Financing Biodiversity Conservation:

Scale-up of Green Bond Market

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Abstract

The imperative to address the pressing issue of biodiversity conservation and restoration has recently prompted a quest for innovative financial solutions to mobilize private capital and overcome funding gaps. Corporate green bonds have emerged as a financing tool in bridging the biodiversity funding gap. This study explores the financing of biodiversity conservation, focusing on the use of green bonds and their determinants of performance. This research examines 1) the characteristics of projects financed through green bonds, further analyzing the co-benefits and impact level to biodiversity enhancement and 2) transparency orientation of green bond with biodiversity objectives. The findings shed light on significant role of project characteristics in determining green bond performance, while further find that higher co-benefits and impact level increase the performance of green bonds. Lastly, the study uncovers that the choices of pre-issuance review are perceived differently by investors. The implications of these findings extend to issuers, policymakers, and investors, highlighting the potential of green bonds to drive the scaling up of biodiversity conservation efforts.

Key words

Biodiversity Finance; Green Bonds; Conservation Finance, Environmental Finance; Sustainable Finance

JEL Classification

G23; G3; G12; Q57; Q2; Q5

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1. Introduction

There is a growing concern among investors and financial institutions about emerging risks in their portfolios related to biodiversity (Principles for Responsible Investment, 2020). They are becoming more aware of the synergies and trade-offs between climate change and biodiversity. In light of the growing concern, investors and financial institutions are starting to integrate biodiversity aspects in their investment decision-making.

However, more capital is needed as many have expressed concern with global biodiversity underinvestment (Seidl et al., 2020; Deutz et al., 2020; UNEP et al., 2021;). Several recent studies estimate the need for scale up for global investment towards nature and biodiversity. UNEP et al. (2022) approximate that $133 billion currently flows into land-related nature-based solutions (NBS) annually with 2020 as base year, and the need to scale up by additional $165 billion by 2050. The annual amount of funding of which only 14%, or USD 18 billion, was private funds. An even bolder estimate of biodiversity financing gap (Deutz et al., 2020), as of 2019, spending on biodiversity conservation was estimated at between $124 billion and $143 billion per year, against a total of $722 and $967 billion per year of biodiversity protection needed –financing gap at between US$ 598 billion and US$ 824 billion per year. It should be noted that both estimations do not contradict as the former only focused on NBS. This proportion and the funding gap highlight the importance of private sector contributions, presenting a big loophole for private sector to fill.

The estimation gaps highlight some barriers in financing biodiversity. However, the main barrier lies in the information asymmetry on return and impact due to complete lack of transparency and benchmarked data on market rates and return (WWF, 2022). Nature-positive project is also deemed as a too complex deal by financial sector for ‘easy’ processing of deals scale-up, which lack of structures and framework. Karolyi (2022) emphasize the need for framework to identify nature-related risks to support flows toward nature-positive investments.

Biodiversity conservation require significant up-front investment: 1) To plan the conservation strategies, including undertaking consultations and developing policies, conducting comprehensive assessments of forest resources, and integrating socio-economic factors into the

strategies; 2) To strengthen institutions, such as land tenure and ecosystem governance; and 3) To monitor, report and verify that biodiversity conservation has actually taken place. In this sense, long-term borrowing remains the best option for capital raising as an alternative to equity financing for a variety of practical reasons (Chiesa & Barua, 2019). Specifically, bond could be the tool that directly fulfill this significant up-front investment while addressing the concerns of time and scale and enabling issuers existing and anticipated future income.

The issuance of green bonds, specifically, could be one of the main tools in bridging the biodiversity funding gap. Importantly, green bond is also a familiar and proven mechanism for private-sector finance, which is key party to the scale for financing biodiversity. Ever since their emergence as a new form of environmental financing in 2007, green bonds have stirred investors with the promise of providing a direct means of investing in environmentally oriented projects, has shown a skyrocketed issuance –Green bond boom—from $5B in 2013 to $621 billion in 2021 (Bloomberg, 2022).

On my empirical analysis of literature review, I find that green bond has never been used for urban nature positive projects in Europe. However, there is evidence that green bond is used in biodiversity related projects –including the demand and investor preference perspective. Thompson (2023) proves that Investors have good appetite for biodiversity bond where all bonds were oversubscribed. Consistently, Cooper & Trémolet (2019) shows investors' high interest in impact investments in biodiversity conservation.

Yet, market still has little notion of on what drives the performance for green bond with biodiversity objective. I, therefore, delve deeper into the determinants affecting the performance of green bond issued with biodiversity objective by investigating two factors: the project categories for biodiversity and the issuer's transparency orientation. I define the former as eligible categories of green bond project with biodiversity benefits mapped by the International Capital Market Association (ICMA) while analyzing further the multiple categories (co-benefits) and the impact level of green bond on biodiversity enhancement. The latter determinant, the issuer's transparency orientation, is defined through the presence of (a) green bond certification; (b) second opinion; and

(c) compliance body choices. These determinants will be tested in relation to the performance of green bonds with biodiversity related objective.

The findings of this study have important implications for both theory and practice. I first find that the performance of green bond with biodiversity objective is influenced by the project category. Surprisingly, certain project categories, such as circular economy and eco-efficient products and technology, impacting the performance negatively. As the first to explore these variables, I find that green bond with multiple co-benefits and higher impact level contributes to the green bond performance positively. In regard to the issuer's transparency orientation, I find that transparency orientation affects the green bond performance. Specifically, green bond certification affects the performance positively, while Second Party Opinion (SPO) negatively affects the performance. Lastly, I find that the choice of compliance body does not affect green bond performance.

This study fills an important gap to the existing literature of green bond by exploring the use of proceed designated specifically for biodiversity enhancement, proving the multifaceted approach that drives the green bond performance. Moreover, this study also the first to define the multiple categories (co-benefits) and impact level of green bond. I define the latter as different impact the biodiversity objective project categories as having primary, secondary, and tertiary impact to biodiversity enhancement. Thus, the research complements the existing literature on this relatively new financial instrument and its role as a key to bridge the biodiversity financing gap. The pioneering step this literature takes and the theory I develop enrich the foundation for future research and exploration in this crucial area.

Finally, I also contribute to the literature on green bond reporting as the first who analyze the impact of compliance body choices. This could be interpreted through the lens of signaling theory (Flammer, 2021). The use of more compliance bodies would be perceived as 1) better transparency therefore higher legitimacy on the market and 2) having higher biodiversity contribution as ICMA has project type-focus while CBI has a sector-focus, therefore reach more investors with different interests that leads to higher investor's attraction, consecutively, leads to better performance. This align with Pham and Huynh (2020) who find an interdependence between green bond performance and investors' attention.

The remainder of this paper is organized as follows. First, I present the literature review by dividing it into theoretical evidence (Section 2.1) and empirical evidence (Section 2.2). I next present the hypotheses development (Section 3). Then, I delve deeper into the empirical strategy (Section 4). Finally, I present the result discussion and implication (Section 5) and present the conclusion (Section 6).

2. Literature Review

2.1. Theoretical Evidence

2.1.1. Biodiversity Finance Landscape

This paper defines biodiversity as in the Convention on Biological Diversity (CBD) lenses as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.[1]

Biodiversity protection is severely underinvested (Seidl et al., 2020; Deutz et al., 2020; UNEP et al., 2021). Even though the current biodiversity investment estimation (Seidl et al., 2020) shows a steady increase of global public biodiversity investment to an average of US$121 billion or 0.19–0.25% of global GDP invested annually from 2008–2017, UNEP et al. (2022) and Deutz et al. (2020) underlines the need to scale up annual biodiversity investment by an additional $165 billion and US$ 824 billion per year, respectively. These funding gap highlight the importance of private sector contributions, presenting a big loophole for private sector to fill.

Philanthropic donation takes up the majority of funding for conservation (Bos et al., 2015, Flammer et al., 2023), yet still, these financing are critically insufficient. This study focuses on the debt-financing, specifically bonds for biodiversity which have been used for conservation purposes in recent years (Thompson, 2023; Jeffries et al., 2019; Löfqvist & Ghazoul, 2019; Madeira & Gartner, 2018). The issuance of green bonds, specifically, could be one of the main tools in bridging the funding gap for biodiversity conservation.

Understanding multifaceted dimension of financial market participants for biodiversity and nature-positive investment, biodiversity investment may simultaneously provide co-benefits for nature, biodiversity, climate and human well-being. Having identified the co-benefits of nature positive investment and the processes through which to engage multi-disciplinary teams is one of the important actions to scale up nature positive implementation (Raymond et al., 2017). The scale up

[1] Article 2 of the Convention on Biological Diversity

factor materialize through expanding interventions and demonstrating the contribution to broader and multiple impact and policy objectives (Geneletti and Zardo, 2016).

As this study is built around signaling rationale, assessing the co-benefits of the nature positive investment (Connop et al., 2016) and stakeholder co-creation and design of the nature positive investment (Collier et al., 2016) are ways of overcoming barriers of negative stakeholder perception around nature-positive investment, including biodiversity projects. This approach is essential because promoting co-benefits necessitates ensuring that the challenges to be socially understandable and acceptable to a diverse range of stakeholders (Maes and Jacobs, 2017).

2.1.2. Green bond: bridging finance and biodiversity conservation

The majority of conservation funding comes from non-return-seeking philanthropic donations (Bos et al., 2015); yet still highlighting the underinvestment of biodiversity protection (Seidl et al., 2020; Deutz et al., 2020; UNEP et al., 2021). Investors are only likely to fund biodiversity conservation that can provide a financial return alongside a positive social and (biodiversity) environmental impact (also known as 'for-profit conservation') (Dempsey & Bigger, 2019, Flammer et al., 2023). In the light of this, a comparatively new financial yet booming tool used in the debt capital market, has been explored further: green bonds. Green bonds are any form of bond instrument whose proceeds will be used solely to fund or re-finance new and/or current qualified green projects (ICMA, 2022), including biodiversity conservation. As the use of proceeds for green bond is directly linked to specific green projects –project that contribute to environmental objectives, it can be used to scale-up the necessary financing needed for biodiversity conservation alongside a financial return. Importantly, green bond is also a familiar and proven mechanism for private sector finance; which is the key to scale up the financing for biodiversity (Suisse and McKinsey, 2016).

