ESG Investing Beyond Risk and Return

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Abstract

Are investors willing to sacrifice wealth for social benefits? We study green bonds to empirically disentangle nonpecuniary motivations from pecuniary benefits behind socially responsible investing. We propose a new method to estimate the premium of a green bond, the so-called "greenium", by comparing the green bond to an equivalent synthetic non-green bond that is constructed using a yield curve bootstrapped from the same issuer's conventional bonds. In contrast to recent studies of green bonds, we find an economically sizable greenium both at issuance and after trading. Our analyses show that previous studies underestimate the greenium because of the green halo effect. Our greenium estimates also increase when investors are less concerned about greenwashing or become more aware of climate change. Overall, this paper provides direct evidence of investors' nonpecuniary preferences for green assets.

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1 Introduction

Environmental, Social, and Governance (ESG) assets are increasingly important research topics in both academic and professional areas. A recent survey reports that global ESG assets are on track to exceed $53 trillion by 2025, more than one-third of the estimated global assets under management (Bloomberg, 2022). ESG assets are also referred to as "green" assets, as environmental concerns now play the leading role.

An important and highly debated question in this area is whether ESG or green assets have value to investors beyond the expected risk and return attributes (e.g., Starks, 2021). If we were to present investors with a high-ESG and low-ESG asset with identical risk and payoffs, are they willing to pay more for the high-ESG asset? The empirical evidence thus far remains mixed. On the one hand, experimental and survey studies suggest that social preferences play a more important role in socially responsible investing than financial motives (e.g., Riedl and Smeets, 2017; Bauer, Ruof, and Smeets, 2021). There is evidence that investors invest in green assets that earn lower returns (e.g., Hong and Kacperczyk, 2009; Barber, Morse, and Yasuda, 2021). On the other hand, studies also find that ESG investing is primarily motivated by financial considerations. Investors expect to earn higher returns and manage climate risk by investing more responsibly (e.g., Hartzmark and Sussman, 2019; Krüger, Sautner, and Starks, 2020). Many investors also cite higher returns as a top motivation for adopting ESG principles (Døskeland and Pedersen, 2016; BNP Paribas, 2019; BlackRock, 2020), and asset managers often market ESG assets as a source of superior alpha's (Lester and He, 2018).

Recent empirical literature uses U.S. municipal green bonds to separate investors' non-pecuniary motivations from pecuniary benefits behind ESG investing (e.g., Larcker and Watts, 2020). This setting has two advantages. First, green bonds are *almost identical* to conventional (non-green) bonds from the same issuer, except that the use of proceeds is explicitly allocated to finance environmental-friendly projects. Second, the average issuance size of municipal green bonds is also small, allowing green investors to set the price by purchasing most of the offerings. If the green bonds are issued or traded at a premium (i.e., higher prices or lower yields) relative to conventional bonds from the same issuer, this premium, the so-called "greenium", would reflect investors' willingness to accept a lower return in exchange for holding assets more aligned with their ESG values.

This paper proposes, develops, and tests a new method to estimate the greenium. Greenium estimates from extant studies differ substantially depending on the estimation methods. While some studies find an economically small but statistically significant greenium (e.g., Zerbib, 2019; Baker, Bergstresser, Serafeim, and Wurgler, 2022), others find no greenium (e.g., Larcker and Watts, 2020) or even a negative greenium (e.g., Karpf and Mandel, 2018). A small or zero greenium is particularly at odds with the increasing popularity of green bond issues globally, which have surpassed $1.5 trillion by December 2021 (CBI, 2022).

Our method for estimating the greenium is based on the no-arbitrage pricing principle. We measure the greenium by comparing green bonds with equivalent non-green synthetic bonds that are constructed using bootstrapped yield curves. As any fixed coupon bond can be replicated by holding a portfolio of zero coupon bonds with maturities corresponding to the coupon dates, we can construct a synthetic non-green bond with the same financial risk and return using the zero-coupon yield curve bootstrapped from the traded conventional bonds of the same issuer. This synthetic bond has the same credit risk and replicates the cash flows the bondholder is entitled to but does not finance eco-friendly projects. Thus, we quantify the greenium as the price or yield difference between the green and synthetic bonds. Simulation analyses and placebo tests show that our method provides reliable estimates for bond prices and yields as it prices conventional bonds accurately.

We use a sample of 3,699 U.S. municipal green bonds issued between June 2013 and December 2020. Our greenium estimates are not only statistically significant but also economically sizable. The offering price greenium is 2.8% on average, corresponding to a yield greenium of 35 bps. After trading on the secondary market, the average price greenium decreases to 1.9% but remains significant, corresponding to a yield greenium of 25 bps. Further tests confirm that the greenium estimates cannot be explained by other bond characteristics or commonly known pricing and trading frictions in the municipal market.

Importantly, our offering greenium estimates are the highest when green bonds are issued for the first time and lower when issued repeatedly. The greenium estimates of first-time issues also drop by nearly half in the first two years after trading on the secondary market. These patterns are consistent with the *green halo effect* (Harrison, Partridge, and Tripathy, 2020), which predicts that green bond issuance signals the issuer's environmental commitment to investors and thereby also reduces the yield of conventional bonds from the same issuer. Indeed, we find that the yield of conventional bonds from the same issuer declines by approximately 23 bps over the three years following the first green bond issuance, which explains the lower offering greenium of the repeated issues and the lower traded greenium on the secondary market. Prior research that ignores the green halo effects would therefore underestimate the greenium, especially when the green bond is a repeated issue. In addition, we provide evidence that the green halo effects, in combination with the similarities between green and non-green bonds, help reconcile the zero offering greenium of bundled green bond issues as in Larcker and Watts (2020).

Moreover, we find that the greenium is driven by the demand from green investors. As one of the main concerns among green bond investors is greenwashing (Grene, 2015), we find a higher greenium when investors are less concerned about greenwashing because of third-party certifications or better credit ratings. The greenium is also higher when local investors become more aware of climate change and have more trust in issuers' environmental commitment due to local environmental regulation and enforcement.

Taken together, the results in this paper suggest that green bonds are offered and traded at an economically sizable premium, which increases with the demand from green investors. The significant greenium is direct evidence that investors have green preferences and are willing to sacrifice wealth for environmental and social benefits

Related literature

Our findings contribute to two strands of literature. First, we add to the growing empirical literature that attempts to separate investors' nonpecuniary motives from the financial benefits behind ESG investing. Specifically, we present evidence that investors still pay more for green assets when risk and payoffs are held constant. Our results are consistent with several recent studies suggesting that investors invest in green assets or impact funds even though these assets or funds earn lower returns than traditional ones (e.g., Barber, Morse, and Yasuda, 2021). As such, our paper supports the view that investors value positive societal externalities in utility in addition to wealth, which is a crucial assumption made in many theoretical models studying ESG investing (e.g., Hart and Zingales, 2017; Pastor, Stambaugh, and Taylor, 2021).

Our paper also contributes to the growing literature on green bonds. Baker et al. (2022) study a sample of both corporate and green municipal bonds issued between 2010 and 2016 in the U.S. and find an 8 bps lower yield for green bonds. Ehlers and Packer (2017) estimate the greenium at the issuance of EU and US green bonds between 2014 and 2017 and find a premium of 18 basis points using a matching methodology. Hachenberg and Schiereck (2018) focus on the secondary market and use a matching procedure and panel regressions to study the global green market over 6 months between 2015 and 2016. They find a trivial yield premium of 1 bps. Zerbib (2019) uses a similar methodology to study 110 corporate green bonds issued globally from July 2013 to December 2017 and estimates a statistically significant but economically trivial greenium of 2 bps on the secondary market. Two recent studies even find no pricing difference at all for green bonds. Larcker and Watts

(2020) explore a matched sample of nearly identical green and non-green municipal bonds in the U.S. and find the greenium to be essentially zero. Moreover, Flammer (2021) rejects the hypothesis that green bonds reduce the cost of debt by showing no price difference for corporate green bonds and matching "brown" bonds. We show that these studies likely underestimate the greenium as they do not account for the green halo effect.

