack of of standards that mandates disclosure and assurance, assessment of green bond quality can be difficult. Finally, due to the lack of external monitoring and enforcement, issuers may still maintain the green label of the bond even when they fail to fulfill their promises. Concerned about the misuse of green label, green bond investors may assign average greenness to all bonds, resulting in a typical lemons market (Akerlof 1978).

2.2 The Active Monitors

To mitigate investors' greenwashing concerns, issuers of high quality green bonds may differentiate themselves from greenwashing issuers by bonding with the Active Monitors (i.e., CBI and LGX) which impose high disclosure and assurance requirements and provide on-going monitoring. Issuers bond with CBI or LGX by obtaining a CBI certification or list their bonds on LGX. Both of the Active Monitors require issuers to provide a detailed green bond plan (usually in the form of a Green Bond Framework), obtain a pre-issuance external review from third party reviewers to verify alignment with selected standards and issuers' ability to fulfill their green bond plan, and provide post-issuance reporting on the actual UOP. However, there are a few differences. First, while LGX mandates publication of all relevant green bond documents (e.g., Green Bond Framework, pre-issuance external review reports, post-issuance disclosure reports, and assurance reports if available) on LGX's website, CBI only requires private disclosure to existing bond holders and CBI.[9] Second, CBI requires post-issuance assurance on the UOP, whereas LGX do not. Finally, CBI follows a detailed green taxonomy that with aligns with the 2015 Paris Climate Agreement to define eligible green projects while LGX accepts higher-level categories. Conceptually, CBI represents Active Monitoring with a focus on private communication and external certification, while LGX represents Active Monitoring with a focus on public disclosure on a centralized platform.[10] Issuers that fail to comply with the disclosure and assurance requirements will risk having their CBI certifications revoked or their green bonds removed from LGX.

Issuers may benefit from bonding with the Active Monitors in two ways. First,

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[9]After December 2019, CBI certified green bonds complying with Climate Bond Standard (CBS) Version 3.0 are required to publicly disclose post-issuance reporting.

[10]Over the years, some other exchanges (e.g., The Hong Kong Stock Exchange, the London Stock Exchange), have joined LGX at requiring post-issuance reporting. However, LGX is by far the only green exchange that creates a central platform where investors and the public can find all relevant green bond documents (e.g., green bond base prospectus, final pricing terms, pre-issuance external review reports, post-issuance green bond reports, and if available, post-issuance assurance reports).

since pre-issuance external reviews are required by both CBI and LGX, Active Monitored Issuers benefit from enhanced credibility of the legitimacy of their planned green investment. CBI Issuers may further benefit from the certification that their intended green investment are aligned with the 2015 Paris Climate Agreement. Second, by bonding with the Active Monitors and committing to provide more post-issuance disclosure and assurance, issuers signal their willingness to be evaluated and held accountable by green investors, which could further enhance their credibility and reduce concerns of greenwashing.

3   Hypotheses Development

3.0.1   Active Monitoring and the Greenness of the Bond

Since bonding with CBI and LGX is voluntary, I first examine the factors that affect issuers' choice of bonding. The bonding theory predicts that firms bond with reputable external monitors to signal their superior quality (e.g., Klein and Leffler 1981; Ippolito 1990; Titman and Trueman 1986; Coffee Jr 2002; Stulz 1999). Consistent with the bonding theory, empirical studies document firms hire Big 4 auditors, reputable underwriters, or cross-list in the U.S. to signal quality in financial reporting, IPO performance, and corporate governance (e.g., Pittman and Fortin 2004; Carter et al. 1998; Doidge et al. 2004). On the other hand, agency theory predicts that the demand for external monitoring arises when the information asymmetry problem is severe (Jensen and Meckling, 1976; Fama, 1980; Leftwich et al., 1981; Watts, 1977; Datar et al., 1991). Consistent with the agency theory, Chow (1982) finds that firms large size and more severe conflicts among shareholders and debtholders are more likely to engage with an external auditor. In the relatively new ESG literature, Simnett et al. (2009) investigate the factors that drive firms' demand for ESG assurances and find that firms with high exposure to environmental or social risks tend to have stronger incentive to obtain ESG assurances.

Green bond issuers weigh the costs and benefits when bonding with the Active

Monitors. The marginal cost of bonding with the Active Monitors consists of: 1) the cost of complying with high disclosure and assurance requirements; and 2) the cost of delivering high greenness ex-post. I expect that issuers with existing ESG reporting and audit practices have a lower marginal costs of bonding, as they can easily extend their reporting and assurance technology to cover their green bonds. Moreover, assuming that issuers with better environmental performance relative to their industry peers (i.e., environmental leaders) tend to have access to better green investment opportunity, I expect the environmental leaders to have lower costs to provide higher greenness. In contrast, assuming bonding with the Active Monitors effectively enhance issuer credibility, I expect issuers from industries or countries with poor environmental performance to enjoy a larger marginal benefit from bonding due to their poor environmental credibility. I state my hypothesize formally below in alternative form:

H1: Green bond issuers that are 1) environmental leaders, 2) with existing ESG reporting and audit practices, or 3) belong to industries or countries with poor environmental performance are more likely to voluntarily bond with the Active Monitors.

To sustain the bonding equilibrium, the Actively Monitored Issuers should provide higher greenness for their bonds. First, since the Active Monitors upholds higher transparency requirements, I expect the Actively Monitored Issuers to deliver more detailed post-issuance disclosure and obtain more comprehensive assurance relative to Non-Actively Monitored Issuers. Moreover, considering the different focuses of the Active Monitors' transparency requirements, I expect the LGX Issuers to provide more post-issuance disclosure and the CBI Issuers to provide more post-issuance assurance. Second, assuming that the choices to bond with the Active Monitors is positively associated with issuers' firm-level environmental commitment, I expect larger environmental improvements among the Actively Monitored Issuers in comparison to Non-Actively Monitored Issuers.[11] I state

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[11]Prior studies in the green bond literature have proposed that firms issue green bond to signal their

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my second set of hypotheses formally below in alternative form:

H2a: Actively Monitored Issuers will provide more post-issuance disclosure and assurances than Non-Actively Monitored Issuers. Specifically, LGX Issuers will provide more post-issuance disclosure, while CBI Issuers will provide more post-issuance assurance.

H2b: Actively Monitored Issuers will achieve larger environmental improvements than the Non-Actively Monitoring Issuers.

Finally, I examine whether the pre-issuance bonding signal is perceived credible by green bond investors by examining the green bond premium. Assuming that a significant portion of green bond investors have a taste for environmental-friendly assets, greenwashing risks should be relevant.[12] To the extent that bonding with the Active Monitors effectively enhances investor confidence in the expected greenness of their investment and reduce concerns of high variance in the green outcome, we should expect a larger green premium (i.e., green bonds receives lower yield in comparison to brown bonds) among the Actively monitored green bonds (Friedman and Heinle, 2016; Fama and French, 2007). Existing studies investigating green premium in corporate green bonds in the primary market have reached inconclusive results.[13] To start with, using data from earlier years, both Flammer

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overall commitment to the environment (Flammer (2021), Lu (2020), and Tang and Zhang (2020)). In particular, Flammer (2021) and Lu (2020) find that green bond issuers, especially those that obtain pre-issuance external reviews, are more likely to achieve environmental targets, reduce carbon emissions, and improve environmental ratings (Flammer, 2021; Lu, 2020). However, we do not know the link between Active Monitoring, which requires both pre-issuance external reviews and post-issuance disclosure and assurance, and environmental improvements at the firm level.

[12]From reading green bond reports which discloses investor compositions, the disclosed proportion of green investors range form 40-60%.

[13]Other studies investigating green bond premium using municipal bonds or a mixed sample of green bonds from different types of issuers have also reached mised results. To start with, using data from earlier years, several papers find green premium in the sample of reviewed green bonds (e.g., Baker et al. 2022; Zerbib 2019; Hyun et al. 2020; Kapraun et al. 2021). In contrast, Karpf and Mandel (2017) find a green discount (i.e., green bonds receive higher yield in comparison to brown bonds) among municipal bonds, perhaps due to mistakenly comparing taxable vs. non-taxable municipal bonds (Baker et al. 2022; Larcker and Watts 2020). Larcker and Watts (2020) adopt a stricter matching on municipal bonds and find no evidence of green premium in municipal green bonds sample, even when for bonds certified by CBI. Lu 2020 find that with the issuance of green bonds, municipal bond issuers experience a reduction of offering yield in its brown bonds as well, and propose that the cost-saving due to issuers' green commitment is realized at the entity-level.

(2021) and Tang and Zhang (2020) do not find a significant green premium among corporate green bonds. However, three concurrent studies identified a green premium when incorporating data of recently issued corporate green bonds (*kapraun2021credibly, wang2022investor, caramichael2022green). Both Kapraun et al. 2021 and Caramichael and Rapp 2022 identified a larger green premium among bonds with pre-issuance external reviews.[14] In this study, I re-examine the green premium puzzle with a special focus on the Actively Monitored Green Bonds.Given that the Active Monitors requires pre-issuance external reviews and impose and enforce high transparency requirements, I expect that the green premium to be more pronounced among the Actively Monitored green bonds. I state my third hypothesize formally below in alternative form:

H3: Actively Monitored green bonds receive a larger a green premium than Non-Actively Monitored green bonds.

4 Sample and Data

4.1 Sample Construction and Descriptive Statistics

In this study, I limit my sample to green bonds issued by public corporations (i.e., public corporate green bonds) to allow collection of data on green bond post-issuance transparency (see Section 4.2 for details). I construct a comprehensive dataset of public corporate green bonds by augmenting green bond data from the Climate Bonds Initiative (CBI) with that from the Bloomberg. The CBI green bond dataset and the Bloomberg green bond dataset are by far the most comprehensive datasets on green bonds and are widely used in academic studies (e.g., Baker et al., 2018; Flammer, 2020; Tang and Zhang, 2020; Larcker and Watts, 2020; Lu, 2020).

The CBI database provides data on CBI certification and other pre-issuance review

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[14]Using a small matched sample, Kapraun et al. 2021 find a green premium among bonds listed on green exchanges in the secondary market.

types. For the green bonds that are included in the Bloomberg database but not in the CBI database, the pre-issuance external review indicator from Bloomberg is used. The Bloomberg database provides data on the issuers' full name, issue date, issuance amount, currency, coupon, maturity, maturity type, credit rating, seniority, offering yield, and listed exchanges. I use the public company indicator on Bloomberg to identify bonds issued by public corporations. I further require issuers to have financial information available from Refinitiv Wolrdscope. My sample period starts from November 1, 2013 because the first corporate green bond was issued in November, 2013. I end my sample on December 31, 2020 to allow companies at least 12 months to publish their first post-issuance disclosure. My final sample contains 698 public corporate green bonds from 326 public corporations located in 40 countries.

The average green bond in my sample has the issuance size of $346 million and a coupon rate of 2.37%. The average maturity is 83 months or about 7 years. I collect credit rating data from Bloomberg and Refinitiv. The bond credit rating is set to be S&P rating if S&P rating is available. If not, Moody's rating is used. If both S&P and Moody's rating are unavailable, Fitch rating is used. Finally, if none of the big three rating agency rated the bond, I use the data item "TR.GR.RatingSPEquivalent" from Refinitiv which translates credit rating by local rating agencies to S&P equivalents. For the 464 bonds with credit rating available, the average credit rating scale is 6.05, which corresponds to an S&P equivalent of A. I collect bond offering yield data from Bloomberg and supplement with the SDC Platinum Database. For the 446 green bonds with offering yield data available, the average offering yield is 2.19%. An average public corporate green bond issuer is of the size of $192.3 billion, market to book ratio of 1.94, leverage ratio of 0.36, return on asset of 3%, and tangibility of 0.36.

