

report (2016) also says that “with the right approach, green bonds can be powerful instruments and play a tremendous role in facilitating sustainable infrastructure investment and growth.”

Green bonds are important for closing the infrastructure gap because they help to “broaden the universe of highly-rated fixed-income products (bonds) attached to clean energy, thereby making it easier for investors to increase allocations to clean energy within existing liquidity/creditworthiness constraints” (Fulton and Capalino 2014).

Against the background of increasing ESG (environmental, social, and governance) investment, the question in this article is whether there is evidence of a green premium (“greenium”) in the pricing of green bonds. Green bonds need to be competitive with respect to the overall market in order to prove appealing to investors who are subject to fiduciary duty, in that they are mandated to put profits before all other investment criteria. We argue that if it can be shown that green assets can give returns as good as, or better than, their conventional counterparts, then investors can comply with their fiduciary duty and help invest in sustainability at the same time (Sandberg 2011).

This discussion is relevant at a time when ESG investing is becoming increasingly important (Chandler 2018) and where the demands of socially conscious retail investors are starting to influence the mandates of the larger institutional investors. At present, there are \$22.89 trillion of assets under SRI (socially responsible investment) management, which is an increase of 25% since 2014 and accounts for 26% of all managed assets (Global Sustainable Investment Alliance 2016; US SIF 2016). Also, there are more than \$60 trillion in assets under management by signatories to the Principles for Responsible Investment (OECD 2017). As stated by Amy O’Brien, head of responsible investment at TIAA Investments, “we’re seeing the political climate actually act as a catalyst for ESG and impact investing solutions” (Napach 2017).

A primary way to motivate ESG investment in green infrastructure is to demonstrate that the performance of green assets, such as green bonds, is comparable to the overall market. As long as the impression persists that ESG investing means taking a hit in terms of profitability (Köb 2018), most investors (both retail and institutional) will shy away from ESG investing. It is not necessarily true that ESG investing is less profitable,

however, and now there is beginning to be enough data to explore this issue (Barclays Research 2016, 2018).

Nevertheless, it still remains difficult to assess ESG preferences due to a paucity of directly comparable bond issues representing green versus non-green bonds. Therefore, this work focuses on the US municipal bond market—the largest and most active municipal bond market in the world. Furthermore, many studies focus only on pricing at issue in the primary market or after-issue pricing performance in the secondary market. We seek to combine findings from both the primary and the secondary markets to take a broader view on green bond pricing trends.

The objective of this work is to give a summary of relevant pricing surveys for green bonds in the primary and secondary markets, both corporate and municipal. Then, we will focus on the overall differences in the findings of these analyses, particularly for US green municipal bonds, and investigate reasons for differences in green bond pricing behavior between the primary and secondary municipal bond markets.

US GREEN MUNICIPAL BONDS

The US municipal bond market is the largest municipal bond market in the world, so it is also the largest aggregation of green and climate-aligned municipal bond data (Garrett 2008; Sanders, Milford, and Rittner 2013). While there is also a growing corporate green bond market, these bonds are not issued in the same numbers as US municipal bonds because muni bonds are generally issued in series.

The US saw \$11 billion in green municipal bonds issued in 2017, the largest year ever, however, these represent only about 2% of the overall US muni bond market. For the green municipal bond market to scale up, investors need to know that buying green bonds does not expose them to greater losses than buying into conventional muni bonds. Moreover, if the green muni bond market showed a green premium, or greenium, this would show that some investors are willing to pay more for these bonds.

As green municipal bonds face increasing demand, their pricing performance relative to their conventional counterparts has been questioned. This line of inquiry is partly motivated by market watchers who are wondering if a greenium could possibly compensate issuers for the added costs of issuing green bonds (Chiang 2017).

A green premium occurs when a green bond is priced higher, with lower corresponding yield, than equivalent conventional “vanilla” bonds.