The remainder of the paper is organized as follows. Section 2 describes our data and sample construction. Section 3 outlines our method and discusses potential estimation errors. Section 4 presents our main empirical results. We show evidence of the green halo effect in Section 5. Section 6 explores the cross-sectional and time-series variations in greenium. Section 7 provide concluding remarks.

2 Data

2.1 MSRB data

We obtain a comprehensive historical data set of municipal bond transaction prices from the Municipal Securities Rulemaking Board (MSRB) from January 2013 to December 2020. Each trade observation has data on the bond's identifier (CUSIP), coupon rate, issue date, maturity date, the date and time of the trade, the transaction price and yield, and a variable indicating whether the trade is sale to a customer, a purchase from a customer, or an interdealer trade. We clean the data using the procedure outlined in Green, Li, and Schürhoff (2010) to eliminate obvious data errors and obtain fundamental prices and liquidity measures. First, we exclude all trades in a bond if coupon and maturity information is missing for all trades in that bond. We further exclude trades if the coupon is listed as greater than 20% or maturity is listed as over 100 years. We also drop all trades where the price is less than 50 (i.e., 50% of face value) or greater than 150 with a short time to maturity and exclude trades occurring after the bond's maturity, as these are likely data errors. We further drop bonds with fewer than 10 transactions, as these provide little information for our analysis.

Bond price As municipal bonds trade infrequently and intraday price variation can be large relative to the underlying fundamentals (Green, Hollifield, and Schürhoff, 2006), we smooth transaction prices and aggregate data to weekly level so that our findings are not driven by intraday or daily price swings. Following Green et al. (2010) and Schwert (2017), we first construct daily "fundamental prices" by taking the midpoint of the highest price on customer sales and the lowest price on customer purchases on each day. When customer sales and purchases are unavailable on a given day, the daily fundamental price is the mean price of the interdealer trades. The weekly fundamental price is the average of the available daily fundamental prices each week.

Liquidity measures Following Dick-Nielsen, Feldhütter, and Lando (2012) and Schwert (2017), we use the transaction-level data to construct three daily measures of bond liquidity, which can be aggregated to weekly or monthly level by taking the average or median values. The first measure is the number of trades on a given day, which captures the bond trading activity. The second measure is the daily round-trip trading costs. For days with at least one investor buy price and one investor sell price, the round-trip cost is calculated as the difference between the average investor buy price and average investor sell price, divided by the average investor buy price. The third measure is price impact Amihud (2002). The price impact of a trade is defined as the absolute return for this trade relative to the previous trade divided by the transaction volume of this trade. We then take the daily average of the price impact measure.

On-the-run bonds Default risk and liquidity risk have been shown to be the primary drivers of yield spreads in the municipal market (Cestau, Hollifield, Li, and Schürhoff, 2019). As discussed below, our methodology accounts for differences in default risk by studying bonds from the same issuer. To control for differences in liquidity risk within the issuer, we keep only on-the-run conventional bonds for any given issuer and week, i.e., the most recently issued bonds of a particular maturity. Bonds transition from on-the-run to off-the-run once a new bond of the same maturity is issued. On-the-run bonds are the most frequently traded security of their maturity and, therefore, typically trade at a premium (lower yield) than their off-the-run counterparts. Using only on-the-run bonds ensures that the price differences between on-the-run and off-the-run bonds do not drive our results. Note that we keep both on-the-run and off-the-run traded green bonds.

2.2 Green bond sample

The starting point for our sample is all U.S. self-labelled green bonds in the municipal market from Bloomberg's fixed income database, which industry professionals consider the most comprehensive publicly available source for green municipal securities. Our sample period is from June 2013 to December 2020 because the few issues before June 2013 are unlikely to have been marketed as green bonds (Larcker and Watts, 2020). We follow Schwert (2017) to drop issues smaller than $100,000 and to remove all federally taxable issues to ensure similar tax treatment across bonds in our sample. To simplify price calculations, we restrict the sample to fixed-rate coupon bonds. We further drop issues whose issuer has no bond transaction data in the MSRB database. Finally, we drop issues with fewer than 5 on-the-run conventional bonds being traded the week before the green bond issuance, leaving us with 3,699 issues from 115 unique issuers. The detailed data cleaning steps are outlined in Appendix Table A1. Matching the green bond issues to the MSRB data gives us trading data including 79,032 bond-week observations in 3,687 distinct bonds.

Figure 1: Number and Issuance Volume of Green Bond Issues

This figure plots our green bond sample, issued between June 2013 and December 2020. The bars (left scale) show the number of green bond issues in each year, and the line shows the total issuance volume (in $ billion) by year.

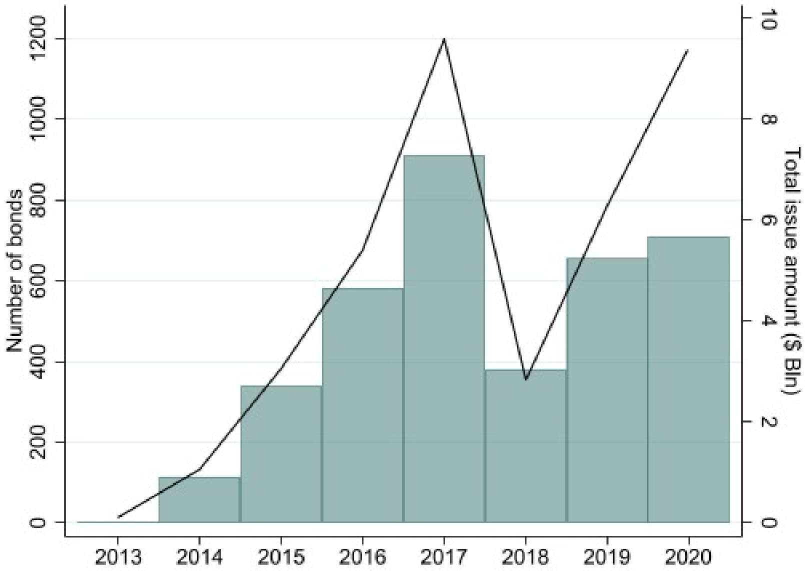


Figure 1 shows the distribution of our sample by year. The number and size of green bond issues increased substantially from 3 issues in 2013 to 911 issues in 2017 but dropped sharply in 2018. However, this drop is not specific to green bond issues but to all municipal bonds in general because of the 2017 Tax Cuts and Jobs Act, which eliminates the ability for municipal issuers to advance refund outstanding new money bonds on a tax-exempt basis. Nevertheless, the green bond market quickly regains momentum and has surged since 2019. In 2020 alone, the total green bond issues amounted to almost $10 billion.

2.3 Summary statistics

Table 1 reports the descriptive statistics of the green bonds in our sample. The average bond price is 114.22 (% of face value) with an average yield of 238 bps. The offering amount of most green bond issues is small. About 75% of green bond issuers raise fewer than $10 million. The smallest issue in our sample is only $55 thousand, while the largest issue raises $408 million. On average, green bonds have a coupon rate of 4.19% and mature in around 12 years. Moreover, about 55% of our sample green bonds are callable, 9% are taxable at the state level, and 43% are first-time issues.

Table 1: Summary statistics of green bonds

This table presents summary statistics of the green municipal bonds in our sample. The sample period runs from June 2013 to December 2022.

