

IS THERE A “GREENIUM” IN INDIAN CAPITAL MARKETS? AN EMPIRICAL ANALYSIS OF SOVEREIGN AND CORPORATE GREEN BOND PRICING

Amulya Bahadur Singh

Research Scholar Department of Applied Economics and Commerce, Patna University

amulyabahadur@gmail.com

ARTICLE INFO.

Keywords: greenium; green bonds; sovereign green bonds; corporate green bonds; India; yield differential.

Abstract

Green bonds are issued to finance projects with environmental benefits. A central pricing question is whether they carry a lower yield than comparable conventional bonds—the differential known as the greenium. India offers a useful setting because it has two distinct segments: sovereign green bonds auctioned by the Reserve Bank of India since January 2023, and corporate green bonds issued under SEBI’s disclosure framework. This study examines whether a significant greenium exists in Indian capital markets and whether sovereign and corporate greeniums differ.

Greenium is defined as conventional yield minus green yield, in basis points. Sovereign data consist of eleven completed auctions (January 2023–February 2025) paired with same-tenor government securities and are tested with parametric, non-parametric, bootstrap, time-pattern and sensitivity methods. Corporate evidence is screened from published matched-pair studies against the same rule. The paper finds a small positive sovereign greenium that declines over time, directionally consistent but unverified corporate magnitudes, and an indicative rather than confirmatory comparison between segments.

<http://www.gospodarkainnowacje.pl/> © 2026 LWAB.

1. Introduction

Green bonds are debt securities whose proceeds are earmarked for environmental projects. A central empirical question is whether investors accept a lower yield on a green bond than on an otherwise comparable conventional bond. If they do, the gap—called the greenium—means issuers can borrow more cheaply by labelling a bond green. Theory is ambiguous: environmental preferences and lower transition risk can compress yields, while liquidity premia, verification costs and greenwashing concerns can widen them. International evidence generally finds a small positive greenium[1], larger in emerging markets for sovereigns[2][3].

India has two green-bond segments. Corporate issuers place green debt under SEBI’s framework[4]. The Sovereign Green Bond Framework was approved in November 2022; the first RBI auctions on 25 January and 9 February 2023 raised ₹16,000 crore. By end-2024 India had issued USD 55.9 billion of labelled sustainable debt[5]. The inaugural five- and ten-year sovereign bonds cleared 5 and 6 bps

below conventional comparators; later auctions were mixed, with cancellations and partial acceptances. Published Indian pricing evidence is scattered and has not applied one definition and one method to both segments.

A yield differential is an association, not proof of investor motivation or a causal reduction in borrowing costs. This paper (i) states an explicit greenium rule, (ii) subjects the sovereign auction data to a full battery of small-sample tests and sensitivity checks, (iii) grades every corporate figure by verifiability, and (iv) reports only an indicative comparison between segments.

2. Institutional Background

Sovereign green bonds are sold by RBI auction under a framework aligned with ICMA Green Bond Principles. The first two auctions (January–February 2023) were fully accepted with strong demand. Subsequent auctions proved harder: the May 2024 auction was cancelled; three later ten-year auctions were accepted at only 21–30 % of the notified amount; and all bids for a 30-year bond were rejected in June 2025. Corporate green bonds are priced in a thinner market where issuer credit, rating and structure matter at least as much as the green label. The sovereign comparator is a conventional government security of identical tenor and credit risk; corporate matching is more complex. These structural differences limit direct statistical comparison of the two segments.

3. Research Gap

Zerbib[6] estimates a global greenium of about 2 bps after liquidity and maturity controls. Baker[7] report a 6 bp primary-market premium for US municipal green bonds. Löffler find 15–20 bps in matched samples. A systematic review reports a premium in 56 % of primary-market and 70 % of secondary-market studies, averaging 1–9 bps. For sovereigns, Ando estimate 4 bps in advanced and 11 bps in emerging economies; Panizza report roughly 2 bps and 13 bps respectively. Time variation is material: the premium peaked after the Paris Agreement and later reversed for many corporates[8][9].

Indian evidence is thinner. The inaugural sovereign auctions priced 5–6 bps below comparators. Arora[10] examines eleven completed auctions and describes the greenium as “structurally thin” at 2–3 bps. Naik[11] reports –9 bps for the August 2024 auction. Poola[12] analyse fifteen matched corporate pairs and report a green yield discount in every pair, ranging from small for highly rated PSUs and banks to above 150 bps for some private issuers. Singh[13] report a modest greenium for 22 SEBI-registered bonds; the accessible abstract gives no verified magnitude.

Research gap. Sovereign auction data have not been subjected to a complete small-sample test suite with sensitivity analysis. Corporate magnitudes lack pair-level documentation that a reader can verify. The two segments are sometimes treated as statistically comparable when they are not. This paper addresses these gaps within the limits of available data.

4. Objectives and Hypotheses

Objectives: (1) To examine the existence of greenium in Indian capital markets. (2) To compare greenium between sovereign and corporate green bonds.

H_{01} : There is no significant greenium in Indian capital markets.

H_{11} : There is a significant greenium in Indian capital markets.

H_{02} : There is no significant difference in greenium between sovereign and corporate green bonds.

H_{12} : There is a significant difference in greenium between sovereign and corporate green bonds.

H_{01} is operationalised as mean greenium = 0 in each segment; H_{02} as equality of the two segment means. All tests use a 5 % significance level and two-sided p-values. The sovereign component of H_{01} can be tested formally on 11 auctions. The corporate component can be assessed only for direction. H_{02} cannot be tested confirmatory-style; an indicative comparison is reported instead.

5. Methodology

5.1 Design, data and evidence grades

This is a secondary-data study. Sovereign yields are taken from the auction table in Arora, cross-checked against RBI releases and Business Standard reports for key auctions. Corporate evidence is drawn from Poola and Singh at abstract level. Every figure receives one of four evidence grades (Table 1).

Grade	Meaning	Treatment
A	Official record or figure calculated/tested in this paper from source yields	Used in all computations
B	Aggregate finding of a published study, not re-estimated	Reported as stated; not used in tests
C	Press, institutional or preprint statement	Context and sensitivity scenarios only
D	Attributed figure not confirmed against accessible text	Excluded from computations

Table 1: Evidence grades

5.2 Period, selection and matching

The sovereign analysis covers completed auctions from 25 January 2023 to 21 February 2025. An auction is included if a cut-off yield was set, part of the notified amount was accepted, and a same-tenor comparator yield is tabulated. The cancelled May 2024 auction is excluded, leaving 11 observations. For sovereigns the comparator is a conventional government security of identical tenor on the same or an adjacent day (identical credit risk). For corporates the standard is a same-issuer conventional bond matched on currency, seniority, rating and residual maturity.

