Green Bonds: New Label, Same Projects*

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Abstract

A central proposition of green finance is "additionality," which means that funded projects are sufficiently distinct and impactful to justify a novel label. We examine additionality of U.S. corporate and municipal green bonds by comparing the uses of their proceeds against the issuer's other projects, funded conventionally. In our corporate green bond sample, 30% of aggregate proceeds is used simply to refinance ordinary debt, 7% is used to acquire existing green assets, 29% is used to continue projects already underway, 33% is used to initiate projects of a character that is not novel for the issuer, and only 1% is used to initiate novel green projects. Municipal green bonds show similar patterns. Investors and market participants also do not appear to distinguish among these levels of additionality: Offering yields, green bond index inclusion, and holdings in green bond ETFs and mutual funds are unrelated to the nature of the use of proceeds. Overall, U.S. green bonds typically do not fund projects with green aspects that are novel for the issuer, and investors do not differentiate between those that do and those that don't.

Keywords: Climate finance, green bond, ESG, investment

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I. Introduction

Green bonds, so labelled by the issuer because the proceeds are directed to an environmentally friendly project, are considered a leading capital market response to environmental challenges (OECD 2017); over $3 trillion in green bonds has been issued worldwide since the birth of the concept less than twenty years ago.[1] Prolific issuers of green bonds include U.S. and international municipalities and corporations, sovereigns, and supranational entities.

Most academic research on green bonds has focused on pricing. This question has now been answered with relatively high precision: On average, U.S. green bonds sell for a premium between zero and a handful of basis points over comparable ordinary bonds by the same issuer.[2] However, there has been little systematic analysis of the fundamental "real" proposition of green bonds, which is that in buying an issuer's green bond as opposed to its ordinary bond an investor is indeed doing some novel good, funding an activity with a sufficiently distinct environmental aspect as to merit a distinct label. In fact, rhetoric across the green bond market often takes this proposition for granted:

> *Green bonds were created to fund projects that have positive environmental and/or climate benefits.*[3] (Climate bond industry association)

> *Apple is committed to leaving the planet better than we found it, and our Green Bonds are a key tool to drive our environmental efforts forward.*[4] (Apple, Inc.)

[1] https://www.climatebonds.net/.
[2] Flammer (2021) and Larcker and Watts (2020) find no premium for US corporate and municipal green bonds, respectively. Zerbib (2019) and Baker, Bergstresser, Serafeim and Wurgler (2021) find a slight premium, the latter arguing that both green and ordinary bonds are issued at a slightly lower yield when issued simultaneously.
[3] https://www.climatebonds.net/market/explaining-green-bonds.
[4] https://www.apple.com/newsroom/2022/03/apples-four-point-seven-billion-in-green-bonds-support-innovative-green-technology.

Green bonds look set to revolutionise not just the speed at which the world transitions to clean energy, but also how broader bond markets work.[5] (Institutional investment advisor)

Green bonds are remarkable and innovative instruments that help mobilize private capital toward solving the climate challenge by driving more and more capital into low-carbon emission and renewable energy infrastructure projects.[6] (Academic research)

Financial markets can help solve the climate challenge by meeting the growing demand for low-carbon projects around the world…. New financial tools like green bonds are helping drive more capital to these projects ...[7] (Michael Bloomberg, U.N. Special Envoy on Climate Ambition and Solutions)

Green bonds' transparent use-of-proceeds structure and their focus on delivering measurable environmental benefits make them an effective tool for issuers to finance the climate transition.[8] (Institutional fund marketing)

[The Nuveen Green Bond Fund provides a] climate-aligned portfolio that intentionally directs capital to projects and initiatives that accelerate the transition from fossil fuels to renewable energy sources, reduce greenhouse gas emissions, and help position companies to achieve various global climate compact goals.[9] (Retail fund marketing)

Since these perspectives now influence the allocation of trillions of dollars to green bonds, it is important to examine the projects *that green bonds actually fund*. Are green bonds

[5] https://www.portfolio-institutional.co.uk/roundtables/impact-investing/the-green-bond-revolution/.
[6] Sharma and Koutish (2023).
[7] https://www.oecd.org/environment/cc/Green%20bonds%20PP%20%5Bf3%5D%20%5Blr%5D.pdf.
[8] https://www.gsam.com/content/gsam/global/en/market-insights/gsam-insights/perspectives/2022/green-bonds-fixed-income-capital.html.
[9] https://www.nuveen.com/en-us/mutual-funds/nuveen-green-bond-fund?shareclass=I.

really “driving” capital to projects toward “solving the climate challenge”? Alternatively, is the label more of a marketing approach used by those with incentives to grow the market? Where the reality lies between these extremes is the empirical question that we tackle here.

But first, to be clear, issuing a green bond is a choice and there is no arrow of causality running from green bond issuance to project. Most green bond issuers can and do raise funds through traditional means, and money is fungible. As an analogy, one cannot say that junk bonds cause leveraged buyouts, but one can often still closely link them to that purpose. The question we address here is similar, and is the question an ESG-sensitive investor would reasonably ask: Are green bonds *associated* with projects that are as unique as the label being put on the bond? For green bonds, the use of proceeds is often explicitly stated, so it is usually possible to link the proceeds to a project (even more directly than in the junk bond case).

Specifically, we analyze how a broad set of U.S. corporate and municipal issuers used the proceeds of their first green bonds relative to how they usually invest based on other sources of finance. We reason that an issuer’s first green-labeled issue is more likely than subsequent green issues to attract special scrutiny by investors, and therefore most likely to be associated with a credibly unique project. After an extensive, bond-by-bond search for similarities and differences between the green bond’s green purpose, or central green aspect, and those of the issuer’s other projects—an operational measure of the “additionality” of the bond, to use the jargon of green finance—we examine the extent to which the degrees of additionality of different green bonds influence ownership patterns and bond prices. In short, we ask whether green bonds are different not just in their label but in their specific green use of proceeds, and we then ask how much investors notice or care.

Our findings fall into two categories. The first involves the supply of green bonds—where do green bond proceeds go? Our main finding is that few U.S. green bonds are used to support projects whose essential green aspect is novel for the issuer. Indeed, in our sample, 30% of aggregate corporate green bond proceeds and 45% of aggregate municipal green bond proceeds simply refinance existing ordinary debt. Most green bond proceeds are devoted either to expanding a project that was already in progress or used to initiate a new project that is similar in its essential green aspects to other, prior projects. Since our sample includes only first green bond issues, these prior or ongoing projects would have been heretofore financed by other, traditional means. These expansion projects make use of 29% of our aggregate corporate green bond proceeds and 26% of aggregate municipal green bond proceeds, and new projects of a traditional green "type" utilize 33% of our aggregate corporate green bond proceeds and 25% of aggregate municipal green bond proceeds. Only a handful of issues appear to fund a project whose green aspect appears genuinely novel and different for the issuer. These aggregate proceeds breakdowns are not driven by large issuers; the distribution for the average corporate and municipal green bond is similar. These results do not support the view that green bonds are funneling capital to uses with particularly unique environmental merits.