	N	Mean	St. Dev.	P10	P25	P50	P75	P90
Price (% Par)	3,699	114.22	11.07	100.00	103.61	116.02	122.52	127.27
Yield (%)	3,699	2.38	1.00	1.03	1.60	2.38	3.20	3.69
Issue Amount ($ MM)	3,664	10.29	23.42	0.43	1.26	3.36	9.91	24.89
Coupon (%)	3,699	4.19	1.14	2.25	3.85	5.00	5.00	5.00
Maturity (years)	3,699	12.20	7.60	3.36	6.30	10.93	16.92	22.68
Callable	3,699	0.55	0.50	0	0	1	1	1
State Taxable	3,699	0.09	0.28	0	0	0	0	0
First Green Issuance	3,699	0.43	0.50	0	0	0	1	1
Certification								
CBI	3,699	0.25	0.44	0	0	0	1	1
ICMA	3,699	0.16	0.36	0	0	0	0	1
CBI & ICMA	3,699	0.10	0.30	0	0	0	0	0
Credit Rating								
AAA	3,699	0.34	0.47	0	0	0	1	1
AA	3,699	0.52	0.50	0	0	1	1	1
A	3,699	0.12	0.32	0	0	0	0	1
BBB	3,699	0.02	0.12	0	0	0	0	0
BB or Not Rated	3,699	0.01	0.09	0	0	0	0	0
Reference Bonds								
Number of Bonds	3,699	14.31	6.27	7	9	14	18	23
Round-Trip Costs (%)	3,498	0.75	0.60	0.13	0.30	0.54	1.11	1.54
Amihud $\times 10^6$	3,699	0.79	0.88	0.29	0.41	0.63	0.93	1.48

Regarding the third-party certification, 25% of our bonds are certified by Climate Bond Initiative (CBI), 16% by the International Capital Market Association (ICMA), and 10% by both. For credit ratings, we translate Moody's and Fitch's ratings to the S&P scale and take the maximum of the available ratings for each bond. Almost all bonds in our sample are investment-grade, with 34% rated as AAA and 52% as A.A. Only 1% are rated as B.B. or not rated by any of the three rating agencies.

3 Methodology

In this section, we explain our methodology to estimate the premium of green bonds over equivalent synthetic conventional bonds from the same issuer.

3.1 Theoretical bond price and bootstrapped yield curve

Based on the no-arbitrage pricing principle, any fixed coupon bond can be replicated by holding a portfolio of zero coupon bonds with maturities corresponding to the coupon dates. Hence, the theoretical bond price equals the present value of all future coupon payments and principal, which are discounted using the zero curve. More precisely, suppose a bond pays deterministic coupon c_τ at time T_τ, $\tau = 1, \ldots, n$, and principal value K at maturity T_n, the price, B_t, at a time $t < T_1$, of this coupon bond is given by

$$B_t = K \cdot Z_{t,T_n} + \sum_{\tau=1}^{n} c_\tau \cdot Z_{t,T_\tau}, \tag{1}$$

where $Z_{t,T}$ denotes the price at time t of a zero coupon bond with maturity T.

The common practice to derive the associated zero-coupon yields is to bootstrap the yield curve using information from traded coupon bonds. Suppose we have traded prices of M traded bonds with different maturities from the same issuer. Let $B_{m,t}$ denote the price of bond m at time t, $i = 1, \ldots, M$, and Y_{mn} denote the payment of bond m at time n, $n = t+1, \ldots, t+N$. Y_{mn}'s may be zero, e.g., if bond m matures before $t+N$. Then, the associated zero-rates (discount factors) $Z_{t,t+1}, \ldots, Z_{t,t+N}$ must satisfy the following system of equations

$$\begin{pmatrix} B_{1,t} \\ \vdots \\ B_{M,t} \end{pmatrix} = \begin{pmatrix} Y_{1,t+1} & \cdots & Y_{1,t+N} \\ \vdots & \ddots & \vdots \\ Y_{M,t+1} & \cdots & Y_{M,t+N} \end{pmatrix} \begin{pmatrix} Z_{t,t+1} \\ \vdots \\ Z_{t,t+N} \end{pmatrix}. \tag{2}$$

This system has M equations with N unknowns, which can be solved numerically, and the estimated yield curve could be further smoothed by using linear interpolation. Using this bootstrapped zero-coupon curve, we can now calculate the theoretical price of any fixed-coupon bond from the same issuer at time t.

Note that the usual problem with bootstrapping from coupon bond prices is that the system of equations does not have feasible solutions, for example, when $M \ll N$ or when the Y-matrix contains too many zeros. This problem typically applies to corporate bonds but much less to municipal bonds, as most municipal issuers have many outstanding bonds with the same structure and coupon frequency but a wide range of maturities at any point in time. We will also test the robustness of our results by using alternative term-structure models such as the reduced-form T.S. model like Duffee (1999).

3.2 Estimating greenium

Our methodology follows the insights above and measures the greenium as the difference in the bond price (yield) between the green bond and an equivalent synthetic non-green bond constructed using the same cash flows and bootstrapped zero-coupon bonds as in Equation (1). In other words, we use a bootstrapped yield curve for each green bond to price it as if it is a conventional non-green bond.

More specifically, for each green bond i issued at time t by issuer j, we first collect information about all on-the-run conventional bonds from the same issuer j that have been traded in the week prior to t. We refer to these bonds as reference bonds. We then bootstrap the zero-coupon yield curve using the most recent prices of those reference bonds. As long as there are a few reference bonds with sufficiently different maturities, the bootstrapping approach is able to estimate the entire zero-coupon yield curve. Note that the bootstrapped yield curve captures the credit risk as the reference bonds are from the same issuer. Liquidity differences are also unlikely to drive our results as the reference bonds are on-the-run bonds with the best liquidity of their maturity.

We then use the bootstrapped zero-coupon yield curve to price bond i as if it is a conventional bond and obtain the estimated price, $\widehat{P}_{i,t}$, and its corresponding yield, $\widehat{Y}_{i,t}$. The premium of green bonds over conventional bonds is then defined in terms of prices as

$$\text{Price Greenium}_{i,t} = \frac{P_{i,t}^{Actual} - \widehat{P}_{i,t}}{\widehat{P}_{i,t}}, \tag{3}$$

and in terms of yield as

$$\text{Yield Greenium}_{i,t} = \widehat{Y}_{i,t} - Y_{i,t}^{Actual}. \tag{4}$$

3.3 Estimation errors

In practice, actual bond prices could deviate from their theoretical values because of other bond characteristics such as restrictive covenants, tax status, and embedded call or put options. While none of the existing credit risk models is able to price all possible characteristics, ignoring them would obviously introduce pricing errors in our estimation of greenium. However, as different characteristics move prices in different directions, it is theoretically unclear whether the estimation errors cancel out on average or lead to a systematic bias.

To better understand the potential estimation errors, we conduct a sanity check based

Table 2: Potential Estimation Errors

This table reports the errors in estimating prices and yields based on our methodology. In Panel A, we draw 500 random samples of 3,000 bond-week observations from all the on-the-run *conventional* bonds in MSRB. In Panel B, we draw 500 random samples of 3,000 new issues of *conventional* bonds whose issuers have trading data available in MSRB. For each randomly drawn observation, the estimation errors are the price and yield differences between theoretical and actual values calculated as in Equation (3) and (4). We compute the key statistics (e.g., mean, median, and confidence interval) of the errors in each sample, and report the average value of these statistics across the 500 random samples. The 99% confidence intervals (C.I.) are based on standard errors clustered at the issuer level.

						99% C.I.	
	N	Mean	P25	P50	P75	Lower	Upper
Panel A: Traded Bonds							
Error in Price Estimates (%)	500 × 3,000	0.01	-2.00	-0.02	1.67	-0.27	0.29
Error in Yield Estimates (%)	500 × 3,000	-0.02	-0.29	-0.01	0.27	-0.05	0.02
Panel B: New Issues							
Error in Price Estimates (%)	500 × 3,000	0.09	-0.90	0.00	1.04	-0.14	0.32
Error in Yield Estimates (%)	500 × 3,000	0.04	-0.09	0.00	0.14	0.01	0.07

on randomly drawn conventional bonds. We draw 500 random samples of 3,000 bond-week observations from all the on-the-run conventional bonds in our cleaned MSRB data. For each bond-week observation in each sample, the estimation error is the price and yield differences between theoretical and actual values calculated as in Equation (3) and (4). We winsorize the errors at the 1st and 99th percentiles to mitigate the impact of outliers and compute the key statistics (e.g., mean, median, and confidence interval) of the errors in each sample. The 99% confidence intervals (C.I.) are based on standard errors clustered at the issuer level, which corrects for potential sampling biases from large issuers with many traded bonds. The average value of these statistics across the 500 random samples are reported in Panel A of Table 2.