Finally, in my sample, 19% of the green bonds are under Active Monitoring. Specifically, 9% of them are CBI certified and 11% are listed on LGX. Based on the

statistics, issuers tend not to obtain CBI certification and listed their bonds on LGX at the same time.

4.2   Data on Post-Issuance Transparency

Since existing data providers do not provide data on post-issuance transparency, I hand collect bond issuer's post-issuance disclosure and assurance data through web searching.[15] I capture green bond issuers' post-issuance transparency in three ways. First, since enabling easy access to information on green bonds is encouraged by guideline providers and standard setters (IMCA 2022; CBI 2021), I assess the accessibility of post-issuance disclosure by searching whether issuers have established a green bond web page (*Green Bond Website*) where investors and the public can access relevant green bond documents. In my sample of 326 public corporations, 73% have established a Green Bond Website. 66% have published their green bond framework on the Green bond Website, 61% have published pre-issuance external review reports, 47% have published stand-along post-issuance reports (i.e., Green Bond Report), and 16% have posted post-issuance information directly on their website. Majority of issuers only publish their most recent green bond report – only 26% of the issuers have made historical reports available on their website. To capture the overall accessibility of green bond information, I assign one point to each document issuers publish on their green bond website and construct a composite measure – *Website Transparency Score*) by summing the individual indicators up.[16] The maximum Website Transparency Score is 4 and the average (median) is 2.14 (3) points.

Second, I assess the scope of post-issuance disclosure by reviewing issuers' post-issuance reporting, available on their website or elsewhere. In particular, I focus on whether an issuer has disclosed information on the actual UOP and the environmental

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[15]The last round of data collection finished in May 2022.

[16]For example, an issuer that have published green bond framework, pre-issuance external reviews, post-issuance reports (or information on website), and historical reports would have 4 points for Website Transparency Score.

impact of its green bond(s). In my sample, 66% of the issuers provide disclosure of actual UOP, 63% provide qualitative environmental impact descriptions, and 57% of the issuers disclose quantitative impact measures. Nevertheless, only 31% of the issuers describe their impact calculation methodologies. Furthermore, only 19% of the issuers disclose impact at the project level. I construct a composite measure *Post Disclosure Score* which captures the over all scope of disclosure by summing up the number of disclosure aspects covered.[17] The maximum Post Disclosure score is 5 points, and the average (median) is 2.36 (3) points.

Third, I review the post-issuance assurance reports that accompany the Green Bond Reports. Post-issuance assurance is mainly provided by issuers' statutory auditors.[18] Among the 46% of the issuers that obtain post-issuance assurance for their green bonds, 18% only obtain assurances on the actual UOP or impact reporting (*Post Assurance (UOP or Impact)*), and 28% obtain assurances that assess both the UOP and the calculation of impact indicators (*Post Assurance (UOP & Impact)*). I construct *Post Assurance Score* which equals to 1 if the assurance only covers UOP or Impact, and 2 if the assurance covers both UOP and Impact. The average (median) for *Post Assurance Score* is 0.73 (0) points.

Finally, I construct a composite measure to capture the overall post-issuance transparency. *Post Transparency Score* is the sum of *Website Transparency Score*, *Post Disclosure Score*, and *Post Assurance Score*. The average (median) for *Post Transparency Score* 5.23 (6) points.

In summary, the data reflect the lack of post-issuance disclosure and assurance in the green bond market. Specifically, public reporting on quantitative impact (especially at the project level), impact calculation methodology, and post-issuance assurance are still

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[17]An issuer that disclosed information on actual UOP only would get one point. An issuer that disclosed actual UOP (1 pt), qualitative and quantitative impact measures (2 pts), impact calculation methodologies (1 pt), and project level impact (1pt) would have five points for Post Disclosure Score.

[18]In some cases, issuers engage with ESG specialists such as Sustainalytics and DNV or environmental consulting companies such as Multiconsult.

uncommon. Moreover, there's some heterogeneity of post-issuance transparency across country and sectors. Specifically, issuers from European countries and issuers that belong to Communication Services, Financials, and Real Estate sectors are more transparent. In addition, there seem to be a positive correlation between the prominence of Active Monitoring and the average Post Transparency Score at the country and sector level.

5 Research Design and Empirical Results

5.1 Determinant of Active Monitors Engagement

5.1.1 Research Design

To examine the factors that drive issuers' choices to bond with the Active Monitors, I employ the following logistic regression model:

$$
\begin{aligned}
Pr(Active\ Monitoring = 1|X) = f(&Issuer\ Environmental\ Performance, \\
&Firm\ ESG\ reporting\ \&\ Auditing\ Practice, \\
&Industry\ \&\ Country\ Environmental\ Performance, \\
&Firm\ Characteristics,\ Bond\ Characteristics, \\
&Country\ Legal\ System,\ Country\ Legal\ Environment)
\end{aligned} \tag{1}
$$

where *Active Monitoring* is an indicator variable that is coded as one if a green bond has CBI certificate or is listed on LGX, and zero otherwise. I capture issuers' environmental performance by *Industry CO2 Intensity Ranking*, which is the issuers' within industry rank base on its carbon intensity (i.e., total Scope1 and Scope2 GHG emission scaled by revenue in USD), normalized by the total number of green bond issuers from that industry. Higher ranking corresponds to lower carbon intensity relative to industry peers. I capture issuers' existing ESG reporting and auditing practices using *GRI Reporting & Auditing*, an indicator variable that is coded as one if the issuer has been reporting in accordance to the Global Reporting Initiative (GRI) standards and has obtained CSR audits. Similar to Simnett et al. (2009), I capture industry environmental performance by identifying high-emitting, high-polluting sectors. Specifically, *Polluting Industry* is an indicator

17

that equals to one if the issuer's GIC sector is Industrial, Utitlities, Materials, or Energy.[19] Finally, I capture country level environmental performance using the Environmental Performance Index developed by the Yale Center for Environmental Law & Policy and the Center for International Earth Science Information Network Earth Institute, Columbia University (Wendling et al., 2020). Holding everything else constant, I expect the marginal cost of bonding with the Active Monitors to be lower for issuers that are environmental leaders of their industry and with existing ESG reporting and auditing practices. Moreover, I expect the marginal benefits of bonding to be larger for issuers that belong to industries or countries with poor environmental performance (Simnett et al., 2009; Datar et al., 1991).

I include various firm, issuer, bond, and country level controls. Specifically, I control for issuer size ($Lag\ ln(Total\ Assets)$), leverage ($Lag\ Leverage$), market to book ratio ($Lag\ M/B$), and ROA ($Lag\ ROA$). I also control for bond characteristics such as issuance size ($ln(Amount\ Issued)$) and bond maturity ($ln(Maturity)$). In addition, following Simnett et al. (2009), I control for *Country Legal System* (i.e.,civil law vs. common law), and *Country Legal Environment*, which is proxied by issuer's country's rule of law measure ($Rule\ of\ Law$) in the World Governance Indicators (WGI) developed by the World Bank (Kaufmann, 2007). Finally, to control for the time trend in the issuers' preferences to bond with the Active Monitors, I include issue year fixed effects. Standard errors are clustered at the GIC 6 digit industry level.

5.1.2 Results

Table 3 presents the results for Equation (1). In column (1), the dependent variable is *Active Monitoring*. Consistent with H1, I find that issuers with lower carbon intensity relatively to industry peers, issuers that are already preparing audited ESG reports according to the GRI standards, and issuers from *Polluting Industries* are more likely to bond with the Active Monitors. However, I do not find country EPI are important in affecting issuers' bonding choices.

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[19]Industrial sector covers industries such as Electrical Equipment, Air Freight & Logistics, Airlines, Road & Rail, Transportation Infrastructure, etc. Utility sector covers industries such as Electric Utilities, Gas Utilities, Multi-Utilities, etc. Materials sector covers industries such as Chemicals, Construction Materials, Metals & Mining, and Paper & Forest Product. And finally, Energy sector covers the Oil, Gas & Consumable Fuels industry.

In columns (2) and (3), I examine determinants of bonding with the CBI or the LGX monitoring separately. Interestingly, the findings suggest that while the LGX tend to attract bonding from carbon leaders and issuers with good ESG reporting and auditing practices, the CBI seems to be more attractive to issuers from countries with poor environmental performance. This finding is consistent with the observation from Table 2, Panel C which suggest that issuers from developing countries with poor environmental institutions (e.g., Thailand and China) are much more likely to bond with the CBI, while issuers from European countries tend to bond with the LGX. Overall, I find that larger issuers are more likely to engage with an active monitor. This finding is consistent with the notion that large firms may have more green investment opportunities, and more resources to comply with the reporting and disclosure requirement. On the other hand, large firms may also suffer more agency conflict, and thus would benefit more from external monitoring (Chow, 1982; Simnett et al., 2009). Moreover, larger green bond issues are more likely to be listed on the LGX. Finally, I find that less profitable issuers and issuers from common law countries and countries with better legal institutions are more likely to bond with the CBI.

5.2 Active Monitoring and Post-Issuance Transparency

5.2.1 Research Design

To examine whether Actively Monitored Issuers provide higher post-issuance transparency than Non-Actively Monitored Issuers, I adopt the following OLS regression model:

$$
\begin{aligned}
Post\ Issuance\ Transparency_i = {}& \beta_0 + \beta_1 Actively\ Monitored\ Issuers_i \\
& + Firm\ Characteristics + Bond\ Characteristics \\
& + Country\ Characteristics \\
& + Issue\ Year\ FE + Industry\ FE
\end{aligned}
\tag{2}
$$

where $Post\ Issuance\ Transparency_i$ is either $Website\ Transparency\ Score$, $Post\ Disclosure$ $Score$, $Post\ Assurance\ Score$, or $Post\ Transparency\ Score$. Since the measures for

Post Issuance Transparency$_i$ are collected at the issuer level based on issuers' latest green bond disclosure and assurance reports, I conduct this analysis at the issuer level.[20] The main variable of interest is *Actively Monitored Issuers$_i$*, which is an indicator variable that is coded to one if an issuer has ever issued a green bond that is certified by the CBI or listed on the LGX, and zero otherwise. If bonding with active monitoring is positively associated with more post-issuance transparency, β_1 should be positive and significant.

I control for the same set of firm level and bond level characteristics and country level characteristics as in Equation (1). Firm level, and country level controls are from the year prior to issuers' most recent green bond issuance year. Bond level controls are the characteristics of the issuers' most recent green bond.[21] Finally, I include issue year fixed effects to control for time-variant trend in disclosure and assurance practices, and industry fixed effects to control for industry-specific, time-invariant unobservables.[22] Standard errors are clustered at the GIC 6 digit industry level.