5.3 Greenium calculation rule

$$G_i = (Y_{\text{conv},i} - Y_{\text{green},i}) \times 100 \quad (1)$$

Yields are in per cent per annum; a positive G means the green bond yields less than its comparator. Both yields must be on the same basis and date. Coupon-versus-later-yield comparisons, pairs differing in currency or seniority, and cancelled auctions are excluded. Press-reported yields are rounded to 0.01 %, so G is an integer with a tolerance of about ± 1 bp; this tolerance is tested in sensitivity analysis. Missing yields are not imputed; means are unweighted.

Worked example: 25 January 2023 five-year bond, $G = (7.15 - 7.10) \times 100 = +5$ bps; ten-year bond, $G = (7.35 - 7.29) \times 100 = +6$ bps.

5.4 Statistical methods

For sovereign data the paper reports: (i) descriptive statistics overall, by fiscal year and by tenor; (ii) one-sample t -test of H_{01} with 95 % t -interval, Shapiro–Wilk normality test and Cohen’s d ; (iii) exact Wilcoxon signed-rank and sign tests (non-parametric) and a percentile bootstrap interval (20,000 resamples); (iv) date-level averaging of same-day tranches; (v) time-pattern tests (Kruskal–Wallis, Welch, Mann–Whitney, Spearman, Kendall, OLS slope on auction sequence); (vi) tenor comparison; (vii) nine sensitivity scenarios that vary the comparator yield, add omitted auctions and bound the effect of cancelled auctions. All calculations were reproduced independently from the yields in Table 2. Corporate evidence is screened against the calculation rule and assessed directionally only.

6. Data Analysis and Hypothesis Testing

6. Data Analysis

6.1 Sovereign dataset and computed greenium

Table 3 lists every SGrB auction from January 2023 to February 2025, the cut-off yield of the green bond, the yield of the same-tenor conventional government security and the greenium computed under equation (1). The 11 completed auctions form the sovereign sample for all tests that follow. They cover three tenors (5, 10 and 30 years) and three fiscal years (FY2023 to FY2025).

Table 3: Completed Sovereign Green Bond auctions and computed greenium (Grade A)

Auction date	FY	Tenor (yrs)	SGrB yield (%)	G-sec yield (%)	Greenium (bps)
25 Jan 2023	FY2023	5	7.10	7.15	5
25 Jan 2023	FY2023	10	7.29	7.35	6
9 Feb 2023	FY2023	5	7.23	7.27	4
9 Feb 2023	FY2023	10	7.30	7.34	4
10 Nov 2023	FY2024	5	7.25	7.27	2
8 Dec 2023	FY2024	10	7.32	7.34	2
19 Jan 2024	FY2024	30	7.28	7.30	2
2 Feb 2024	FY2024	30	7.34	7.35	1
31 May 2024	FY2025	10	—	—	n.a. (cancelled; excluded)
2 Aug 2024	FY2025	10	6.90	6.90	0
13 Dec 2024	FY2025	30	6.98	6.98	0
21 Feb 2025	FY2025	30	7.07	7.07	0

Source: yields from Arora (2026), Table 3, cross-checked in part against RBI[14] and Business Standard; greenium computed by the author under equation (1). n.a. = not available.

Three further points about coverage. First, the 31 May 2024 auction was cancelled and has no clearing yield, so it cannot enter the calculation; Section 6.5 and Section 6.6 examine how much this omission could matter. Second, two ten-year auctions that did take place, in November 2024 and January 2025, are missing from the tabulation of yields; a November 2024 pair reported by RFMLR (6.79% against 6.81%, +2 bps) is used in a sensitivity scenario. Third, a compilation of long-tenor results suggested a recovery to 4 to 6 bps in FY2026, but the 13 June 2025 auction was cancelled with the greenium reported absent, so that claim is uncorroborated and is excluded.

6.2 Descriptive statistics

The 11 greenium values are 0, 0, 0, 1, 2, 2, 2, 4, 4, 5 and 6 bps. Eight auctions (72.7%) show a positive greenium, three show zero and none is negative. The mean is 2.36 bps, the median is 2 bps, the standard deviation is 2.11 bps, the standard error is 0.64 bps and the range is 0 to 6 bps. The distribution is mildly right-skewed (skewness 0.37) and bunched at low integer values, which is why the robustness tests in Section 6.3 do not assume normality. Table 4 breaks the sample down by fiscal year and by tenor.

Table 4: Descriptive statistics of the sovereign greenium (bps)

Group	n	Mean	SD	Median	Min	Max
All completed auctions	11	2.36	2.11	2.0	0	6
FY2023	4	4.75	0.96	4.5	4	6
FY2024	4	1.75	0.50	2.0	1	2

FY2025	3	0.00	0.00	0.0	0	0
5-year tenor	3	3.67	1.53	4.0	2	5
10-year tenor	4	3.00	2.58	3.0	0	6
30-year tenor	4	0.75	0.96	0.5	0	2

Source: author's calculation from Table 3.

The fiscal-year breakdown shows the main feature of the data: a steep fall in the average. The mean is 4.75 bps in FY2023, when only the two inaugural auctions took place, 1.75 bps in FY2024 and exactly zero in the three completed FY2025 auctions. The values for FY2023 and FY2024 agree with those reported by Arora and are verified here by recalculation from the tabulated yields.