We find that the average error in price estimates is 0.01% and in yield estimates is -2 bps. The quantiles and confidence intervals further imply that the estimation errors remain close to zero and statistically insignificant, suggesting that our methodology provides unbiased price and yield estimates for traded bonds. Moreover, we repeat the same exercise on 500 randomly drawn samples of 3,000 new issues of conventional bonds whose issuers have trading data available in MSRB. As shown in Panel B of Table 2, the estimation errors in the offering prices remain close to zero and statistically insignificant, whereas the estimation errors in the issue yields are statistically significant. Nevertheless, the average error in issue yield estimates is only 4 bps with a 99% confidence interval ranging from 1 to 7 bps, which is economically very small. As shown later, our estimates of the yield greenium are magnitudes larger.

Hence, this simulation analysis shows that, even though our methodology does not explicitly model all possible bond characteristics, it provides reliable estimates for bond prices and yields. The simulation results are not surprising as our methodology carefully controls for credit and liquidity risks, the two factors that are shown to be the primary drivers of bond prices in the municipal market (e.g., Schwert, 2017; Cestau et al., 2019).

4 Greenium

In this section, we estimate the greenium at issuance and after trading for the green municipal bonds in our sample. To mitigate the impact of outliers, we winsorize the greenium estimates at the 1st and 99th percentiles.

4.1 Greenium on the primary and secondary markets

Panel A of Table 3 reports the key statistics (e.g., mean, median, and confidence interval) of the estimated price premium and yield greenium at the time of issuance. The 99% confidence intervals are based on standard errors clustered at the issuer level, which corrects for potential sampling biases from large issuers with many traded bonds. We find that the average price greenium is 2.8% and statistically highly significant with a 99% confidence interval ranging from 1.8% to 3.9%. The quantiles also imply that the majority of the price greenium is positive. Similarly, we find a significant yield premium with an average of 35 bps and a 99% confidence interval ranging from 24 to 46 bps. The offering greenium is also larger when municipalities issue green bonds for the first time. As shown in Panel B of Table 3, the average price greenium is 3.1%, and the average yield greenium is 38 bps.

Panel C of Table 3 further shows the greenium estimates from traded prices of green bonds on the secondary market. The average traded price premium is 1.9% with a 99% confidence interval ranging from 1.0% to 2.8%, corresponding to a yield premium with an average of 25 bps and a 99% confidence interval ranging from 12 to 37 bps. While the estimates of traded greenium are, on average, smaller than those of the offering greenium, the estimates imply that greenium remains significant on the secondary market. We defer the detailed discussion of the difference between offering and traded greenium to Section 5.

Table 3: Univariate Analysis of Greenium

This table reports the key statistics (e.g., mean, median, and confidence interval) of the estimated price premium and yield greenium (both in percentages). The 99% confidence intervals (C.I.) are based on standard errors clustered at the issuer level. Panel A reports the estimates at the time of issuance. Panel B reports the price premium and yield greenium estimates when the issuer offers green bonds for the first time. Panel C reports the estimates of price and yield greenium after trading on the secondary market.

						99% C.I.	
	N	Mean	P25	P50	P75	Lower	Upper
Panel A: At Issuance							
Price Greenium (%)	3,699	2.84	0.04	1.17	5.16	1.79	3.90
Yield Greenium (%)	3,699	0.35	0.01	0.20	0.61	0.24	0.46
Panel B: First Green Issue							
Price Greenium (%)	1,594	3.11	0.07	1.29	5.39	1.88	4.33
Yield Greenium (%)	1,594	0.38	0.01	0.21	0.62	0.24	0.52
Panel C: Secondary Market							
Price Greenium (%)	77,655	1.93	-0.51	0.81	4.36	1.01	2.84
Yield Greenium (%)	77,655	0.25	-0.09	0.13	0.53	0.12	0.37

Overall, the economically sizeable estimates of both offering and traded greenium suggest that green investments have value to municipal bond investors beyond the assets' expected risk and return attributes.

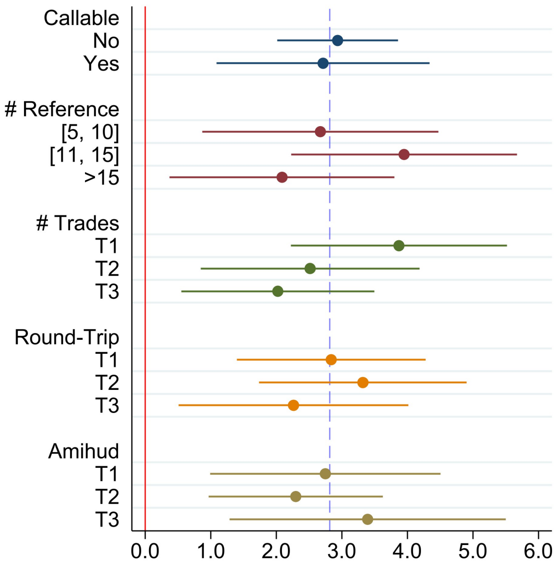
4.2 Greenium and pricing frictions

There could be some potential pricing frictions that drive our results. First, 55% of our sample are callable bonds, which are known to have a lower price (higher yield) than identical non-callable bonds. As our methodology treats those bonds as if they are non-callable, we could still find a premium even in the absence of greenium. To check whether callability drives our results, we divide our sample into callable and non-callable bonds and plot the average greenium and the corresponding 99% confidence intervals from the two groups separately in Figure 2. If callability explains the greenium estimates, we expect only to observe a significant greenium for callable bonds and an insignificant greenium for non-callable bonds. However, we still find a significant greenium for non-callable bonds. If anything, the greenium for non-callable bonds is even higher than for callable bonds.

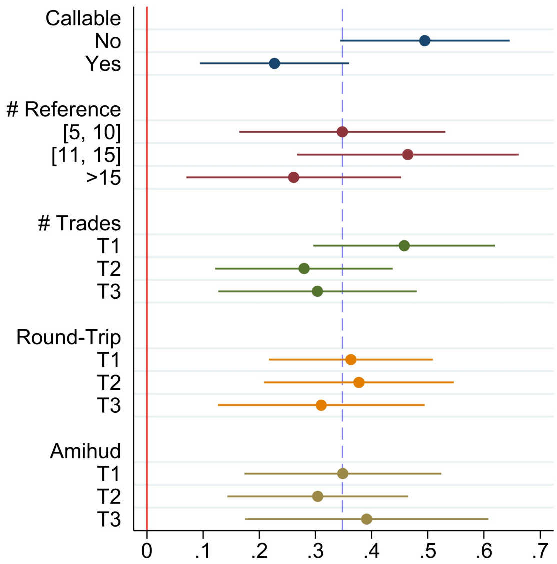
Second, the number of conventional bonds used in the bootstrapping procedure could affect the quality of the estimated zero-coupon yield curve. A low number of reference

Figure 2: Greenium and Potential Pricing Frictions

This figure shows how the offering greenium varies with different measures of potential pricing frictions. Panel (a) and (b) plot the results for price greenium and yield greenium, respectively. We consider the following pricing frictions: 1) whether the bond is callable; 2) the number of the reference conventional bonds; 3) the trading activity of reference bonds proxied by the average number of trades per day; 4) illiquidity proxied by the average round-trip cost of the reference bonds; 5) illiquidity proxied by the average Amihud value of the reference bonds. For the trading activity and illiquidity measures, we divide the sample into their terciles. We plot the average greenium and the corresponding 99% confidence intervals based on standard errors clustered at the issuer level. The dashed blue line represents the average greenium in our baseline analysis.