5.2.2 Results

Table 4, Panel A presents the regression results from Equation (2). Consistent with H2, the findings in columns (1) - (4) suggest that the Actively Monitored Issuers tend to provide more post-issuance disclosure and assurance and allow wider access to their green bond information than the Non-Actively Monitored Issuers. In columns (5) to (8), I separate the Actively Monitored Issuers into the CBI Issuers and the LGX Issuers to examine the consequences of the differential transparency requirements.[23] Consistent with the CBI focusing more on external assurance, while LGX focusing more on public disclosure and easy accessibility, I find that the LGX Issuers tend to provide more post-issuance transparency on every metric,

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[20]This is because only a small portion of issuers that have multiple green bonds publish historical green bond reports on their website, making collection of historical data infeasible.

[21]If an issuer issued multiple green bonds in the most recent green bond issuance year, *ln(Amount Issued)* is the total issuance size of all green bonds in that year; and *ln(Maturity)* is longest maturity of all green bonds issued in that year.

[22]Industry fixed effects are at the GIC 2 digit industry level.

[23]I drop the 5 issuers that have bonded with both the CBI and the LGX to allow for cleaner identification.

while the CBI Issuers only provide more post-issuance assurance.

Issuers with larger percentage of tangible assets, which tend to belong to heavy industries, provide less post-issuance transparency. On the other hand, issuers with larger green bond issuance amount and longer maturity tend to provide more post-issuance transparency, perhaps due to the larger potential benefit. At the country level, issuers from countries with good environmental performance tend to be more transparent about their green bonds. Moreover, consistent with prior findings suggesting that firms from civil law countries are more likely to supply information privately to their insider owners (e.g., banks), instead of disclosing them publicly, I find that issuers from civil law countries are less transparent. In addition, while issuers from countries with good *Rule of Law* provide more disclosure, they tend to provide less assurance. This could be due to the differences in litigation risks associated with voluntary disclosure with low verifiablility versus external audit, which tend to limit issuers' ability to overmarketing the greenness of their bonds.[24]

Table 4, Panel B presents the robustness tests. Since some other green exchanges (e.g., the Hong Kong Stock Exchange, the London Stock Exchange) have recently started requiring post-issuance reporting. To make sure that the findings in Panel A are not driven by the Actively Monitored Issuers that also bond with the other green exchanges (i.e., "double bond"), I drop such double bond issuers in columns (1) - (4) and find robust results. In columns (5) - (8), I drop the country level variables in Equation (2) and include country fixed effects to control for country level, time-invariant heterogeneity and find that LGX Issuers provide more disclosure and overall transparency, while the CBI Issuers provide more assurance.[25]

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[24]Auditors in countries with better Rule of Law may also provide higher quality audits due to the potential litigation risks

[25]To confirm whether the Actively Monitored Issuers also tend to provide more transparency than the Active Monitors' minimum requirement, in untabulated analysis, I replace the dependent variable to be *Non-Required Transparency Items*, which captures the number of non-required disclosure and assurances items provided. The finding suggest that the Actively Monitored Issuers tend to provide about 2 more non-required items than the Non-Actively Monitored Issuers.

In an additional analysis, I examine the credibility of green bond issuers' ex-ante commitment by evaluating the discrepancies between issuers' ex-ante reporting commitment disclosed in their green bond framework and their ex-post disclosure and assurance practices.[26] I exploit the textual data on issuers' reporting commitment provided by the LGX Data Hub to construct the *Transparency Commitment* variable. Specifically, I scrape the text of pre-issuance reporting commitment to identify whether an issuer has promised to disclose use of proceeds, impact reporting, quantitative impact metrics, and seek post-issuance assurance. *Transparency Commitment*, takes integer values from 0 to 4, is the number of transparency items an issuer commits to. I compare issuers' ex-ante transparency commitment to their ex-post transparency scope and construct an indicator variable – *Deliver Promise*, which is coded to one if an issuer delivers its promised transparency items, and zero otherwise. I run the same regression model in Equation (2) but replace the dependent variables with *Transparency Commitment* and *Deliver Promise*, and report the results Table 4, Panel C. I find that among green bond issuers with non-missing pre-issuance reporting commitment data, the Actively Monitored Issuers commit to fewer transparency items and are more likely to deliver their promise. The results in this panel suggest that the Actively Monitored Issuers tend to provide less aggressive yet more credible reporting commitments.

5.3 Active Monitoring and Environmental Improvements

5.3.1 Research Design

To investigate whether Actively Monitored Issuers experience larger environmental improvements post bond issuance in comparison to Non-Actively Monitored Issuers, I

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[26]Typically, the commitment to obtain post-issuance external reviews are also discussed in the reporting commitment section of the green bond framework.

adopt the following difference-in-difference (DID) model.

$$ln(Carbon\ Intensity_{it}) = \beta_0 + \beta_1 Actively\ Monitored\ Issuer_{it} \times Post_{it}$$
$$+ \beta_2 Actively\ Monitored\ Issuer_{it}$$
$$+ \beta_3 Post_{it} + Controls \tag{3}$$
$$+ Firm\ FE + Year\ FE$$

where $ln(Carbon\ Intensity_{it})$ is the natural log of $CO2\_Revenue\_USD$, which is the total Scope1 and Scope2 GHG emission scaled by total revenue in USD. $Actively\ Monitored\ Issuer_{it}$ is an indicator variable which is coded to one if firm i is a green bond issuer that bonded with the Active Monitors in a given green bond issuance year t, and zero otherwise. $Post_{it}$ is an indicator variable which is coded to one for years of and after a green bond issuance, and zero otherwise.[27] I control for contemporaneous firm characteristics $ln(Total\ Assets)$, $Leverage$, M/B, and ROA and require the firms in my sample to appear both in the pre- and post-periods. Firm fixed effects and Year fixed effects are included. Standard errors are clustered at the GIC 6 digit industry level.

5.3.2 Results

Table 5 Panel A presents the regression results using the DID analysis. I find that although the Actively Monitored Issuers tend to have larger carbon intensity prior to green bond issuance, there are weak evidence suggesting that they achieve larger percentage reduction in carbon intensity in comparison to the Non-Actively Monitored Issuers (column (1) and (3)). Moreover, the environmental improvements are more pronounced among the CBI Issuers. On average, the CBI Issuers achieve 16%-18% more reduction in carbon intensity relative to the Non-Actively Monitored Issuers.

In an additional analysis, I try to control for the differences in issuer characteristics

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[27]Since an issuer may bond with the Active Monitors for some of their bonds but not others, $Actively\ Monitored\ Issuer_{it}$ and $Post_{it}$ are both issuer-year level variables and may not be subsumed by Firm FE or Year FE.

by matching a green bond issuer with a comparable brown bond issuer that is also a publicly listed company. In the same spirit as Flammer (2020), I construct a matched sample using coarsened exact matching (CEM) (Iacus et al. 2008). Specifically, I match a green bond issuer to a brown bond issuer within the same country, same GIC 2 digit industry, and with similar size in for the year prior to green bond issuance. The matching gives me 122 green and brown matched issuer pairs. Table 5, Panel B presents the summary statistics of the matched sample. I adopt the following regression equation:

$$
\begin{aligned}
ln(Carbon\ Intensity_{it}) = \beta_0 &+ \beta_1 Actively\ Monitored\ Issuer_{it} \times Post_{it} \\
&+ \beta_2 Non-Actively\ Monitored\ Issuer_{it} \times Post_{it} \\
&+ \beta_3 Actively\ Monitored\ Issuer_{it} \\
&+ \beta_P post_{it} + Controls \\
&+ Firm\ FE + Year\ FE
\end{aligned} \tag{4}
$$

where $Non-Actively\ Monitored\ Issuer_{it}$ is an indicator variable which is coded to one if firm i is a green bond issuer that have not bonded with the Active Monitors in a given green bond issuance year t, and zero otherwise. For Non-Green Bond Issuers, $Post_{it}$ is set to one for years of and after the green bond issuance of the matched Green Bond Issuer. I adopt the same controls, fixed effects, and clustering as Equation (3).

Table 5, Panel C presents the regression results from Equation (4). In column (1), I find that the Actively Monitored Issuers experience 13% larger reduction in carbon intensity relative to matched brown bond issuers, whereas the Non-Actively Monitored Issuers do not. The difference in coefficients $Actively Monitored Issuer \times Post(\beta_1)$ and $Non-Actively Monitored Issuer \times Post$ (β_2) is statistically significant. However, in column (2), I do not find significant evidence supporting the larger percentage reduction in carbon intensity for the CBI Issuers or the LGX Issuers. Nevertheless, there are weak evidence suggesting that comparing to Non-Atively Monitored Issuers, the CBI and the

LGX Issuers achieve larger percentage reduction in carbon intensity relative to matched brown bond issuers.

5.4 Active Monitoring and Green Premium

5.4.1 Research Design

To investigate whether the Actively Monitored green bonds earn a green premium, I restrict my sample to rated, fixed coupon green bonds that is not privately placed and with non-missing offering yield from Bloomberg or the Refinitiv SDC Plantinum Database (Larcker and Watts (2020), Flammer (2020), and Tang and Zhang (2020)). This gives me 337 green bonds issued by 216 public companies. Next, for the 216 issuers, I extract all conventional (brown) bonds issued between January 1, 2010 and December 31, 2021 from Bloomberg.[28] In total, I obtain 3952 brown bonds that satisfy the same sample selection criteria as above.

I adopt a pooled fixed-effects model that is in the same spirit as Baker et al. (2018), Wang and Wu (2022), and Caramichael and Rapp (2022). Specifically, I employ the following regression equation.

$$
\begin{aligned}
Offering\ Yield = \beta_0 &+ \beta_1 GreenBond \\
&+ \beta_2\ ln(Amount\ Issued) + \beta_3\ ln(Maturity) \\
&+ Issuer\ FE + Credit\ RatingFE + Currency\ FE \qquad (5)\\
&+ Maturity\ Type\ FE + Seniority\ FE \\
&+ Listed\ FE + Issue\ Year\ FE
\end{aligned}
$$

where $Offering\ Yield$ is the yield at issuance of a bond. $GreenBond$ is an indicator variable that equals to one if the bond is a green bond. Similar to Wang and Wu (2022) and Caramichael and Rapp (2022), I control for bond issuance amount ($ln(AmtIsseued)$) and maturity ($ln(Maturity)$). I further control for issuer, credit rating, maturity type, seniority,

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[28]Money market instruments with maturity less than one year is dropped.

listed, and issue year fixed effects. Standard errors are clustered at the issuer level.

As Larcker and Watts (2020) point out, the pooled fixed-effects model may not fully control for the non-linearities and issuer-specific time variation. Ideally, I would match a green bond to a brown bond from the same issuer, issued on the same day and with the same characteristics (Crabbe and Turner, 1995; Larcker and Watts, 2020). However, such matches are rare in the corporate green bond setting. Moreover, given the small sample size, the potential matches may be scarce. As an alternative, I expand my sample to cover both public and private corporations that issued green bonds. I collect the conventional bonds issued by private corporate green bond issuers using the same criteria above. My total sample of corporate green bonds consists of 4289 bonds from public green bond issuers and 5716 bonds from private green bond issuers.

I first test whether the findings from the pooled fixed effects model are robust with the enlarged sample. Then I conduct CEM matching to construct the matching sample. Specifically, I require the matched pair to be from the same issuer, issued in the same year, with the same currency, and with the same credit rating, same maturity type (i.e., callable bonds are matched with callable bonds), same seniority, and same listing status. I further require the matched pair to have similar maturity and coupon rate.[29] Like Larcker and Watts, 2020, I allow a green bond to be matched with multiple brown bonds as long as the matching criteria is satisfied. The matching procedure results in 134 green bonds matched with 254 brown bonds. With the matched sample, rerun the regression model in Equation 5 with only matched pair fixed effects.