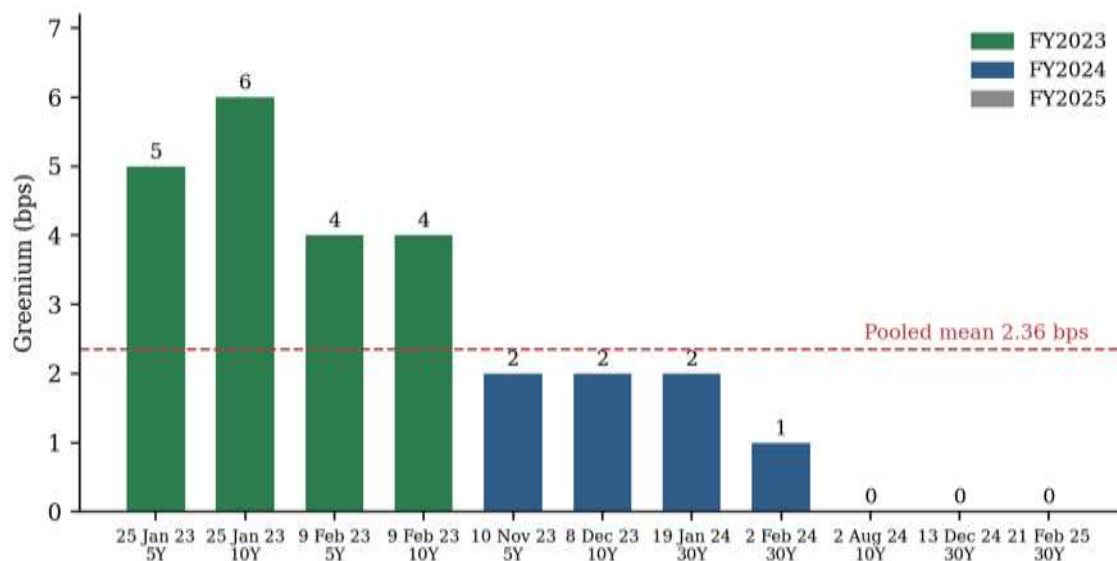


Figure 1: Greenium in each completed SGrB auction (bps)

Source: author's calculation from Table 3. The dashed line is the pooled mean.

6.3 Test of H_{01} for the sovereign segment

The first question is whether the mean sovereign greenium differs from zero. A one-sample t-test gives a pooled mean of 2.36 bps (standard error 0.64; 95% CI 0.95 to 3.78), $t(10) = 3.71$ and a two-sided p-value of 0.004. The null of no greenium is therefore rejected at the 5% level. The standardised effect is large (Cohen's $d = 1.12$), meaning that the mean lies more than one standard deviation above zero. The Shapiro–Wilk test does not reject normality ($W = 0.906$, $p = 0.216$), but with 11 integer-valued observations it has little power, so the result is checked against three methods that make weaker assumptions.

Table 5: Tests of H_{01} on the 11 completed sovereign auctions

Test	Result	p-value	Decision at 5%
One-sample t-test	Mean 2.36 bps; SE 0.64; $t(10) = 3.71$; 95% CI [0.95, 3.78]	0.004	Reject H_{01}
Exact Wilcoxon signed-rank (8 non-zero values)	$V = 36$	0.008	Reject H_{01}
Sign test	8 of 8 non-zero values positive	0.008	Reject H_{01}
Percentile bootstrap (20,000 resamples)	95% interval [1.18, 3.55]	Interval excludes 0	Reject H_{01}

Date-level t-test (9 distinct dates)	Mean 1.83 bps; $t(8) = 2.89$; 95% CI [0.37, 3.30]	0.020	Reject H_{01}
Shapiro–Wilk normality test	$W = 0.906$	0.216	Normality not rejected
Effect size	Cohen's $d = 1.12$	—	Large

Source: author's calculation. Wilcoxon and sign tests discard the three zero values. Two-sided p-values are reported; one-sided values are half as large.

All four approaches agree. The exact Wilcoxon signed-rank test ($V = 36$, two-sided $p = 0.008$) and the sign test (all eight non-zero values positive, $p = 0.008$) do not rely on the shape of the distribution, and the bootstrap interval of 1.18 to 3.55 bps lies entirely above zero. The date-level check addresses a different concern. Two dates, 25 January and 9 February 2023, each contain two tranches that were sold together and are unlikely to be independent. Averaging them gives 9 observations with a mean of 1.83 bps, and the result is still significant ($t(8) = 2.89$, $p = 0.020$), so the finding does not rest on treating same-day tranches as independent.

Three qualifications apply. The pooled average describes a period in which the greenium changed sharply and does not describe the market as it stands at the end of the sample. The sample excludes cancelled auctions, which may bias the mean (Section 6.6). And the result depends on the comparator yield (Section 6.5). With $n = 11$ and integer data, all p-values are indicative rather than exact.

6.4 Time pattern

Because the pooled mean averages very different periods, the time pattern is examined directly. Table 6 reports the tests.

Table 6: Tests of the time pattern in the sovereign greenium

Test	Result	p-value
FY2023 mean versus zero (t-test, $n = 4$)	4.75 bps; 95% CI [3.23, 6.27]; $t(3) = 9.92$	0.002
FY2024 mean versus zero (t-test, $n = 4$)	1.75 bps; 95% CI [0.95, 2.55]; $t(3) = 7.00$	0.006
FY2025 ($n = 3$)	All three values equal zero; test undefined	n.a.
FY2024–25 combined versus zero (t-test, $n = 7$)	1.00 bps; 95% CI [0.08, 1.92]; $t(6) = 2.65$	0.038
Kruskal–Wallis across three fiscal years	$H = 9.29$, $df = 2$	0.010
Welch test, FY2023 versus FY2024–25	Difference 3.75 bps; 95% CI [2.29, 5.21]; $t(6.6) = 6.15$	< 0.001
Mann–Whitney, FY2023 versus FY2024–25	$U = 28$	0.009
Spearman correlation, sequence and greenium	$\rho = -0.97$	< 0.001
Kendall correlation, sequence and greenium	$\tau = -0.90$	< 0.001
OLS slope on auction sequence	-0.61 bps per auction; 95% CI [-0.75, -0.47]; $R^2 = 0.92$	< 0.001

Source: author's calculation. Arora (2026) reports a regression on tenor, bid-to-cover ratio and a fiscal-year dummy in which no single coefficient is significant at 10% (fiscal-year dummy $p = 0.113$) while the joint F-test has $p = 0.004$. The simple tests above do not control for tenor or demand.