The use of bonds for biodiversity is significant because biodiversity conservation—whether through habitat and species protection, restoration, or sustainable management—is severely underfunded (McCarthy et al., 2012). Green bond has the capacity to mobilize big capital for large scale projects, such as the extensive use for infrastructure projects (Tolliver et al., 2020). Indeed,

achieving global conservation goals requires around six-fold (Deutz et al., 2020) to ten-fold increase in conservation finance (McCarthy et al., 2012). The return for green bonds could be generated from attaining premium price for sustainably produced goods such as wood, rubber and other commodities, or by offering ecosystem services (e.g. carbon credits generation from reducing emission from deforestation and forest degradation (REDD) projects, or the newly developed biodiversity credits from protected species). A rather unique mechanism, such as Green Bond for Working Forest that generate revenue from securing a permanent conservation easement –legally binding contractual agreement that forest will be conserved in perpetuity, while building plan to produce sustainable timber plan (Thompson, 2023). Therefore, this, demonstrates that different business model could be generated for green bond mechanism.

Delve deeper into the buy-side, Cooper & Trémolet (2019) find that projects to improve biodiversity protection were rated among the most popular in a poll of 58 sustainable investors. Conservation finance shortfall is increasingly advocating finance from the private sector (Credit Suisse and McKinsey, 2016, Deutz et al., 2020., Seidl et al., 2020). As previous evidence on funding gap highlights the importance of private sector contributions, I analyze further corporate green bond.

Green bonds have piqued the interest of academic scholars in recent years, as the growing widespread use this financing instrument. Research have touched upon different aspects of green bond. In regard to green bond performance, Flammer (2021) shows that cost of capital argument does not hold for corporate green bonds –no pricing difference to the identical brown bonds by the same issuer. However, she highlighted that companies improve their environmental performance following the green bond issuance. Consistently, Yongjun Tang and Zhang (2020) discover no evidence of a significant premium for green bonds, therefore proving that the positive stock returns around the issuance announcements are not fully driven by the cost of capital rationale.

A study by du Pont et al. (2015) was one of the first to analyze green bond's use of proceeds for sustainable land use and conservation projects. They found that green bonds do not offer a better cost of capital, as only 1% of total green bond issuance have been allocated to the land conservation projects (duPont et al., 2015). This lack of scalability of green bond for conservation project did

not yet allow borrowers to access capital at a lower cost. On the other hand, a more recent evidence of green bond determinants to its performance, Russo et al. (2021) found that certain project categories, such as avoid and pollution control, eco-efficient products and technologies, sustainable management of natural resources and water management, and terrestrial and aquatic biodiversity conservation are linked to higher green bond performance. This, shows the growing scalability of the green bonds and investors are starting to price the green bond determinants. These project categories are found to have a direct positive impact, whether directly on reducing firm's cost such as pollution prevention and eco-efficient products, or have mainly reputational effects such as biodiversity, natural resources, and water management project, which goes beyond the firm dimension. This simply means that these project categories involve broader environmental concerns that go beyond the immediate operations of a single firm and rather solve larger ecosystem-level issues and have wider societal impacts. As a result, the direct financial benefits to the issuer may be less significant compared to projects focused on internal efficiency or pollution control, which directly affect the firm's costs. This is consistent with Dailami & Hauswald (2003) proving that features of a project (e.g., asset specificity and types of activity financed) do influence the performance of green bond. Based on this empirical evidence, it is reasonable to assume that there is a link between project categories to the green bond performance

Taking a closer look at the market perspective, the use of proceed is seen as key determinant of green bond signaling. Since the market is currently not equipped with green bond disclosure regulation (European Commission, 2023), a more granular use of proceed, such as those explicitly specified for biodiversity purposes, can serve as a stronger signal to investors. Therefore, investors pay more attention to the specific use of proceed. **I further analyze the use of proceeds for biodiversity objective as the determinants of green bond performance.**

In Thompson's (2023) study, the findings reveal that investors exhibit a strong interest in biodiversity bonds, as evidenced by their oversubscription in all cases. Consistently, Cooper & Trémolet (2019) shows investors' high interest in impact investments in biodiversity conservation. This, might not be driven by the appetite for biodiversity purpose, rather for the oversubscribed bond –bonds with higher attention, therefore higher signaling effect. This is consistent with Pham and Huynh (2020) on the interdependence between green bond performance and investor attention.

In the case when a new issued green bond with biodiversity objective is oversubscribed, underwriters or other financial entities offering the bond can adjust the price upward, therefore investors would invest in bond with higher price that leads to higher premium.

Looking deeper into the signaling rationale, the issuance of green bond also serves as a credible signal of the company's environmental commitment. By issuing green bonds, companies commit substantial money and managerial efforts to green projects. The average size of green bonds is higher than other bond types (Flammer, 2021). Furthermore, additional managerial efforts often centralized in its effort to pursue external opinion, such as second party opinion (SPO) and green bond certification. The role of external opinion is to verify that the bond's proceeds are truly used to finance the eligible green projects (according to compliance body) outlined in the bond prospectus. External opinion and compliance with the green bond standards—such as ICMA's Green Bond Principle (GBP) and Climate Bond Initiative (CBI)'s Climate Bond Standard— not only requires further managerial efforts from additional administrative and compliance burden, but also its resources as it is costlier to issue. Additionally, non-compliance with green bond certification, known as "green default", can also be very expensive.

As Investors often lack sufficient information in regard to company's environmental commitment (e.g., Lyon and Maxwell, 2011; Lyon and Montgomery, 2015), external opinion acts as a tool for investor to credibly distinguish environmental signal versus those that are not verified by external opinion. This plays an even bigger role as there is a growing concern for greenwashing –deceptive practice and misleading claims about the company's environmental commitment which is a prevalent practice in the growing importance of sustainability practice (e.g., Lyon and Montgomery, 2015). Greenwashing could materialize in many ways, including misleading narratives and imagery, and eco-labels (Lyon and Montgomery, 2015). In the case of green bond, companies may use selective proceed disclosure, and to the extent, the proceeds are not used to finance biodiversity objective projects described in the bond prospectus. There is also a growing concern whether green bonds actually make any real difference. The more prevalent greenwashing practices roots in the lack of public governance of green bonds. As a result, investor relies on private governance mechanism such as SPO and certification to ensure the proceeds are used to finance the pre-determined projects. Even though these private governance mechanism does not

impose the same power as the public mechanism, they currently provide investors with a means to distinguish a more credible and greenwashing practices.

While it is possible to not seek external opinions, it is important to recognize that external opinion plays an instrumental role in the market's perspective in how they perceive the issuance of green bonds. Flammer (2021) proves that investors react positively to the issuance announcement for bonds certified by third parties. Simeth (2022) also shows that external reviews serve as an effective means of signaling while highlighting SPO being the most effective signaling of credibility and quality of green bond's greenness information. Both, inferring a more credible commitment of issuer's environmental commitment.

Based on all this evidence related to the disclosure of the green bonds, the issuance of second party opinions and certification are considered as factors improving the disclosure and transparency of green bonds as it requires substantial efforts and resources, therefore signaling the overall biodiversity commitment, consecutively, having a positive impact on the performance of green bond with biodiversity-objective. Li et al., (2020) green bonds with green certificates have lower interest costs than those without them. Its function is comparable, to some extent, to conventional rating agencies. Consistently, Russo (2020) finds that the presence of SPO affect green bond performance positively. To gain a more comprehensive understanding of the governance mechanisms surrounding the utilization of green bond proceeds, I further explore external opinions. These external opinions are a catalyst in ensuring the credibility of the use of proceeds and promoting scalability, particularly in relation to biodiversity conservation.

2.2. Empirical Evidence

I conducted a preliminary analysis of 1000 urban nature positive projects in Europe.[2] One of the fast-emerging concepts used in introducing nature and biodiversity enhancement into urban areas while addressing the climate change issue, is Nature-Based Solutions. NBS beyond traditional conservation biology and ecosystem management (Cohen Shacham et al., 2016). NBS not only

[2] Data Gathered by Utrecht University and the consortium of NATURVATION under a Horizon 2020 graph (data partly available: https://naturvation.eu/.)

focuses on how nature and ecosystem service (ES) can be beneficial to the society but also on how they can respond to several acute challenges, such as climate change and biodiversity (Eggermont et al., 2015).