---

[29]Coupon rate is matched using the CEM default algorithm, whereas maturity is matched using ¡=3 years, 3-10 years, 10-30 years, and ¿ 30 years as bins.The bins are selected mainly based on the definition of short-term, medium-term, and long-term bonds by the Financial Industry Regulatory Authority. See, Bond Basics, FINRA, accessible at: `https://www.finra.org/investors/learn-to-invest/types-investments/bonds/bonds-basics`

5.4.2 Greenium Results

Table 6, Panel A presents results from the pooled fixed effects model. Consistent with the idea that investors perceive bonding with Active Monitoring as a signal of higher greenness, in column (1), I find that the Actively Monitored green bonds earn a 13.4 basis points green premium, whereas no significant green premium is observed among the Non-Actively Monitored green bonds. The difference in the coefficients of the Actively Monitored Green and the Non-Actively Monitored Green is statistically significant. In column (2), I further divide the Actively Monitored green bonds into the CBI certified green bonds and the LGX listed green bonds and find that the green premium is concentrated in the LGX listed bonds. The non-finding of green premium among the CBI certified green bonds is consistent with the survey evidence from European asset managers, which suggest that having a CBI certification is not considered an important factor that makes the green bond investments more attractive. Instead, issuers emphasize more on post-issuance transparency and detailed UOP disclosure, and impact reporting (Sangiorgi and Schopohl 2021). The findings are robust when I expand the sample to include all bonds issued by public and private corporate green bond issuers (columns (3) - (4)). In columns (5) - (6), I further control for issuer-year level unobservables by replacing issuer, issue year fixed effect by issuer $\times$ issue year fixed effects and find robust results.

Next, I check the robustness of the findings from the pooled fixed effects model using the CEM matched sample and find a green premium of 7 basis points among the Actively Monitored green bonds and 12 basis points among the LGX listed green bonds(columns (1) - (2) of Panel B). Again, I find significant differences of the green premium when comparing the LGX listed green bonds and the Non-Actively Monitored green bonds at 11% confidence level. In addition, the findings are robust when dropping green bonds under Active Monitoring and also listed on other green exchanges (columns (4) - (5) of Panel B).[30]

---

[30]The findings are weaker but still robust when I drop all green bonds without pre-issuance external

The green premium identified in this study is comparable in size to those identified in other green premium studies adopting the corporate green bond setting (e.g, Wang and Wu (2022), Caramichael and Rapp (2022), and Kapraun et al. (2021)). For example, both Wang and Wu (2022) and Caramichael and Rapp (2022) focus on USD- and EUR-denominated green bonds and identified a 6-11% green premium among all green bonds.[31] Caramichael and Rapp (2022) further find that the green premium is mainly driven by green bonds with pre-issuance external reviews. In another concurrent paper, Kapraun et al. (2021) finds a 12.8 bps green premium in offering yield using all green bonds and a 24 bps green premium for green bonds with pre-issuance external reviews.[32] Unlike these studies, this study focuses on the link between Active Monitoring and green bond premium in the primary market.

The green premium is likely to be economically significant. Taking the lowest estimate of 7 basis points as the baseline, for the median Actively Monitored green bond in my sample with the size of $450 million USD, the green premium of 7 basis points per year would translate into roughly $315,000 USD in savings.

5.5 Green Bond Transparency and Secondary Market Liquidity

5.5.1 Research Design

To study whether post-issuance transparency is associated with higher green bond liquidity, and whether secondary market investors reward Actively Monitored green bonds with larger

reviews (untabulated). Additionally, I find robust results when limiting my sample to larger green bond issuance (above $500,000 USD in size) that are investment grade.

[31]Both studies link the green premium to access investor demand in the primary market.

[32]Using a small matched sample, Kapraun et al. (2021) also find a small green premium of 3.6 bps for green bonds (not limited to corporate green bonds) listed on the LGX and the London Stock Exchange in the secondary market.

liquidity benefits, I adopt the following OLS regression model:

$$
\begin{aligned}
Liquidity_{ijt} = {} & \beta_0 + \beta_1 High\ Post\ TransparencyScore \times Actively\ Monitored\ Green \\
& + \beta_2 High\ Post\ TransparencyScore \\
& + \beta_3 Actively\ Monitored\ Green \\
& + \beta_4 ln(Amt\ Isseued)_i + \beta_5 ln(Matutiry)_i \\
& + \beta_6 ln(Age)_{it} \\
& + \beta_7 Bond\ Volatility_{it} + \beta_8 Equity\ Volatility_{jt} \\
& + Industry\ FE + Country\ FE + Credit\ Rating\ FE \\
& + Currency\ FE + Maturity\ Type\ FE + Seniority\ FE \\
& + ListingStatusFE + Issue\ Year\ FE
\end{aligned}
\tag{6}
$$

where $Liquidity_{ijt}$ is either the average bid-ask spread of the bond in month t or the γ liquidity measure developed in (Bao et al., 2011). *High Post Transparency Score* is an indicator variable that is coded to one if an issuer's *Post Transparency Score* is above sample median, and zero otherwise. Actively Monitored Green is an indicator variable that is coded to one if a green bond is either certified by the CBI or listed on the LGX or both, and zero otherwise. I control for various bond liquidity determinants (Chen, Lesmond, and Wei 2007; Mahanti, Nashikkar, Subrahmanyam, Chacko, and Mallik 2008; Bao, Pan, and Wang 2011). Specifically, $ln(Matutiry_i)$ is bond i's time to maturity. $ln(Amt\ Issued)_i$ is the issuance size in USD millions. $ln(Age)_{it}$ is the age of the bond in months. *Bond Volatility*$_{it}$ is the standard deviation of daily bond returns between $[t - 126, t - 1]$ window.[33] *Equity Volatility*$_{jt}$ is the standard deviation of daily stock returns between [t-126, t-1] window. I further control for the same set of firm level characteristics included in Equation (1) and Equation (2). Finally, I control for industry, country fixed, credit rating, currency, maturity type, seniority, listing

---

[33]I only use half of the trading year's data to compute bond volatility because majority of the post-issuance disclosure are released around 11-14 months after green bond issuance. And I hope to capture both the pre and post period in my sample.

status, and issue year fixed effects. Observations are at the bond-month level. Standard errors are clustered at the year-month level.[34]

5.5.2 Results

Table 7 presents results from Equation (6) using all active, non-private-placement, fixed coupon green bonds with secondary market data available from Refinitiv Datastream.[35] Consistent with the role of post-issuance disclosure and assurances in mitigating information asymmetry among investors (e.g., Diamond and Verrecchia, 1991; Botosan, 1997; Dhaliwal et al., 2011; Blackwell et al., 1998; Willenborg, 1999), I find that green bonds issued by issuers that end up providing high post-issuance transparency tend to have higher liquidity (lower bid-ask spread or lower γ). Moreover, the liquidity benefits are more pronounced among the Actively Monitored green bonds with high post-issuance transparency. In contrast, the Actively Monitored green bonds with low post-issuance transparency seem to experience lower liquidity relative to the Non-Actively Monitored green bonds with low post-issuance transparency. This finding suggests that secondary market investors reward the Actively Monitored Issuers with high post-issuance transparency with a larger liquidity benefit, but penalize those with low post-issuance transparency with a liquidity cost. When separating Active Monitored green bonds into the CBI certified green bonds and the LGX listed green bonds, I find that ex-post, both the CBI green bonds and the LGX green bonds that provide high post-issuance transparency both experience extra liquidity benefits. The results seems more robust for the CBI green bonds. Overall, the findings in this section corroborates the role of post-issuance transparency in mitigating investors' greenwashing concerns, reinforcing green bond issuers' ex-ante commitment, and facilitating market liquidity.

---

[34]The results are robust if I cluster standard errors at the issuer and year-month level using two-way clustering.

[35]Following Bao et al. (2011), I drop the bonds with more than 25% trading days of zero returns.

6 Conclusion

This study documents that issuers of high-quality green bonds differentiate themselves from greenwashing issuers by bonding with the CBI and the LGX, two reputable institutions that act as the Active Monitors and promote transparency in the green bond market. By investigating the determinants of bonding, this study provides evidence on the key factors that affect issuers' cost-and-benefit analysis and drive their bonding choices. Moreover, by establishing the positive association between Active Monitoring and high post-issuance transparency, larger environmental improvements, this study validates that in equilibrium, the Active Monitoring Issuers provide higher environmental quality. In particular, consistent with the Active Monitors' differential focuses, I find that the LGX Issuers provide higher-quality in terms of transparency, while the CBI Issuers provide higher-quality in terms of environmental performance. In addition, by documenting a larger green premium among the Actively Monitored green bonds, particularly the LGX green bonds, this study provides evidence corroborating prior survey findings that identify high post-issuance transparency as a key feature of attractive green bonds (Chiang 2017; Sangiorgi and Schopohl 2021). Finally, by identifying the positive link between post-issuance transparency and secondary market bond liquidity, and an additional liquidity benefit among the Actively Monitored green bonds from highly transparent issuers, this study underlines the role of post-issuance transparency in mitigating information asymmetry in the secondary market and reinforcing the issuers ex-ante commitment.

In a way, this study answers the call of Flammer (2021), as it examines the features of *de facto* green bond standards, and compares the two governance regimes – 1) Active Monitoring with a focus on private communication and external certification (CBI) and 2) Active Monitoring with a focus on transparency and visibility (LGX). The findings suggest that although a regime that emphasize on a stringent taxonomy and post-issuance assurances may allow selection of issuers with larger environmental improvement potential,

they are not enough to effectively enhance issuers' environmental credibility. Instead, an alternative regime that imposes strict public disclosure rules and provide a centralized platform for all relevant disclosure documents (analogous to SEC's EDGAR platform) may effectively mitigate investors' greenwashing concerns. The findings provides timely empirical evidence supporting the stringent green bond standard proposed in the EUGBS. While detailed taxonomy of environmental projects and strict rules on external reviews and post-issuance reporting might deter potential issuers, they are critical for cultivating trust between green investors and issuers that seek funding to facilitate transition into a low-carbon economy. The finding on the green bond premium and secondary market liquidity should motivate more issuers to seek bonding with stringent standards.

This study has a few limitations. First, due to the data collection hurdle, I had to limit myself to the sample of green bonds issued by public firms and conduct analyses with transparency measures at the issuer level. As more data on post-issuance transparency becomes available, future research may provide evidence using larger samples with firm-year level transparency measures, and explore whether the findings in this study can be generalized to other green bond settings (e.g., private corporate green bonds, sovereign green bonds, municipal green bonds) where the dynamics of the information asymmetry problem between issuers and investors may be different. For example, sovereign governments, especially those in the Europe, may deemed to be of high credibility by investors. For credible issuers, it is unclear whether bonding with the Active Monitors creates net benefits. On the other hand, private corporate issuers are more opaque, would they deem the cost of committing too high when making the bonding decision? Do their bonding decision send a stronger signal to the market, for it is costlier? Second, this paper mainly relies on the matching technique to mitigate concerns of endogeneity. Future research may overcome this limitation by exploiting the establishment of EUGBS or the recent passage of the EU on Sustainable Finance Disclosure Regulation as policy shocks to facilitate better research design.

