Green Bonds: New Label, Same Projects*

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Abstract

Green bonds are often characterized as an encouraging "real" capital market response to environmental challenges. Using hand-collected data on the use of proceeds of first-time U.S. corporate and municipal green bond issues, we find that green bond proceeds are most often used to refinance ordinary debt, continue existing projects, or initiate projects with green aspects that do not go beyond the issuer's norm. Less than 3% of proceeds are directed to projects whose green aspects are truly novel for the issuer. Overall, U.S. green bonds are typically used to scale existing environmentally beneficial activities; the label seldom signals meaningful innovation.

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I. Introduction

Green bonds are often characterized as a leading capital market response to environmental challenges (OECD 2017). Worldwide, over $3 trillion in green bonds have been issued since the first use of the label less than twenty years ago.[1] Issuers who have labeled a subset of their bonds "green" include U.S. and international corporations, municipalities, sovereigns, and supranational entities; projects funded include solar and wind energy, public transport, water treatment, ecosystem conservation, energy-efficient buildings, waste recycling, water monitoring, and other projects with positive environmental qualities.[2]

Many participants have highlighted the green bond asset class in terms of the novelty and promise of the projects the bonds fund. For example, Michael Bloomberg, as the U.N. Special Envoy on Climate Ambition and Solutions, remarked, "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 ... "[3] In a similar spirit, Apple, Inc.'s green bond press release stated, "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] Countless other enthusiastic characterizations of the market could be cited, as industry reports, institutional investment materials, and some academic commentary have all emphasized the potential for green bonds to, in some direct or indirect manner, actively channel finance toward projects with environmental benefits.[5]

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[1] Climate Bonds Initiative (2025).
[2] https://www.climatebonds.net/standard/taxonomy.
[3] https://www.oecd.org/environment/cc/Green%20bonds%20PP%20%5Bf3%5D%20%5Blr%5D.pdf.
[4] https://www.apple.com/newsroom/2022/03/apples-four-point-seven-billion-in-green-bonds-support-innovative-green-technology.
[5] E.g., see https://www.climatebonds.net/market/explaining-green-bonds; https://www.portfolio-institutional.co.uk/roundtables/impact-investing/the-green-bond-revolution/; https://www.gsam.com/content/gsam/global/en/market-insights/gsam-insights/perspectives/2022/green-bonds-fixed-

Existing academic research on green bonds has largely focused on pricing as opposed to the use of the funds.[6] We extend green bond research in an additional, "real" direction by analyzing the projects to which U.S. green bond proceeds are actually directed. While there is no question that green bonds generally support environmentally beneficial activities—they do—the existence of green bonds as an asset class is based on a more substantive proposition: that in purchasing a green-labeled bond, *as opposed to an ordinary bond or other instrument from the same issuer*, represents an investment in a project with a sufficiently novel purpose as to merit a novel label. Using a sizeable, hand-collected data set on the allocation of proceeds of U.S. green bonds, we empirically assess this proposition. Our study can be thought of as the flip side of studies of green bond pricing. Those ask whether an issuer's green bond sells for the same price as its unlabeled bond; we compare not prices, but where the proceeds go.

In particular, we focus on how U.S. corporate and municipal issuers used the proceeds of their initial green bond issue. We reason that a first green-labeled issue is likelier than any follow-on green bonds to attract investor attention to a project with distinctive green qualities. Through a detailed, bond-by-bond investigation, we compare each project's core environmental aspect with those of the issuer's ongoing or prior activities. For an ESG-oriented investor confronted with two bonds by the same issuer, one labeled green and one not, this is a core question in determining whether to treat the green bond as distinctive.