Greenium is essential to some market players, because on the issuance side, higher prices and lower yields at time of issue translate to lower costs of capital, thereby offsetting some or all of the additional expenses of disclosure. On the investor side, a greenium may reduce the yields for the bond holder, but rising prices in the secondary market mean that they could more easily sell the green bonds on at a profit. However, the Climate Bonds Initiative (hereafter, CBI; 2018) pricing report explains that “intuition suggests that a bond being green should not influence its price. Green bonds rank *pari passu* (on equal footing) with bonds of the same rank and issuer. There is no credit enhancement to explain pricing differences, and issuers of green bonds incur minimal additional costs.”

The presence of a greenium in the secondary market could lend pressure to primary market prices, because secondary market prices are an indicator of what the market will bear. As stated in a recent CBI pricing report (2018), “when green bond curves have a handful of maturity points, they could be used as a reference for pricing new green bonds. If green bonds were trading tighter than vanilla bonds, we would reasonably expect to see a consistent greenium emerging,” however, “a secondary green curve does not guarantee a greenium.” Nevertheless, “the secondary market structure seems to have the potential for increasing the green bond issuance and offering a primary yield which is slightly lower than that observed on the conventional bond curve” (Zerbib 2016).

THE SEARCH FOR GREENIUM: LITERATURE REVIEW

The search for greenium initially started by looking for differences in yields for corporate green bonds compared with non-green corporate bonds. Recent studies that explore this pricing dynamic include those by Ehlers and Packer (2017), Hachenberg and Schiereck (2018), Bachelet, Becchetti, and Manfredonia (2019), Kapraun and Scheins (2019), Wulandari et al. (2018), and Zerbib (2018). All of these studies focus on using a matched pair analysis method to compare the yields of green bonds with their closest equivalent non-green counterparts, some of which may be synthetic. This is also the main

approach taken in the Climate Bonds Initiative (2017, 2018, 2019) pricing reports.

These papers comprise a mix of analyses across primary and secondary markets. Ehlers and Packer (2017) looked at 21 green bonds issued between 2014 and 2017 and found that at issue, “green bond issuers on average have borrowed at lower spreads than they have through conventional bonds,” with a mean difference of around 18 basis points. Hachenberg and Schiereck (2018) looked at secondary market spreads and found that a sample of 63 green bonds trading over the period spanning October 2015 to March 2016 traded marginally tighter than non-green bonds from the same issuers. Kapraun and Scheins (2019) looked at a sample of 2,000 green bonds in the primary and secondary markets and found “a significantly negative premium of 20–30 bps for green bonds” in the primary market. For a selection of 64 green bonds issued between 2013 and 2015, Wulandari et al. (2018) found a greenium in the secondary market in 2016 of nearly 70 bps, while also observing that “conventional bonds are less liquid than green bonds.” Zerbib (2018) also observed a greenium of 2 bps in green bonds issued from July 2013 to December 2017.

All of these studies have relied on yield analysis on near neighbors or synthetic matched pairs; however, it can be helpful to monitor the aggregate behavior of the green bond sectors by doing performance benchmarking of green bond indices. In the latest CBI pricing report (Harrison 2019), there was a section contributed by Jason Mortimer, a portfolio manager at Nomura. His analysis looked at the evolution of the greenium of corporate bonds after issue in the secondary market, especially as compared with an index. Mortimer found that from October 2015 to March 2019, “both the Global Aggregate Green Bond and European Green Bond indices outperformed their non-green counterparts by 201 and 292 bp respectively, with a consistent pattern of outperformance starting around July 2016.” Ehlers and Packer (2017) performed a comparison of green bond indices by Bank of America Merrill Lynch, Barclays MSCI, Standard & Poor’s, and Solactive against global bond indices and found that the Sharpe ratio for the green bond indices was slightly higher in some cases, although not statistically significant.