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Appendices

Appendix A: Variable Definition

Variable Name	Definition	Source
Bond Characteristics Variables		
ln(Amount Issued)	Natural log of bond issuance size in USD millions.	Bloomberg
Coupon	Coupon rate of the bond in percentage.	Bloomberg
ln(Maturity)	Natural log of bond maturity in months.	Bloomberg
Credit Rating	Bond-level credit rating at issuance transferred into 1 to 21 scale. 1 for AAA bond and 21 for C bond. Credit rating is set to the S&P rating if it is available from Bloomberg. If not, Moody's rating is used. If neither is available, Fitch rating is used. If none of the above is available, data item "TR.GR.RatingSPEquivalent", which translates credit rating by local rating agencies to S&P equivalents, is used.	Bloomberg, Refinitiv
Offering Yield	Bond yield at issuance in percentage. It is set as the yield at issuance from Bloomberg if that's available. If not, offering yield from Refinitiv's Securities Data Company (SDC) Platinum database is used.	Bloomberg, Refinitiv SDC Platinum
Issuer Characteristics Variables		
ln(Total Assets)	The natural log of issuer's total assets in USD millions.	Refinitiv Worldscope
Leverage	The ratio of total debt over total asset.	Refinitiv Worldscope
ROA	Issuer's return on asset, calculated as $Net Income Total Asset$.	Refinitiv Worldscope
M/B	The ratio of market value of equity over the book value of equity.	Refinitiv Worldscope
Tangible	The ratio of property, plant, and equipment over total asset.	Refinitiv Worldscope
Industry CO2 Intensity Ranking	the issuers' within industry rank base on its carbon intensity (i.e., total Scope1 and Scope2 GHG emission scaled by revenue in USD), normalized by the total number of green bond issuers from that industry	Refinitive Datastream
GRI Reporting & Auditing	An indicator variable which equals to one if a green bond issuer has been reporting their ESG activities in compliance with the Global Reporting Initiative Standards and obtained external assurance for its ESG/CSR report in the year prior to its latest green bond issuance, and zero otherwise.	Refinitiv Datastream
Polluting Industry	An indicator variable that equals to one if the issuer belongs to any of the following GIC 2 digit sectors: Materials, Utitlities, Industrials, and Energy.	Refinitiv Eikon
Pre-Issuance Bonding Variables		
CBI Green	An indicator that equals to one if a green bond has obtained a Climate Bond Certifications issued by the CBI prior to issuance, and zero otherwise.	CBI
LGX Green	An indicator variable that equals to one if a green bond is listed on the Luxembourg Stock Exchange after September 2016, and zero otherwise.[36]	Bloomberg

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[36]Cross-checked with LGX's list of listed green bonds with minor discrepancies. I decided to use data from

Variable Name	Definition	Source
Actively Monitored Green	An indicator variable that equals to one if a green bond is either certified by Non-Actively Monitored Green	An indicator variable that equals to one if a green bond is not an *Actively Monitored Green*
Constructed. CBI or listed on LGX, and zero otherwise.	Constructed	
CBI Issuer	An indicator variable that equals to one if an issuer has issued a green bond that is certified by CBI	CBI
LGX Issuer	An indicator variable that equals to one if an issuer has issued a green bond that is listed on the LGX.	
Actively Monitored Issuer	An indicator variable that equals to one if an issuer has issued a green bond that is either certified by CBI or listed on the LGX, or both	Constructed.
Non-Actively Monitored Issuer	An indicator variable that equals to one if a green bond issuer is not an *Actively Monitored Issuer*	Constructed.

Pre-Issuance Bonding Variables

Green Bond Website	An indicator variable that equals to one if a green bond issuer has established a dedicated green bond web page on which investors and the public can find all relevant green bond documents, and zero otherwise.	Hand Collected
Green Bond Framework on Website	An indicator variable that equals to one if a green bond issuer has published its green bond framework(s) on the green bond website, and zero otherwise.	Hand Collected
Pre-Issuance External Review on Website	An indicator variable that equals to one if a green bond issuer has published its pre-issuance external review report(s) on the green bond website, and zero otherwise.	Hand Collected
Green Bond Report on Website	An indicator variable that equals to one if a green bond issuer has published its stand-along post-issuance green bond report(s) on the green bond website, and zero otherwise.	Hand Collected
Green Bond Data on Website	An indicator variable that equals to one if a green bond issuer has published green bond post-issuance data directly on the green bond website (i.e., not in a report), and zero otherwise.	Hand Collected
Historical Green Bond Report on Website	An indicator variable that equals to one if a green bond issuer has published historical green bond report(s) on the green bond website, and zero otherwise.	Hand Collected
Website Transparency Score	The sum of *Green Bond Framework on Website* (1 point), *Pre-Issuance External Review on Website* (1 point), *Green Bond Disclosure on Website* (1 point if a issuer has either published green bond report on website or released green bond data on website), and *Historical Green Bond Report on Website* (1 point).	Constructed

Post-Issuance Disclosure Variables

UOP Reporting	An indicator variable that equals to one if a green bond issuer has disclosed the actual use of proceeds (UOP) of the green bond(s), and zero otherwise.	Hand Collected

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Bloomberg because it captures the listing status at issuance, while the LGX list captures the listing status as of January 2022. The findings are robust using if I follow LGX's list.

Variable Name	Definition	Source
Qualitative Impact Reporting	An indicator variable that equals to one if a green bond issuer has disclosed the qualitative (quantitative) impact associated with the green bond(s), and zero otherwise.	Hand Collected
Quantitative Impact Reporting	An indicator variable that equals to one if a green bond issuer has disclosed the qualitative (quantitative) impact associated with the green bond(s), and zero otherwise.	Hand Collected
Quantitative Impact Method	An indicator variable that equals to one if a green bond issuer has disclosed the methods used to calculate the quantitative impact, and zero otherwise.	Hand Collected
Bond Level Impact Reporting	An indicator variable that equals to one if a green bond issuer has disclosed quantitative impact at the bond level, and zero otherwise.	Hand Collected
Project Level Impact Reporting	An indicator variable that equals to one if a green bond issuer has disclosed quantitative impact at the project level, and zero otherwise.	Hand Collected
Post Disclosure Score	The sum of *UOP Reporting*, *Qualitative Impact Reporting*, *Quantitative Impact Reporting*, *Quantitative Impact Method*, and *Project Level Impact Reporting*, 1 point for each dimension.	Constructed

Post-Issuance Assurance Variables

Variable Name	Definition	Source
Post Assurance	An indicator variable that equals to one if a green bond issuer obtained post-issuance assurance for its green bond report, and zero otherwise. The post-assurance could cover only actual use of proceeds, or the environmental impact associated with the green bond, or both.	Hand Collected
Post Assurance (UOP or Impact)	An indicator variable that equals to one if a green bond issuer obtained post-issuance assurance that either reviews the actual use of proceeds or the environmental impact, but not both, and zero otherwise.	Hand Collected
Post Assurance (UOP & Impact)	An indicator variable that equals to one if a green bond issuer obtained post-issuance assurance that reviews both the actual use of proceeds and the environmental impact, and zero otherwise.	Hand Collected
Post Assurance Score	Issuers get one point for obtaining *Post Assurance (UOP or Impact)*, and two points for obtaining *Post Assurance (UOP & Impact.*	Constructed

Overall Transparency Scores

Variable Name	Definition	Source
Post Transparency Score	The sum of *Website Transparency Score*, *Post Disclosure Score*, and *Post Assurance Score*.	Constructed
High Post Transparency Score	An indicator variable that equals to one if an issuers' *Post Issuance Transparency Score* is above sample median.	Constructed
Transparency Commitment	The number of transparency items (i.e., actual use of proceeds, impact reporting, quantitative impact metrics, and post-issuance assurance) an issuer commits to. The variable takes integer values from 0 to 4.	LGX DataHub
Deliver Promise	An indicator variable that equals to one if an issuer delivers its promised transparency items, and zero otherwise.	Constructed

Country Variables

Variable Name	Definition	Source
Country EPI	The Environmental Performance Index for the issuer's country of domicile.	2020 Environmental Performance Index (EPI)
Civil Law Country	An indicator that equals to one if the issuer's country of domicile is a civil law country.	JuriGlobe-World Legal Systems, University of Ottawa
Rule of Law	The issuer's country of domicile's rule of law score from the World Governance Index (WGI).	WGI, World Bank
Other Variables		
Bond Volatility	The standard deviation of daily bond returns between [t-126, t-1] window.	Constructed
Equity Volatility	The standard deviation of daily stock returns between [t-126, t-1] window.	Constructed
Bid-Ask Spread (USD)	The difference between ask and bid price of the green bond in USD.	Refinitive Datastream
γ	The liquidity measure developed in (Bao et al., 2011). Specifically, it is calculated as $\gamma = -COV(\Delta p_t, \Delta p_{t+1})$, where $\Delta p_t = p_t - p_{t-1}$ is the price change from t-1 to t, and p is the clean price of the bond.	Refinitive Datastream

Appendix B: Rules Imposed by Active Monitors

This Appendix provides an over view of the most prominent standards in the green bond market, including the rules imposed by the Active Monitors.[37]

Requirements	CBI (Climate Bond Standard V2.1)①	LGX Listing Rules②	Proposed EU Green Bond Standard (EUGBS)③
Green Taxonomy	Allows high-level categories	Climate Bonds Taxonomy	EU Taxonomy
Green Bond Framework	✓	✓	✓
Pre-Issuance External Reviews	✓	✓	✓
On-going monitoring by an enforcer	✓	✓	✓
Post-Issuance Reporting of UOP	✓	✓	✓
Post-Issuance Reporting of Impact	✗	✗	✓
Post-Issuance Assurance of UOP	✓	✗	✓
Post-Issuance Assurance of Impact	✗	✗	✓
Publication of Green Bond Documents	✗	✓	✓
Centralized Publication Platform	✗	✓	✗

① Since December 2019, issuers complying with CBS V3.0 will need to publish their post issuance disclosure and assurance reports. For details, see CBS V2.1 2017, V3.0 2019.

② For details, see LGX Eligibility criteria, available at `https://www.bourse.lu/displaying-bonds-on-lgx`.

③ For details, see European Commission, EUGBS (2021).

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[37]Also see, LGX, Sustainability Standards and Labels, available at `https://www.bourse.lu/sustainability_standards_and_labels`

Figures

Figure 1: Green Bond Documents on LGX website

Figure 2: Apple Prospectus Supplement to their 2019 Green Bonds

The notes may not be a suitable investment for all investors seeking exposure to green assets.

In connection with this offering, a second party opinion from an outside consultant regarding our green bond framework has been made publicly available. The examples of projects in "Use of Proceeds" are for illustrative purposes only and no assurance can be provided that disbursements for projects with these specific characteristics will be made by us with the proceeds from the notes. We have significant flexibility in allocating the net proceeds from the notes, including re-allocating the net proceeds in the event we determine in our discretion that projects receiving allocation no longer meet the criteria for Eligible Projects. There can be no assurance that the projects funded with the proceeds from the notes will meet, or continue to meet, investor criteria or expectations regarding sustainability performance or expectations for sustainable finance products. In particular, no assurance is given that the use or allocation of such proceeds for any Eligible Projects will satisfy, whether in whole or in part, any present or future investor expectations or requirements, taxonomies or standards or other investment criteria or guidelines with which such investor or its investments are required to comply, whether by any present or future applicable laws or regulations, by its own bylaws or other governing rules or investment portfolio mandates, ratings criteria, taxonomies or standards or other independent expectations (in particular with regard to any direct or indirect environmental, sustainability or social impact of any Eligible Projects).