Our second category of results makes use of the cross-sectional variation in additionality to investigate the extent to which investors differentiate between the more- and less-additional bonds available to them. We find little evidence for this hypothesis: (1) there is no premium, even a small one, built into the offering yields for more-additional bonds; (2) green bond index providers are not likelier to include more-additional green bonds; (3) green bond ETFs and mutual funds do not tilt toward more-additional bonds and away from, for example, green bonds that simply refinance ordinary debt.

Our results suggest that investors be wary of rhetoric that green bond proceeds are making substantial contributions relative to what issuers already have been doing. A cynical interpretation is that the green bond market is largely a financing sideshow. A more positive interpretation is that ESG-oriented investors may often be able to provide essentially similar support to an issuer's environmental efforts by buying ordinary sources of finance as opposed to limiting holdings to green bonds alone. Either way, the empirical conclusion is that the green bond label itself provides little assurance that the funds are being directed toward a green project that is novel for the issuer.

The paper proceeds as follows. Section II reviews the sample and the method we use to assess levels of additionality. Section III presents the breakdown of sample green bonds across levels of additionality. Section IV examines how offering yields and institutional holdings vary with levels of additionality. Section V concludes.

II. Sample and Methodology

A. Sample of U.S. Corporate and Municipal Green Bond First Issues

Our sample focuses on the first issues of green bonds by a given issuer. For each corporate issuer, we gather detailed data about the use of proceeds, among other characteristics, on its first green bond, and for each municipal issuer we track the first green bond series (i.e., the total ladder across different maturities) as one issue. We reason that this approach increases the likelihood of finding that the green bonds in our sample involve new and, for the issuer, distinct uses of proceeds, for a few reasons.

First, in departing from raising money through standard instruments, the issuer's first green bond, as opposed to its second or third, seems likely to generate the most scrutiny by its investor base and thus require the most detail and justification by the issuer and its bankers.

Second, the initial green bond may signal a new direction for the issuer with respect to environmental investment, as implied by the market rhetoric, and therefore offer the best potential to document a contrast between the green bond's use of funds and the uses of unlabeled bonds and funds. Flammer (2021) reports that corporate green bond issuers see a positive announcement effect in the stock market. One would not want to penalize an issuer, in terms of biasing the characterization of the additionality of projects toward low novelty, by ratcheting its own behavior against it over time.[10]

Third, as a practical matter, corporations do not always spend the proceeds immediately and their initial announcements about the intended uses of proceeds are imprecise. First issues are likelier than subsequent issues to make available the necessary disclosures to be included in our sample.

Fourth, and finally, the youth of the market implies that most issuers in our sample have yet to issue a second green bond, so our focus on first issues is more conceptually useful than practically significant.

Bloomberg is our primary source for both corporate and municipal green bonds. Shurey (2016) explains their process. We limit our sample to green bonds as those that issuers themselves explicitly label as such. As a result, we don't consider corporate bonds that are tagged as green by Bloomberg simply because it views all activities conducted by the company as intrinsically green. This is an ex-post investing industry definition of green and not a choice

[10] We conjecture that an issuer's follow-up green bond issues, if any, are usually devoted to a similar use as the first.

by the issuer.[11] And, as mentioned, we limit the sample further to the first green bond issue in situations where the issuer has issued multiple green bonds over time.

Our final corporate sample starts with the first U.S. corporate green bonds from 2013 and ends with the green bonds from first-time issuers through 2022. Our final municipals sample starts with the first offering from 2013 through the first-time green bond issuers through 2016 plus a random sample of several dozen first municipal issues from 2020. Our issuer-by-issuer investigation is laborious, so we limit the municipal bond sample size for practical reasons but added the random sample to confirm that the empirical impressions from the earlier part of the sample carried forward.

Table 1 shows summary statistics for our sample. Panel A summarizes the corporate green bonds. There are a total of 86 U.S. corporate first-by-issuer green bonds; hence, 86 issuing corporations are represented. The typical corporate green bond issue raises around $500 million. Roughly speaking, this constitutes an average around 10% of the corporation's long-term debt. Typical offering yields depend on the yield curve, maturity, and rating. Corporate green bonds are treated pari passu with ordinary bonds, being different in the use of funds but not recourse or rating, so their yields and risk characteristics closely resemble those of ordinary bonds.

Panel B summarizes the first-by-issuer municipal green bonds. There are 109 such issues in our sample; hence, 109 issuing authorities are represented. Municipal bonds are frequently offered in series consisting of multiple bonds with a ladder of maturities, while the proceeds are devoted to the same projects. We therefore collapse these individual bonds into a single

[11] Some municipal issues in our 2020 subsample that Bloomberg flags as green are associated with green investing in connection to bond insurance provided by Build America Mutual Assurance Company, which issues a "GreenStar" designation based on the use of proceeds and provides a logo on the offering document. We regard these as green bonds by intention of the issuer because the issuer signs off on the offering document, pays for this insurance, approves the GreenStar classification, etc., a process which resembles a third-party green bond certification.

observation by summing the proceeds or averaging the yields or maturities. The typical municipal green offering is about one-tenth the size of the typical corporate green bond; while there are some issues by, for example, large housing and water authorities, there are also offerings by school districts. Offering yields vary with the yield curve (and Covid-era support) and cross-sectionally with tax considerations. Municipal issues are on average much safer than corporate bonds; the median municipal green bond is not rated, and the median rating among issues that are rated is AA, which denotes even lower risk than the same alphabetical rating on S&P's corporate scale. That said, we are not aware of any defaults of either corporate or municipal green bonds in our sample.

B. Levels of Additionality: An Operational Approach

Additionality is an imprecise term, but we use it because it is popular in the green bond and ESG practitioner community. "Unfortunately, despite years of debate within the environmental policy community, there is no commonly held precise understanding of what additionality means or how to best implement it" (Gillenwater (2012), p. 2). But the basic concept is straightforward. A project is "additional" to the extent that it is an improvement in some key environmental aspect—a reduction in emissions, often—over some baseline or counterfactual. A primary empirical challenge to measuring additionality is that the baseline may be ambiguous, and counterfactuals are unobservable.