(a) Price Greenium (%)



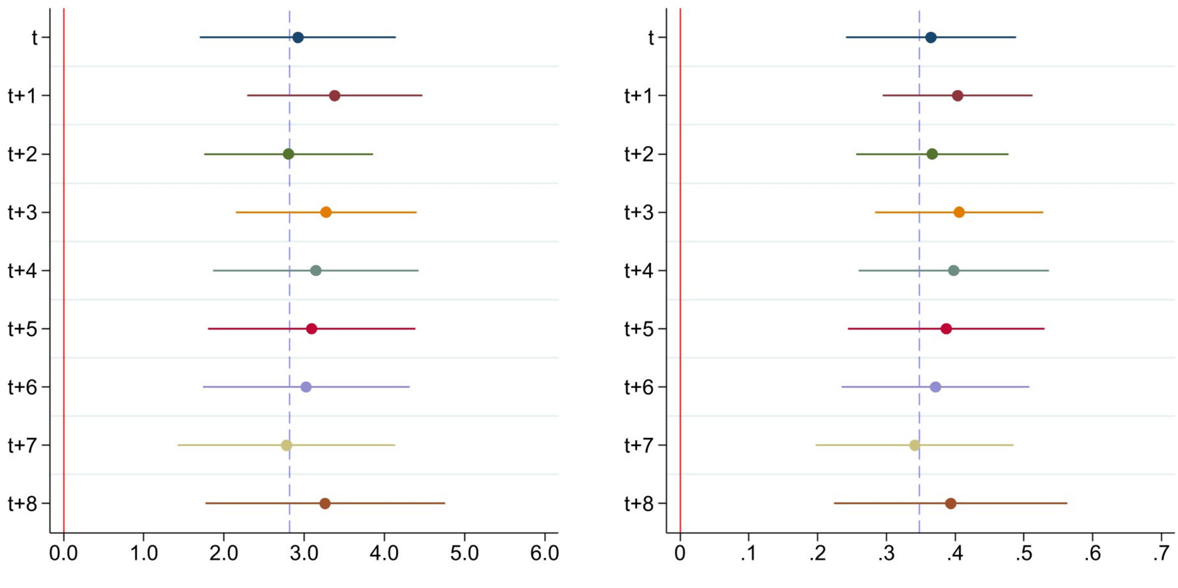
(b) Yield Greenium (%)

bonds also suggests that conventional bonds from the same issuer are traded infrequently and therefore have less efficient prices. While we exclude green bonds for which we find fewer than 5 reference bonds, about 30% in our sample still have fewer than 10 reference bonds. To test whether those cases drive our results, we divide the green bonds into three groups based on the number of reference bonds, between 5 and 10 bonds, 11 and 15 bonds, and more than 15 bonds. If poorly estimated zero-curves or inefficient prices drive our results. In that case, we would expect to see the highest greenium for green bonds in the first group and the lowest and insignificant greenium in the third group. As evident in Figure 2, we find no relationship between the number of reference bonds and our greenium estimates. The greenium estimates remain significant and indistinguishable from the baseline in all three groups.

A related concern is the illiquidity in the municipal bond market, which causes high trading costs and hinders price formation and efficiency. To check whether the underlying reference bonds' illiquidity or transaction costs drive our results, we follow Schwert (2017) to use three measures of bond liquidity and divide our green bonds into terciles of these measures, respectively. The first measure is the number of trades in the month before green bond issues, and more trades imply higher liquidity and trading activity. The second is the median of daily round-trip costs within the month before green bond issues, and lower round-trip costs imply higher liquidity. The third is the average price impact measure of Amihud (2002) in the month before green bond issues, and a lower Amihud price impact implies higher liquidity. We take the average across reference bonds used for each green bond for all the above three measures. Figure 2 shows no relationship between these liquidity measures and our greenium estimates. The greenium also remains significant and similar to the baseline when the reference bonds have the highest liquidity.

Figure 3: Greenium based on post-issuance prices of reference bonds

This figure shows the greenium estimated using reference conventional bonds traded in the weeks after the green bond issuance. Panel (a) and (b) plot the results for price greenium and yield greenium, respectively. We plot the average greenium and the corresponding 99% confidence intervals based on standard errors clustered at the issuer level. The dashed blue line represents the average greenium in our baseline analysis.



(a) Price Greenium (%) **(b)** Yield Greenium (%)

Another concern is that the issuance of green bonds may coincide with new green projects, and these new projects, instead of the investors' green preferences, can also change the costs of capital for the issuers. Consequently, our greenium estimates may just capture the value of the new projects that have not yet been incorporated into prices of the conventional reference bonds in the week prior to green bond issues. To address this concern, we re-estimate greenium using prices of reference bonds traded in the same week of green bond issuance, week t, as well as in each of the eight weeks after the issuance, week $t+1, \ldots, t+8$, respectively. If our greenium estimates only capture the value of new green projects, when these projects get incorporated (possibly slowly) in the prices of the conventional bonds from the same issuer, we would see the greenium decrease the weeks after issuance. However, as shown in Figure 3, we find no such pattern. If anything, in most cases, the average greenium is even slightly higher than the baseline.

Taken together, the results show no evidence that our greenium estimates are explained by the callability of green bonds or by commonly known pricing frictions in the municipal bond market. We also obtain similar results when conducting the same set of tests for traded greenium.

In the rest of the paper, we follow the green bond literature to focus our discussion on the yield greenium for brevity. The results for the price greenium remain qualitatively identical and available upon request.

5 Green Halo Effect

In this section, we investigate and discuss in greater detail why the greenium of first-time issues is higher and why the greenium is lower after trading on the secondary market. Specially, we find strong evidence that green bond issuance signals the issuer's climate commitment and reduces the yield of the conventional bonds from the same issuer, which is consistent with the so-called *green halo effects* (Harrison et al., 2020).

Recent studies suggest that green bonds can serve as signalling tools. Flammer (2021) show evidence that companies credibly signal their commitment toward the environment by issuing green bonds. Maltais and Nykvist (2020) find that the main incentives to issue green bonds may not be financial but rather reputation signalling. As engagement on ESG issues helps reduce issuers' downside risk (e.g., Hoepner, Oikonomou, Sautner, Starks, and Zhou, 2022) and bond yields (e.g., Hasan, Hoi, Wu, and Zhang, 2017), the signal of climate commitment from green bond issuance may also lower the yields of other outstanding conventional bonds from the same issuer. Therefore, the green halo effects predict that the yield differential between green and conventional bonds decreases over time, especially after the first green bond issues. While our results in Section 4.1 are consistent with this prediction, we now provide more corroborative evidence.

We start by showing that greenium decreases with the number of times a municipality has already issued green bonds prior to the current issue. Panel (a) of Figure 4 plots the average offering yield greenium by the number of times the issuer has already issued a green bond. The greenium is the highest when green bonds are issued for the first time and lower when issued repeatedly. The offering greenium becomes insignificant after the third time of green bond issuance. This pattern is consistent with the notion that first green bond issues send a strong commitment signal to the market, and this signalling effect is weaker for repeated issues.

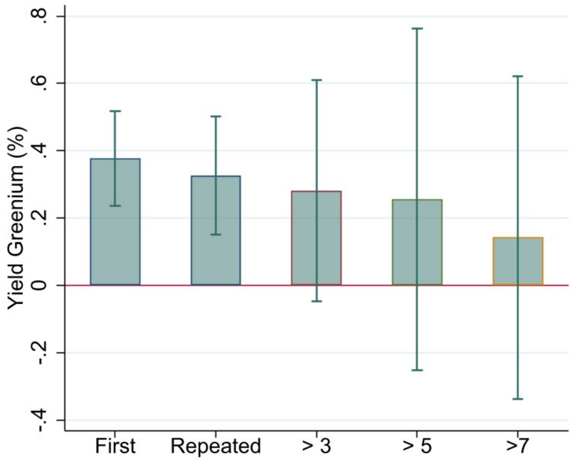
Next, Panel (b) of Figure 4 plots the quarterly changes of traded yield greenium relative to the offering greenium since green bond issuance. For first-time issues, the greenium after trading drops sharply by about 10 bps in the first year, decreases by another 6 bps in the second years and remains stable afterwards. For repeated issues, the greenium only declines significantly by 6 bps in the first two quarters, likely due to the lower offering greenium of repeated issues. These patterns suggest that the yield differential between green and conventional bonds decreases significantly after trading. Nevertheless, it is still unclear whether the lower yield differential is driven by increasing yields of green bonds ("no greenium") or decreasing yields of comparable conventional bonds ("green halo").