The Eligible Projects to which we allocate the net proceeds from this offering have complex direct or indirect environmental, sustainability or social impacts and adverse environmental or social impacts may occur during the design, construction and operation of the projects. In addition, projects may become controversial or criticized by activist groups or other stakeholders, which could have a negative effect on the trading price of the notes.

Source: Apple SEC filing, available at

https://www.sec.gov/Archives/edgar/data/320193/000119312519288412/d804226d424b2.htm

Tables

Table 1: Descriptive Statistics - Bond and Issuer Characteristics

Panel A: Bond Characteristics at Issuance

This panel presents the descriptive statistics of green bond characteristics at bond issuance. *Amount Issued* is the issuance size in USD millions. *Coupon* is the coupon rate of the bond in percentage. *Maturity* is the bond maturity in months. *Credit Rating* is the bond-level credit rating at issuance. *Offering Yield* is the bond yield at issuance in percentage. The statistics are presented at the bond level. Detailed description of variables can be found Appendix A.

	N	Mean	P50	P25	P75	SD	Min	Max
Amount Issued (USD Millions)	698	346.07	145.22	52.69	544.14	476.07	0.00	4332.93
Coupon	698	2.37	1.60	0.62	3.50	2.43	0.00	19.69
Maturity (Months)	698	83.56	60.00	55.00	86.00	83.24	6.00	735.00
Credit Rating	464	6.05	7.00	3.00	8.00	3.62	1.00	21.00
Yield at Issuance	468	2.19	1.60	0.53	3.26	2.20	0.02	15.50

Panel B: Bond Issuer Financial Characteristics

This panel presents the descriptive statistics of green bond issuers financial characteristics in the year prior to most recent bond issuance. *Lag Total Assets (USD Billion)* is the natural log of issuer's total assets in USD billions. *Lag M/B* is the ratio of market value of equity over the book value of equity. *Lag Leverage* is the ratio of total debt over total asset. *Lag ROA* is the return on asset. The statistics are presented at the issuer level. Detailed description of variables can be found in Appendix A.

	N	Mean	P50	P25	P75	SD	Min	Max
Lag Total Assets (USD Billion)	326	192.31	14.72	4.38	74.27	503.95	0.02	3386.07
Lag Leverage	324	0.36	0.35	0.23	0.46	0.17	0.02	0.82
Lag ROA	323	0.03	0.03	0.01	0.05	0.04	-0.13	0.23
Lag Market to Book Ratio	309	1.94	1.20	0.77	1.83	3.13	0.08	43.88
Lag Tangible	320	0.36	0.27	0.01	0.69	0.34	0.00	0.98

Table 2: Descriptive Statistics - Active Monitoring and Post-Issuance transparency

Panel A: Active Monitoring and Post-Issuance transparency (full sample)

This panel presents the descriptive statistics of green bond issuers' choices to bond with the Active Monitors and provide post-issuance disclosure and assurance. The statistics are presented at the bond level for Panel A1 and at the issuer level for Panel A2. Detailed description of variables can be found in Appendix A.

Panel A1: Pre-Issuance Bonding								
	N	Mean	P50	P25	P75	SD	Min	Max
Actively Monitored Green	698	0.19	0.00	0.00	0.00	0.40	0.00	1.00
CBI Green	698	0.09	0.00	0.00	0.00	0.28	0.00	1.00
LGX Green	698	0.11	0.00	0.00	0.00	0.32	0.00	1.00
Panel A2: Post Issuance Transparency								
	N	Mean	P50	P25	P75	SD	Min	Max
Website Transparency								
Green Bond Website	326	0.73	1.00	0.00	1.00	0.45	0.00	1.00
Green Bond Framework on Website	326	0.66	1.00	0.00	1.00	0.47	0.00	1.00
Pre-Issuance External Review on Website	326	0.61	1.00	0.00	1.00	0.49	0.00	1.00
Green Bond Report on Website	326	0.47	0.00	0.00	1.00	0.50	0.00	1.00
Post-Issuance Data on Website	326	0.16	0.00	0.00	0.00	0.36	0.00	1.00
Historical Green Bond Report on Website	326	0.26	0.00	0.00	1.00	0.44	0.00	1.00
Website Transparency Score [1]	326	2.14	3.00	0.00	3.00	1.53	0.00	4.00
Post-Issuance Disclosure								
UOP Reporting	326	0.66	1.00	0.00	1.00	0.48	0.00	1.00
Quaslitative Impact Reporting	326	0.63	1.00	0.00	1.00	0.48	0.00	1.00
Quantitative Impact Reporting	326	0.57	1.00	0.00	1.00	0.50	0.00	1.00
Quantitative Impact Method	326	0.31	0.00	0.00	1.00	0.46	0.00	1.00
Bond Level Impact Reporting	326	0.10	0.00	0.00	0.00	0.29	0.00	1.00
Project Level Impact Reporting	326	0.19	0.00	0.00	0.00	0.40	0.00	1.00
Post Disclosure Score [2]	326	2.36	3.00	0.00	4.00	1.85	0.00	5.00
Post-Issuance Assurance								
Post Assurance	326	0.46	0.00	0.00	1.00	0.50	0.00	1.00
Post Assurance (UOP or Impact)	326	0.18	0.00	0.00	0.00	0.39	0.00	1.00
Post Assurance (UOP & Impact)	326	0.28	0.00	0.00	1.00	0.45	0.00	1.00
Post Assurance Score [3]	326	0.73	0.00	0.00	2.00	0.87	0.00	2.00
Overall Transparency Scores								
Post Transparency Score ([1]+[2]+[3])	326	5.23	6.00	1.00	9.00	3.78	0.00	11.00

Panel C: Active Monitoring and Post-Issuance Transparency by Country

This panel presents the descriptive statistics of green bond issuers' pre-issuance bonding with the Active Monitors and post-issuance disclosure and assurance practices by country. Detailed description of variables can be found in Appendix A.

Country	Active Monitoring	CBI	LGX	Post Transparency Score	Num of Bonds
Australia	0.92	0.92	0.17	10.00	12
Thailand	0.81	0.81	0.00	7.10	21
Germany	0.73	0.23	0.64	8.23	22
Netherlands	0.62	0.44	0.19	9.25	16
Italy	0.62	0.00	0.62	9.21	24
United Kingdom	0.36	0.18	0.27	6.82	11
Spain	0.19	0.00	0.19	5.90	21
Austria	0.13	0.00	0.13	7.73	15
Japan	0.12	0.04	0.08	4.95	125
Norway	0.11	0.00	0.11	6.37	19
United States	0.11	0.00	0.11	5.89	46
Sweden	0.09	0.00	0.09	8.84	93
Brazil	0.00	0.00	0.00	3.07	15
China	0.04	0.04	0.00	1.32	99
France	0.02	0.02	0.02	7.29	56
Other	0.20	0.10	0.11	5.67	6

Panel D: Active Monitoring and Post-Issuance Transparency by Sector

This panel presents the descriptive statistics of green bond issuers' pre-issuance bonding choices and post-issuance disclosure and assurance choices by industry sector (GIC 2 digit industry code). The sectors highlighted in are considered Polluting Industry, as their core businesses involve high emitting, high polluting activities. Detailed description of variables can be found in Appendix A.

Industry	Active Monitoring	CBI	LGX	Post Transparency Score	Num of Bonds
Health Care	1.00	0.00	1.00	10.00	1
Communication Services	0.33	0.00	0.33	7.67	6
Materials	0.33	0.00	0.33	5.67	27
Utilities	0.31	0.16	0.18	5.54	127
Financials	0.28	0.12	0.18	6.44	215
Industrials	0.25	0.21	0.06	3.96	71
Consumer Discretionary	0.18	0.00	0.18	4.18	11
Consumer Staples	0.08	0.08	0.00	6.08	12
Real Estate	0.01	0.00	0.01	6.38	197
Information Technology	0.00	0.00	0.00	3.94	18
Energy	0.00	0.00	0.00	0.00	3

Table 3: Determinants of Active Monitor Engagement

This table presents the results from the logistic regression of the model outlined in Equation 1. *Active Monitoring* an indicator variable that equals to one if a bond is either certified by CBI or listed on the LGX, or both. *CBI* an indicator variable that equals to one if a green bond is certified by CBI. *LGX* an indicator variable that equals to one if a green bond is listed on LGX. *Industry CO2 Intensity Ranking* is the issuers' within industry rank base on its carbon intensity normalized by the total number of green bond issuers from that industry. *GRI Reporting & Auditing* is an indicator variable that equals to one if the issuer has been reporting in accordance to the GRI standards and has obtained CSR audits. *Polluting Industry* is an indicator variable that equals to one if the issuer belongs to any of the following GIC 2 digit sectors: Materials, Utitlities, Industrials, and Energy. *Country EPI* is the Environmental Performance Index for the issuer's country of domicile. *Lag ln(Total Assets)* is the natural log of issuer's total assets in USD millions. *Lag M/B* is the issuer's market to book ratio. *Lag Leverage* is the ratio of total debt over total asset. *Lag ROA* is the return on asset. Lag Tangible is the issuer's PP&E over total asset. *ln(Amount Issued)* is the natural log of the total amount issued in the green bond in USD millions. *Maturity* is the bond maturity at issuance in months. *Civil Law Country* is an indicator that equals to one if the issuer's country of domicile is a civil law country. *Rule of Law* is the issuer's country of domicile's rule of law score from the World Bank's WGI. The unit of observation is at bond level. Standard errors are clustered at the GIC 6 digit industry level. Z-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found in Appendix A.

Dependent Var =	Active Monitoring (1)	CBI Certified (2)	LGX (3)
Industry CO2 Intensity Ranking	3.039***	0.186	3.428***
	(3.83)	(0.18)	(2.67)
GRI Reporting & Auditing	0.950*	-0.693	2.948***
	(1.90)	(-1.03)	(4.25)
Polluting Industry	2.344***	2.588**	1.647**
	(3.02)	(2.21)	(2.16)
Country EPI	-0.049	-0.186***	0.020
	(-1.16)	(-4.29)	(0.33)
Lag ln(Total Assets)	0.294*	0.192	0.258
	(1.92)	(0.65)	(1.31)
Lag M/B	0.124	0.200	-0.108
	(0.70)	(0.81)	(-0.50)
Lag Leverage	2.035	1.528	1.269
	(1.05)	(0.55)	(0.47)
Lag ROA	-26.391***	-37.642**	-9.740
	(-2.95)	(-2.09)	(-1.02)
Lag Tangible	-0.798	-1.545	-0.492
	(-0.83)	(-1.02)	(-0.51)
ln(Amount Issued)	0.087	-0.225	0.457***
	(0.68)	(-1.50)	(2.59)
ln(Maturity)	-0.011	0.297	-0.233
	(-0.03)	(0.44)	(-0.47)

Civil Law Country	-0.904	-1.693***	-0.116
	(-1.45)	(-2.72)	(-0.31)
Rule of Law	0.142	2.829***	-0.227
	(0.22)	(4.44)	(-0.35)
Constant	-2.510	9.757**	-13.186***
	(-0.81)	(2.52)	(-2.75)
Issue Year FE	YES	YES	YES
Observations	303	303	303
Pseudo R-squared	0.230	0.341	0.276

Table 4: Active Monitoring and Post-Issuance Disclosure

Panel A: Regression Analysis - Active Monitoring and Post-Issuance Transparency

This panel presents the results from the OLS regression of the model outlined in Equation 2. *Website Transparency Score* captures the accessibility of green bond documents on issuers' website. *Post Disclosure Score* captures the scope of green bond post-issuance disclosure. *Post Assurance Score* captures the scope of green bond post-issuance assurance. *Post Transparency Score* captures the overall scope of post-issuance disclosure, assurance, and accessibility of green bond information. The main independent variable, *Active Monitored Issuer*, is an indicator variable that equals to one if an issuer has ever issued a green bond that is either certified by CBI or listed on the LGX, or both. *CBI Issuer* is an indicator variable that equals to one if an issuer has ever issued a green bond that is certified by CBI. *LGX Issuer* is an indicator variable that equals to one if an issuer has ever issued a green bond that is listed on the LGX. For columns (5) - (8), I drop the 5 issuers that have bonded with both CBI and LGX to allow for cleaner identification. Standard errors are clustered at the GIC 6 digit industry level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found in Appendix A.