Where do green bond proceeds go? In many cases, to business as usual. Relatively few U.S. green bonds in our sample fund projects whose core green feature is novel for the issuer. In

income-capital.html; https://www.nuveen.com/en-us/mutual-funds/nuveen-green-bond-fund?shareclass=I; Sharma and Koutish (2023)

[6] Flammer (2021) and Larcker and Watts (2020) find no premium for US corporate and municipal green bonds, respectively, Zerbib (2019), Baker, Bergstresser, Serafeim and Wurgler (2021), and Li, Wang, and Yu (2025) find a modest premium. Pastor, Stambaugh, and Taylor (2022) find a modest premium for German green bonds.

our sample, about 31% of aggregate corporate and 30% of aggregate municipal green bond proceeds refinance existing debt, an activity that by definition does not involve any novelty. Another 4% of corporate and 11% of municipal proceeds acquire existing green assets, an activity which does not provide an economy-wide additionality component but rather a shift in the investment mix of the issuer.

The greatest share of green bond proceeds is devoted to expanding a project that was already in progress or to initiate a new project of a type that is not unusual for the issuer. Since our sample includes only first green bond issues, these projects would have heretofore been financed by traditional means. Expansion projects constitute 35% of aggregate corporate green bond proceeds and 38% of aggregate municipal green bond proceeds in our sample. New projects of a traditional albeit green type—an extensive margin of investment but not novelty or innovation by the issuer—consume 28% of our aggregate corporate green bond proceeds and 19% of aggregate municipal green bond proceeds.

Ultimately, only a small fraction of green bonds in our sample, amounting to about 3% of proceeds for corporate issuers and 1% of municipal issues, fund a project whose green aspect might be considered novel for the issuer. These patterns are similar across sectors and issue sizes. Overall, the results indicate that U.S. green bonds generally support the continuation or scaling of existing green activities rather than the initiation of entirely new ones. This seems in contrast to the proposition that green bonds are distinctively "driving" capital toward them, and begs the question whether, in most cases, the green bond label distinguishes the bond from the issuer's other securities.

Importantly, our analysis does not question whether green bonds finance environmentally beneficial or climate-aligned activities. They do. Nor do we test whether green bonds have a

causal impact on the existence or success of the associated projects. That is untestable, because money is fungible, and green bonds are almost always investment grade so there is no obvious role for green bonds to relax financial constraints. Instead, our contribution is to establish the operational meaning of an issuer's choice to use the green bond label. We find that the label cannot in general be used as shorthand that the proceeds are funding projects with particularly innovative green traits.

Overall, a cynical interpretation of the results is that the green bond market is a bit of a sideshow, as the analysis invites skepticism about the meaning of green bonds as a distinct asset class, with distinct real investment objectives that merit a special label. We encourage the reader to also consider a more positive perspective, however. ESG-concerned investors may often be able to support to an issuer's same environmental efforts through ordinary sources of finance and thereby not constrain their investment opportunity set to labeled green bonds alone. Roughly speaking, there is a "latent," unlabeled green bond market that is at least an order of magnitude larger than the formal green bond market.

The paper proceeds as follows. Section II reviews the U.S. green bond sample and the method we use to assess levels of green novelty. Section III presents the breakdown of green bonds across these levels. Section IV 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 aggregate the first green bond series (i.e., the ladder of different maturities) as one bond issue and then gather the same data.

We focus on first issues in an effort to maximize the likelihood that the green bonds in our sample involve a novel green use of proceeds. First, in departing from traditional, ordinary financing instruments, the issuer's first green bond, as opposed to a seasoned issue, is most likely to generate scrutiny by its investor base and thus require the most detail and justification by the issuer and its underwriters. Second, the initial green bond may signal or coincide with a new direction for the issuer with respect to environmental investment and therefore offer the best potential to document a break between the green bond's use of funds and the uses of other funds. We would not want to penalize an issuer, in terms of biasing the characterization of the funded projects toward low novelty, by ratcheting its own increasingly green investment behavior against it over time and thus requiring that its projects become ever more novel. But, in any event, more than half the issuers in our sample have just one green bond, and those that have issued more than one green bond turn out to be highly likely to use the funds for the second bond for similar purposes as the first. As a consequence, our focus on first issues should be considered more of a conceptual attempt to put green bonds in their best light as opposed to a practical limit on sample size.