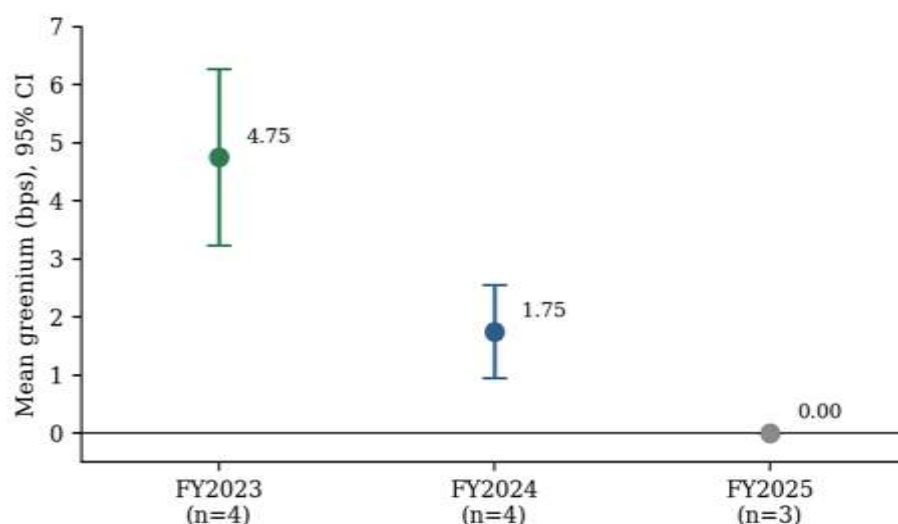


Figure 2: Mean greenium by fiscal year with 95% confidence intervals

Source: author's calculation from Table 3. FY2025 has zero variance, so no interval can be drawn.

The greenium was significantly positive in both FY2023 and FY2024, but at very different levels, and it was zero in FY2025. The fall is statistically strong: the FY2023 mean is 3.75 bps above the FY2024–25 mean (Welch $p < 0.001$), the rank correlations with auction sequence are close to -1 , and the fitted slope implies a loss of about 0.6 bps per auction. The FY2024–25 sub-sample is still weakly positive (1.00 bps, $p = 0.038$), but this comes entirely from FY2024. In the three FY2025 auctions the sovereign bond cleared exactly at its comparator.

The tenor comparison in Table 4 raises an obvious question, because the three 30-year auctions that carry the lowest values all occurred late in the sample. The 5-year tenor has a mean greenium of 3.67 bps ($n = 3$), the 10-year tenor 3.00 bps ($n = 4$) and the 30-year tenor 0.75 bps ($n = 4$), but the differences are not significant (Kruskal–Wallis $H = 3.99$, $p = 0.136$). More informative is the pattern within each tenor. In the 5-year series the greenium runs 5, 4, 2 bps; in the 10-year series 6, 4, 2, 0 bps; and in the 30-year series 2, 1, 0, 0 bps. Every series falls over time, so the decline cannot be explained by a shift in tenor mix alone. With 11 observations, however, tenor, time and demand are partly collinear, and the tests do not explain why the greenium fell. Interest rates, the investor base and the issuer's own acceptance behaviour also changed over the period.

6.5 Sensitivity analysis and a data discrepancy

The pooled result depends on how the comparator yield is measured and on which auctions are in the sample. Sources disagree on the August 2024 comparator. Arora and Business Standard, which report a 6.90% cut-off against a 6.90% benchmark, imply a greenium of zero. RFMLR reports a 6.89% cut-off against a 6.80% government security rate, which is -9 bps, and Naik also reports -9 bps. RFMLR also reports a November 2024 ten-year auction at 6.79% against 6.81% (+2 bps), which is absent from the tabulation. In addition, because yields are rounded to two decimals, comparator timing can shift each value by about 1 bp. Table 7 shows how the pooled result moves under nine alternative scenarios[15].

Table 7: Sensitivity of the pooled sovereign greenium

Scenario	n	Mean (bps)	95% CI	p (t-test)	CI excludes 0
Baseline: 11 completed auctions	11	2.36	[0.95, 3.78]	0.004	Yes
S1: Aug 2024 comparator	11	1.55	[-1.15, 4.24]	0.230	No

gives -9 bps					
S2: add Nov 2024 ten-year (+2 bps)	12	2.33	[1.05, 3.61]	0.002	Yes
S3: S1 and S2 together	12	1.58	[-0.85, 4.01]	0.179	No
S4: all comparators +1 bp	11	1.36	[-0.05, 2.78]	0.058	No
S5: all comparators -1 bp	11	3.36	[1.95, 4.78]	< 0.001	Yes
S6: exclude FY2023 launch auctions	7	1.00	[0.08, 1.92]	0.038	Yes
S7: add cancelled May 2024 auction at -1 bp	12	2.08	[0.66, 3.50]	0.008	Yes
S8: add cancelled May 2024 auction at -7 bps	12	1.58	[-0.56, 3.72]	0.132	No
S9: S1 and S8 together	12	0.83	[-2.06, 3.72]	0.539	No

Source: author's calculation. S1, S2 and S7–S9 use Grade C inputs and are scenarios, not corrections. S4 and S5 reflect the ± 1 bp tolerance. S7 and S8 use the bounds of the reported range of bids for the cancelled auction (1 to 7 bps above the benchmark), not a midpoint.