Dependent Var =	Website Transparency Score (1)	Post Disclosure Score (2)	Post Assurance Score (3)	Post Transparency Score (4)	Website Transparency Score (5)	Post Disclosure Score (6)	Post Assurance Score (7)	Post Transparency Score (8)
Active Monitoring Issuer	0.704***	0.768**	0.508***	1.980***				
	(3.39)	(2.50)	(5.03)	(3.78)				
CBI Issuer					0.562	0.293	0.569***	1.424
					(1.17)	(0.39)	(3.02)	(1.11)
LGX Issuer					0.719***	1.042***	0.436***	2.198***
					(3.82)	(5.72)	(3.41)	(6.11)
Lag ln(Total Assets)	0.066	0.054	0.003	0.123	0.062	0.050	0.005	0.117
	(0.79)	(0.51)	(0.08)	(0.61)	(0.71)	(0.47)	(0.11)	(0.56)
Lag M/B	-0.056	-0.078	0.008	-0.126	-0.052	-0.079	0.012	-0.119
	(-1.38)	(-1.41)	(0.34)	(-1.38)	(-1.25)	(-1.38)	(0.53)	(-1.25)
Lag Leverage	1.006	1.035	0.253	2.294	0.887	0.984	0.170	2.042
	(1.18)	(1.14)	(0.79)	(1.22)	(1.00)	(1.02)	(0.52)	(1.04)
Lag ROA	0.907	3.803	-1.043	3.667	0.734	4.193	-1.437	3.490
	(0.34)	(1.17)	(-0.78)	(0.64)	(0.28)	(1.35)	(-1.00)	(0.62)

Lag Tangible	-0.497	-0.606	-0.594***	-1.698**	-0.521	-0.599	-0.621***	-1.742**
	(-1.26)	(-1.67)	(-3.12)	(-2.15)	(-1.32)	(-1.61)	(-3.34)	(-2.19)
ln(Amount Issued)	0.122	0.165	0.084	0.371	0.111	0.146	0.078	0.335
	(1.04)	(1.60)	(1.56)	(1.61)	(0.97)	(1.48)	(1.43)	(1.51)
ln(Maturity)	0.307**	0.216	0.067	0.590	0.314**	0.176	0.100	0.590
	(2.41)	(1.06)	(0.74)	(1.67)	(2.28)	(0.80)	(1.18)	(1.57)
Country EPI	0.028*	0.039**	0.031***	0.099***	0.027	0.036*	0.031***	0.093**
	(1.82)	(2.47)	(5.85)	(2.87)	(1.43)	(1.72)	(5.31)	(2.19)
Civil Law	-0.171	-0.566**	-0.257**	-0.995*	-0.162	-0.619**	-0.237**	-1.018*
	(-0.57)	(-2.18)	(-2.57)	(-1.91)	(-0.53)	(-2.38)	(-2.17)	(-1.95)
Rule of Law	0.392***	0.509***	-0.147**	0.754**	0.410**	0.552**	-0.152**	0.809**
	(3.15)	(3.18)	(-2.08)	(2.67)	(2.67)	(2.50)	(-2.12)	(2.14)
Constant	-3.003***	-3.095**	-1.794***	-7.892***	-2.788**	-2.532	-1.881***	-7.200**
	(-2.76)	(-2.24)	(-2.89)	(-3.02)	(-2.04)	(-1.45)	(-2.73)	(-2.11)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Issue Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	292	292	292	292	287	287	287	287
R-squared	0.379	0.371	0.318	0.430	0.368	0.366	0.306	0.417
Adjusted R-squared	0.318	0.310	0.251	0.374	0.302	0.299	0.234	0.356

Panel B: Robustness Check - Active Monitoring and Post-Issuance Transparency

This table checks the robustness of the findings in Table 4, Panel A. In columns (1) - (4), I drop the 31 Active Monitoring Issuers that also bond with other green exchanges. In columns (5) - (8), I drop the country level variables and include country fixed effects. Standard errors are clustered at the GIC 6 digit industry level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found in Appendix A.

Robustness Check =	Drop Double Bonded Green				Country FE			
Dependent Var =	Website	Post	Post	Transparency	Website	Post	Post	Transparency
	Transparency	Disclosure	Assurance	Score	Transparency	Disclosure	Assurance	Score
	Score	Score	Score		Score	Score	Score	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CBI Issuer	0.407	0.062	0.552**	1.021	0.039	-0.325	0.551*	0.265
	(0.72)	(0.08)	(2.26)	(0.72)	(0.06)	(-0.46)	(1.82)	(0.19)
LGX Issuer	0.934**	1.129***	0.789***	2.851***	0.236	0.551**	0.188	0.975**
	(2.28)	(4.22)	(6.72)	(4.23)	(1.19)	(2.47)	(1.48)	(2.24)
Constant	-3.187**	-2.482	-1.887***	-7.556**	-1.948*	-1.558	-0.822	-4.328*
	(-2.03)	(-1.44)	(-2.71)	(-2.13)	(-1.86)	(-1.24)	(-1.19)	(-1.81)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Issue Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	NO	NO	NO	YES	YES	YES	YES
Observations	261	261	261	261	277	277	277	277
R-squared	0.335	0.319	0.309	0.372	0.519	0.484	0.425	0.556
Adjusted R-squared	0.258	0.240	0.229	0.299	0.415	0.373	0.301	0.461

Panel C: Regression Analysis - Active Monitoring and Credibility of Commitment

This table presents the results from the OLS regression of the model outlined in Equation 2. In column (1), the dependent variable *Transparency Commitment* captures the scope of an Issuer's ex-ante disclosure and assurance commitment. In column (2), the dependent variable *Deliver Promise* captures whether the scope of an issuer's actual disclosure and assurance is more than its ex-ante promise. Standard errors are clustered at the GIC 6 digit industry level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found in Appendix A.

Dependent Var =	Transparency Commitment	Deliver Promise
	(1)	(2)
Active Monitored Issuer	-0.280*	0.183**
	(-1.81)	(2.49)
Constant	0.559	-0.548
	(0.60)	(-1.46)
Controls	YES	YES
Industry FE	YES	YES
Issue Year FE	YES	YES
Observations	220	220
R-squared	0.216	0.242
Adjusted R-squared	0.120	0.149

Table 5: Active Monitoring and Environmental Improvements

Panel A: Active Monitoring and Environmental Improvements - Green Bond Sample

This panel presents the results from the Diff-in-Diff regression of the model outlined in Equation 3. In this analysis, I use all green bond issuers with Asset 4 carbon intensity data. The dependent variable is *ln(Carbon Intensity)*, the natural log of total Scope 1 and Scope 2 GHG emissions dividend by Revenue in USD. *Green Bond Issuer* is an indicator variable if the firm is a green bond issuer. *Active Monitoring Issuer* is an indicator variable that equals one if the green bond issuer has bonded with either LGX or CBI for at least one of its newly issued green bond in a given year. *Non-Active Monitoring Issuer* is an indicator variable that equals one if the green bond issuer has not bonded with either LGX or CBI for any of its newly issued green bond in a given year. *CBI Issuer* is an indicator that equals one variable if the green bond issuer has obtained CBI certification for one of its newly issued green bond in a given year. *LGX Issuer* is an indicator variable that equals one if the green bond issuer has listed one of its newly issued green bond on LGX in a given year. *Post* is defined within each matched pair and is an indicator variable that equals 1 post the green bond issuance, and 0 otherwise. The unit of observation is at firm-year level. Standard errors are clustered at the GIC 6 digit industry level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found in Appendix A.

Dependent Var =	ln(Carbon Intensity)			
Sample =	Green Bond Issuers		Drop Double Bonds	
	(1)	(2)	(3)	(4)
Actively Monitored Issuer × Post	-0.0792		-0.120*	
	(-1.333)		(-1.710)	
Actively Monitored Issuer	0.0309		0.0501*	
	(1.307)		(1.696)	
CBI Issuer × Post		-0.162*		-0.180*
		(-2.004)		(-1.939)
LGX Issuer × Post		0.0148		-0.0800
		(0.170)		(-1.182)
CBI Issuer		0.102*		0.109*
		(1.751)		(1.823)
LGX Issuer		-0.00327		0.0341
		(-0.0842)		(1.190)
Post	0.0185	0.0198	0.0311	0.0334
	(0.515)	(0.547)	(0.886)	(0.953)
ln(Total Assets)	-0.222	-0.278*	-0.415***	-0.415***
	(-1.414)	(-1.718)	(-2.996)	(-3.047)
M/B	-0.00964	-0.00996	-0.00532	-0.00495
	(-0.326)	(-0.336)	(-0.194)	(-0.180)
ROA	-1.105	-1.125	-0.321	-0.304
	(-0.968)	(-0.992)	(-0.269)	(-0.255)
Leverage	0.247	0.254	0.473	0.481
	(0.493)	(0.510)	(0.988)	(1.015)
Tangible	-0.484	-0.515	-0.427	-0.435

	(-1.613)	(-1.685)	(-1.109)	(-1.125)
Constant	5.724***	6.389***	7.865***	7.870***
	(3.084)	(3.331)	(4.506)	(4.601)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	1,479	1,439	1,313	1,291
R-squared	0.979	0.979	0.980	0.979
Adjusted R-squared	0.976	0.976	0.977	0.977

Panel B: Matched Sample Summary Stats

This panel presents the descriptive statistics of bond characteristics for the green and brown bonds in the matched sample. *Lag ln(Total Assets)* is the natural log of issuer's total assets in the year prior to green bond issuance. *Lag M/B* is the ratio of market value of equity over the book value of equity in the year prior to green bond issuance. *Lag Leverage* is the ratio of total debt over total asset in the year prior to green bond issuance. *Lag ROA* is the return on asset in the year prior to green bond issuance. Detailed description of variables can be found in Appendix A.

	Green Bond Issuer (1)	Brown Bond Issuer (2)	Diff = (2)- (1)
Lag ln(Total Asset)	10.44	10.41	-0.04
Lag Market to Book Ratio	1.59	1.79	0.20
Lag ROA	0.04	0.04	0.00
Lag Leverage	0.31	0.28	-0.03
Lag Tangible	0.40	0.36	-0.04
Observations	122	122	244

Panel C: Active Monitoring and Environmental Improvements – Matched Sample

This panel presents the results from the Diff-in-Diff regression of the model outlined in Equation 4. In this analysis, I match a green bond issuer with a comparable conventional bond issuer that has never issued green bonds before. *Non-Active Monitoring Issuer* is an indicator variable that equals one if the green bond issuer has not bonded with either LGX or CBI for any of its newly issued green bond in a given year. *Post* is defined within each matched pair and is an indicator variable that equals 1 post the green bond issuance, and 0 otherwise. The unit of observation is at firm-year level. Standard errors are clustered at the GIC 6 digit industry level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. All other variables are defined the same way as in 5, Panel A. Detailed description of variables can be found in Appendix A.