Bloomberg is our source for U.S. corporate and municipal green bonds. Shurey (2016) explains their process, but 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 Bloomberg has established that all activities conducted by the

company as intrinsically green, because this is an ex-post industry definition of green as opposed to a choice by the issuer.[7,8]

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 2024. Our final municipals sample includes all first-time green bond issuers from 2013 through 2016 plus a random sample of 50 first-time issuers from 2020 and another 50 from 2024. The number of first-time U.S. municipal green bond issuers has exploded in recent years, and the bond-by-bond investigation is laborious, so we limit the municipal sample size for practical reasons.

Table 1 shows summary statistics for our sample. Panel A summarizes the corporate green bonds. There are 113 U.S. first-by-corporate-issuer green bonds; hence, 113 issuing corporations are represented, which is essentially the universe of U.S. non-pure-play corporate green issuers. The typical corporate green bond issue raises around $500 million. This is an average of 11% of the issuing corporation's long-term debt. Corporate green bonds are treated pari passu with ordinary bonds, being potentially different in the use of funds but not recourse or rating, so their yields and risk characteristics are similar to those of ordinary bonds.

Panel B summarizes the first-by-issuer municipal green bonds. There are 158 such issues in our sample; hence, 158 issuing authorities are represented. Municipal bonds are commonly offered as a series of distinct bonds with a ladder of maturities, but the proceeds are devoted to the same projects. Reflecting this, we collapse these individual bonds into a single observation

[7] Including pure-play issues would also bias our findings in the direction of low novelty of green bond proceeds.
[8] One exception is that Bloomberg flags some municipal issues in our 2020 and 2024 subsamples as green because they are associated with green investing in connection to bond insurance provided by Build America Mutual Assurance Company, which provides 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 of the sort offered by such firms as Sustainalytics. Tomunen and Li (2024) argue that the BAM designation is an exogenous green label.

by summing the proceeds and averaging the yields or maturities. The typical municipal green offering is a fraction of the size of the typical corporate green bond; there are some large issues by large housing and water authorities, for example, but there are also offerings by rural school districts. Yields depend on the prevailing yield curve and state and local tax considerations. General obligation municipal green bonds are also treated pari passu with ordinary municipal bonds. Municipal issues are generally much safer than corporates; the median rating among issues that are rated is AA, which represents an even lower default risk than the AA rating on S&P's corporate scale.

As an aside, we are not aware of a default on any green bond in our sample or any bankruptcy by an issuer. We are also not aware of any allegations that an issuer's green bonds were spent on projects other than those articulated by the issuer.

B. A Taxonomy of Green Novelty

The green finance community often uses the term "additionality." "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)). But what the term is trying to capture is straightforward. A project is described as "additional" to the extent that it is an improvement in a significant environmental outcome, such as a reduction in emissions, over a baseline or counterfactual.

Clearly, the challenge to measuring additionality in this sense is that the baseline or counterfactual is unclear. We focus on the more objective notion of "novelty," where historical practice by the issuer can be used as an objective, observable baseline. Novelty can thus be seen as a necessary but not sufficient condition for additionality. A business-as-usual baseline is

typical in discussions of the additionality of greenhouse gas offset programs by the EPA or U.S. legislation (Gillenwater (2012)).

Besides its objectivity, an issuer's historical investment practice is a fundamentally important baseline from an investor's perspective. Consider an investor with an all-else-equal preference for supporting environmentally responsible projects, and, in particular, higher-additionality projects. This is a common modeling assumption (e.g., Fama and French (2007), Baker et al. (2021), Pastor, Stambaugh, and Taylor (2021), and Pedersen, Fitzgibbons, and Pomorski (2021)). Suppose such an investor is presented with various corporate bonds by Apple, Inc., with one labeled as a green bond while the others are simply described as designated for general corporate purposes. The practical question that such an investor might ask is whether the green label can, or cannot, be used to identify bonds that support a higher-additionality project that the others do not. For this to be so, a necessary condition is that the green bond is funding a project whose green aspects are novel.

To implement this approach, we associate the proceeds of each green bond with an actual project, or make pro rata associations for bonds that fund multiple projects. Then we characterize the novelty of this use relative to the issuer's past and ongoing projects.