To explicitly test the green halo effect on the yield of conventional bonds, we plot in Panel (c) the quarterly yield changes of the conventional bonds around the quarter when the issuer offers a green bond for the first time. The yield changes are relative to the average yield in the quarter of green bond issuance. As is shown, we find a significant decrease in the yield of conventional bonds. Over the three years following green bond issuance, the yield of conventional bonds from the same issuer drops by about 23 bps on average. This is direct evidence of the green halo effect, which explains the lower offering greenium of repeated green bond issues and the lower traded greenium on the secondary market.

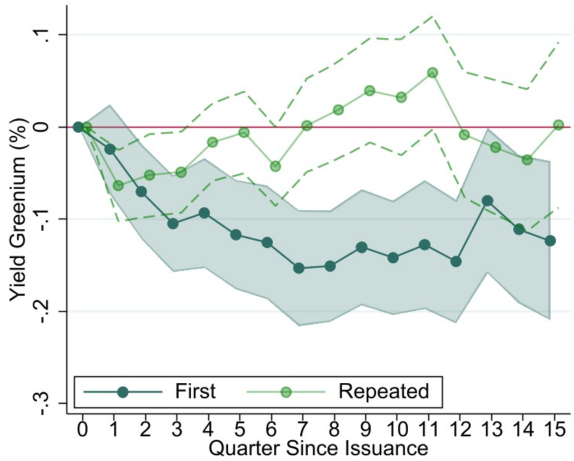
Last but not least, the green halo effect also helps reconcile the mixed evidence of greenium in the literature. Larcker and Watts (2020) is perhaps the most well-cited "no greenium" paper. The authors study a small sample of green municipal bonds issued simultaneously with conventional bonds and find no pricing difference at issuance. However, as discussed in Baker et al. (2022), the decision to bundle green and conventional bonds is endogenous. When we construct a similar sample of bundled green bond issues as that of Larcker and Watts (2020), we find that close to 80% of the bundled issues are also repeated issues for which the green halo is likely already in effect. This also suggests a smaller difference in offering yield between bundled green and non-green bonds.

Figure 4: Greenium and the Green Halo Effect

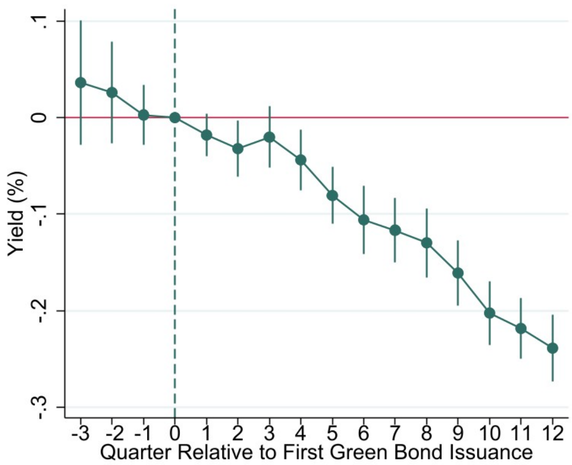
Panel (a) plots the average offering yield greenium by the number of times the issuer has already issued a green bond. Panel (b) plots the quarterly changes of traded yield greenium relative to offering yield greenium over the 16 quarters since issuance, with the results for the first-time issues (dark green) and the repeated issues (light green) plotted separately. Panel (c) plots the quarterly average yield changes of the conventional bonds over the 16 quarters around the quarter (0) when the same issuer offers a green bond for the first time. The changes are relative to the average yield in quarter 0. Panel (d) plots the β-estimates from Equation (5), which capture the yield differences between bundled non-green bonds and conventional bonds from the same issuer over time. The shaded area and dashed lines in Panel (b) and the error bars in Panel (c) and (d) represent the corresponding 99% confidence intervals based on standard errors clustered at the bond level.



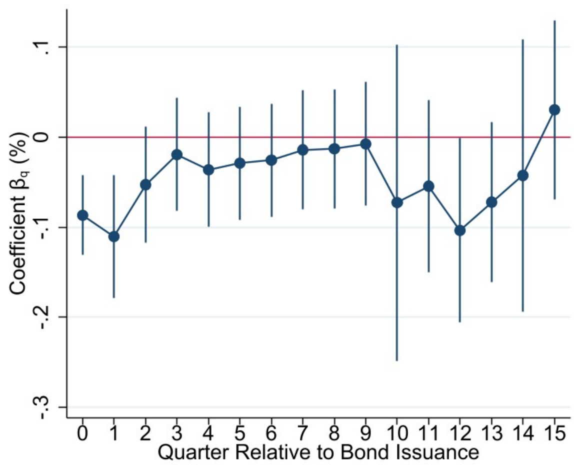
(a) First and Repeated Issues



(b) Traded Yield Greenium



(c) Traded Yield of Conventional Bonds



(d) "Greenium" of Bundled Non-Green Bonds

Moreover, we find evidence that the bundled non-green bonds have a similar pattern after trading on the secondary market as green bonds. In Panel (d) of Figure 4, we plot the β-estimates from the following regression specification,

$$Y_{ijt} = \sum_{q=0}^{15} \beta_q \mathbf{1}\{Quarter_{ijt} == q\} \times \mathbf{1}\{Bundle_j\} + \gamma' X_{jt} + \alpha_i + \alpha_t + \varepsilon_{ijt}, \tag{5}$$

where Y_{ijt} is the yield of bond j issued by municipality i in week t, $Quarter$ indicates the time since the bundle issuance, $\mathbf{1}\{Bundle_j\}$ is a dummy equal to 1 if bond j is a non-green conventional bond in the bundled issue, X_{jt} includes the bond-specific coupon and maturity and time-varying bond age in years, α_i and α_t are respectively the issuer and year-quarter fixed effects. We estimate this regression for bundled non-green bonds and conventional bonds from the same issuer. We find a significantly lower yield of around 10 bps for bundled non-green bonds relative to conventional bonds in the first half year since the bundle issuance, which is very similar to the traded greenium of repeated green bond issues in Panel (b). This finding is in line with the argument in Baker et al. (2022): as bundled issues share the same offering document and marketing effort, it is unclear whether investors are able to distinguish green bonds from non-green bonds given the close connections. Taken together, our findings suggest that the green halo effects and the similarities between green and non-green bonds help reconcile the zero offering greenium of bundled green bond issues.

6 Variations in Greenium

In Section 4, we provide compelling evidence that the greenium in the municipal market is economically sizable and statistically significant. This finding suggests that the marginal investor in the municipal market is willing to forgo returns to invest in eco-friendly assets. Nevertheless, there is a significant variation in both offering and traded greenium, with an interquartile range of about 60 bps. In this section, we examine and discuss the cross-sectional and time-series variations in greenium.

6.1 Greenium by bond characteristics

Issuance Size First, for a greennium to emerge, investors with green preferences must be the marginal investors or traders such that the amount of green demand is sufficient to clear the entire supply of the green bond issue at a higher price. When the issuance size of the green bond is large, there may be a lack of green investor demand to meet this large green supply, leading to lower or no greenium. To provide insight into the supply-demand effects, we analyze the relationship between the issuance size of a green bond and its greenium estimate. We plot the average offering greenium by issuance size terciles in Panel (a) of Figure 5. While we find no apparent relationship between issuance size and greenium, it is noteworthy that the greenium remains sizable even in the highest supply terciles (average issuance size of $26 million). The average offering greenium is 40 bps among first-time issues and 25 bps among repeated issues. Therefore, a lack of green investor demand is unlikely, even for large bond issues.