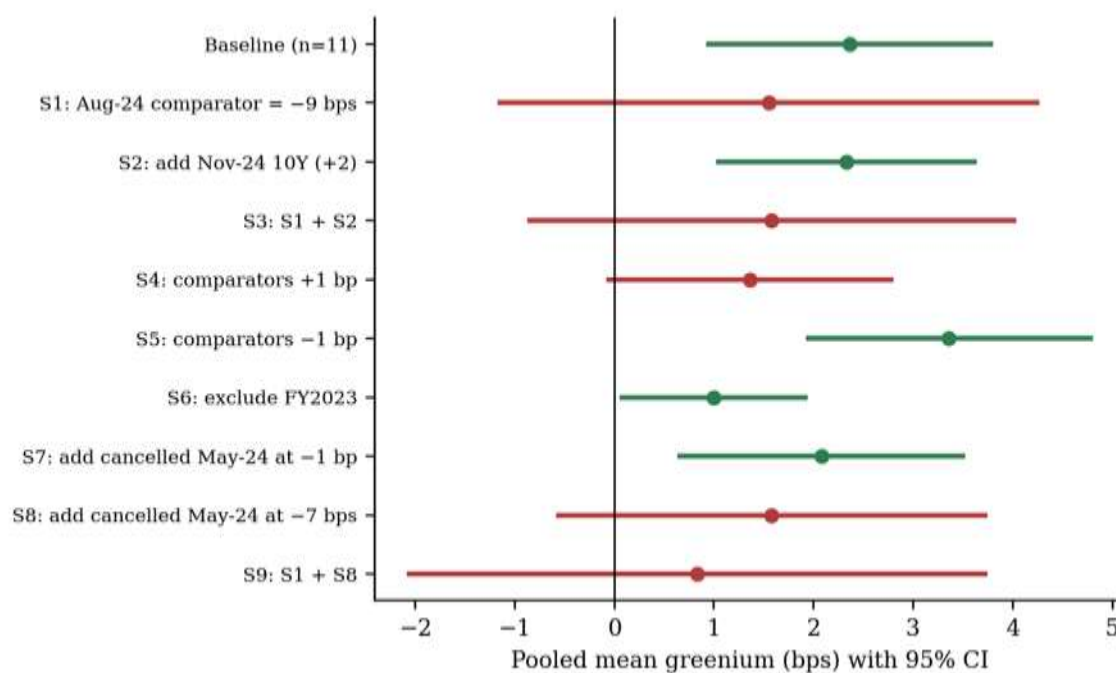


Figure 3: Pooled mean greenium and 95% confidence interval under each scenario

Source: author's calculation. Intervals that include zero are shown in red.

The mean stays positive in every scenario, ranging from 0.83 to 3.36 bps, but significance is fragile. The confidence interval includes zero in five of the nine alternative scenarios. A single comparator change for August 2024 (S1) is enough to remove significance, a uniform 1 bp shift in comparators (S4) leaves the interval just touching zero, and the conclusion fails whenever the cancelled May 2024 auction is imputed near the bottom of its reported range (S8, S9). The result is more robust to additions that raise the mean (S2, S5, S7) and holds when the launch auctions are removed (S6). The honest summary is that a small positive sovereign greenium is likely, that its sign is robust, but that statistical significance of the pooled average depends on assumptions the data cannot settle.

6.6 Auction outcomes and the selection problem

Yield does not describe the whole market. Table 8 summarises how each auction ended.

Table 8: Outcomes of the Sovereign Green Bond auctions

Date	Tenor	Notified (₹ crore)	Outcome	Source
25 Jan 2023	5Y and 10Y	4,000 each	Fully accepted; nil devolvement; bids about ₹32,892 crore against ₹8,000 crore	RBI; RFMLR
9 Feb 2023	5Y and 10Y	4,000 each	Fully accepted; nil devolvement	RBI
31 May 2024	10Y	Not stated	Cancelled; bids reported 1–7 bps above benchmark	Business Standard; IEEFA
2 Aug 2024	10Y	6,000	₹1,697 crore accepted (28.3%); substantial devolvement	Business Standard
Nov 2024	10Y	5,000	₹1,502 crore accepted (30.0%)	RFMLR
13 Dec 2024	30Y	Not stated	Reported fully subscribed	Business Standard
31 Jan 2025	10Y	5,000	₹1,054 crore accepted (21.1%); ₹3,945 crore devolved	Business Standard
21 Feb 2025	30Y	Not stated	Reported fully subscribed	Business Standard
13 Jun 2025	30Y	5,000	All bids rejected; bids ₹10,943.5 crore (2.19 times)	Business Standard; IEEFA

Source: RBI (2023a, 2023b); Business Standard (2024a, 2024b, 2025a, 2025b); RFMLR (2025); IEEFA (2025). Percentages are accepted amount divided by notified amount.



Figure 4: Share of the notified amount accepted at auction

Source: author's calculation from Table 8. Only auctions with a stated accepted and notified amount are shown.

The two inaugural auctions were heavily oversubscribed and fully accepted. After that, acceptance fell to between 21% and 30% of the notified amount in the ten-year auctions of August 2024, November 2024 and January 2025, and two auctions (May 2024 and June 2025) produced no sale at all. The June 2025 case shows that bid cover alone is a misleading indicator of a greenium: bids were 2.19 times the

notified amount, yet all were rejected because they were at yields above those the RBI would accept.

This creates a selection concern. Cancelled auctions have no clearing yield and are therefore missing from the sample, and partly accepted auctions reflect the issuer's choice of which bids to take. The missing observations are probably not random. If the cancelled May 2024 auction had cleared at the reported range of bids, its greenium would have been between -1 and -7 bps, which is the logic of scenarios S7 and S8. Under the less severe bound the pooled mean is 2.08 bps and remains significant; under the more severe bound it falls to 1.58 bps and loses significance. The pooled mean of 2.36 bps should therefore be read as an upper estimate of the market-clearing greenium, by an amount that cannot be determined from these data.

6.7 Economic magnitude

For a par bond with a constant differential, the annual saving equals the principal multiplied by the greenium: ₹0.24 crore per ₹1,000 crore at the pooled mean of 2.36 bps, ₹0.5 crore at 5 bps, ₹1.1 crore at 11 bps and ₹15 crore at 150 bps. For the January 2023 auctions, 5 bps on ₹4,000 crore plus 6 bps on ₹4,000 crore gives ₹2.0 crore plus ₹2.4 crore, or ₹4.4 crore a year. This is 0.76% of the annual interest of about ₹575.6 crore on those securities, and about ₹34 crore over their lives (₹10 crore for the 5-year and ₹24 crore for the 10-year bond), undiscounted. From August 2024 onwards the saving implied by the tabulated yields is zero.

The differential is also small against ordinary market movements. IEEFA reports yield changes of 4 to 5 bps on the day of the June 2025 auction and 18.6 bps over the preceding weeks, which is far more than any sovereign greenium observed here. Debt managers therefore cannot plan on a fixed greenium, and a differential of this size can be overwhelmed by market conditions on the day.

6.8 Corporate green bond evidence

Corporate evidence comes from two studies, both read at abstract level. Poola report that every one of 15 matched pairs, issued between 2022 and 2025, shows a green yield discount, from small for highly rated PSUs and banks to above 150 bps for some private and infrastructure issuers (Grade B). Singh report a modest greenium for 22 SEBI-registered bonds between 2017 and 2024 (Grade B). Category ranges of 5 to 25 bps (PSUs and banks), 20 to 60 bps (NBFCs) and 50 to 150 bps (private and infrastructure issuers), and a mean of about 11 bps for the 22 bonds, are sometimes attributed to these studies but could not be confirmed in the accessible text (Grade D). No pair-level yields, issuers, ratings, standard errors or tests were available, so no corporate greenium can be computed or tested here.