This process is straightforward for municipal issuers, because they explain the use of bond proceeds in the offering document posted on the Electronic Municipal Market Access (EMMA) website. This document usually provides enough detail for our purpose. In some cases, however, we reviewed authorizing legislation or even minutes of community meetings to fully understand the context of the proposed use of funds.

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 detail required so the classification and allocation exercise is more involved. In addition, corporate issuers may be more complex than municipal entities, with a potentially diverse set of ongoing investment projects, some of which are unobservable to an outsider. The most useful resources are in Table 2. Firms are increasingly likely to describe the use of green bond proceeds in a voluntary green bond allocation or sustainability report, and the corporate website often supplements such reports. SEC filings may also provide detail about the use of proceeds. When public sources were insufficient, we directly 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 stress that we do not second-guess the environmental bona fides of any project or assets; we are comparing the purpose of the green bond with the issuer's prior projects that were not funded by a labeled green bond. While some commentators have been concerned about the potential for abuse of green bond funds, we suspect that the reputational costs borne by the issuer, investment banker, and potentially third-party certifier would far exceed any private benefits to deviating from a stated use of proceeds. See Curtis, Weidemaier, and Gulati (2023) for a discussion. While these are interesting points to debate, we encountered no allegations, at least in our sample, that any issuer bait-and-switched its use of green bond proceeds, so we are comfortable assuming that funds in the U.S. green bond market are generally used as stated by the issuers.

Language in the offering documents does, sometimes, give the issuer some flexibility. For example, some include a disclaimer stating the description of eligible green projects is for illustrative purposes only and providing no assurance 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 confirmatory allocation data are unavailable, we treat the bond's allocation of proceeds as incomplete.

Ultimately, based on the data and the desire for an objective characterization that is as granular as possible while still able to incorporate the universe of issuer types, we distinguished five levels of green novelty. Level 5 denotes the strongest notion and Level 1 the weakest. These are best explained by example. When a bond's proceeds are designated for multiple uses with different levels of green novelty, we allocate the monies pro-rata.

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 has a novel green aspect for the issuer. Interested market participants can reasonably view such bonds as distinct from the issuer's other bonds and as indicative of additionality as an outsider could observe. Green bond market rhetoric noted in the Introduction commonly suggests this notion. For example, at face value, Apple, Inc.'s statement that "… our Green Bonds are a key tool to drive our environmental efforts forward" suggests that the company considers its other financing methods as less suited to furthering these efforts.

The first panel of Table 3 shows examples of bonds supporting this type of project. One is from the biotech company Amgen. Its vehicle fleet, 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 convert some of 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 in terms of project novelty are green bonds issued to initiate projects whose essential green aspect is not innovative for the issuer. 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 to a new, specific project. However, such a project is not of a unique type for the issuer, which implies that financial support for it could have been obtained through other methods such as ordinary bonds.

As an example of this level of novelty, the semiconductor firm ADI promoted its first green bond as underwriting a new headquarters that was LEED Gold certified. 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. Similarly, Indiana University's first green bond financed the construction of a LEED-certified building, but such buildings had already been built on campus.

Level 3. Expansion of Existing Project

As mentioned above, our design choices, such as considering only an issuer's first green bond, intentionally err on the side of characterizing green bonds as more novel, i.e., potentially more "additional." Another choice in this spirit is that we do not consider a project as "existing" until ground has been broken or, at a minimum, prior funding was secured. Until then, we conservatively consider the project as "new." Hence, a green bond-funded project will be considered Level 4 or 5 under this taxonomy even if the project had already been discussed in the business press.

Once a project is already underway, from an investment or at least funding perspective, we treat a green bond that furthers the project as an expansion of an existing project. We denote such a bond as involving Level 3 novelty. By definition, preexisting projects are not novel, so it is difficult to articulate a quality that distinguishes a green bond as providing a unique environmental exposure for the investor vis-à-vis existing financial instruments. It is thus fairly clear that the funds provided by the green bond were not critical to success, but the green bond did provide support on an intensive margin.