Because of the relative paucity of data available for true matched-pair analysis of corporate green bonds, several researchers have focused their analysis on the US green municipal bond market, where smaller green

AQ5 **EXHIBIT 1****A Summary of Greenium Studies to Date, with Their Data Scopes, Methodologies, and Findings**

Study	Ehlers and Packer (2017)	Hachenberg and Schiereck (2018)	Wulandari et al. (2018)	Zerbib (2018)
Dataset	Corporate	Corporate	Corporate	Bloomberg Green Labeled
Market	Primary	Secondary	Secondary	Secondary
Sample Size	21	63	64	1,065
Timeframe	2014–2017	2015–2016	2014–2016	2013–2017
Method	Nearest Neighbors	Nearest Neighbors + Panel Regression	Nearest Neighbors + OLS with Fixed Effects	Synthetic Pairs + OLS with Fixed Effects
Greenium	–18 bps	–1 bp	–5 to –30 bp	–2 bp

Study	Karpf and Mandel (2018)	Baker et al. (2018)	Larcker and Watts (2019)	Kapraun and Scheins (2019)	Partridge and Medda (2020)
Dataset	Bloomberg Green Muni	Bloomberg Green Muni	Bloomberg Green Muni	Green Labeled	Green-Labeled Muni
Market	Secondary	Primary	Primary	Primary and Secondary	Primary and Secondary
Sample Size	1,880	2,083	640	2,257	453
Timeframe	2010–2016	2010–2016	2013–2017	2010–2018	2013–2018
Method	OLS Regression + Oaxaca Blinder Decomposition	OLS Regression + Fixed Effects	Matched Pairs	Nearest Neighbors + Fixed Effects	Matched Pairs + Fixed Effects
Greenium	–18 bps	–7 bps	Negligible	–20 to –30 bps	Negligible Primary, –5 bps Secondary

bonds are issued more frequently, which enables more direct comparisons. One of the first analyses of this market was published by Karpf and Mandel (2018); using a dataset of 1,880 municipal bonds that were labeled green by Bloomberg, they compared these green bonds with 36,000 conventional bonds by the same set of issuers for 2010–2016. Their results indicated no clear greenium in the secondary market until 2016, where they subsequently found a mean spread of 23 basis points.

This work was followed up by Baker et al. (2018), who performed an analysis of 2,083 municipal bonds defined as green by Bloomberg. Their comparison bond data comprised 643,299 conventional municipal bonds, also issued during the 2010–2016 period. In their study, the focus was on the primary market, and their regression analysis found an average greenium at issue of 6 bps. The bonds used for this analysis included taxable and tax credit muni bonds along with the tax-exempt bonds, so they took the step of adjusting the equivalent yields before doing the regression analysis, in contrast to Karpf and Mandel (2018), who did not adjust their equivalent after-tax yields.

Further narrowing the focus to a sample of 640 pairs of matched green and non-green municipal bonds issued from 2013 to July 2018, Larcker and Watts (2019) found a nominal green discount of 0.45 bp, with the difference in price at issue being zero in 85% of the matched cases. They found negligible greenium when their analysis was expanded to include neighboring bonds issued by the same issuers but at different times. This work also found no significant difference in liquidity or institutional ownership levels and no pricing difference for certified green bonds. Overall, they state unequivocally that “our results suggest that municipalities actually increase their borrowing costs by issuing Green bonds.”

OUR ANALYSIS AND FINDINGS

In order to clarify some of the issues around greenium in municipal bonds, we undertook our own pricing surveys starting in 2015. One key differential between our data and that of other studies is that we rely on issuer-declared green labels, rather than Bloomberg-determined green labels. This means that our sample

is composed solely of green municipal bonds that were overtly declared as green bonds by the issuers rather than interpreted as such by a third party. We feel that this is a key distinguishing feature, especially when it is the green issuers that are most interested in potentially lowering their costs of capital by recouping a greenium at issue.

Another aspect that the primary market analyses have neglected is the potential change over time in the degree of greenium at time of issue in the municipal bond markets. Our recent article based on a previous analysis (Partridge and Medda 2018a, 2020) also performs a matched-pair analysis, but for 453 matched pairs of green and vanilla bonds issued from 2013 to 2018, inclusive. The paired bonds in their sample were issued at the same time under the same official statement, such that they had the same issuer, use of proceeds, issue date, maturity date, and coupon. This analysis looks at greeniums in both the primary and secondary markets and furthermore breaks down the pricing differences into yearly averages in order to detect trends in greeniums as time progresses and the market grows.