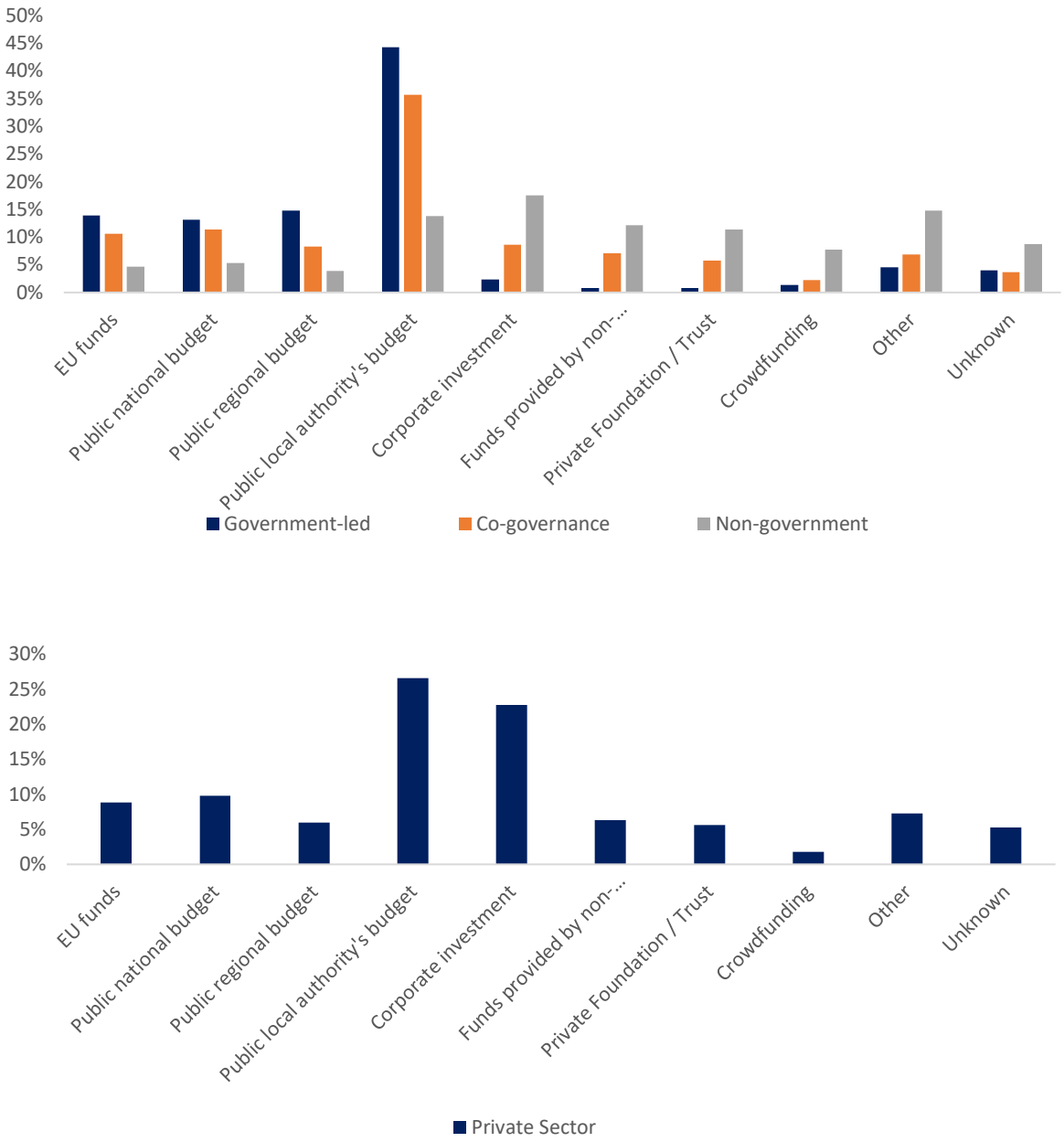
In this preliminary analysis, I focus on the financing aspect of investment in nature by analyzing the source of financing and the financing instrument. I use descriptive statistics to understand the landscape of financing Urban NBS.

I first, found that nature-positive projects in urban areas have a highly dependency on public budget, subsidies, and donations as shown in **Graph 2** (Appendix). This is consistent with Bos et al. (2015) who states that the majority of conservation funding comes from non-return-seeking philanthropic donations (Bos et al., 2015). These mechanisms are not a sustainable long-term mechanism, as Dempsey & Bigger (2019) show that investors are only likely to fund 'for-profit conservation'. Thus, highlight that the key to scale up is to develop a financing mechanism beyond philanthropic and non-profit mechanism.

Interestingly, I also found that green bond has never been used to finance nature-positive project in urban areas. Green bond is the suitable instrument for profit conservation mechanism as the success has been proven (Thompson, 2022), while at the same time, McCarthy et al. (2012) shows that the use of green bonds is still severely underfunded. This shows the opportunity to scale up financing for conservation through the use of green bond.

I further found that urban nature positive projects developed by non-government significantly financed by corporate investment shown in **Graph 1**. This finding shows an opportunity to scale up financing biodiversity from the private sectors. Conservation finance shortfall is increasingly advocating finance from the private sector (Credit Suisse and McKinsey, 2016). Combining the reasons and the opportunity from private sector, this assure my research area analyzing corporate green bond further.

Graph 1. Governance and financing source of urban nature positive projects



Reasonably, as shown in **Graph 3** (Appendix), I also found that external building greens and green indoor areas are higher for non-government governance projects as this would be directly related to corporate's investment. The reason that corporate investment focuses on external building green and green indoor areas could be explain from the signaling rationale. These types of projects could directly increase firm's green reputation. Other reasoning would be that the project directly increases the firm's intangibles, such as employee's satisfaction and well-being. This intangible could be materialized from two reasons: 1) employee's perspective of knowing they work for

'greener' firm; or 2) solely due to a greener working environment, therefore a healthier environment. Consistent with Almassy and Maia (2022)[3] proving that corporate investment seems to focus more on projects that involve climate action simultaneously with economic development. This is aligned with my signaling argument, which I analyze further in this study through the biodiversity use of proceeds.

[3] https://una.city/sites/default/files/Analysis%20report_27Oct.pdf

3. Hypothesis Development

Green bonds have been used over the years to finance biodiversity conservation. I analyze the use of proceeds for biodiversity objective as the determinants of green bond performance. The use of proceed –specifically for biodiversity-purpose, is seen as key determinant of green bond signaling. Since the market is currently not equipped with green bond disclosure regulation, a more granular use of proceed, such as those designated for biodiversity purposes, can serve as a stronger signal to investors. This is consistent with Pham and Huynh (2020) who find interdependence between green bond performance and investor attention. Therefore, investors pay more attention to the specific use of proceed.

Thompson (2023) analyzes impact investing through five bonds with biodiversity impact and shows that Investors have good appetite for biodiversity bond where all bonds were oversubscribed. Consistently, Cooper & Trémolet (2019) shows investors' high interest in impact investments in biodiversity conservation. This, might not be driven by the appetite for biodiversity purpose, rather for the oversubscribed bond –bonds with higher investors' attention, therefore higher signaling effect as investor acknowledges more the existence of biodiversity bonds. Due to this higher investors' attention, green bond performance increases. In the case when a new issued green bond with biodiversity objective is oversubscribed, issuers or other financial entities offering the bond can adjust the price upward, therefore investors would invest in bond with higher price that leads to higher premium. This is consistent with Pham and Huynh (2020) on the correlation of green bond performance and investor attention.

In this respect, Russo et al. (2020) also found that the project categories –activity financed are linked to higher green bond performance. This correlation materialized through either directly on reducing firm's cost, or have mainly reputational effects. This is consistent with Dailami & Hauswald (2003) proving that features of a project (e.g. types of activity financed) do influence the performance of green bond. In the case of biodiversity conservation, the reputational effect goes beyond the firm dimension, therefore having a higher signaling effect of company's commitment towards the environment. Based on this evidence, it is reasonable to assume that there is a link between biodiversity objective green bond to its performance. Therefore, I hypothesize:

H1: Green bond with biodiversity-objective project categories has higher yield

H1a: Green bond with *declared* biodiversity objectives has higher yield

I acknowledge that most of green bonds with biodiversity objective has multiple project categories, therefore having multiple benefits (co-benefits) and higher impact to biodiversity. To begin with, understanding that different typology of investors has different preference, green bond with multiple project categories and value added of nature is very subjective to the one that invest. This relates to investors perspective, having identified the co-benefits of nature positive investment and the processes through which to engage multi-disciplinary teams is one of the important actions to scale up nature positive implementation (Raymond et al., 2017) and overcoming negative stakeholder perception around biodiversity project (Connop et al., 2016).

Since there are multiple benefits that can't be comprised by only one stakeholder and with only one nature solutions, having multiple benefits signals different typology of investors. By knowing what the benefits and the use of proceeds for the green bond are that has multifaceted approach, green bond with biodiversity objective is able to signal different type of stakeholders with different interest about the multiple benefits the bond has, therefore attracting different typology investors according to benefit and impact they are interested in. This would lead to better matching of the value of nature and the monetary value of the investors, *e.g., green bond with three project category contributions: terrestrial biodiversity conservation, aquatic biodiversity conservation and sustainable water and wastewater management is able to attract investors with terrestrial conservation focus and investors with multiple benefit interest of aquatic biodiversity conservation and water and wastewater management.* Consistent with Raymond et al. (2017) proving that a crucial step in scale up nature positive investment involves engaging multi-disciplinary stakeholders, including different typology of investors. Therefore, more investors are reached, and investors perceive the multiple categories green bond as having higher contribution to different biodiversity projects and at same time, has higher impact, therefore, perform better. Given the presence of above literature, I hypothesize:

H1b: Green bond *with multiple categories (co-benefit)* for biodiversity objectives has higher yield

H1c: Green bond with *higher impact level to* biodiversity objectives has higher yield

I further analyze green bond with biodiversity objective through the signaling rationale. This means, by issuing green bond, companies signal a commitment towards the biodiversity objective projects. This will be investigated through issuer's characteristics, namely, (a) *the presence of external green bond certification*; (b) *the presence of a second opinion*; lastly, (c) *compliance body choices*.

The first determinant of my signaling rationale relates to the presence of external green bond certification. Flammer (2021) proves that investors react positively to the issuance announcement for bonds certified by third parties. Consistently, Li et al., (2020) green bonds with green certificates have lower interest costs than those without them. Pursuing green bond certification not only requires additional managerial efforts from administrative and compliance burden, but also its resources as it is costlier to issue. Additionally, non-compliance with green bond certification, known as "green default", can also be very expensive. As an example, controversies around €500 M green bond of Spanish oil company was deemed green default. On the same day, the stock price dropped by 1%, bond excluded from bond indices and major reputational damage for green default and green washing practices.