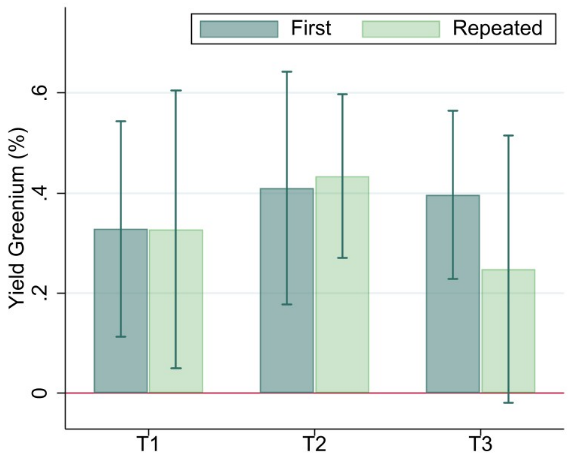
Third-Party Certification Second, we examine the impact of third-party certification on the offering greenium. One of the main concerns among green bond investors is greenwashing (e.g., Grene, 2015). That is, the issuance of securities labelled as green actually lacks genuine environmental benefits. There are no universally agreed-upon criteria for green bonds. Any municipality can issue a bond under a green label as long as it can convince investors of the environmentally friendly purposes of the bond issues. As a result of the lack of standardization in this market, several third-party institutions have emerged to certify green bond issuers' use of funds for eco-friendly purposes. Approved verifiers verify bond issuers' compliance with their standards for a small fee. Among green municipal bonds, the Climate Bond Initiative (CBI) and the International Capital Market Association (ICMA) are the two primary certification providers (Chiang, 2017).

We manually identify the bond issues with a certification in our sample and plot the average offering greenium of issues with or without a certification in Panel (b) of Figure 5. We only consider the certification effect on first-time issues because issuers tend to pay for the certification of all their bonds. Extant certification is likely to downward-bias the greenium of repeated issues due to the green halo effect. We find that first green bond issues with either certification (CBI or ICMA) earn a higher offering greenium. When an issue is certified by both CBI and ICMA, its greenium is about 80 bps, more than twice as large as that of other issues (35 bps). This difference falls just short of statistical significance ($t = 1.51$) as we have only 109 issues with both certifications. Nevertheless, third-party certification seems to alleviate investors' concern about greenwashing and thereby increases the green demand.

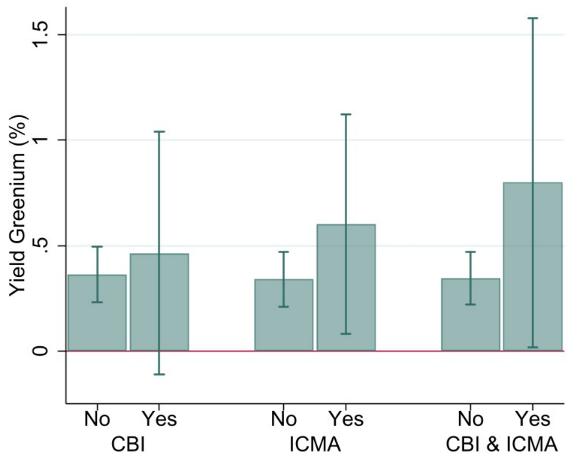
Credit Rating Third, we break down the offering greenium by green bonds' credit rating at issuance. A high credit rating implies that the issuer is financially healthy and, therefore, less likely to misuse the proceeds of green bonds for other purposes than green investments. Thus, if the greenium is higher when investors are less concerned about greenwashing and trust the issuers more, we expect to see a higher greenium for bonds with better credit ratings. To test this hypothesis, Panel (c) of Figure 5 plots the average

Figure 5: Greenium by Issuance Size, Third-Party Certification, and Credit Rating

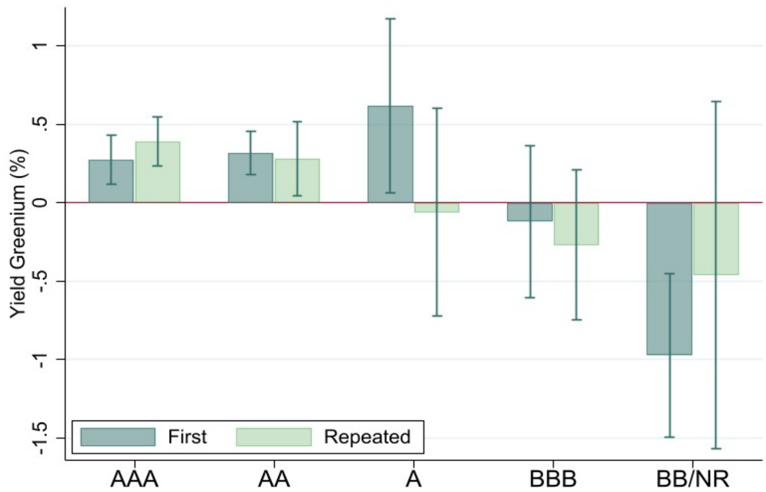
This figure shows how the offering greenium varies with issue sizes and credit ratings. Panel (a) plots the average yield greenium by issue amount of terciles. Panel (b) plots the average yield greenium of first-time issues with or without a third-party green bond certification (CBI or ICMA). Panel (c) plots the average yield greenium by credit ratings. Both panels plot the results for the first-time (dark green) issues and repeated (light green) issues separately. The error bars represent the corresponding 99% confidence intervals based on standard errors clustered at the issuer level.



(a) Issue Amount Tercile



(b) Third-Party Certification



(c) Credit Rating

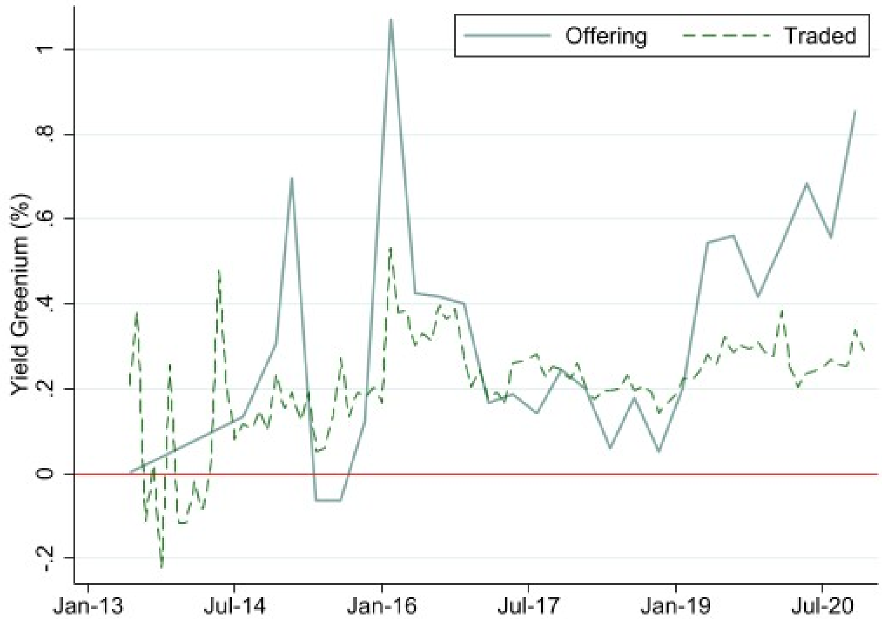
yield greenium by credit ratings, from AAA to B.B. and not related, for the first time and repeated issues respectively. We find a clear pattern that the greenium is higher as the rating improves. The offering greenium is significantly positive for bonds with AAA to A ratings and insignificant or even negative for BBB or lower ratings. The difference between first-time and repeated issues is mostly insignificant. This pattern is consistent with our conjecture that demand from green investors is higher when investors are less concerned about greenwashing.

6.2 Greenium over time

Next, we look at the greenium of the average green bond issues over time. We take the average offering greenium estimates across green bond issues each quarter and plot the quarterly average values from 2013Q2 to 2020Q4 in Figure 6. The offering greenium increased from nearly 0 bps in 2013 to about 70 bps in 2014. After that, it dropped to below 0 in 2015 and increased again in 2016. These fluctuations in the early years are not surprising given the immaturity of the green bond market back then and the small number of green issues before 2015. The peak in 2016Q1 is likely due to the Paris Agreement, which significantly increases investors' awareness of climate change and sustainability. The offering greenium dropped to around 20 bps in 2017-18 and has increased again since 2019. The monthly average of traded greenium shows a very similar pattern.

Figure 6: Greenium over Time

This figure shows how greenium varies over time. We plot the quarterly average offering greenium, and monthly average traded greenium from June 2013 to December 2020.



6.3 Cross-sectional analyses

We now use cross-sectional analyses to examine how the greenium relates to investors' ESG sentiment, local environmental regulation stringency, and climate policy uncertainty (CPU).