Our approach is to take historical practice by the issuer as an objective and observable baseline. A business-as-usual baseline is common in discussions of additionality in the context of greenhouse gas offset programs by the EPA or U.S. legislation (Gillenwater (2012)). For our purpose, a *necessary* condition for green bonds to be funding so-called additional projects is that the green aspects of the projects are distinct from historical business as usual. Since historical

practice is often observable with sufficient detail, even if it may take detailed investigation, this approach is usually feasible.

In addition to its objectivity, the history-as-baseline approach is a natural one from an investor's perspective. Consider an investor with an all-else-equal preference for funding environmentally responsible projects, particularly higher-additionality projects. This is a common modeling framework (e.g., Fama and French (2007), Baker et al. (2021), Pastor, Stambaugh, and Taylor (2021), and Pedersen, Fitzgibbons, and Pomorski (2021)). Suppose the investor is presented with the many corporate bonds issued by Apple, Inc., and Apple has chosen to label one of these as a green bond whereas others are for "general corporate purposes," in the standard language of ordinary corporate bonds. The practical question that an investor asks is whether the green label can be used to identify funds that support a higher-additionality project. For this to be the case, the green bond must be funding a project whose green aspects are unique or distinct from standard practice that is being funded by other bonds. We therefore characterize green bonds by how novel their essential green aspect of their purpose is relative to the issuer's traditional or historic set of investment projects.

To implement our approach, the first task is to associate the proceeds of each green bond with an actual investment project (or make a pro rata association for bonds that fund multiple projects), and the second is to characterize the additionality of this use based on how it compares with the nature of the issuer's past and ongoing projects.

This process is fairly straightforward for municipal issuers. They must explain the use of proceeds in the offering document posted on the Electronic Municipal Market Access (EMMA) website, including details of construction, improvements, or renovations. This usually provides enough detail for our purpose, and the offering document also may include many particulars of

the outstanding projects and obligations of the issuer to help delimit historical practice. In some cases, however, we needed to review authorizing legislation or even minutes of community meetings to fully understand the context of the proposed use of funds. Based on these sources, we were able to characterize the uses of funds for 95 out of 109 municipal green bonds in our sample with confidence.

The process is more involved for corporate green bonds. Green corporate bonds are distinct from ordinary corporate bonds in that they commit to a more specific use of proceeds than general corporate purposes, but there is no consistent reporting framework or degree of detail required. In addition, corporate issuers may be more complex than municipal entities, with a potentially broad set of past and ongoing investment projects, some of which may be unobservable. We list some of the most useful resources in Table 2. Firms are increasingly likely to describe the use of proceeds in a voluntary green bond allocation or sustainability report, and the corporate website often supplements such reports. SEC filings may provide detail about the use of proceeds. When public sources were insufficient, we contacted investor relations departments to ask about the use of proceeds of their green bonds and how these uses compare to other projects undertaken by the corporation. We were able to characterize the uses of funds of 60 out of 86 corporate green bonds in our sample with confidence. There is no size difference between the issues for which we have complete versus incomplete data, and that is also the case for municipals.

To be clear, we do not challenge the environmental bona fides of any project or assets from a scientific perspective. We take firms and municipalities at their word that the proceeds are devoted to projects that satisfy environmentally responsible criteria. While many have written about the potential for abuse of green bond funds, the private benefits to deviating from a stated

use of proceeds would appear to be much smaller than the reputational costs borne by the issuer, investment banker, and potentially third-party certifier. See Curtis, Weidemaier, and Gulati (2023) for an extensive discussion. This explains why we are aware of no controversies, at least in our sample, in terms of spending the proceeds of a green bond on a project different from what was advertised to investors.

In addition, language in the offering documents generally give the issuer some flexibility. For example, some include a disclaimer stating the description of eligible green projects is for illustrative purposes only and no assurance can be provided that the proceeds of the notes offered will be allocated to fund transactions with these specific characteristics. When the "for illustrative purposes only" clause is particularly forceful and/or allocation data are unavailable, we treat the bond's allocation of proceeds as incomplete.

Ultimately, based on the available data and the desire for an objective characterization that is as granular as possible while still able to accommodate a comprehensive variety of issuer types, we distinguish five levels of additionality. Level 5 denotes the strongest notion of additionality relative to historical norms and Level 1 the weakest. These are best explained by example. (Some bonds' proceeds are designated for multiple uses with different levels of additionality. In such cases we allocate the monies pro-rata across the levels below.)

Level 5. New Project of Novel Type

The highest likelihood of meaningful additionality arises when a green bond is associated with a new project that entails a novel green aspect—informally, a novel green "type"—for the issuer. Concerned market participants can reasonably view such bonds as distinct from the issuer's other bonds and as indicative of additionality as an investor could realistically observe. Market rhetoric evokes this notion of additionality. For example, from the Introduction: "Green

bonds look set to revolutionise not just the speed at which the world transitions to clean energy.…" An impact on the speed of transition requires that green bonds involve more than business as usual, financed by conventional means. Alternatively, consider the statement by Apple, Inc., that " … our Green Bonds are a key tool to drive our environmental efforts forward." At face value, this statement implies that the company views other financing tools as less suited to furthering these efforts.

The first panel of Table 3 shows examples of this sort. The vehicle fleet of the biotech company Amgen, used by sales professionals to visit medical professionals and customers, accounts for a large fraction of its corporate carbon footprint. A portion of the proceeds of the company's first green bond was allocated to a "pilot" program that would begin to convert the fleet from gas to electrical vehicles. On the municipal side, the State of Hawaii's Department of Business, Economic Development, and Tourism introduced a bond that, in part, financed loans to underserved communities to purchase solar energy equipment pursuant to recent state legislation. We were unable to find a precedent for this program by the State, which described it as "innovative."

Level 4. New Project of Traditional Type

One rung down are green bonds issued to initiate projects whose essential green aspect/type is not innovative for the issuer in the sense that similar such projects had been underwritten by traditional sources in the past. An investor in these green bonds can be assured that the associated project is helping to kick off an endeavor with environmental qualities, contributing capital on an extensive margin in the sense of a new specific project, albeit one that is not unique; similar support for environmental efforts might have been provided by investing in the issuer's existing securities.

As an example, the semiconductor firm ADI promoted its first green bond as underwriting a new headquarters that was LEED Gold certified. Less emphasized was the fact that ADI's Irish R&D facility had already achieved the same level of LEED certification, so the green aspect of the project was not novel for the issuer. Similarly, Indiana University's first green bond financed the construction of a LEED-certified building. However, it was easy to document that such buildings had previously been built on campus.