Due to information asymmetry (Lyon and Maxwell, 2011; Lyon and Montgomery, 2015), gaining comprehensive insight into the use of proceeds of bond issuance is a challenging task for bond investors without due diligence process. While acknowledge that green bond certificate does not provide continuous monitoring services, this eventually acts as the first step to provide greater granularity. The certificate helps investors identify climate-oriented investments and alleviate information asymmetry in the market, therefore providing better transparency –while acts as a crucial tool to gain investors trust for scaling up biodiversity investment, consecutively leads to better performance of green bond. This reasoning is captured in my second hypothesis:

H2: Green bond with biodiversity-objective's transparency orientation affects its performance

H2a: The presence of *external green bond certification* has a positive effect on the performance of the green bond.

The second determinant of my signaling rationale is the presence of a second opinion. Second-opinion providers offer evaluations that are independent, comprehensive and of superior quality with regards to the green bond's sustainability profile. Simeth (2022) shows that external reviews serve as an effective means of signaling while highlighting SPO being the most effective signaling of credibility and quality of green bond's greenness information. Its function is comparable, to some extent, to conventional rating agencies.

Based on the above evidence, it is reasonable to assume that the presence of SPO is considered as factors improving the transparency of green bonds and bond issuers, therefore, having a positive effect on green bond performance. Consistently, Russo et al. (2020) finds that the presence of SPO affect green bond performance positively. From the signaling perspective, by seeking SPO that acts as governance mechanism, this creates more credible and stronger signaling of company's commitment towards biodiversity enhancement as it requires substantial efforts and resources. This, once again, consistent with Pham and Huynh (2020) who find that investors' attention influence green bond performance. Therefore, investors pay more attention to the specific use of proceed. Therefore, I hypothesize:

H2b: The presence of a *SPO* on biodiversity-objective green bond enforcing the green effectiveness of the bond has a positive effect on the performance of the green bond.

This study is the first to fill the gap in the literature of green bond reporting by analyzing the external governance body and investigates its effect to green bond performance. The factor investigated in this hypothesis is the number compliance bodies the green bond follows. Two main compliance bodies are generally accepted in the green bond market: The Climate Bond Initiative (CBI) and ICMA. The former has taxonomy with sector-focused while the latter focuses on the green project categories. However, a growing number of different standards are seen in the past years in their aim to create a more standardized governing mechanism for green bond.

I analyze recent trend and found that more green bonds are issued following several compliance bodies. It is reasonable to assume that the reason these bonds followed more than one compliance body is that so they could reach more investors, therefore having stronger signaling effect. In the case of CBI, when one follows the compliance body, the bond will appear in the registry system

of the website, therefore, receiving higher investors' attention, consecutively, perform better. This also align with Pham and Huynh (2020) find that higher investor attention leads to better green bond performance.

I also acknowledge the possibility that green bond follows more than one compliance body because following only one compliance body does not capture the rest of the use of proceed as ICMA is project type focus while CBI is sector focus. The combination of different compliance bodies can potentially fill a gap, but it may also serve merely as a means of signaling. The more compliance bodies the bond uses, the more they signal that they are contributing on certain project type (in the case of ICMA, such as biodiversity or natural capital focus) and sectors (in the case of CBI, such as forestry). In its direct relation to green bond with biodiversity objective, they need to follow ICMA as biodiversity conservation is specified as one of the project types, while CBI can't capture this impact. Furthermore, biodiversity projects have reputational impact (Russo et al., 2021). Investors perceive this as having higher contribution and better transparency, therefore, perform better. Therefore, given the presence of above literature, I hypothesize:

H2c: Bond issued *with several compliance body* has higher transparency and reaches more investors therefore has a positive effect on the performance of biodiversity-objective green bond.

4. Empirical Strategy

4.1. Sample and Analysis

A sample collection of corporate green bonds was obtained from the Refinitiv Eikon database for the period between 2008 and 2023. Refinitiv provides data in-depth characteristics of the green bond issues, including the fundamentals on the project type of the bonds in the sample. The start of the period is chosen as the first biodiversity objective bond issued. Given the nature of this research, the original sample was screened in a series of steps: the first involved removing all non-corporate issuers, reducing the sample from 258 to 189 data. The rejection of non-corporate issuances also contributes to disappearance of certain time frame, such as 2008, 2010, 2011, and 2013. Finally, 106 green bonds were discarded due to unavailability of data for the variables needed either on the bond characteristics or the company characteristics.

Since a substantial proportion of the sample consist of private companies, missing data on key company characteristics is expected. Interestingly, the elimination of data is escalated by bond characteristic data, specifically by bond rating. In East Asia, particularly in China, most bonds are accompanied by ratings from local agencies (such as Dagong, China Chengxin, Chingyuan Long-term Issue Credit Rating, and many others) instead of the major global rating agencies such as S&P, Moody's, and Fitch (the Big Three Agencies). The diversity of rating agencies in the East Asian market makes it challenging to find equivalent conversions between them. Currently, there is limited literature supporting the conversion of ratings from local agencies to those of S&P, Moody's, or Fitch. As a result of this elimination process, my end sample consists of 83 issuance observations between 2014 and 2023.

Refinitiv Eikon collects data on the transparency orientation, as well as comprehensive information on both bond characteristics and issuer characteristics for control variables. Specifically, Green bond certification and SPO data are obtained from a combination of Refinitiv and CBI database, while Compliance bodies retrieved solely from Refinitiv.

Table 1. Summary statistics

Variable		**n**	
Aquatic biodiversity conservation		21	
Terrestrial biodiversity conservation		16	
Eco-efficient product		58	
Sustainable management of living natural resource		13	
Sustainable management of land use		15	
Sustainable water and wastewater management		47	
Total[4]		83	
Variable	**Mean**	**Min**	**Max**
Multiple categories	2.048	1	5
Impact level	4.180	1	14
Second party opinion	0.638	0	1
Certified bond	0.108	0	1
Compliance bodies	1.663	1	3
Bond rating	4.482	3	7
Coupon	3.127	0	12
Collateral	0.048	0	1
Maturity	8.132	2	60
DER	2.213	0.213	39.79
Firm size	24.08	17.35	30.25

It is important to understand how my data approach differs from previous research. While Russo et al. (2021) assigned one specific project category on each bond e.g., strictly only Renewable Energy for a bond issued, I acknowledge that most of the green bond issued have contributions to several project categories e.g. green bond issued by CaixaBank in 2021 contributes to three categories of Aquatic biodiversity, Terrestrial biodiversity and Sustainable water and wastewater management. I acknowledge the possibility of utilizing different database provider might result in

[4] As one bond might contribute to several project categories at the same time, the cumulative of the project categories will not result in the same sample. In total, the end sample consist of 83 green bond.

different data conclusion as Refinitiv is not able to conclude one specific project category on each bond. However, this is also reflected by green bond's SPO report and prospectus that bond has more than one contribution. This is reasonable by looking at the capital market participants perspective, contributing to more categories would serve as a stronger signal to investors with different objectives, therefore receiving higher investors' attention. Therefore, one cannot assign one specific project type for one green bond.

The summary of the green bond characteristics in this study is provided in **Table 1**. Most green bond proceeds are contributing to eco-efficient products (58) and sustainable water and wastewater management comes close in second (47). While the remaining biodiversity categories are significantly smaller as none goes above 17, aquatic biodiversity conservation is higher (21) considering it highly correlates with sustainable water and wastewater management. The highest multiple categories and impact contribution is up to 5 project categories and impact is 14 level, respectively. For the bond characteristics, the average coupon rate is 3.127% and have been assigned investment-grade bond ratings of 4.482. However, since the average assigned rating is four, which categorized within the BBB– to BBB+ (equivalent of Baa3 to Baa1 for Moody's), it is close to the start of non-investment (speculative) bond rating. Lastly, green bonds exhibit a long time-to-maturity, with some bonds having a maturity of up to 60 years. I acknowledge that this long maturity might be the challenge as cross-sectional analysis is used in this study, therefore explained in detail in the Limitation chapter.

4.2. Data and Variables

4.2.1. Dependent variable: Green bond performance

Green bond performance is obtained from Refinitiv Eikon, measured as the expected long-term green bond yield-to-maturity (YTM). YTM represents how much an investor will receive if the bond is held until maturity (Brigham & Ehrhardt, 2005; Fabotzi, 2005). This is calculated as the long-term green bond rate. The dependent variable is a continuous variable representing the long-term yield to maturity of green bond with biodiversity objective in the sample. I mainly follow Russo et al. (2021), while understanding that recent green bond literature suggests that long-term bond yields are an increasingly important performance indicator (Bag, 2020; Gruber & Kamin,

2012). Furthermore, as Gruber and Kamin (2012) suggest, the long-term yield-to-maturity prediction can be enhanced by fully utilizing the existence of bond characteristics. This is also consistent Dailami & Hauswald (2003) proving that features of a project (e.g., asset specificity and types of activity financed) do influence the performance of green bond, which is the primary goal of this study.

4.2.2. Independent variables

4.2.2.1. Biodiversity-objective green bond

There are two main standards are generally accepted in the green bond market: CBI and ICMA. The former has taxonomy with sector-focused while the latter focuses on the green project categories. I further will delve deeper into the ICMA's use of proceeds as a tool to differentiate the biodiversity purpose as my main variables in this research.

Table 2 maps the contribution of Green Project categories to the Green Bond Principles' environmental objectives based on their most commonly observed contributions. The GBP mapping also highlighting different contribution of each project to the biodiversity as having primary, secondary, and tertiary impact. Primary impact is defined as the most immediate impacts on biodiversity, down to indirect impacts for tertiary. My interest lies in biodiversity objective project categories to understand the landscape of project types with biodiversity benefits. Four project categories are explored: 1) terrestrial and aquatic biodiversity conservation (primary); 2) sustainable management of living natural resource and land use (primary); 3) sustainable water and waste water management (secondary); 4) and eco-efficient and circular economy adapted products, production technology and processes (tertiary). In this research, the first two categories are split into four categories: terrestrial biodiversity conservation, aquatic biodiversity conservation, sustainable management of living natural resource, and sustainable management of land use. This result in total of six project categorizations, benefitting us to analyze to a deeper extent.