We observed a greenium grew to nearly 5 bps in the secondary market by 2018. No statistically significant differences in greenium were observed in the primary market; however, we did observe cases in 2017 and 2018 in which paired bonds were issued with lower green yields than their vanilla counterparts. This is in contrast with the findings Baker et al. (2018) and Larcker and Watts (2019), who looked for a greenium in the primary markets by considering the yield spreads, but neither study looked at the frequency of greenium issues relative to vanilla issues, which could potentially be an early sign of a market trend that is only beginning to be apparent due to a general lack of data from which to extrapolate.

For the secondary market, we took two approaches: We analyzed the yield spreads between the matched green and vanilla pairs to detect any greenium as it emerged after issue, and we also undertook an index performance benchmarking of a set of green municipal bonds as compared with the S&P investment-grade municipal bond index (Partridge and Medda 2018b, 2020). For this analysis, we constructed a green municipal bond index composed of green-labeled municipal bonds issued between 2013 and 2017 and benchmarked their pricing performance in the secondary market. We also benchmarked the green bond index against an index constructed of vanilla bonds that were issued by the

same issuers at the same time as the green bonds went to market, which enabled a like-for-like comparison.

We observed a compound annual growth rate (CAGR) of 3.31% for the index constructed from green, and a CAGR of 3.17% for the index constructed from the green bonds that were issued in tandem with vanilla bonds from 2015 to 2018. These results compared favorably with the S&P Investment Grade index CAGR, which was 2.45%. Overall, the index returns of our benchmarks indicate the presence of greenium in the secondary market, which was also consistent with the results of our yield analysis, where we observed a statistically significant greenium of 4 bps across the entire sample, increasing to a greenium of nearly 5 bps in 2018. In summary, we found that green muni bonds have been issued at prices comparable to their conventional counterparts but that their prices have increased more in the secondary markets.

Greenium in the Secondary Market vs. the Primary Market

Our findings, along with the greenium findings from others, beg the question as to why greenium has been observed in the secondary market for both corporate and municipal green bonds but is much harder to detect in the primary market. We assert that this effect arises because of the way that the bond markets are constructed.

When municipal bonds are issued, they do not come to market through an open outcry process but rather through a much more restricted new issue period in one of three methods: competitive, negotiated, or private placement (Fruits et al. 2008). At some point in this process, the initial offering prices of the bonds is predetermined by the underwriters and published in the official statement (OS). While the underwriters will have initial price talks about setting these prices, once they come to market, no other adjustment occurs until the bonds are re-sold in the secondary market. The retail order period will only last a couple of days for municipal bonds and may not occur at all if a bond offering has been fully sold, usually to institutional investors.

Essentially, buying a municipal bond at issue is generally not accessible to retail or smaller investors and has high barriers to entry, not least of which is the requirement that the bond buyer has an account with one of the banks underwriting the issue. Despite the fact

that municipal bonds in the United States are considered to be reasonably accessible to retail investors, this is not as true of the primary markets. As stated on a retail investing website, “Understand that getting involved at this level can be difficult and is often reserved for high net worth individuals” (Pearlman 2018).

In contrast, the secondary market can draw from a much larger pool of retail investors. This has implications for both pricing and liquidity. When green municipal bonds are compared with similar vanilla bonds, we observed a similar level of liquidity. If anything, green muni bonds could eventually grow to be slightly more liquid, simply from the perspective that they can pull from the entire investor base for non-green bonds along with an additional ESG/SRI investor base that will be focusing on green bonds. Some have posited that green bonds are less liquid, but if we follow the reasoning that green bonds are structured the same as non-green bonds except they pull from an additional ESG investor pool, then we would expect the opposite, as also described by Bowman (2019).