Table 9 screens every issuer-level corporate figure found against the calculation rule. None of the issuer-level figures in circulation is a valid greenium, which is why no corporate value enters the computations.

Table 9: Screening of corporate figures against the calculation rule

Figure	Source	Assessment	Treatment
Discount in all 15 pairs; largest above 150 bps	Poola et al. (2026)	Matched-pair design, but pair data not accessible	Grade B: direction used; magnitude unverified
Category ranges 5–25, 20–60, 50–150 bps; mean about 11 bps	Attributed to Poola et al. and Singh et al.	Not found in accessible text	Grade D: excluded
Tata Cleantech: coupon 8.74% against 9.50% (76 bps gap)	JMSR (n.d.)	Compares coupons of two issues; dates, maturity and rating not stated	Not a greenium; excluded

ReNew Power USD 325 million green bond (2021): coupon about 15 bps lower	Shodhsagar (n.d.)	Earlier conventional bond; different date	Not a greenium; excluded
ReNew Power 2021, Adani Green 2020, IREDA 2023: “~65”, “~15”, “~40” bps	Shodhsagar (n.d.)	Coupon compared with a 2024 secondary yield; reflects rate moves	Invalid under the rule; excluded

Source: sources as listed; assessment by the author under the rule in Section 5.3. Authors of the JMSR and Shodhsagar documents were not identified in the accessible record.

Direction. If all 15 pairs truly show a positive differential, the probability of that outcome under equal odds of a positive or negative sign is $0.5^{15} = 3.1 \times 10^{-5}$, and the lower limit of an exact two-sided 95% interval for the share of positive pairs is 0.78. This is illustrative. It relies on the source’s summary, ignores magnitude, assumes independent pairs and cannot speak to size or cause, so it is not a test of H_{01} for the corporate segment.

What a future test would need. For a sample of n bonds with mean m and standard deviation s , the t -statistic is $m/(s/\sqrt{n})$. At the 5% level (two-sided) the null is rejected only if m exceeds $2.145 \cdot s/\sqrt{15} \approx 0.554s$ for 15 pairs, or $2.080 \cdot s/\sqrt{22} \approx 0.443s$ for 22 bonds. A mean of 11 bps across 22 bonds would therefore be distinguishable from zero only if the standard deviation were below about 24.8 bps. This is arithmetic, not a finding, because the accessible sources report neither a standard deviation nor a sample mean that could be checked.

The 150+ bps claim. The accessible source supports only the statement that some pairs exceed 150 bps. The figure cannot be accepted as a finding for four reasons. No pair table was examined. It is more than ten times the largest emerging-market sovereign estimates (11 to 13 bps) and far above the 15 to 20 bps in Löffler. It sits uneasily with the modest greenium reported for 22 bonds, since a mean of about 11 bps and a maximum above 150 bps could coexist only with a very wide, skewed distribution or with samples that differ materially. And liquidity, seniority, call features, guarantees, differing observation dates and rating-scale differences can generate large gaps between two bonds of the same issuer. It is classed as reported but unverified, and no conclusion here rests on it. The corporate period (2022 to 2025) also overlaps with the period in which Wollny report a global reversal of the corporate premium, which is a further reason to document Indian corporate pairs one by one before relying on them.

6.9 Evidence on H_{01} for Indian capital markets as a whole

Bringing the two segments together, the evidence on whether a greenium exists in India is as follows. In the sovereign segment, the null of no greenium is rejected by four independent test procedures ($p = 0.004$ to 0.020), with a mean of 2.36 bps. The finding is strong at launch (4.75 bps in FY2023, $p = 0.002$), weaker in FY2024 (1.75 bps), and absent in FY2025 (0.00 bps in all three completed auctions). The pooled result is not robust to plausible changes in the comparator yield or to the treatment of the cancelled auction. In the corporate segment, a published matched-pair study reports a discount in all 15 pairs and a second study reports a modest greenium, which is directionally consistent with a positive differential, but neither can be tested or quantified here.

The two segments are not pooled into a single statistic, because that would mix auction yields with secondary-market yields and tested data with reported summaries. The overall evidence therefore supports the existence of a significant but small and declining greenium in the sovereign segment, and a directionally positive but unquantified greenium in the corporate segment.

6.10 Sovereign versus corporate greenium (H_{02})

A formal two-sample test of H_{02} requires both segments to be measured with the same definition, price type, period and uncertainty method. Here the sovereign figures are primary-market auction yields

against same-tenor government securities with identical credit risk, over 11 auctions, with full uncertainty computed. The corporate figures are reported matched-pair yields to maturity, over 15 pairs or 22 bonds, with no accessible uncertainty measures or data. None of the required conditions holds, so a confirmatory test is not possible. What the data do allow are three indicative checks.

Check 1: the sovereign data against a corporate benchmark. Taking the attributed corporate mean of about 11 bps (Grade D) as a fixed benchmark, a one-sample test of the sovereign mean gives $t(10) = (2.36 - 11)/0.64 = -13.57$, with $p < 0.001$, and the upper end of the sovereign 95% interval (3.78 bps) is far below 11 bps. This shows that the sovereign data are incompatible with a mean greenium of 11 bps. It does not show that the corporate mean is 11 bps, because that figure is unconfirmed and the test ignores its sampling variability.

Check 2: what-if analysis with a Welch test. To allow for corporate variability, Table 10 assumes a corporate sample of 22 bonds with a mean of 11 bps and a range of possible standard deviations, and tests it against the observed sovereign sample ($n = 11$, mean 2.36, SD 2.11) using a Welch two-sample test.

Table 10: What-if Welch test of H_{02} (hypothetical corporate sample: $n = 22$, mean 11 bps)

Assumed corporate SD (bps)	Welch t	Df	Two-sided p	Decision at 5%
5	6.96	30.5	< 0.001	Reject H_{02}
10	3.88	24.5	0.001	Reject H_{02}
15	2.65	22.6	0.015	Reject H_{02}
20	2.00	21.9	0.058	Do not reject
25	1.61	21.6	0.122	Do not reject
30	1.34	21.4	0.193	Do not reject
40	1.01	21.2	0.324	Do not reject
50	0.81	21.1	0.428	Do not reject

Source: author's calculation. The corporate mean, sample size and standard deviations are hypothetical and are not findings.