Table 2. Mapping of the GBP-project categories to GBP-environmental objectives

GBP – Environmental Objectives		
GBP-project categories	**Biodiversity**	**Natural resource conservation**
Renewable Energy		Tertiary
Energy Efficiency		
Pollution prevention and control projects		Tertiary
Sustainable management of living natural resource and land use	Primary	Primary
Terrestrial and aquatic biodiversity	Primary	Primary
Clean transportation		Tertiary
Sustainable water and waste water management	Secondary	Secondary
Climate change adaptation projects		
Eco-efficient and/or circular economy adapted products, production technologies and processes	Tertiary	Primary
Green buildings		

My analysis goes further in details to understand how the project categories contribute to the biodiversity purpose. Disentangling biodiversity from natural resource conservation is deemed necessary. As seen in **Table 2**, project category could have a distinct different impact on both objectives, e.g. eco-efficient and/or circular economy adapted products has a tertiary impact on biodiversity but primary impact on natural capital conservation.

Terrestrial and aquatic biodiversity conservation project includes the protection of coastal, marine and watershed environments –which clearly has a direct biodiversity impact. Environmentally sustainable management of living natural resources and land use project is addressing broader considerations for natural capital, such as waste management and energy and water usage. For instance, preventing food loss investment may be addressed through circular economy/ waste management perspective. This project includes sustainable forestry, agriculture, animal husbandry, and fishery and aquaculture.

Sustainable water and wastewater management project includes wastewater treatment, sustainable infrastructure for flood mitigation, clean and/or drinking water. Circular economy adapted products, production technologies and processes and/or certified eco-efficient products is understood to maintain the value of materials and product for as long as possible while minimizing the need for input resource. Operations with higher energy and water efficiency typically result in reduced impacts on biodiversity while decreasing the demand for land, thereby mitigating land use change and promoting the availability of land for biodiversity conservation. Eco-efficient product would also support multiple agendas of the United Nations' SDG (Griggs et al., 2013). Biodiversity criteria are being addressed in eco-certification schemes (KPMG, 2012) and can be expanded as ecosystem services certification (Jaung et al., 2019). In understanding its different impact to biodiversity and natural capital, evaluating these criteria is challenging as it is difficult to separate the impact on biodiversity from other indicators (e.g. water conservation, soil management, use of pesticides). These eco-certifications schemes covering natural resource directly, however still limited for biodiversity aspect.

This research is the first to analyze the multiple categories and impact level each bond has. I developed the two variables by realizing two trends: 1) Most green bond contributes to several project categories at the same time as mentioned in the previous sub-chapter; 2) Each project category impacts biodiversity differently. I therefore differentiate each impact in this study.

4.2.2.2. Transparency orientation

The second determinants for biodiversity objective green bond performance focus on the transparency orientation of the issuer. Three main variables were computed, namely, (a) the presence of external green bond certification; (b) the presence of a SPO; lastly, (c) compliance body choices.

Green bond certification is a dummy variable with the value of one if the issuer has obtained a green bond certificate. The certificate helps investors identify climate-oriented investments and alleviate information asymmetry in the market, therefore providing better transparency. Second opinion is also a dummy variable taking the value of one if issuer obtained an SPO that are

independent, comprehensive and of superior quality with regards to the green bond's sustainability profile. Lastly, compliance body is a numerical variable following the number of compliance bodies the bond follows. The number ranges from one to as many as three, with one and two as the majority of data distribution. The more compliance bodies the bond uses, the more they signal their contribution on certain green objectives. A detailed description of the operationalization of the variables included in the above equations is presented in **Table 3**.

4.2.3. Control variables

The control variables in this study follows the recent green bond literature that analyzes long-term bond yields as the dependent variables (Russo et al., 2021; Bag, 2020; Gruber & Kamin, 2012). This data is obtained from Refinitiv Eikon. The variables were divided into two classes. I look closer into the company-specific factors such as leverage (*DER*) and size (*SIZE*). I also analyze variables referring to bond characteristics factors, such as bond ratings (*Bond Rating*), coupons (*Coupon*), collateral (*Collateral*), and maturity (*Maturity*). My control variable slightly differ from previous research as this study does not explore the country dimension and Refinitiv limitation of not being able to detect what country hosting the project financed (location where use of proceed is allocated) through the green bond. Therefore, geographical effect is not analyzed in this study. The extensive descriptions of the control variable are explained in **Table 3**.

Table 3. Definitions of variables.

Variable	**Definition**
Dependent variable	
Green bond performance	Continuous variable representing the long-term yield-to-maturity for each green bond issuance
Predictors: Project categories	
Aquatic biodiversity conservation	Dummy variable coded "1" if the bond is aquatic biodiversity conservation
Terrestrial biodiversity conservation	Dummy variable coded "1" if the bond is terrestrial biodiversity conservation
Eco-efficient product	Dummy variable coded "1" if the bond is eco-efficient product
Sustainable management of living natural resource	Dummy variable coded "1" if the bond is sustainable management of living natural resource

Variable	Definition
Sustainable management of land use	Dummy variable coded "1" if the bond is sustainable management of land use
Sustainable water and wastewater management	Dummy variable coded "1" if the bond is sustainable water and wastewater management
Multiple categories	Total category of the bond ranges from 1 to 6. If the bond only contributes to only 1 project category, e.g. aquatic biodiversity, "1" is assigned. "3" is assigned if bond contribute directly to three categories, e.g. aquatic biodiversity, terrestrial biodiversity and eco-efficient. 1 to 6 is not a scale, rather a way to cluster. 6 does not necessarily imply that it has better impact than 2.
Impact level	Total impact of green bond as different project category impacts biodiversity differently. "1" to project category that has tertiary impact, "2" to secondary impact, and "3" to primary impact towards biodiversity. Higher level implies better impact.
Predictors: Transparency orientation	
Second party opinion	Dummy variable "1" if bond with biodiversity objective has an SPO
Certified bond	Dummy variable "1" if bond with biodiversity objective is certified
Compliance bodies	Number of compliance bodies the bond follows
Control variables: Bond characteristics	
Bond rating	S&P, Moody's or Fitch credit rating assigned to the single bond. The numeric values of bonds' rating categories (i.e., AAA = 7, AA = 6, etc.).
Coupon	Periodic interest payment received by bondholder between the issuance of the bond and its maturity
Collateral	Dummy variable coded "1" if the bond has a collateral
Maturity	The maturity of a bond in years.
Control variables: Issuer characteristics	
DER	Debt to equity ratio calculated as total liabilities divided by total shareholders' equity to measures the company's financial leverage
Firm size	The logarithm of issuer's total asset, as a proxy for the size of the firm

4.3. Data Analysis

To study the research question, I estimate a cross-sectional generalized least squares (GLS) regression on the data to identify the impact of biodiversity use of proceed and transparency orientation to the green bond performances. Based on the heteroskedasticity test using Breusch-Pagan / Cook-Weisberg test, I found that heteroskedasticity is present in my regression. Therefore,

I use generalized least squares (GLS) to control for heteroskedasticity. GLS requires specifying a covariance structure for the errors, such as heteroscedasticity-corrected structures in this case, and offers a flexible approach to handle violations of the assumptions of constant error variance and independence of errors in linear regression. I also tested for multicollinearity and normality, and both tests revealed that multicollinearity and normality was not a problem. The exception applies to Model 2.3 (Equation 6) as heteroskedasticity is not present, therefore ordinary least squares (OLS) is used.

The cross-sectional analysis allows us to estimate the relationship between green bond performance measured by the long-term yield-to-maturity and my predictors of projects' typologies. The methodology used becomes one of the limitations in this study due to data availability and time constraint. Here my expectation is that in line with hypothesis 1, I will examine that green bond with biodiversity objective has higher yield. A main equation testing hypothesis 1 is presented in Equation 1.1.

$$Green\ bond\ performance_i = \alpha + \beta_1 Aquatic\ biodiversity\ conservation_i + \beta_2\ Terrestrial\ biodiversity\ conservation_i + \beta_3\ Eco-efficient\ product_i + \beta_4\ Sust\ mgmt\ of\ living\ natural\ resource_i + \beta_5\ Sust\ mgmt\ of\ land\ use_i + \beta_6\ Sust\ water\ and\ wastewater\ management_i + \beta_7\ Bond\ rating_i + \beta_8\ Coupon_i + \beta_9\ Collateral_i + \beta_{10}\ Maturity_i + \beta_{11}\ DER_i + \beta_{12}\ Firm\ size_i + \varepsilon_i. \quad (1.1)$$

Additional analysis of the first hypothesis is developed, I further analyze the impact of bond issued with multiple project categories. Multiple categories of the bond ranges from 1 to 6. If the bond only contributes to only 1 project category, e.g. aquatic biodiversity, "1" is assigned. "3" is assigned if bond contribute directly to three categories, e.g. aquatic biodiversity, terrestrial biodiversity and eco-efficient. this, rather a way to cluster. "3" does not necessarily imply that it has better impact than "1". My expectation is that green bond with multiple project categories for biodiversity objective has higher yield. The equation to test this additional analysis is presented in Equation 1.2.

$$Green\ bond\ performance_i = \alpha + \beta_1\ Multiple\ categories_i + \beta_2\ Bond\ rating_i + \beta_3\ Coupon_i + \beta_4\ Collateral_i + \beta_5\ Maturity_i + \beta_6\ DER_i + \beta_7\ Firm\ size_i + \varepsilon_i. \quad (1.2)$$