Level 3. Expansion of Existing Project

A further, and substantial, step more modest in the notion of additionality is a green bond that further an effort that was already in progress, perhaps for many years. By definition, preexisting projects are conventional for the issuer, so it would be difficult to articulate a quality that distinguishes this type of green bond as providing a special exposure for the concerned investor vis-à-vis previously issued financial instruments. In this sense, it is even more apparent in Level 3 projects than in Level 4 projects that the funds provided by the green bond were not critical to success, but they do at least provide some support on an intensive margin.

As it turns out, there is no shortage of green bonds of this character. Table 3 gives two examples of green bonds from energy companies whose proceeds were directed to renewable energy projects that were already underway. We also list a bond from a Chicago wastewater and stormwater management agency with proceeds earmarked to existing infrastructure programs and projects. Level 3 green bond issues are sometimes issued alongside ordinary bonds directed to the same or essentially similar purpose.

Level 2. Acquisition of Existing Asset

At each additionality level above, the green bond was associated with a new or enlarged investment or asset, often a brick-and-mortar asset. Acquiring a pre-existing green asset, by

contrast, changes the environmental footprint of the new owner for the better, but changes the previous owner's footprint for the worse. At best, there is economywide additionality to the modest extent that the new owner uses the asset more productively. An investor in a Level 2 additionality green bond may be incorrect if she thought her bond was associated with an impact on the environment as a whole.

Duke Realty's green bond, which was the first industrial REIT green bond, provides a straightforward example. It was partially used to finance the acquisition, as opposed to the development, of three LEED-certified properties. A municipal example is Ramsey County's green bond, which was used to acquire and operate an existing solid waste recovery facility. In each case, the green bond simply effected a transfer of ownership.

Level 1. Refunding of Ordinary Debt

The least novel use of green bond proceeds is to pay off or refinance outstanding debt that was not issued under a green label. The only distinction between the new and retiring obligation is the label. The green bond is not associated with a novel environmental effort of the issuer, any special environmental benefit for the broader community, or even incremental investment on an intensive margin, so there is no notion of additionality. The casual investor could be forgiven for assuming that a green bond would not be used so plainly for business as usual, but Table 3 provides two corporate and two municipal bond examples of this use. It raises the question how common this use of funds is.

III. Levels of Additionality of Corporate and Municipal Green Bonds

Our first main results are in Table 4, which tabulates how the proceeds of green bonds are spent across the additionality taxonomy. Using the sources from Table 2, we were able to gather

complete allocation data for 60 out of the 86 (70%) of the first-green-issue corporate bonds in our sample. These complete-data bonds represent $33 billion out of the $50 billion (67%) total corporate green bond proceeds. The most recent issues in our sample may make more complete data available as the proceeds are deployed over time.

Of the $33 billion in corporate green bonds with complete data, 30% was used simply to refinance ordinary debt under a new "green" label, an exercise of no additionality. Just over 7% was used to acquire an existing asset. As mentioned before, this activity may improve the green footprint of the issuer but there is no notion of additionality to society as a whole. In sum, 37% of the corporate green bond monies have no additionality from a social perspective and most of that has no additionality even from a private issuer perspective. Within the average bond, the total allocated to such non-additional efforts is 41% (but when taking this perspective keep in mind that most green bonds in our sample channel their proceeds to one or two of our levels of additionality, not all five).

Another important use of corporate green bond proceeds is to expand existing projects that were by definition initiated using other types of finance. This purpose accounts for 29% of the total proceeds of our complete-data sample, and constitutes 27% for the average bond. 33% further of aggregate proceeds are used to initiate a project of a traditional type, i.e., a type of project with an essential green aspect that had previously been pursued by the issuing company; for the average bond, 30% of proceeds go to this type. Totaling these results, we estimate that 62% of funds in the sample, or 57% of the monies in the average corporate green bond, are allocated to advance projects with a green aspect that was not novel for the issuer.

The remaining proceeds are devoted to projects with a high level of additionality: new projects whose green aspect appears to be novel for the issuer. Two examples from corporate

bonds were given in Table 3, but there are few others to describe. Such bonds account for just above 1% of corporate green bond proceeds in our sample, or 2% of the proceeds of the average corporate green bond. It is worth mentioning that this is an upper bound on the degree of additionality, because we cannot be sure that we observe the current or prior projects of any particular issuer. But it is a low upper bound, so we can fairly determine that if investors assume that buying a corporate green bond means financing a project with a green aspect that goes substantially beyond the issuer's prior undertakings, they would usually be incorrect. While the green bond may indeed be financing a green project, it is often of a type that they could have supported through existing financing instruments.

The distribution of additionality is similar in our sample of municipal bonds. Because of the stricter reporting requirements for municipal sources and uses, we could gather complete allocation data for 95 out of the 109 (87%) of the first-green-issue municipals. These complete-data bonds represent approximately $8.6 billion out of the $9.7 billion (89%) total proceeds. In these bonds, a striking 45% of total proceeds are devoted to refinancing activities, while another 2% contribute no external additionality. At the level of the average municipal bond, these figures are 37% and 3% of proceeds, respectively.

This leaves only a bit more than half of total municipal green bond proceeds to contribute some notion of additionality. As with first-green issue corporates, a substantial fraction of municipal aggregate proceeds, 26%, is devoted to projects already underway, and 25% is devoted to initiating new projects, albeit ones whose green aspect has previously been financed with other means. This again leaves only a modest 2% of proceeds for green bond proceeds whose green aspect is novel. For the average municipal green bond, these figures round to 31%, 26%, and 2%, respectively. Thus, municipal green bonds have close to the same character with

respect to additionality as corporates. Usually, a municipal issuer's first green bonds did not fund projects with a novel green aspect, either.

The bottom panel of Table 4 reports Hotelling T^2 tests for the equality of the distribution of proceeds of the average bond in various subsamples of complete data bonds. The corporate first green bond issues are concentrated in the last few years of the sample; a comparison of 2013-2019 issues with 2020-2022 issues (which leaves approximately the same number of bonds in each subsample) fails to reject the hypothesis that the allocations across additionality levels are equal. We nearly reject equality of the additionality allocations of the 2013-2016 municipal green bonds and the 2020 subsample (p-value = 0.11); the point estimates show an increase in the number of refunding issues in 2020. Interestingly, we do not even reject equality of the additionality distribution of the average corporate and the average municipal green bond.

In Table 5, we tabulate these results according to the sector to which the bond proceeds were allocated. The sectors are those that the Climate Bond Institute (CBI) consider for certification. Note that these sectors are coarse classifications only, and they do not define whether the green aspect of any given project is novel for the issuer. For example, many issuers concentrate their work within a particular sector, e.g., waste management, and in such cases, we are interested in whether the green aspect of the funded project is novel regardless of whether it falls within the same sector as the issuer's usual investments.