Table 3 gives two examples of green bonds from energy companies whose proceeds went to renewable energy projects that were already underway. It also describes 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 similar purpose.

Level 2. Acquisition of Existing Asset

Green bonds of the above levels were associated with a new or enlarged project or asset. Acquiring a pre-existing green asset, by contrast, changes the environmental footprint of the new owner for the better, but this is a transfer from another owner. At best, there is economywide additionality to the extent that the new owner uses the green asset in a greener way. An investor in a Level 2 degree-of-novelty green bond would be incorrect if she thought her bond was associated with an impact on the environment as a whole, but it may represent some expansion in a green direction for the issuer.

Duke Realty's green bond, which was the first industrial REIT green bond, provides an 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 these examples, the green bond, to a first approximation, simply effected a transfer of ownership.

Level 1. Refunding of Ordinary Debt

Without doubt, the least novel use of green bond proceeds is to pay off or refinance outstanding debt that was not issued with 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 incremental investment even on an intensive margin. The only obvious justification for a green bond label on a refunding bond is to reemphasize to inattentive investors that some pre-existing activity, the activity being refinanced, was already "green." Table 3 provides two corporate and two municipal bond examples.

III. Green Novelty of U.S. Corporate and Municipal Green Bonds

Our main results are in Table 4, which tabulates how the proceeds of green bonds are allocated across the novelty taxonomy. Using the sources from Table 2, we were able to gather complete allocation data for 77 out of the 113 (68%) of the first-green-issue corporate bonds in our sample. These represent $44 billion out of the $70 billion (63%) total corporate green bond proceeds in our sample. Some incomplete allocation data is to be expected among the corporate issuers, especially the most recent issuers where the proceeds have yet to be fully committed and therefore not disclosed.

Of the $44 billion in corporate green bonds with complete data, 31% of proceeds were used to refinance ordinary debt under a new label, an activity of no additionality. 4% were 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. Thus, one-third of the corporate green bond monies we can track offer no additionality from a social perspective, relative to the baseline provided by non-green monies, and little or none even from a private issuer perspective. The "average" green bond allocated a total of 38% to these efforts (most bonds allocate proceeds to only one or two levels of green novelty).

Another frequent use of corporate green bond proceeds is to expand existing projects. This purpose accounts for 35% of the total proceeds of our complete-data sample and 35% of the average bond's proceeds. A further 28% 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, 25% of proceeds go to this level of novelty. Hence, about two-thirds of aggregate funds in the corporate green bond sample are allocated to projects with a green aspect that was not novel for the issuer, sometimes on an intensive margin and sometimes on an extensive margin. These projects had precedents financed by traditional means.

The remaining proceeds are devoted to projects with a high level of novelty. An example was given in Table 3, but there are few others to describe. Such bonds account for just 3% of corporate green bond proceeds in our sample. It is worth mentioning that this is an upper bound on this type of novelty, because as outsiders we are unable to observe all of the ongoing or past projects of any particular issuer. But this upper bound is sufficiently low that we can conclude that investors should not assume that buying a corporate green bond means financing a project with a green aspect that goes beyond the issuer's prior undertakings. While the green bond may be supporting a green project, it is generally of a type that the investor could have supported through traditional financing instruments.

The distribution of novelty is quite 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 146 out of the 158 (92%) of the first-green-issue municipals. These complete-data bonds represent approximately $18.6 billion out of the $9.7 billion (92%) total proceeds. In these bonds, a 30% of total proceeds are devoted to refunding, while another 11% represent acquisitions of existing green assets. At the level of the average municipal bond, these figures are 29% and 4% of proceeds, respectively.

As with first-green issue corporates, a substantial fraction of municipal aggregate proceeds, 38%, is devoted to projects already underway, while 19% is devoted to initiating new projects, albeit ones whose green aspect has previously been financed with other means. This leaves only 1% of green bond proceeds to kick off projects whose green aspect is novel for the issuer. At the bond level, these figures are 45%, 20%, and 1%, respectively. Thus, municipal green bonds and corporate green bonds have roughly the same character with respect to green novelty of their projects.