While many have stated that a greenium in the secondary market should influence subsequent initial offering prices in the primary market (CBI 2018; Zerbib 2016), that has not happened to date, but due to the earlier explanation, this could be an artefact of marketing dynamics rather than market dynamics. In effect, primary prices are pitched toward large institutional investors and may or may not exhibit the true open market value of the asset. As a result, as long as the primary markets are inaccessible to retail investors, it could continue to be difficult to detect greenium in the primary municipal bond markets. This observation is also noted by Larcker and Watts (2019), who state that “underwriters may structure some portion of a deal for retail investors who are generally less price sensitive than institutional investors.” Additionally, as Zerbib (2018) states, “since bonds [...] are not frequently traded, a bond yield does not accurately reflect the fair value of the bond in some cases.”

This effect likely stems from institutional investors complying with their fiduciary duty, which is generally to buy assets at the lowest price possible. Some investors may operate under a sustainability mandate, which would both compel and enable them to buy greener assets at a premium, but they often struggle to fill orders due to lack of supply. This undersupply of green bonds can apply price pressure and could also explain why

greenium is more pronounced in the secondary market: If primary investors of green municipal bonds take a buy-and-hold approach, then increasing competition from retail investors will further squeeze supply in the secondary markets.

This shortage of supply could also affect issuing prices in a contrary fashion. Without a significant number of price points showing a greenium at issue, green issuers are not incentivized to price their bonds higher for fear of pricing themselves out of the market. Additionally, the detection of greenium in the primary market could also be confounded by the green halo effect, as described by Basar and Krebbers (2019), who state that “the entire green debt curve trades at tighter spreads than a non-green curve,” so comparing green against non-green issuances from the same issuer may not currently give enough resolution to detect a greenium at issue.

Notably, our pricing surveys detect no greenium in either market until around 2017, which is when green municipal bond issuance increased rapidly. Issuance in 2018 dropped off again as a result of tax code changes, so there is still an unknown dynamic developing around greenium in the primary market.

Regardless of a clear greenium, issuers still seem to like issuing green bonds for various reasons, such as raising their sustainability profile, and are not as fixated on generating a greenium as some investors. These repeat issuers seem to be content with drawing from a new investor base rather than focusing on pricing, as long as prices are competitive with the overall market. Nevertheless, a greenium at issue is still a key to growing out the green bonds market, because it is the primary market prices that ultimately affect the cost of capital for the issuer, not the secondary market prices.

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ADDITIONAL READING

New Time-Dependent Risk–Return Trade-offs from CBI-Certified Municipal Bonds

CAROLIN SCHELLHORN

The Journal of Investing

<https://joi.pm-research.com/content/29/2/46>

ABSTRACT: Forced to address human-induced climate change, the world has embarked on the transition to a low-carbon economy, requiring massive amounts of financing. Municipalities in the US have begun to issue bonds that are third-party certified and registered with the Climate Bonds Initiative (CBI) to attract funding for much-needed climate-related infrastructure. As this market is developing, borrowers and lenders are assessing the potential for new risk–return trade-offs over time. Variations in the pricing of CBI-certified municipal bonds with different terms to maturity likely depend on the extent to which climate-related projects are expected to be prioritized in fund allocations to correspond to increases in public attention to the dynamics of climate change. As the pricing of time-dependent climate-related risks progresses, the market for CBI-certified bonds promises to become an efficient funding mechanism for communities grappling with climate risks while expanding the menu of risk–return choices for investors.

Data-Driven Green Bond Ratings as a Market Catalyst

PATRICK REED, TODD CORT AND LOGAN YONAVJAK

The Journal of Investing

<https://joi.pm-research.com/content/28/2/66>

ABSTRACT: The authors diagnose the lack of premiums in the green bond market as a result of the inability to differentiate net environmental benefits among bonds. They emphasize data-driven bond ratings as the solution to grow the market. Next, they present an idealized rating framework and contrast currently proposed green bond rating systems from major firms.

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