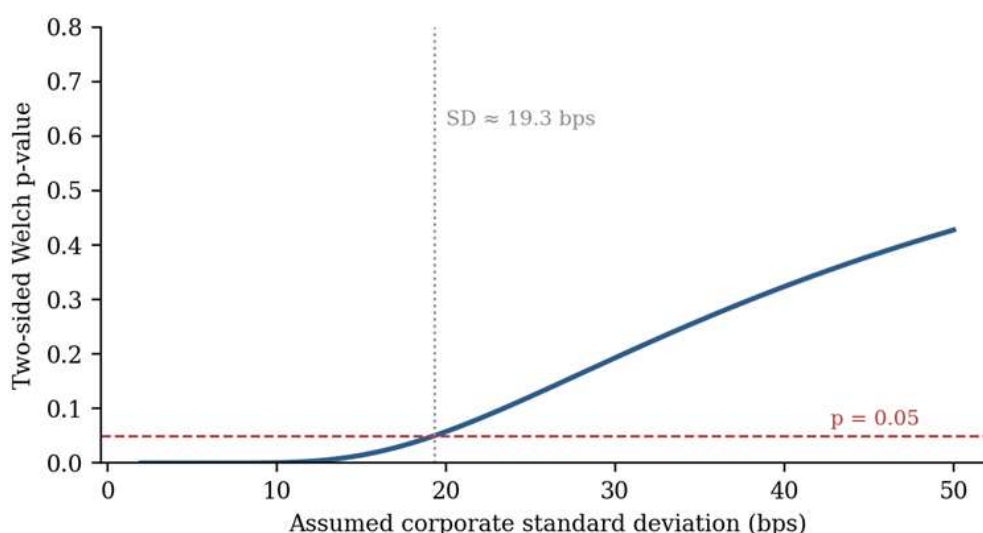


Figure 5: Two-sided p-value of the what-if test as the assumed corporate standard deviation rises

Source: author's calculation. The dotted line marks the standard deviation (about 19.3 bps) at which p reaches 0.05.

The difference would be statistically significant only if the corporate standard deviation were below

about 19.3 bps. Since the same sources describe discounts ranging from small values to above 150 bps, a corporate standard deviation of that size is plausible, and the what-if result is a warning against assuming that a large reported mean automatically means a significant difference. The conclusion depends on data that are not available.

Check 3: magnitudes and benchmarks. Descriptively, the largest sovereign greenium observed is 6 bps and the pooled mean is 2.36 bps, which lies close to the 2 to 4 bps advanced-economy sovereign estimates and well below the 11 to 13 bps emerging-market estimates. The corporate figures reported for India run from about 11 bps to above 150 bps, which is more than 25 times the largest sovereign value, and exceeds the 15 to 20 bps found in matched international samples. The documented sovereign path is a decline after launch, whereas the corporate time pattern cannot be assessed because no time series is reported.

Taken together, these checks show that reported corporate magnitudes are larger than the sovereign greenium, but they do not establish that the difference is statistically significant or that it reflects the sovereign or corporate nature of the bond rather than differences in liquidity, rating, maturity or method.

6.11 Alternative explanations for a yield differential

A positive yield differential is consistent with investors valuing the green characteristics of labelled bonds, but it is equally consistent with the other explanations in Table 11, which this study cannot separate.

Table 11: Alternative explanations for a measured yield differential

Explanation	Effect on measured differential	Ruled out here?
Investor preference for green characteristics	Increases it	No
Liquidity differences between the two bonds	Either direction	No (not controlled)
Maturity mismatch or interpolation error	Either direction	Partly (explicit rule; yields rounded)
Choice of comparator or benchmark	Either direction (Aug 2024: 0 versus -9 bps)	No (tested in Table 7)
Issuer self-selection or unobserved credit quality	Increases it	No
Guarantees or structure not captured in the match	Increases it	No (pair details unavailable)
Auction mechanics, cancellations and partial acceptance	Either direction	Partly (bounded in Table 7)
Market-wide shocks on the auction date	Either direction	Partly (described, not controlled)

7. Evaluation of the Hypotheses

H₀₁: No significant greenium exists in Indian capital markets. The null is rejected for the sovereign segment. The mean greenium over 11 completed auctions is 2.36 bps (95% CI 0.95 to 3.78), and the t-test ($p = 0.004$), exact Wilcoxon test ($p = 0.008$), sign test ($p = 0.008$), bootstrap interval and date-level test ($p = 0.020$) all agree. The evidence therefore supports H₁₁ for the sovereign segment. The decision carries three qualifications. The greenium was concentrated in FY2023 and FY2024 and was zero in all three completed FY2025 auctions. The pooled significance is lost in five of nine sensitivity scenarios, so it should be described as fragile. And cancelled auctions are missing from the sample, so the pooled

mean is probably an upper estimate. For the corporate segment, the null cannot be tested formally. The reported discount in all 15 matched pairs and the modest greenium in 22 bonds point in the direction of H_{11} , but the evidence is Grade B and its magnitude is unverified. Overall, H_{01} is rejected for the sovereign segment, and the corporate segment is directionally consistent with rejection.

H_{02} : No significant difference exists in greenium between sovereign and corporate green bonds. A confirmatory test is not possible, because the two segments do not share a dataset, a price measure or a method. H_{02} is therefore neither formally rejected nor accepted. The indicative checks in Section 6.10 show that reported corporate magnitudes (about 11 bps to above 150 bps) are larger than the sovereign mean (2.36 bps), and that the sovereign data are incompatible with a mean of 11 bps. However, the what-if analysis shows that the difference would be significant only if the corporate standard deviation were below about 19.3 bps, and no such figure is available. The evidence leans toward H_{12} but does not establish it, and the statement that corporate greenium is statistically greater than sovereign greenium is not supported by the data assembled here.

Table 12: Hypothesis decisions

Hypothesis	Segment	Evidence	Decision	Grade
H_{01}	Sovereign	$t(10) = 3.71, p = 0.004$; confirmed by four methods; zero in FY2025; fragile to scenarios	Rejected (H_{11} supported), with qualifications	A
H_{01}	Corporate	Discount in 15 of 15 pairs and modest greenium in 22 bonds, as reported; no data or tests	Not tested; direction consistent with H_{11}	B
H_{02}	Sovereign vs corporate	Reported corporate magnitudes larger; no common dataset; what-if test depends on unknown SD	Not formally testable; indicative evidence leans to H_{12}	A/B/D

Source: Sections 6.3 to 6.10. Grades as defined in Table 2.