Additionally, each project category impacts biodiversity differently as shown in **Table 2**. I therefore differentiate each impact in this study. "1" is assigned to project category that has tertiary impact, "2" to secondary impact, and "3" to primary impact towards biodiversity. Higher level implies better impact. Therefore, my expectation is that green bond with higher impact for biodiversity objective has higher yield. The equation to test this additional analysis is presented in Equation 1.3.

$$Green\ bond\ performance_i = \alpha + \beta_1\ Biodiversity\ Impact_i + \beta_2\ Bond\ rating_i + \beta_3\ Coupon_i + \beta_4\ Collateral_i + \beta_5\ Maturity_i + \beta_6\ DER_i + \beta_7\ Firm\ size_i + \varepsilon_i. \quad (1.3)$$

Lastly, the same reasoning has been applied regarding the second set of hypotheses, where bond's transparency orientation affects the green bond performance. Here my expectation is that in line with the set of hypotheses 3, three different main equations testing of green presence of external green bond certification, the presence of a second opinion, and bond issued with multiple compliance body has higher transparency, and thus have a positive effect on the performance of green bond are presented in Equations 2.1 to 2.3, respectively.

$$Green\ bond\ performance_i = \alpha + \beta_1 Certf.biodiversity\ bond_i + \beta_2\ Bond\ rating_i + \beta_3\ Coupon_i + \beta_4\ Collateral_i + \beta_5\ Maturity_i + \beta_6\ DER_i + \beta_7\ Firm\ size_i + \varepsilon_i. \quad (2.1)$$

$$Green\ bond\ performance_i = \alpha + \beta_1 SPO_i + \beta_2\ Bond\ rating_i + \beta_3\ Coupon_i + \beta_4\ Collateral_i + \beta_5\ Maturity_i + \beta_6\ DER_i + \beta_7\ Firm\ size_i + \varepsilon_i. \quad (2.2)$$

$$Green\ bond\ performance_i = \alpha + \beta_1 Compliance\ bodies_i + \beta_2\ Bond\ rating_i + \beta_3\ Coupon_i + \beta_4\ Collateral_i + \beta_5\ Maturity_i + \beta_6\ DER_i + \beta_7\ Firm\ size_i + \varepsilon_i. \quad (2.3)$$

A detailed description of the operationalization of the variables included in the above equations is presented in **Table 3**.

4.4. Methodological and Data Limitation

While this study provides valuable insights into the performance and determinants of green bonds with a biodiversity objective, it is important to acknowledge certain limitations inherent in the methodological and data in this study. The first and main limitation of this study pertains to the

data sample used for the analysis. The rejection of data from non-corporate issuances and missing issuers and bond characteristics information also contributes to disappearance of certain time frame and region, such as East Asia. The limited sample potentially result in unbalanced data and reducing the statistical significance of the findings. It would be beneficial to recognize the potential benefits of expanding the data sample in future research to enhance the robustness and representativeness of the findings.

A limitation of the chosen methodology based on the limited availability of data, which involves cross-sectional regression analysis, has the potential inability to adequately capture certain factors that unfold over time, such as the maturity effect and the unique characteristics of biodiversity projects that generally involve projects with long tenure and complex ecological impacts. The dynamic nature of these projects and their long-term effects on performance may require a more comprehensive approach to better understand their influence.

Lastly, Refinitiv data used in this study did not provide explicit information on the country hosting the project financed through the green bond, which represents a limitation. The inability to detect the location where the proceeds are allocated hinders a comprehensive understanding of the geographical context and potential variations in performance based on different countries' characteristics.

5. Empirical Result

Table 4. Coefficients for the independent variables

Variable	Model 1.1	Model 1.2	Model 1.3	Model 2.1	Model 2.2	Model 2.3
Aquatic biodiversity conservation	0.146					
	(0.49)					
Terrestrial biodiversity conservation	-0.194					
	(0.51)					
Eco-efficient product	-0.931**					
	(0.39)					
Sustainable management of living natural resource	-0.211					
	(0.40)					
Sustainable management of land use	0.456					
	(0.39)					
Sustainable water and wastewater management	0.450					
	(0.27)					
Multiple categories		0.240**				
		(0.10)				
Impact level			0.095**			
			(0.03)			
Certified bond				0.692*		
				(0.42)		
Second party opinion					-0.717***	
					(0.26)	
Compliance bodies						0.254
						(0.25)
Bond rating	-0.382**	-0.172	-0.208	-0.197	-0.221	-0.226
	(0. 16)	(0.15)	(0.15)	(0.15)	(0.15)	(0.16)
Coupon	0.4827***	0.456***	0.464***	0.435***	0.462***	0.435***
	(0.57)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Collateral	-0.618	0.297	0.275	0.204	-0.067	0.045
	(0.72)	(0.67)	(0.66)	(0.68)	(0.67)	(0.67)
Maturity	0.026	0.021	0.022	0.008	0.023	0.013
	(0.02)	(0.2)	(0.02)	(0.02)	(0.02)	(0.02)
DER	0.010	0.015	0.012	0.011	0.023	0.011
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Firm Size	0.023	-0.033	-0.038	-0.015	0.022	-0.005
	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)
N	83	83	83	83	83	83
Pseudo-R2						0.4590

z-statistics are reported in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 % levels, respectively.

Table 4 summarizes the result of regression models tested in this study. Model 1.1 analyzes the impact of biodiversity objective project categories to the green bond performance while controlling other determinants of green bond performance: bond rating, coupon, collateral, maturity, DER and firm size. The result reveals that project categories have different effects on bond performance. Terrestrial biodiversity conservation and sustainable management of living natural resources have a negative coefficient and are insignificant, meaning that these two projects do not positively

affecting green bond performance. Aquatic biodiversity conservation, sustainable management of land use, and sustainable water and wastewater management have positive coefficient but it is not significant. Therefore, for these five project categories with biodiversity objectives, the model does not provide enough evidence to support the predicted hypothesis. The sole remaining project category, Eco-efficient product, has a negative coefficient and significant at 5% level, interpreting that financing an eco-efficient project is associated with a 0.931 percent decrease in green bond performance. Based on these empirical result, Hypothesis 1a is rejected considering none of the project categories are positive and significant.

Further testing Hypothesis 1, model 1.2 refers to the effect of green bond with multiple biodiversity objective project categories on green bond performance. The result has a positive coefficient and is significant at 5% level, indicates that a one-point increase in green bond's multiple categories (co-benefits) increase the green bond performance by 0.24 percent. This result confirms hypothesis 1b. Furthermore, model 1.3 acts as the first step to measure the impact of green bond on its performance. The predictor yields positive coefficient and is significant at 5% level, indicating that one-point increase in its impact level towards biodiversity enhancement increases its performance by 0.095 percent. The result confirms hypothesis 1c. Important assumption to understand in this model is that bonds with higher co-benefits–which imply have multiple categories—also generally have higher impact level towards biodiversity enhancement. Considering impact level is built based on two factors of 1) the contributing multiple project category of the bond and 2) the impact of those towards biodiversity (tertiary, secondary and primary), the former is the base for Model 1.2, therefore Model 1.2 and 1.3 are highly correlates with each other.

The three models used to test the second and final hypothesis of this study aimed to understand the landscape of transparency orientation for biodiversity objective green bond. Hypothesis 2a refers to the influence of certified biodiversity objective green bond to its performance. According to the result, model 2.1 reveals that the predictor of certification is significant at 10% level and positively correlated to the green bond performance. Therefore, Hypothesis 2a is supported, indicates that if green bond issued is accompanied by certification, it increases its performance by 0.682 percent. Hypothesis 2b refers to the presence of a SPO the performance of the green bond.

The result in model 2.2 shows a significant at 1% level and yields a negative coefficient. The result rejects Hypothesis 2b, interprets that the presence of a SPO in green bond issuance decrease its performance by 0.717 percent. Lastly, model 2.3 is the first ever to analyzes the impact of compliance body choices to the green bond performance. The predictor has a positive coefficient, but insignificant. Hence, there is not enough evidence in favor of Hypothesis 2c. It is important to acknowledge that the control variables are mainly insignificant, with coupon as the only with consistency of being significant. Table 5 of correlation table in Appendix indicates this result as correlation of yield to maturity with other control variables are low. The limitation chapter in this study may shed light behind the lack of significance of control variables.

6. Discussion and Implications

6.1. Result Discussion and Future Research

This research is the first to analyze the factors driving the performance for green bond with biodiversity objective. Specifically, the study delves deeper into the signaling rationale by two key determinants: the project categories for biodiversity and the issuer's transparency orientation.

First, I analyze the determinants affecting the performance of green bond issued with biodiversity objective. The result reveals that most of project categories with biodiversity objective has insignificant effect on green bond performance. Interestingly, there appear to be a negative correlation between project financed for circular economy/ eco-efficient product and green bond performance. This shows a contradictory result in comparison to the first hypothesis. Based on this significance, I then conclude that features of a project (e.g., types of activity financed) do influence the performance of green bond (Dailami & Hauswald, 2003). This also confirms my argument that the use of proceed, specifically for biodiversity-purpose, is seen as key determinant of green bond signaling. Since the market is currently not equipped with green bond disclosure regulation, a more granular use of proceed, such as those designated and detailed for biodiversity purposes, can serve as a stronger signal to investors.

The significance for eco-efficient product project category could be explained by understanding that it is the only biodiversity objective project category that directly reducing firm's cost, while bringing additional reputational impact of greener and eco-friendly product, therefore boosting firm's green reputation. Aligned with the findings of Almassy and Maia (2022), corporate investment in nature-positive primarily emphasizes projects that combine climate action simultaneously with economic development. As eco-efficient category directly results in improving firm's economic benefit, e.g., reducing firm's cost, while simultaneously improving firm's green reputation, other categories of biodiversity objectives, such as aquatic and terrestrial biodiversity conservation, sustainable management of natural resource and land use, and sustainable water and wastewater management, which goes beyond the firm dimension, have only reputational effects on the issuer. This explains the insignificant of the other biodiversity project categories.