The results of this tabulation indicate a roughly proportionate spread of project additionality levels across the various CBI sectors. As a result, investors interested in the additionality of their green bond investments would generally need to drill down to the project level, as we do, because the sector alone would not provide enough precision.

IV. Do Investors Care about Additionality?

In a recent survey, 84 out of 86 green bond issuers reported that green bonds attracted new investors (Sangiorgi and Schopohl (2023)). And the growth of the green bond category itself implies that green and ordinary bonds are distinguished by market participants. To understand whether the label alone is serving as the shorthand defining characteristic of green bonds, or alternatively whether investors in the green bond market treat the distinction in a more nuanced way based on the novelty in the green aspects of the use of funds, we exploit the cross-sectional variation in additionality just documented.

A. Offering Yields

One hypothesis is that investors are willing to pay more, i.e. sacrifice yield, to own more-additional bonds. As noted in the Introduction, U.S. corporate and municipal green bonds have typically been issued at exact parity or at a small premium to comparable ordinary bonds (e.g., Zerbib (2019), Larcker and Watts (2020), Baker et al. (2021), Flammer (2021), and Li, Wang, and Yu (2023)). These results are averages across large samples of green bonds, so we can look for a cross-sectional pattern that may be hiding within the averages.

We follow the empirical approach of Larcker and Watts in this analysis. They compare the offering yields of municipal green bonds to the offering yields on ordinary bonds from the same issuer, on the same day, with the same maturity. In the extended data kindly provided by Li et al., the bonds are further matched by revenue backing. The matching pairs of municipal bonds are therefore identical except for the green label and the projected use of proceeds. Corporate green bonds are rarely offered alongside otherwise-identical ordinary bonds, so the same exercise cannot be done for corporates, but it is of some comfort that the allocation of green bond proceeds across additionality levels is similar for corporates and municipals.

As noted, municipal bonds are offered in series consisting of multiple bonds with distinct maturities. Any yield differentials between the green and matching ordinary bonds are similar (or identical) across maturities in any given offering, indicating that these bonds are not independent observations. We therefore collapse these into a single observation by computing the yield differential—often called the "greenium"—as the average of the difference in the offering yields of the matched pairs. In this fashion we construct 20 offering-level observations that derive from approximately 300 underlying bond-level green-ordinary matches.

The results in Table 6 do not support for the hypothesis that primary market investors pay more for green bonds associated with greater levels of additionality. In 13 of the 20 matched pairs, the offering yields of the green bonds are identical to those of the ordinary bonds, echoing the message of Larcker and Watts. Among the remaining pairs, the differences are trivial, and there is no pattern across levels of additionality. In light of the magnitudes involved, formal statistical tests are superfluous. The single greatest yield difference between green bonds and their perfect matches is only 4.6 basis points, which in fact favored the ordinary series.

Given previous research on the small greenium, there is little reason to expect that the results would change if one could expand the sample by a factor of ten. There has been no special offering premium, or greenium, for more-additional municipal green bonds.

B. Green Bond Indexes, ETFs, and Mutual Fund Holdings

Our second approach to understanding investor interest in additionality uses ownership data. Given that green bond indexes and green bond mutual funds arise as market responses to investor interests in the climate and the environment, they may be more likely to include more-additional green bonds in their indexes or portfolios, even though their strength in the market may be too small to affect prices.

There are now at least four indexes that substantially or exclusively follow U.S. green corporate bonds. They are constructed by major providers. We were able to obtain comprehensive index membership data for the two most-followed indexes, Bloomberg MSCI USD Green Bond Select Index and the Solactive Green Bond Index.

In addition, at least six green bond ETFs and mutual funds focus on corporate green bonds and cite one of these indexes as benchmarks, and a further municipal green bond fund tracks a conventional municipal bond index. We were able to obtain portfolio composition for all seven funds, whose collective net assets are less than $1 billion but are growing rapidly. These funds are offered by prominent fund families. The Calvert fund was founded in 2013, and the others were started in 2017 or more recently. The quote from the Nuveen Green Bond Fund marketing materials in the Introduction provides a good example of the language that retail green bond funds use to suggest additionality.

We compile the membership in indexes and holdings of green bond funds and ETFs and then create the intersection with our own sample of bonds whose proceeds we have allocated across additionality levels. The results are in Table 7. For example, that 32 of our complete-data corporate bonds are members of the Bloomberg MSCI USD Green Bond Select Index. Since we have complete data on 60 such bonds, there would be ample opportunity to tilt a portfolio toward the subsample of high-additionality green bonds if the index or fund so desires.

The results do not provide strong evidence such tilts. Recall the pattern of our 60 complete-data corporate green bond sample from Table 4. From Level 1 to Level 5, the unconditional distribution of aggregate proceeds is 30%, 7%, 29%, 33%, and 1%, respectively. With the possible exception of the small Calvert fund, which tilts slightly away from refunding issues and toward expansions, ETFs and green bond funds do not tilt toward higher-additionality

green bonds. (The municipal green bond fund in our sample holds too few complete data bonds to draw any conclusions.) Indeed, the largest green bond funds appear to be quite comfortable holding issues that are simply refinancing ordinary bonds.

There is a more tentative message from Table 7. At least in the case of funds that follow the Solactive index, there is a reasonably tight tracking of the distribution of additionality of green bonds held by the funds and those held by the index. The implication is that if return tracking error is low by fund intention, then the index providers have a major role to play in incentivizing otherwise indifferent or inattentive funds to move toward higher-additionality bonds. However, at present, we do not observe indexes themselves tilting in this direction.

In summary, this analysis points to another negative result: Indexes and retail green bond funds are not more likely to include more-additional green bonds in their indexes and portfolios.

V. Conclusion

In little more than a decade, the green bond market has grown from a niche to a nontrivial segment of the global bond market. Green bonds are the most prominent of several asset classes and subclasses—including sustainability bonds, social bonds, and impact investments—which involve the asset pricing question whether an investor can do well by doing good or, instead, must sacrifice some returns to do good. But the premise of these tests and bonds is that there is indeed some special "good" being done by buying the instrument. In the green bond market, in choosing to attach special label to one bond but not another, an issuer implies that the use of proceeds is, in some relevant way, different from business as usual.