Green sentiment Since municipal bonds are mostly bought by local individuals either directly or through mutual funds, local investors' awareness of climate change and sustainability is likely to determine the demand for green bonds and, thereby, the greenium. To investigate this hypothesis, column (1) of Table 4 reports the panel regression of offering greenium on local investors' green sentiment and control variables. To measure local investors' green sentiment, we follow previous research to use monthly Google search trends for two specific green-related terms, "Climate Change" and "Global Warming", originated in the state where the green bond is issued (Pham and Huynh, 2020; Koziol et al., 2022). We control for issuance size and dummy variables, indicating whether the bond is callable, taxable at the state level, certified by CBI or ICMA, or a first-time issue. We also control for the state, maturity bucket, credit rating, and year-fixed effects. Standard errors are clustered at the issuer level.

The regression estimate implies that offering greenium increases by 34 bps when local investors have high green sentiment (i.e., the top quartile of Google search trends). To ensure that issue-specific factors do not drive this relationship, we further exploit the time-series variation in local green sentiment in column (4) by using the bond-week panel of traded green bonds and regressing the traded greenium on the green sentiment variable. We can also include bond-fixed effects in this panel regression to control for unobserved bond-specific variables. The coefficient on the sentiment variable remains positive and statistically significant, implying that traded greenium increases with the local green sentiment. Thus, the regression results are consistent with the idea that awareness of climate change increases demand for green assets and, thereby, the prices.

Regulation stringency As shown earlier in the paper, demand from green investors is likely higher when investors are less concerned about greenwashing. In addition to green bonds' third-party certification and credit rating, local environmental regulation may also play an important role in mitigating investors' concerns and increasing their trust in the issuers. In the U.S., significant environmental legislation exists at the federal level under the Environmental Protection Agency (EPA). However, state governments are primarily responsible for enforcing the laws, and states vary widely in their enforcement practices. Some states also impose additional environmental restrictions on those required by the EPA. More stringent local enforcement helps mitigate investors' concerns about

Table 4: Regression Analysis of Yield Greenium

This table shows the regression results of how the yield greenium correlates with investors' ESG sentiment, local environmental regulation stringency, and climate policy uncertainty (CPU). Panel A reports the results at the issue level, and Panel B reports the results at the bond-month level. In both panels, high green sentiment is a state-month-level dummy variable indicating whether the state belongs to the top quartile of Google search trends for two specific green-related terms, "Climate Change" and "Global Warming". High regulation stringency is a state-year-level dummy variable indicating whether the state belongs to the top quartile of environmental regulation stringency, measured as the number of enforcement cases divided by the number of facilities. High CPU is a month-level dummy variable indicating whether the month belongs to the top quartile of the climate policy uncertainty index developed by Gavriilidis (2021). Standard errors are clustered at the issuer level in Panel A and the bond level in Panel B, and the corresponding t-statistics are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10%, respectively

	Panel A: Offering Yield Greenium			**Panel B: Traded Yield Greenium**		
	(1)	(2)	(3)	(4)	(5)	(6)
High Green Sentiment	0.335***			0.047**		
	(3.080)			(2.238)		
High Regulation Stringency		0.137*			0.049***	
		(1.834)			(3.646)	
High CPU			0.303***			0.024**
			(2.921)			(2.095)
Log(Issue Amount)	0.008	0.008	0.007			
	(0.412)	(0.417)	(0.344)			
Callable	-0.379***	-0.395***	-0.413***			
	(-4.329)	(-4.479)	(-4.343)			
State Taxable	-2.734***	-2.710***	-2.469***			
	(-9.717)	(-9.745)	(-11.810)			
CBI	-0.126	-0.161	-0.170			
	(-1.286)	(-1.644)	(-1.513)			
ICMA	0.055	0.076	0.106			
	(0.548)	(0.760)	(1.023)			
First Green Issuance	0.096	0.084	0.051			
	(1.124)	(0.968)	(0.520)			
Bond Age				-0.017	-0.017	-0.016***
				(-0.194)	(-0.201)	(-2.978)
Observations	3,633	3,633	3,660	76,726	76,726	77,194
Adjusted R-squared	0.223	0.222	0.179	0.383	0.384	0.377
State, Maturity & Rating FE	Y	Y	Y			
Year FE	Y	Y	N			
Bond FE				Y	Y	Y
Year-Month FE				Y	Y	N

greenwashing or other environmental misconduct. Thus, even when two issuers are committed to the environment in an objectively similar way, depending on the local regulatory stringency, the demand for their green bonds can differ, driving pricing differences.

To test the idea that local environmental regulation stringency affects greenium, we follow Seltzer, Starks, and Zhu (2022) to measure state-level environmental regulatory stringency per year. We obtain EPA enforcement data from the Integrated Compliance Information System for Federal Civil Enforcement Case Data. For each state and year, we use the number of enforcement actions, both informal enforcement actions (notifications of violation) and formal enforcement actions (fines and administrative orders), and normalize the number of enforcement actions by the total number of facilities subject to EPA regulations in that state and year. In column (2) of Table 4, we regress the offering greenium on this state-level regulation stringency variable and the same control and fixed effects set. The coefficient estimate implies that offering greenium increases by 14 bps when local environmental regulation and enforcement are more stringent (i.e., top quartile of the regulation stringency variable). This effect is also not confounded by unobserved issue-specific factors, as we find a significant effect when estimating for traded greenium using the bond-week panel of traded green bonds in column (5). The traded greenium of the same bond increases when local regulation becomes more stringent.

Climate policy uncertainty A related issue is the uncertainty of climate policies. Despite the growing number of policies aiming to tackle climate change, substantial uncertainty can exist regarding implementing such policies. A higher climate policy uncertainty may lead to greater green demand as investors use green assets to hedge against such uncertainty. To test this hypothesis, we use the monthly Climate Policy Uncertainty (CPU) index developed by Gavriilidis (2021) and regress the offering greenium on this CPU index and the same set of control variables and fixed effects, except the year fixed effects. As shown in column (3) of Table 4, the coefficient estimate is positive and statistically significant, implying that offering greenium increases by 30 bps when the climate policy uncertainty is high (i.e., top quartile of the CPU index). This effect is again not confounded by unobserved issue-specific factors, as the effect remains significant for traded greenium estimated using the bond-week panel of traded green bonds in column (6). The traded greenium of the same bond increases with climate policy uncertainty.

In sum, our findings suggest that greenium is driven by the demand from green investors, which is high when investors are less concerned about greenwashing, become more aware of climate change, and have more trust in issuers' sustainability commitment because of local environmental regulation and enforcement.

7 Conclusion

Despite the popularity of ESG investing, the motivations for adopting this investment approach remain unclear. In particular, whether investors are willing to forgo financial returns for environmental and social benefits is debatable among academics and unclear among industry practitioners. Recent studies have started to use green bonds to empirically study investors' preferences for green assets but find mixed evidence depending on the sample selection and methodology. We propose a new method to estimate the greenium by comparing green bonds with equivalent non-green synthetic bonds constructed using bootstrapped yield curves.

Empirically, our greenium estimates are statistically significant and economically sizable both at issuance and after trading. We show that other bond characteristics or commonly known pricing and trading frictions cannot explain this result. We also find strong evidence of the green halo effects, which helps explain why previous studies fail to find a sizable greenium. Finally, our greenium estimates are higher when investors are less concerned about greenwashing, more aware of climate change, and have more trust in issuers' environmental commitment because of local environmental regulation and enforcement. More importantly, the significant greenium is direct evidence that investors prefer green assets when expected risk and return are constant.

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Appendix

A Sample construction

Table A1

This table describes the data cleaning steps in constructing our green municipal bond sample.

Data cleaning steps	Bonds	Issuers
Full Bloomberg green bond sample	10,951	636
Remove issues dated before June 2013	10,433	543
Drop issues smaller than $100,000	10,021	543
Remove federally taxable issues	8,651	453
Keep fixed-rate coupon bonds	8,555	437
Keep issuers with MSRB data	6,860	285
Keep issues with 5 or more conventional bonds traded in the week before the green bond issuance	3,699	115