The negative coefficient of eco-efficient product can be attributed to two factors that influence investor perception: the rebound effect and backfire effect. The rebound effect demonstrates that increases in product eco-efficiency could have smaller than expected decrease in resource use. For example, if the project is designed to be environmentally friendly, it may contribute to increasing the demand and production, which indirectly still leads to biodiversity loss by increasing the need for land-use change and deforestation. Simply, the decrease of resource use is offset by increase in demand. To extreme extent, it demonstrates that higher eco-efficiency might not only result in a less than expected reduction of resource use but may also increase resource use, known as backfire effect. Looking across the business horizon, this negative impact could also be materialized across the supply chain process due to difficulty in tracking the activities that other parties involved in, highlighting the need for due diligence process across the supply chain. Market participants may consider such indirect effects when assessing the overall impact of the green bond. This intriguing effect might be an interesting future research to be analyzed qualitatively to understand this impact.

Furthermore, this effect is also escalated by the lack of transparency in the green bond's information on the potential biodiversity impact of the funded project. The potential impact also constitutes definition of the project. It means, if the impact is clearly defined, the definition of eco-efficient product could be interpreted by the market participants more clearly because biodiversity covers broad range of aspects. As eco-efficient term itself is generally vague and broad, the market may have different interpretations of what constitutes the project. If there is ambiguity or lack of clear definitions and standards for these projects, it can lead to skepticism and confusion among investors, which leads to negative perception of the bond's overall environmental performance.

The presence of co-benefits and higher impact levels plays a crucial role in attracting different typologies of investors. The specific benefits and impacts they offer have a direct correlation with the performance of green bonds, which is consistent with the findings of Pham and Huynh (2020) on the interdependence of green bond performance and investor attention. This observation further supports the research by Raymond et al. (2017) and Cannop et al. (2016), emphasizing the significance of identifying co-benefits in nature-positive investments. By engaging multi-

disciplinary teams, it becomes possible to scale up the implementation of nature-positive projects and address any negative stakeholder perceptions surrounding biodiversity initiatives.

Understanding my previous result shows that biodiversity projects are still, merely perceived by investors as going beyond the firm dimension and focus only on reputational effects of the issuer and not accompanied by economic benefit, I, finally, analyze green bond with biodiversity objective through the signaling instrument. I look further into how third-party role enhance the signaling effect and the trends of their involvement in the biodiversity objective green bond issuance landscape.

The first determinant of my signaling instrument relates to the presence of external green bond certification. My result shows that issuers experience a better performance of the bond if they decide to involve a certification in the reliability assessment of their bonds. This empirical evidence highlights the relevance of the compliance to well standardized sustainability processes in the green bond issuance process, especially certification is known as having stricter and more stringent requirement compared to solely following the best practice guidance, such as Green Bond Princpe (GBP), without involving third party assessment. Align with Flammer (2021) proving that investors react positively to the issuance of certified green bonds. The certificate helps investors to identify climate-oriented investments and alleviate information asymmetry in the market, therefore providing better transparency –while acts as the first step to provide greater granularity to gain investors trust for scaling up biodiversity investment, consecutively leads to better performance of green bond.

Analyzing other instrument of pre-issuance external review, a SPO, the result reveal that green bonds with biodiversity objective experience a lower performance if the issuance is accompanied by SPO as bond's reliability assessment. I, first, conclude that the pre-issuance reviews the bond chose contributes to determining the green bond performance. As certification and SPO are type of pre-issuance review, both shows a contradictory statistical result. Investor might perceive the issuance of SPO with skepticism as green bond with biodiversity objective have higher reliance and dependency on SPO instead of certification as around 65% of the bond issued accompanied by SPO, but only 10% accompanied by certification. This skepticism could lead investors to

question the underlying environmental quality of the bond, resulting in decrease of the green bond performance. This is especially important considering different scope of requirements the two has.

SPO provider are Environmental Social Governance (ESG) service providers and/or other environmental consultants and assessment organizations, therefore I perceive that it might be that reputational effect of these SPO provider impacting investors' perception towards SPO issuance. Especially, if these SPO providers has ESG controversies surrounding them as financial markets participants and academics have raised serious doubts about the integrity and value of the assessment, pointing the conflicts of interest and abuse risk (Coley, 2022).

To better understand the underlying reasons for the observed decrease in green bond performance when accompanied by an SPO, conducting research on the reputational aspects of SPO providers and their impact on green bond performance would be valuable. Future research could involve qualitative analysis, focusing on aspects such as the identity and characteristics of SPO providers and market perception around them, the structure and process of their evaluations, the standards and requirements employed, and how these standards are implemented. Furthermore, further discussion might be worthwhile to analyze whether external review should be paid for or made mandatory, examining the potential implications of different approaches in terms of ensuring credibility, consistency, and acceptance.

Lastly, this study is the first to analyze the number compliance bodies the green bond follows in my effort to contribute in bridging the gap of green bond reporting literature. This is especially important considering compliance body is the one of only governing mechanism in green bond landscape. My results reveal that, the number of compliance bodies the green bond follows in its issuance does not affect its performance. This effect could be explained by investors' trust in issuer credibility. Investors place greater emphasis on their trust in the issuer's credibility, reputation, and transparency, rather than specific compliance bodies. These three aspects cover (but not limited to) issuer's financial performance, track record in delivering environmental and social commitments, and controversies around ESG risks. This is consistent with Russo et al. (2021) proving that investor exhibit greater attention towards the reputational-related impact with the

issuer's identity of being strategically oriented towards the natural environment and social aspect. These characteristics serves as a more realizable signals of higher performance of a green bond.

The lack of investor awareness might also explain the insignificance as investors may not be fully aware of the significance and implications of different compliance bodies. They may have limited knowledge or understanding of the specific requirements, standards, or impact associated with each compliance body. This argument allows us to highlight the need for future research to conduct this analysis on the whole green bond, and not solely for biodiversity objective. This is especially important considering my previous analysis on the necessary impact measurement and the lack of external reviews for green bond with biodiversity objective, I therefore expect different significance result.

Future research could explore the inclusion of country-level factors beyond the location of project financed, such as regulatory frameworks or market conditions, could provide additional insights into the relationship between green bond performance and biodiversity objectives. Furthermore, Biodiversity financing represents unlimited opportunities for academic research to explore. In particular, I highlight that it might be interesting to look at the sustainability-linked product, such as sustainability-linked bond and loan, for biodiversity where the KPI is directly tied to biodiversity enhancement and analyze what drives their performance, while exploring the scale-up factors and possible ways for transaction standardization.

6.2. Implications

From the issuer perspective, understanding that issuance with multiple project categories (co-benefits) attracts different typology of investors, therefore leads to higher performance could highlight the need for higher disclosure granularity. This means that issuer should be able to identify and disclose the use of proceed to a higher degree. Therefore, this study shows that higher granularity of the use of proceed, which implies a higher disclosure, improve the green bond performance.

Issuer of green bond with biodiversity objective should also provide comprehensive information about the environmental impact of the projects, and more engage in independent verification or certification processes as this study shows an alarming trend around the biodiversity objective green bond issuance are in fact not certified. Therefore, clear and standardized reporting frameworks, along with robust due diligence and impact assessments, can help enhance market confidence and ensure that green bonds are perceived positively as genuinely sustainable investments, and seen as beyond solely reputational.

Furthermore, understanding impact of different type of pre-issuance external reviews to the green bond performance highlight the importance to normalize impact reporting. To begin, comparing the scope and requirements, certification involves a more comprehensive and stricter assessment while SPO focuses merely on bond alignment with established principles and guidelines, such as ICMA, making it a less demanding assessment. Furthermore, certification also requires third party verifier involvement to assess the bond issuance against the CBI's rigorous standards. For SPO, the involvement of a single external party, as opposed to formal verification process, makes it less strict and reliable, therefore decreasing the confidence of investors and affecting their perspective on the green bond performance. As the first step, issuer for green bond with biodiversity objective should reduce its reliance on solely using SPO. It is important to note that this research does not advocate the reduce of SPO issuance in green bond, rather, I recommend a combination of both certification and SPO while importantly, emphasizes the use of the post-issuance review, particularly KPI-based disclosure through impact reporting, such as ICMA Harmonised Framework for Impact Reporting. Impact reporting quantify the environmental impact of the project financed quantitatively, moving towards a standardized reporting. This has the potential to facilitate the scale up of biodiversity financing by improving the green bond reporting, thereby bolstering investor confidence.

From investors perspective, they stand to gain significant benefits from the findings of this research. Understanding the impact of project types with biodiversity impact and the transparency orientation of firms on green bond performance empowers investors to make informed decisions that align with their biodiversity preferences and objectives, especially knowing green bond with higher co-benefits and higher impact increase the green bond performance. By considering these

determinants, investors can balance the desire to maximize their financial returns with better navigation to contribute to their own biodiversity objective preference. By actively supporting biodiversity-focused green bonds, investors can play a vital role in fostering conservation efforts and biodiversity enhancement.

7. Conclusion

A comparatively new financial instrument, green bond, has emerged as one of the potential solutions in bridging biodiversity funding gap, which necessitates significant upfront investment. Green bonds have gained prominence as a familiar and successful mechanism for private-sector finance, which is the key in scaling up financing biodiversity. The significance of this instrument for biodiversity enhancement seems to have been overlooked in the academic literature. Thus, this study takes the pioneering step of examining the biodiversity financing scale up opportunity from green bond.