In this paper, we look at the US green bond market from this functional perspective. We focus on the degree of novelty of the use of proceeds and the relationship between such

additionality and investor reception. The overall finding is that the bonds in our sample are frequently not financing projects of sufficient uniqueness to warrant differentiation from the issuer's other bonds. Moreover, investors in the bonds in our sample either do not discriminate between levels of additionality, or they do not care. The results suggest that at this point in the U.S. green bond market, investors should consider the green label as more useful from a negative screening perspective, i.e., that green bonds are clearly "not brown," as opposed to a positive screening perspective that presumes that green bonds are unique relative to the issuer's ordinary bonds and their underlying projects. More detailed investigation, along the lines of our approach or one that suits the investor's goals, is required to make this determination.

From a practical perspective, the findings are sobering. The rapid growth of green bond issuance would appear to be cause for optimism with respect to environmental challenges, but upon close inspection it appears to overstate the market's real, functional response. Future work could review green bond issues by sovereigns, supranationals, and non-U.S. municipalities and corporations, since the market standards for additionality may be different. Green bonds as a category are here to stay, but we hope that our findings will encourage greater scrutiny of green bond proceeds, and more precise notions of additionality, so that the market might achieve its real promise.

References

Baker, Malcolm, Daniel Bergstresser, Georgios Serafeim, and Jeffrey Wurgler, 2021, "The Pricing and Ownership of U.S. Green Bonds," *Annual Review of Financial Economics* 14, p. 415-437.

Climate Bonds Initiative, 2023, "State of the Market Q3 2023," Climate Bonds Initiative report.

Curtis, Quinn., Mark C. Weidemaier, and Mitu Gulati, 2023, "Green Bonds, Empty Promises," Unpublished working paper, University of Virginia School of Law.

Flammer, Caroline. 2021, "Corporate Green Bonds," *Journal of Financial Economics* 142, p. 499-516.

Friedland, Jamison, 2020, "The U.S. Municipal Green Bond Market: An Examination of the Use of Proceeds," NYU Stern Department of Finance Glucksman Institute Working Paper.

Gillenwater, Michael. 2012. "What is Additionality? Part 1: A Long-Standing Problem." Discussion paper, Greenhouse Gas Management Institute and Princeton University.

Larcker, David F., and Edward M. Watts, 2020, "Where's the Greenium?" *Journal of Accounting and Economics* 69.

Li, Boyuan, Baolian Wang, and Jiawei Yu, 2023, "The Emerging Greenium," University of Florida working paper.

Organization for Economic Cooperation and Development, 2017, *Mobilizing Bond Markets for a Low-Carbon Transition,* Paris: OECD Publishing.

Pastor, Lubos, Robert F. Stambaugh, and Lucian A. Taylor, 2021, "Sustainable Investing in Equilibrium," *Journal of Financial Economics* 142, p. 550-571.

Pedersen, Lasse Heje, Shaun Fitzgibbons, and Lukasz Pomorski, 2021, "Responsible Investing: The ESG-Efficient Frontier," *Journal of Financial Economics* 142, 572-597.

Sangiorgi, Ivan, and Lisa Schopohl, 2023, "Explaining Green Bond Issuance Using Survey Evidence: Beyond the Greenium," *The British Accounting Review* 55, 101071.

Sharma, Aditya, and Pradeep Kautish, 2023, "Measuring Green Finance," in: *Recent Developments in Green Finance, Green Growth and Carbon Neutrality* (Shahbaz, Muhammed, et al., Eds.), Elsevier, p. 171-191.

Shurey, Dan, 2016, "Guide to Green Bonds on the Bloomberg Terminal." Bloomberg New Energy Finance note (July).

Zerbib, Olivier D., 2019, "The Effect of Pro-Environmental Preferences on Bond Prices: Evidence from Green Bonds," *Journal of Banking & Finance* 98, 39-60.

Table 1. Sample of first green bond offerings. Unit of observation is the first green bond offering by a given issuer. Corporate offerings consist of one bond of a single maturity; municipal offerings often consist of a series of bonds of different maturities and yields, which we consider as a single offering, with proceeds totaled and offering yields and maturities averaged across bonds within the offering. Long-term corporate debt is measured at end of the year of issue. Bloomberg does not report offering yield data for six of the corporate green bonds. NR denotes unrated.

Panel A. Corporate Green Bonds

	N First Green Bond Issues/Issuers	Mean Proceeds ($ Million)	Median Proceeds ($ Million)	Total Proceeds ($ Million)	Mean Proceeds/ Long-Term Debt	Median Proceeds/ Long-Term Debt	Mean Offering Yield To Maturity (N=78)	Mean Maturity (Years)	Median S&P Long-Term Rating (Not NR)
2013	1	500	500	500	0.2%	0.2%	-	3.0	-
2014	4	270	310	1,080	8.3%	8.5%	2.6%	10.0	A+/AA-
2015	3	447	500	1,342	2.5%	2.0%	1.6%	7.9	BBB+
2016	2	925	925	1,850	5.9%	5.9%	1.9%	8.5	AA-
2017	4	557	588	2,230	9.3%	8.8%	2.5%	6.9	A-/A
2018	8	522	450	4,175	7.1%	7.1%	2.7%	11.4	A-
2019	13	583	500	7,584	6.8%	3.5%	3.9%	9.8	BBB+
2020	25	542	544	13,543	10.7%	7.4%	0.7%	9.2	BBB+
2021	23	707	550	16,252	18.9%	7.1%	3.4%	11.5	BBB+
2022	3	417	400	1,250	12.0%	2.2%	2.5%	5.6	BBB+
Total or N-wtd Mean	86	579	500	49,805	11.3%	6.3%	2.4%	9.8	BBB+

Panel B. Municipal Green Bonds

	N First Green Bond Issues/Issuers	Mean Proceeds ($ Million)	Median Proceeds ($ Million)	Total Proceeds ($ Million)	Mean Proceeds/ Long-Term Debt	Median Proceeds/ Long-Term Debt	Mean Offering Yield To Maturity	Mean Maturity (Years)	Median S&P Long-Term Rating (Not NR)
2013	1	100	100	100	-	-	3.6%	20.2	-
2014	13	135	102	1,751	-	-	2.5%	13.0	AA-
2015	24	112	51	2,680	-	-	2.6%	12.3	AA/AA+
2016	21	168	66	3,526	-	-	2.2%	12.3	AA+
2017-2019	(uncollected)								
2020	50	33	9	1,654	-	-	1.7%	11.5	AA
2021-2022	(uncollected)								
Total or N-wtd Mean	109	89	30	9,711	-	-	2.1%	12.1	AA

Table 2. Sources describing uses of corporate green bond proceeds. Multiple sources were required for some issues. Uses of municipal green bonds are typically described in the offering document.