The bottom panel of Table 4 reports Hotelling T^2 tests for the equality of the distribution of proceeds of the average bond in certain subsamples. The corporate first green bond issues are concentrated in the last few years of the sample, but a comparison of 2013-2019 issues with 2020-2024 issues rejects the hypothesis that the distributions are equal. We also reject equality of the distribution of the 2013-2016 municipal green bonds and the 2020 plus 2024 subsample. Close inspection of the data indicates that this change is due to both corporate and municipal issuers making a moderate shift away from Level 4 projects toward Level 3 projects, i.e., shifting from initiating new projects to expanding existing ones.

In Table 5, we tabulate green novelty according to the sector to which the bond proceeds were allocated. The sectors are those that the Climate Bond Institute (CBI) consider for certification. They are coarse classifications only, and we did not use them to define whether the green aspect of any given project is novel for the issuer. For instance, 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.

This tabulation indicates a roughly proportionate spread of green novelty levels across various CBI sectors. Investors interested in the novelty of a green bond investment would need to drill down to the project level, as we do, as sector alone does not provide conclusive information on this aspect of the bond.

IV. Conclusion

In less than two decades, the green bond market has grown from a niche to a substantial category of the global debt market. Green bonds are the most prominent of several asset classes and subclasses—including sustainability bonds, social bonds, and impact investments—which involve the question whether an investor can do well by doing good or, instead, must sacrifice some return to do good.

The premise of such tests is that there is indeed some novel or unique "good" being done in the project supported by the financing instrument. In this paper, we look at the U.S. green bond market from this functional perspective. In choosing to attach a special label to one bond but not another, a green bond issuer implies that the use of proceeds is, in some relevant way, different from business as usual. The overall finding is that the bonds in our sample are usually

not funding projects with green aspects that are particularly novel for the issuer. A striking fraction of green bonds are simply rolling over ordinary bonds.

In summary, the rapid growth of green bond issuance would seem to be cause for optimism with respect to environmental challenges and it has been the topic of enthusiastic rhetoric. A close look at where the money is going, at least so far, suggests that this growth may overstate the market's real, functional response. Future work could examine green bonds issued by sovereigns, supranationals, and municipalities and corporations outside the United States. As the green bond market continues to gather momentum, we hope that these findings will encourage deeper investigation of green bond proceeds by market participants and more disclosure about how the projects funded are distinct.

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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	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	5	506	575	2,530	18.3%	11.5%	2.5%	6.1	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	25	672	500	16,802	18.0%	7.1%	3.6%	11.8	BBB+
2022	12	661	500	7,936	7.0%	3.2%	5.3%	12.9	BBB+
2023	9	697	500	6,273	8.7%	5.7%	15.1%	12.7	A-
2024	6	735	675	4,408	16.1%	10.2%	5.6%	15.4	BBB
Total or N-wtd Mean	113	602	500	68,023	11.2%	5.7%	4.1%	10.8	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	14	150	124	2,097	-	-	2.5%	12.9	AA
2015	24	113	51	2,714	-	-	2.7%	12.1	AA
2016	19	182	68	3,455	-	-	2.1%	12.7	AA+
2017-2019	(uncollected)								
2020	50	38	9	1,888	-	-	1.7%	11.5	AA
2021-2023	(uncollected)								
2024	50	198	51	9,909			3.5%	11.9	AA
Total or N-wtd Mean	158	128	42	20,163	-	-	2.5%	12.0	AA
diff 2013-2016 vs. 2020 & 2024	58 vs 50 & 50	144 vs. 38 & 198	67 vs. 9 & 51	8,366 vs. 1,888 & 9,909			2.5 vs. 1.7 & 3.5	12.6 vs. 11.5 & 11.9	AA/AA+ vs. AA & 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	72
Company Website	53
SEC Form 424B Prospectus	18
Direct Correspondence	12
Sustainability Report	9
Government Reporting	5
SEC Forms 10K or 10Q	3
Internal Document	2
SEC Form 8K	3
Verifier Report	3