The composite statement that a significant greenium exists in India is supported for the sovereign segment, strongest at launch and absent in the latest completed auctions, and is directionally consistent but unquantified for the corporate segment.

7. Findings

1. A small positive average sovereign greenium of 2.36 bps (95 % CI 0.95–3.78; $p = 0.004$) is present in 11 completed auctions; confirmed by t-test, Wilcoxon, sign test and bootstrap (Grade A).
2. The mean declines from 4.75 bps in FY2023 to 1.75 bps in FY2024 and 0.00 bps in FY2025 (Kruskal–Wallis $p = 0.010$; Spearman $\rho = -0.97$).
3. Pooled significance is fragile: the CI includes zero in five of nine sensitivity scenarios, although the sign of the mean remains positive throughout.
4. Weak auction outcomes from May 2024 onward imply that the pooled mean may overstate the market-clearing greenium.
5. The economic saving is small ($\approx$ ₹4.4 crore a year on inaugural issues; zero thereafter).
6. Corporate evidence is directionally positive but its size is undetermined.
7. No valid statistical comparison between segments is possible with the data assembled here.
8. Observed differentials are associations; they do not establish causality.

8. Results and Discussion

The sovereign mean of 2.36 bps lies closer to advanced-economy estimates (2–4 bps) than to emerging-market averages (11–13 bps). It is consistent with Arora's characterisation of the Indian greenium as thin. The path—positive at launch, then zero with weak absorption—mirrors international time variation. Possible explanations include an SLR-driven bank investor base, limited green-mandate fund access, thin secondary liquidity, and absence of mandatory third-party verification; with only 11 observations these channels cannot be separated. A large uniform corporate differential would depart from the post-2022 global pattern of narrowing or reversal, underscoring the need for pair-level documentation.

9. Limitations and Future Research

The study relies on secondary data with only partial cross-verification of comparator yields. The sovereign sample is small ($n = 11$), rounded to integer basis points, and contains non-independent same-day tranches. Auction yields may differ from secondary-market yields; cancelled and partially accepted auctions may bias the mean upward. Corporate evidence could not be re-estimated. The design supports association, not causation.

Future research requires pair-level corporate data and a common application of equation (1) to both segments within a panel specification that controls for residual maturity, rating, liquidity and date effects, with cluster-robust inference.

10. Conclusion and Recommendations

Using an explicit calculation rule and original tests on eleven completed sovereign green-bond auctions, this paper finds a small positive average greenium of 2.36 bps (95 % CI 0.95–3.78; $p = 0.004$) and rejects the first null hypothesis for the sovereign segment. The average conceals a decline from 4.75 bps in FY2023 to zero in the completed FY2025 auctions and is sensitive to comparator choice and to the treatment of cancelled auctions. Published corporate evidence is directionally consistent with a positive differential, but its largest magnitudes could not be verified. The second null hypothesis cannot be tested formally. Observed yield differentials are consistent with investor valuation of green characteristics but do not establish causality. Statements about the size of the Indian corporate greenium, and about its difference from the sovereign greenium, should remain provisional until bond-level data and a common method are available. These recommendations are normative and are not findings of the study. Publish, for each sovereign auction, the cut-off yield, the comparator security and its yield, and the resulting greenium under a common rule. Consider twin-bond designs (green and conventional of identical tenor and coupon) to isolate the green effect. Deepen secondary-market liquidity and widen access for green-mandate investors. Encourage standardised third-party verification and impact reporting. Make bond-level yield and liquidity data for corporate green and conventional bonds available to researchers. Treat any greenium as uncertain and variable in planning; prioritise credible use-of-proceeds reporting.

References

- [1] S. MacAskill et al., "Is there a green premium in the green bond market?" *Journal of Cleaner Production*, vol. 280, 2021.
- [2] S. Ando, C. Fu, F. Roch, and U. Wiriadinata, "How large is the sovereign greenium?" *Oxford Bulletin of Economics and Statistics*, vol. 86, no. 6, pp. 1472–1483, 2024.
- [3] U. Panizza, B. Weder di Mauro, S. Shi, and M. Gulati, "The sovereign greenium: Big promise but small price effect," *CEPR Discussion Paper No. 20817*, 2025.
- [4] Securities and Exchange Board of India, "Disclosure requirements for issuance and listing of green debt securities," 2017.

- [5] Climate Bonds Initiative and MUFG Bank, India Sustainable Debt: State of the Market 2024, 2025.
- [6] O. D. Zerbib, "The effect of pro-environmental preferences on bond prices: Evidence from green bonds," *Journal of Banking & Finance*, vol. 98, pp. 39–60, 2019.
- [7] M. Baker, D. Bergstresser, G. Serafeim, and J. Wurgler, "Financing the response to climate change: The pricing and ownership of U.S. green bonds," NBER Working Paper No. 25194, 2018.
- [8] M. Dragotto, A. Dufour, and S. Varotto, "Greenium fluctuations and climate awareness in the corporate bond market," *International Review of Financial Analysis*, vol. 105, 2025.
- [9] L. Wollny, J. Derwall, R. Galema, and K. Koedijk, "The reversal of the green bond premium," working paper, Utrecht University, 2025.
- [10] D. Arora, "The collapse of the greenium: Evidence from India's nascent sovereign green bond market," *Journal of Asia Entrepreneurship and Sustainability*, vol. 22, no. 3S, pp. 748–764, 2026.
- [11] M. M. Naik, "Sovereign green bonds and India's climate finance strategy," preprint, Zenodo, 2026.
- [12] K. Poola, K. Maheswari, A. K. Agrawal, and M. Agrawal, "Pricing sustainability: A matched-pair analysis of green versus conventional corporate bonds in India," 2026.
- [13] R. Singh, C. Singh, and N. Tamta, "Greenium and alpha in India's debt markets," *Economic Sciences*, vol. 21, no. 02S, pp. 239–251, 2025.
- [14] Reserve Bank of India, "Auction results: Sovereign green bonds," press releases, 2023.
- [15] Business Standard, "Reports on sovereign green bond auctions," 2023–2025.