	N
Green Bond Allocation Report	49
Company Website	45
SEC Form 424B Prospectus	18
Direct Correspondence	12
Sustainability Report	6
Government Reporting	5
SEC Forms 10K or 10Q	3
Internal Document	2
SEC Form 8K	2
Verifier Report	1

Table 3. Examples of green bond assignment to additionality levels. Uses of proceeds in municipal green bonds are typically described in the offering document, and the uses of corporate green bond proceeds are ascertained from a variety of sources including green bond allocation reports, corporate website descriptions, news articles, executive interviews, SEC Form 424B, and direct correspondence (see Table 2). We then determine whether that use of proceeds is in a typical sector or novel for the given issuer, based on a similar range of sources, and allocate the proceeds of a green bond issue across one or more levels.

Issuer	Issue Date	Sector	Description
			Level 5. New Project of Novel Type
Corporate	2/22/22	Low Carbon Transport	In a 2022 news release, Amgen announced its electric vehicle "pilot" program as part of its efforts to advance toward a carbon-neutral goal.
Corporate	3/26/21	Electrical Grids and Storage	In a 2021 news release, MP Materials announced the construction of its inaugural rare earth metal, alloy, and magnet manufacturing facility in Fort Worth, Texas, to support its long-term supply contract with General Motors.
Municipal	11/4/14	Solar Energy	In a 2014 offering document, the State of Hawaii Department of Business, Economic Development, and Tourism described a law enacted in June 2013 that authorized the establishment of the Hawaii Green Infrastructure Loan program. The program, funded with proceeds of $146 million, aimed to make clean and renewable green improvements more accessible to Hawaii ratepayers.
			Level 4. New Project of Traditional Type
Corporate	4/8/20	Buildings	In the 2020 green bond allocation report, Analog Devices (ADI) allocated $102 million of the total proceeds ($395 million) to its new location in Massachusetts for the creation of additional green building space meeting LEED certification standards and the installation of solar panels. ADI's existing Limerick, Ireland campus was already LEED-certified.
Municipal	12/10/14	Buildings	In a 2014 offering document, Indiana University outlined its intention to utilize the $66 million in proceeds for the acquisition, construction, and equipping of a new LEED Certified arts and science building on campus, as well as for the renovation of Franklin Hall on the Bloomington campus. The university had already constructed other LEED certified buildings.
			Level 3: Expansion of Existing Project
Corporate	5/7/18	Solar Energy, Wind Energy	In the 2018 green bond allocation report, DTE Electric stated that $184 million of the $518 million in proceeds was allocated to solar and wind projects that were already in operation.
Corporate	11/8/18	Solar Energy	In the 2021 green bond allocation report, Duke Energy Carolinas disclosed the disbursement of proceeds from its 2018 bond issuance. Out of the total proceeds of $992 million, $182 million was allocated to existing solar projects in operation or already under construction, as reported on the company's website.
Municipal	12/16/14	Water Infrastructure	In a 2014 offering document, the Metropolitan Water Reclamation District of Greater Chicago indicated that a portion of the $260 million in proceeds would be allocated to the preexisting tunnel and reservoir plan project and the stormwater management program.
			Level 2: Acquisition of Existing Asset
Corporate	11/15/19	Buildings	In the 2020 green bond allocation report, Duke Realty stated that $62.59 million of the $396.5 million in green bond proceeds was allocated to the acquisition of LEED-certified projects.
Municipal	12/4/15	Water Infrastructure	In the green bond offering document, Rhode Island Infrastructure Bank indicated that a portion of the proceeds would be allocated for the purchase and rehabilitation of an existing 175,000 square foot building owned by Providence Water.
Municipal	1/24/16	Waste Management	In the green bond offering document, Ramsey County specified that the $17.9 million in proceeds would be utilized for the acquisition of a resource recovery facility from another municipality, highlighting its environmental benefits within sustainable waste management.
			Level 1. Refinancing Ordinary Debt
Corporate	11/28/18	Buildings	In an 2018 8K filing, Boston Properties indicated its intention to initially utilize the net proceeds from the offering for the repayment of debt, including the funding of the redemption of the $700 million aggregate principal amount of its 2019 Notes that were outstanding. Any remaining net proceeds from the offering would be directed toward repaying outstanding borrowings from the unsecured revolving line of credit.
Corporate	8/12/20	Buildings	In a 2019 424B2 prospectus, Piedmont Operating Partnership indicated its intention to use the net proceeds to repay outstanding debt under their $300 million unsecured 2020 term loan, which was partly utilized for the Galleria Office Towers purchase. Any remaining proceeds would be allocated to repaying borrowings outstanding on their revolving credit facility, or under one of its other term loans, or for other business purposes.
Municipal	8/12/16	Water Infrastructure	In its green bond offering document, the Upper Mohawk Valley Regional Water Finance Authority outlined its intention to allocate $4.84 million of the offering proceeds to refund outstanding revenue bonds.
Municipal	10/12/16	Water Infrastructure	In the green bond offering document, the Los Angeles County Sanitation Districts Financing Authority specified that the $206 million in proceeds would be earmarked for refunding the 2005 and 2007 bonds, as well as refinancing the Clean Water State Revolving Fund Loan associated with improvements to the sewerage system.

Table 4. Allocation of green bond proceeds across project additionality levels. Panel A tabulates the use of proceeds across additionality levels by use sector of 60 first-issue corporate green bonds with complete allocation data and 26 with incomplete data. Panel B tabulates the distributions for 95 first-offering municipal green bonds with complete data and 14 with incomplete data. Panel C reports Hotelling's T^2 tests for equality of % of Mean Offering Proceeds vectors for complete data bonds.

Panel A. Corporate Green Bonds

	N	Level 1. Refinancing	Level 2. Acquisition	Level 3. Expansion	Level 4. New Project of Traditional Type	Level 5. New Project of Novel Type	Unallocated / Unreported	Total
Complete Data								
Total Proceeds ($ million)	60	10,009	2,180	9,495	10,992	450	-	33,126
% of Total Proceeds	60	30.2%	6.6%	28.7%	33.2%	1.4%	-	100%
Mean Offering Proceeds ($ million)	60	167	36	158	183	7	-	552.1
% of Mean Offering Proceeds	60	33.1%	7.7%	27.1%	30.0%	2.1%	-	100%
Incomplete Data								
Total Proceeds ($ million)	26	632	-	96	12	-	15,939	16,679

Panel B. Municipal Green Bonds

	N	Level 1. Refinancing	Level 2. Acquisition	Level 3. Expansion	Level 4. New Project of Traditional Type	Level 5. New Project of Novel Type	Unallocated / Unreported	Total
Complete Data								
Total Proceeds ($ million)	95	3,893	165	2,215	2,168	190	-	8,631
% of Total Proceeds	95	45.1%	1.9%	25.7%	25.1%	2.2%	-	100%
Mean Offering Proceeds ($ million)	95	41	2	23	23	2	-	91
% of Mean Offering Proceeds	95	37.4%	3.2%	31.0%	26.2%	2.1%	-	100%
Incomplete Data								
Total Proceeds ($ million)	14	165	5	174	0	0	736	1,080