I first examine the determinants affecting the performance of green bond issued with biodiversity objective project categories. While most of biodiversity projects are perceived by market participants as merely reputational, I find that eco-efficient product to be the only significant category due to its economic and reputational impact, affecting the green bond performance negatively. This study is the first to define the co-benefits and impact level of green bond. I discovered the green bond's co-benefits and impact level affect its performance positively. Co-benefits signal different investors typology about the multiple benefits and the value added of nature the bond contributes to. Consistent with Raymond et al. (2017) that prove identifying the co-benefits of nature-positive investments and engaging multi-disciplinary teams as crucial steps in scaling up nature-positive investment.

I then delve deeper into the signaling instrument of green bond with biodiversity objective. I first examine the presence of external green bond certification. I find that issuers experience a better performance of green bond if certification is involved in the reliability assessment of the bonds. In contrary, I find that biodiversity objective green bond experiences a lower performance if the issuance is accompanied by a SPO. Investor perceive the issuance of SPO with skepticism as green bond with biodiversity objective have high reliance and dependency on SPO due to less strict scope and requirements, in comparison to certification. Lastly, this study is the first to analyze the impact of governance bodies in green bond market. I find that the number of compliance bodies the green bond follows in its issuance does not affect its performance.

Overall, this research shed the first light on green bond for biodiversity enhancement, proving there are multifaceted approach that drives their performance, while proving the suitability and possible scalability of the instrument in scaling up biodiversity finance.

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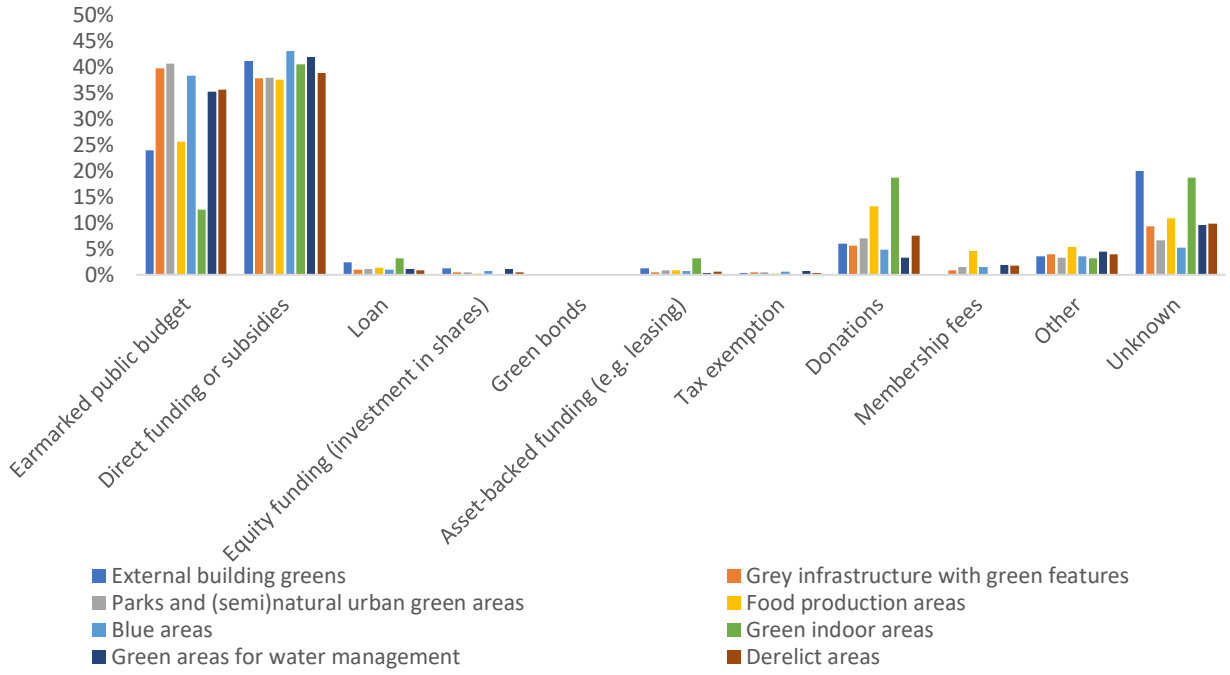
Appendix

Graph 2. Financing instrument and project types of urban nature positive projects



Graph 3. Project type and governance of urban nature positive projects.

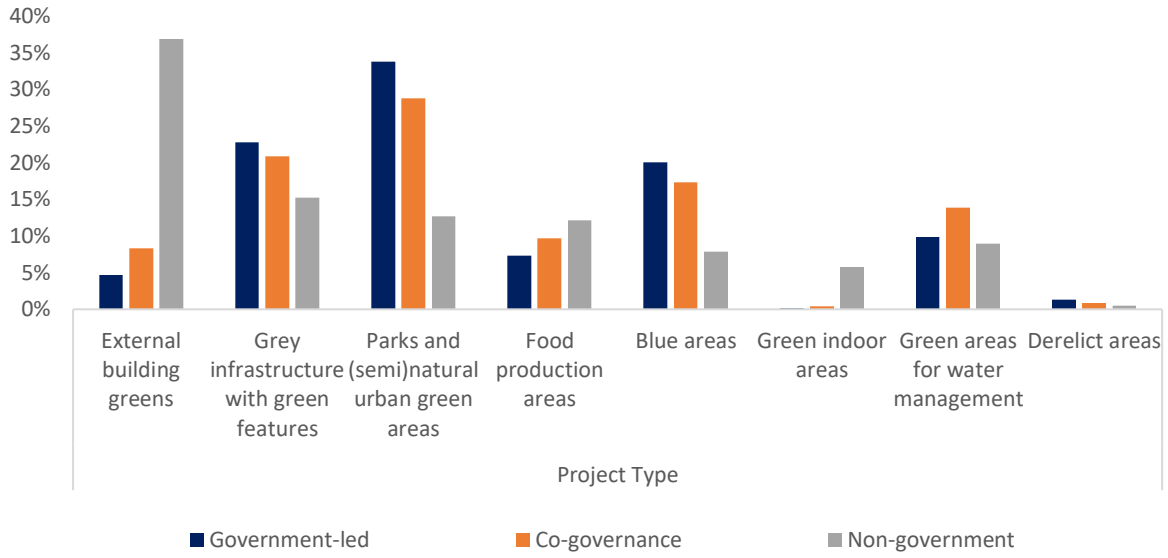


Table 5. Correlation table

	YTM	Aquatic	Terrestrial	Ecoefficiency	Sustmg~s	Sustmg~e	Sustwat~t	Multip~s	Totali~s	SPO
ytm	1.0000									
aquatic	0.0428	1.0000								
terrestrial	-0.003	0.7694	1.0000							
ecoefficiency	-0.06	-0.5240	-0.4115	1.0000						
sustmg~s	-0.1210	0.3592	0.2096	-0.151	1.0000					
sustmg~e	0.0697	0.3749	0.4055	-0.033	0.4868	1.0000				
sustwat~t	0.0946	0.3416	0.2428	-0.363	0.2434	0.2215	1.0000			
multipleca~s	0.0100	0.7156	0.6782	-0.136	0. 6390	0.744	0.5677	1.0000		
totalimpact	0.0173	0.8070	0.7551	-0.328	0. 6536	0.7353	0.5347	0.9754	1.0000	
SPO	-0.073	-0.0813	-0.0138	0.326	-0.09	0.0927	-0.254	-0.011	-0.055	1.0000
certification	0.0824	0.0644	0.0260	-0.024	0. 1696	0.0376	-0.164	0.0167	0.0436	-0.141
compliance bodies	-0.02	-0.0487	-0.6939	-0.123	-0.039	-0.117	-0.67	-0.134	-0.107	-0.15
bondrating	-0.2070	0.2473	0.1829	-0.415	0. 1402	-0.008	0.0371	0.0422	0.1361	-0.072
coupon	0.6542	-0.1860	-0.2069	0.2086	-0.243	-0.096	-0.183	-0.215	-0.244	0.1778
col lateral	0.0187	-0.1310	-0.1100	-0.343	-0.097	-0.106	0.1969	-0.179	-0.126	-0.065
maturity	0.0552	-0.1585	-0.0800	0.0982	-0.149	-0.094	-0.137	-0.162	-0.171	0.1716
der	0.8575	-0.0473	-0.0475	-0.187	-0.07	-0.098	0.0233	-0.134	-0.095	0.0817
ln_firmsize	-0.171	0.2827	0.4045	-0.015	0.2058	0.2815	-0.067	0.3231	0.3403	0.0507
	Certification	**Compliance**	**Bondrating**	**Coupon**	**Collateral**	**Maturity**	**DER**	**Ln_firmsz**		
certification	1.0000									
compliance	0.2257	1.0000								
bondrating	0.0291	0.2223	1.0000							
coupon	-0.0894	-0.127	-0.122	1.0000						
collateral	-0.0785	0.1456	0.0683	-0.022	1.0000					
maturity	0.1900	0.0434	-0.696	-0.044	0.0652	1.0000				
der	-0.0665	0.0203	-0.106	0.0045	0.4969	-0.006	1.0000			
In_firmsize	0.2205	0.0223	0.3352	-0.197	-0.135	-0.051	-0.139	1.0000		

Table 6. VIF table

Variable	VIF	1/VIF
Aquatic biodiversity conservation	3.44	0.291
Terrestrial biodiversity conservation	3.04	0.329
Eco-efficient product	2.38	0.421
Sustainable management of living natural resource	1.57	0.637
Sustainable management of land use	1.65	0.607
Sustainable water and wastewater management	1.39	0.720
Multiple categories	1.22	0.821
Impact level	1.22	0.818
Second party opinion	1.11	0.900
Certified bond	1.11	0.904
Compliance bodies	1.12	0.893
Bond rating	1.52	0.656
Coupon	1.17	0.854
Collateral	1.77	0.565
Maturity	1.07	0.932
DER	1.41	0.707
Firm size	1.57	0.636