Table 3. Examples of green bond assignment to green novelty 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 green novelty levels. Panel A tabulates the use of proceeds across green novelty levels by use of 77 first-issue corporate green bonds with complete allocation data and 36 with incomplete data (Total corporate N = 113). Panel B tabulates the distributions for 146 first-offering municipal green bonds with complete data and 12 with incomplete data (Total municipal N = 158). Panel C reports Hotelling's T^2 tests for equality of % of Mean Offering Proceeds vectors for subsamples of 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)	77	13,570	1,556	15,466	12,266	1,385	-	44,243
% of Total Proceeds	77	30.7%	3.5%	35.0%	27.7%	3.1%	-	100%
Mean Offering Proceeds ($ million)	77	176.2	20.2	200.9	159.3	18.0	-	574.6
% of Mean Offering Proceeds	77	32.8%	5.2%	34.9%	24.6%	2.6%	-	100%
Incomplete Data								
Total Proceeds ($ million)	36	1,412	0	1,061	0	16	21,291	23,779

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)	146	5,627	2,120	7,085	3,547	190	-	18,569
% of Total Proceeds	146	30.3%	11.4%	38.2%	19.1%	1.0%	-	100%
Mean Offering Proceeds ($ million)	146	39	15	49	24	1	-	127
% of Mean Offering Proceeds	146	29.2%	3.8%	45.2%	20.4%	1.4%	-	100%
Incomplete Data								
Total Proceeds ($ million)	12	161	0	158	0	0	1,275	1,593

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

Corporate 2013-19 (N = 29) vs. Corporate 2020-24 (N = 48): F (4, 72) = 2.43, p-value = 0.06
Municipal 2013-16 (N = 52) vs. Municipal 2020, 2024 (N = 93): F (4, 140) = 2.78, p-value = 0.03

Table 5. Allocation of green bond proceeds across proceeds green novelty levels by sector of the use of proceeds. Panel A tabulates the use of proceeds across green novelty levels by use sector of 77 first-issue corporate green bonds with complete allocation data and 36 with incomplete data (Total corporate N = 113). Panel B tabulates the distributions for 146 first-offering municipal green bonds with complete data and 12 with incomplete data (Total municipal N = 158). 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**
Basic Chemicals	61	-	152	-	813	-	1,025
Bioenergy	602	-	550	72	-	-	1,224
Buildings	6,725	313	4,810	3,374	-	-	15,221
Electrical Grids and Storage	506	-	1,240	1,318	342	-	3,405
Geothermal	-	-	-	14	-	-	14
Hydrogen	702	113	-	72	-	-	887
Hydropower	21	-	112	61	-	-	195
Low Carbon Transport	1,384	272	2,915	3,290	242	-	8,103
Power Purchase Agreement	21	-	1,568	-	-	-	1,590
Solar Energy	1,799	-	1,694	1,236	-	-	4,729
Waste Management	216	509	2,096	817	-	-	3,638
Water Infrastructure	486	-	152	-	-	-	638
Wind Energy	2,459	350	1,236	2,013	4	-	6,063
Unreported / Unallocated	-	-	-	-	-	21,291	21,291
Total	14,982	1,556	16,527	12,266	1,401	21,291	68,023

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	310	1887	963	1,767	-	-	4,927
Electrical Grids and Storage	143	75	156	477	-	-	851
Forestry and Land Conservation and Restoration	109	-	33	35	-	-	177
Hydropower	-	-	30	-	-	-	30
Low Carbon Transport	1,655	-	1,450	426	-	-	3,532
Power Purchase Agreement	-	-	1,159	-	-	-	
Solar Energy	-	-	23	50	146	-	219
Waste Management	144	18	104	-	-	-	266
Water Infrastructure	3,342	139	3,324	792	44	-	7,641
Wind Energy	85	-	-	-	-	-	85
Unreported / Unallocated	-	-	-	-	-	1,275	1,275
Total	5,788	2,120	7,243	3,546	190	1,275	20,162