Panel C. Tests for Equality of % Mean Offering Proceeds Allocations

Corporate 2013-19 (N = 28) vs. Corporate 2020-23 (N = 32): F (4, 55) = 0.96, p-value = 0.44
Municipal 2013-16 (N = 52) vs. Municipal 2020 (N = 43): F (4, 90) = 1.94, p-value = 0.11
Corporate 2013-19 (N = 28) vs. Corporate 2020-23 (N = 32): F (4, 150) = 0.71, p-value = 0.59

Table 5. Allocation of green bond proceeds across proceeds addtionality levels by sector of the use of proceeds. Panel A tabulates the distributions across additionality levels by use sector of 60 corporate green bonds with complete allocation data and 26 with incomplete data. Panel B tabulates the distributions for 95 first-offering municipal green bonds with complete data and 14 with incomplete data. Sectors are as defined by the Climate Bonds Institute, and only sectors with positive proceeds are listed.

Panel A. Corporate Green Bonds

	Level 1. Refinancing	Level 2. Acquisition	Level 3. Expansion	Level 4. New Project of Traditional Type	Level 5. New Project of Novel Type	Unallocated / Unreported	Total
Bioenergy	-	-	550	-	-	-	550
Buildings	5,568	313	3,674	3,404	-	-	12,958
Electrical Grids and Storage	404	-	990	1,318	342	-	3,052
Geothermal	-	-	-	14	-	-	14
Hydrogen	100	113	-	-	-	-	213
Hydropower	-	-	-	61	-	-	61
Low Carbon Transport	220	272	808	2,052	108	-	3,460
Power Purchase Agreement	-	1,198	-	-	-	-	1,198
Solar Energy	1,609		1,572	1,266	-	-	4,446
Waste Management	116	284	1,003	1,597	-	-	2,999
Water Infrastructure	425	-	-		-	-	425
Wind Energy	2,200	-	996	1,293	-	-	4,489
Unreported / Unallocated	-	-	-	-	-	15,939	15,939
Total	10,641	2,180	9,591	11,004	450	15,939	49,805

Panel B. Municipal Green Bonds

	Level 1. Refinancing	Level 2. Acquisition	Level 3. Expansion	Level 4. New Project of Traditional Type	Level 5. New Project of Novel Type	Unallocated / Unreported	Total
Buildings	204	13	123	1,188	-	-	1,527
Electrical Grids and Storage	15	-	6	30	-	-	51
Forestry and Land Conservation and Restoration	109	-	33	35	-	-	177
Hydropower	-	-	30	-	-	-	30
Low Carbon Transport	440	-	622	417	-	-	1,479
Solar Energy	-	-	-	50	146	-	196
Waste Management	144	17	12	-	-	-	173
Water Infrastructure	3146	139	1563	447	44	-	5,340
Unreported / Unallocated	-	-	-	-	-	736	736
Total	4,058	169	2,389	2,168	190	736	9,711

Table 6. Differences in offering yields of green municipal bond issues and ordinary bond issues matched on issuer, maturity, issue date, and repayment source. Municipal bonds are offered in issues of several cusips; the difference in offering yields is computed as the average difference across cusips of the green bonds minus the average difference of the matched ordinary bonds. There are 20 offerings with matched pairs of green and ordinary bonds. No green bonds in the matched sample allocate funds to acquisitions or new projects of novel types. A negative yield difference indicates a "greenium," i.e., a lower yield on the green bond.

	Level 1. Refinancing	Level 2. Acquisition	Level 3. Expansion	Level 4. New Project of Traditional Type	Level 5. New Project of Novel Type	Level 1 and Level 3 combinations
N Matched Offerings	1	0	8	9	0	2
N Yield Green = Yield Match	0	.	4	8	.	1
N Yield Green > Yield Match	0	.	1	0	.	1
N Yield Green < Yield Match	1	.	3	1	.	0
Mean Yield Difference (Green Minus Match) in bps	-0.6	.	-0.1	-0.1	.	0.1

Table 7. Green bond index membership and fund holdings by proceeds additionality levels. Net assets, consistuents, and holdings snapshots taken between 2022Q3 and 2023Q1 using data from Bloomberg and the funds and indexes involved. The first four groups if indexes and funds hold corporates only, and the last group holds municipals only. Net Assets figures do not apply to indexes (marked n/a), and composition was unavailable for two indexes and the Bloomberg Muni Bond Index is not specific to green bonds (marked .).

				Allocations of Sample Bonds In Index or Portfolio				
Index *** Fund Using Index as Benchmark**	**Net Assets ($ million)**	**US Green Bond Holdings in Net Assets ($ million)**	**N Sample Complete Data Bonds Held**	**Level 1. Refinancing**	**Level 2. Acquisition**	**Level 3. Expansion**	**Level 4. New Project of Traditional Type**	**Level 5. New Project of Novel Type**
Bloomberg MSCI USD Green Bond Select Index	n/a	n/a	32	40.1%	9.1%	21.3%	29.5%	0.0%
* iShares USD Green Bond ETF	284.1	121.9	30	47.1%	7.1%	16.7%	29.1%	0.0%
* Nuveen Green Bond Fund	139.4	43.5	12	28.0%	0.0%	49.2%	22.9%	0.0%
Solactive Green Bond Index	n/a	n/a	33	38.9%	8.2%	16.9%	35.5%	0.5%
* Lyxor Green Bond (DR) UCITS ETF	554.5	42.7	25	35.3%	8.1%	18.2%	38.3%	0.0%
* Wealthsimple N.A. Green Bond Index ETF	177.4	56.0	23	40.5%	8.3%	14.4%	36.8%	0.0%
S&P Green Bond U.S. Dollar Select Index	n/a	n/a	.	.	.	.	.	.
* VanEck Green Bond ETF	79.1	26.5	29	38.0%	6.5%	14.3%	40.5%	0.6%
ICE BofA Green Bond Hedged Index	n/a	n/a	.	.	.	.	.	.
* Calvert Green Bond Fund	81.1	28.8	16	22.3%	0.0%	41.6%	36.1%	0.0%
Bloomberg Municipal Bond Index	n/a	n/a	.	.	.	.	.	.
* Franklin Municipal Green Bond ETF	112.7	70.7	6	26.7%	0.0%	13.6%	59.7%	0.0%