Dependent Var =	ln(Carbon Intensity)	
Sample =	Matched Sample	Drop Double Bond

	(1)	(2)	(3)	(4)
Actively Monitored Issuer × Post (β_1)	-0.127**		-0.142*	
	(-2.06)		(-1.77)	
CBI Issuer × Post (β_{1a})		-0.213		-0.242
		(-1.14)		(-1.33)
LGX Issuer × Post (β_{1b})		-0.076		-0.019
		(-1.05)		(-0.22)
Non-Actively Monitored Issuer × Post (β_2)	0.065	0.065	0.055	0.056
	(1.42)	(1.41)	(1.00)	(1.02)
Post	0.003	0.004	0.020	0.021
	(0.11)	(0.14)	(0.70)	(0.76)
Constant	5.159***	5.200***	6.179***	6.229***
	(3.08)	(3.13)	(3.94)	(4.13)
P-value:				
$\beta_1 = \beta_2$	0.0001		0.0034	
$\beta_{1a} = \beta_2$		0.1181		0.0826
$\beta_{1b} = \beta_2$		0.0393		0.3422
Controls	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	1,498	1,494	1,271	1,271
R-squared	0.984	0.984	0.984	0.984
Adjusted R-squared	0.982	0.982	0.982	0.982

Table 6: Active Monitoring and Green Premium

Panel A: Active Monitoring and Green Premium - Base Analysis

This panel presents the OLS regression results outlined in Equation 5. The dependent variable is *Offer Yield*, which is the yield at issuance for a bond. *Actively Monitored Green* is an indicator variable that equals to one if a green bond is either certified by CBI or listed on LGX, and zero otherwise. *Non-Actively Monitored Green* is an indicator variable that equals to one if a green bond is not certified by CBI or listed on LGX, and zero otherwise. *CBI Green* is an indicator variable that equals to one if a green bond is certified by CBI, and zero otherwise. *LGX Green* is an indicator variable that equals to one if a green bond is listed on LGX, and zero otherwise. *ln(Amount Issued)* is natural log of the total issuance amount of a green bond in USD millions. *ln(Maturity)* is natural log of the bond maturity in months. In columns (1) - (2), the sample contains all bonds (green and conventional) issued by public corporations that also issued green bonds. In columns (3) - (6), the sample contains all bonds issued by public and private corporations that also issued green bonds. The observations are at the bond level. Standard errors are clustered at the issuer level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found Appendix A.

Dependent Variable =	Offer Yield					
Sample =	Public		Public & Private			
	(1)	(2)	(3)	(4)	(5)	(6)
Actively Monitored Green	-0.134*		-0.153**		-0.174**	
	(-1.77)		(-2.55)		(-2.36)	
CBI Green		0.096		0.058		-0.030
		(0.76)		(0.44)		(-0.24)
LGX Green		-0.243***		-0.268***		-0.173*
		(-2.69)		(-4.04)		(-1.88)
Non-Actively Monitored Green	0.036	0.037	0.077*	0.078*	-0.058	-0.059
	(0.71)	(0.73)	(1.79)	(1.82)	(-1.58)	(-1.58)
ln(Amount Issued)	0.040***	0.040***	0.027***	0.028***	0.020**	0.020**
	(3.57)	(3.56)	(2.99)	(3.04)	(2.39)	(2.41)
ln(Maturity)	0.698***	0.698***	0.631***	0.630***	0.615***	0.615***
	(15.19)	(15.18)	(17.20)	(17.19)	(17.85)	(17.77)
Constant	-1.478***	-1.476***	-0.716***	-0.714***	-0.633***	-0.635***
	(-6.42)	(-6.41)	(-3.95)	(-3.93)	(-3.68)	(-3.67)

P-value:						
Active Monitored Green = Non-Monitored Green	0.0482		0.0011		0.1569	
CBI Green = Non-Monitored Green		0.6966		0.8848		0.6323
LGX Green = Non-Monitored Green		0.0031		0.0000		0.0994
Issuer FE	YES	YES	YES	YES		
Issue Year FE	YES	YES	YES	YES		
Credit Rating FE	YES	YES	YES	YES	YES	YES
Currency FE	YES	YES	YES	YES	YES	YES
Maturity Type FE	YES	YES	YES	YES	YES	YES
Seniority FE	YES	YES	YES	YES	YES	YES
Listed FE	YES	YES	YES	YES	YES	YES
Issuer × Issue Year FE					YES	YES
Observations	4,256	4,252	9,903	9,891	9,042	9,034
R-squared	0.898	0.898	0.901	0.901	0.942	0.942
Adjusted R-squared	0.892	0.892	0.896	0.896	0.931	0.931

Panel B: Active Monitoring and Green Premium - Base Analysis

This panel presents results from robustness analyses of Table , Panel A. In columns (1) - (2), the sample contains all green and brown bond pairs that satisfies the matching criteria. In columns (3) - (4), the sample contains all bonds issued by public and private corporations that also issued green bonds except for the Actively Monitored green bonds that are also listed on other green exchanges. Standard errors are clustered at the issuer level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found Appendix A.

Dependent Variable =	Offer Yield			
Sample =	CEM Matched Sample		Drop Double Bond	
	(1)	(2)	(3)	(4)
Actively Monitored Green	-0.071*		-0.212***	
	(-1.71)		(-2.81)	
CBI Green		0.037		-0.086
		(0.84)		(-0.97)
LGX Green		-0.121**		-0.254**
		(-2.25)		(-2.49)
Non-Actively Monitored Green	-0.028	-0.028	-0.053	-0.054
	(-1.38)	(-1.40)	(-1.45)	(-1.46)
ln(Amount Issued)	0.038***	0.039***	0.020**	0.020**
	(2.74)	(2.75)	(2.41)	(2.39)
ln(Maturity)	0.287***	0.282***	0.616***	0.616***
	(10.62)	(10.75)	(17.71)	(17.71)
Constant	1.110***	1.145***	-0.635***	-0.635***
	(7.08)	(7.19)	(-3.66)	(-3.66)
P-value:				
Active Monitored Green = Non-Monitored Green	0.3526		0.0589	
CBI Green = Non-Monitored Green		0.1833		0.7327
LGX Green = Non-Monitored Green		0.1093		0.0653
Matched Pair FE	YES	YES		

Issuer × Issue Year FE			YES	YES
Credit Rating FE			YES	YES
Currency FE			YES	YES
Maturity ype FE			YES	YES
Seniority FE			YES	YES
Listed FE			YES	YES
Observations	388	388	9,005	9,005
R-squared	0.993	0.993	0.942	0.942
Adjusted R-squared	0.989	0.989	0.931	0.931

Table 7: Post-Issuance Transparency and Bond Liquidity

Panel A: Post-Issuance Transparency and Bond Liquidity - Base Analysis

This table presents the results from the OLS regression of the model outlined in Equation 6. *Bid-Ask Spread (USD)* is the difference between ask and bid price of the green bond in USD. *High Post Transparency Score* is an indicator variable that equals to one if an issuers' *Post Issuance Transparency Score* is above sample median. *Actively Monitored Green* is an indicator variable that equals to one if a green bond is either certified by CBI or listed on LGX. *Bond Volatility* is the standard deviation of daily bond returns between [t-126, t-1] window. *Equity Volatility* is the standard deviation of daily stock returns between [t-126, t-1] window. The unit of observation is at the bond-month level. Standard errors are clustered at year-month level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. Detailed description of variables can be found in Appendix A.

Dependent Var =	Bid-Ask Spread (USD)			γ		
	(1)	(2)	(3)	(4)	(5)	(6)
High Transparency Score	-0.016***	-0.007	-0.000	-0.004***	-0.003**	-0.003***
	(-3.83)	(-1.57)	(-0.09)	(-2.92)	(-2.35)	(-2.78)
Actively Monitored Green		0.036***			0.003	
		(5.35)			(1.49)	
High Transparency Score ×Actively Monitored Green		-0.063***			-0.006***	
		(-9.52)			(-2.78)	
CBI Green			-0.011			0.007**
			(-1.17)			(2.57)
High Transparency Score ×CBI Green			-0.103***			-0.009**
			(-10.42)			(-2.02)
LGX Green			0.108***			-0.006*
			(4.08)			(-1.70)
High Transparency Score ×LGX Green			-0.111***			0.003
			(-5.06)			(0.99)
Lag ln(Total Assets)	-0.012***	-0.010***	-0.013***	-0.001**	-0.001	-0.001
	(-14.36)	(-12.30)	(-13.00)	(-2.21)	(-1.58)	(-1.49)
Lag Leverage	0.002	0.012	0.028***	0.002	0.003*	0.003*
	(0.35)	(1.64)	(4.62)	(1.24)	(1.77)	(1.83)

	(1)	(2)	(3)	(4)	(5)	(6)
Lag M/B	-0.008***	-0.007***	-0.009***	-0.000	0.000	0.000
	(-7.48)	(-6.97)	(-7.23)	(-0.02)	(0.12)	(0.24)
Lag ROA	0.475***	0.505***	0.491***	0.036	0.041	0.039
	(5.75)	(6.15)	(6.26)	(1.33)	(1.52)	(1.43)
ln(Amount Issued)	0.060***	0.059***	0.059***	0.001**	0.001*	0.001*
	(15.38)	(14.08)	(14.58)	(2.02)	(1.69)	(1.97)
ln(Maturity)	0.178***	0.173***	0.173***	0.001	0.001	0.001
	(15.24)	(14.34)	(14.17)	(0.60)	(0.33)	(0.29)
ln(Age)	-0.021***	-0.020***	-0.021***	0.000	0.000	0.000
	(-5.05)	(-4.73)	(-4.79)	(0.16)	(0.19)	(0.17)
Bond Volatility	35.726***	36.243***	36.158***	1.759*	1.805**	1.809**
	(12.58)	(12.53)	(12.48)	(1.95)	(1.99)	(2.00)
Equity Volatility	0.441	0.338	0.378	-0.202*	-0.211*	-0.207*
	(1.25)	(0.96)	(1.07)	(-1.82)	(-1.91)	(-1.88)
Constant	-0.732***	-0.739***	-0.709***	0.003	0.003	0.001
	(-9.82)	(-9.37)	(-9.54)	(0.27)	(0.26)	(0.13)
Industry FE	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Year Month FE	YES	YES	YES	YES	YES	YES
Credit Rating FE	YES	YES	YES	YES	YES	YES
Currency FE	YES	YES	YES	YES	YES	YES
Maturity Type FE	YES	YES	YES	YES	YES	YES
Seniority FE	YES	YES	YES	YES	YES	YES
Listed FE	YES	YES	YES	YES	YES	YES
Observations	6,474	6,474	6,474	6,474	6,474	6,474
R-squared	0.774	0.775	0.775	0.134	0.135	0.136
Adjusted R-squared	0.771	0.772	0.773	0.125	0.125	0.126