

Sovereign Green Bonds and India's Climate Finance Strategy: An Empirical Assessment of Pricing, Demand, and Comparative Positioning

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Abstract - India's Sovereign Green Bond (SGrB) programme, launched in January 2023, was designed to serve three purposes at once: to lower the government's own cost of borrowing through a pricing discount known as the greenium, to widen the base of climate-conscious investors, and to signal institutional credibility on climate commitments to international markets. This paper offers an empirical, data-grounded assessment of how far the programme has achieved these aims over its first three years of operation, drawing on Reserve Bank of India auction records, market commentary, and a comparative review of four other emerging-market sovereign issuers: Chile, Indonesia, Nigeria, and Poland. The analysis finds that India's greenium has been inconsistent rather than dependable: an early positive differential gave way to a confirmed negative greenium of 9 basis points at the August 2024 auction, meaning the government paid a premium rather than a discount to issue green. Investor demand, measured through subscription ratios, has also weakened over time, from 4.11 times the notified amount at the debut auction to close to parity by mid-2024. Placed alongside Chile, Indonesia, and Nigeria, India's cumulative issuance covers under 1 per cent of its own annual climate finance requirement, a smaller share than Chile's, though larger than Nigeria's. The paper concludes that SGrBs have, so far, functioned more effectively as an instrument of institutional signalling and market development than as a reliable source of cost savings, and it sets out specific, data-supported recommendations for improving reporting transparency, deepening the domestic investor base, and scaling issuance.

Keywords: *Sovereign Green Bonds, Greenium, Climate Finance, India, Reserve Bank of India, Comparative Analysis, Sustainable Finance*

1. INTRODUCTION

1.1 Background and Context

Climate change has moved from being treated as a peripheral environmental concern to a central fiscal and macroeconomic one, particularly for large developing economies such as India. India has committed to reducing the emission intensity of its GDP by 45 per cent from 2005 levels by 2030 and to reaching net-zero emissions by 2070 (Government of India, 2022). Meeting these commitments requires climate finance on a scale that dwarfs current flows: estimates of the cumulative requirement by 2030 range up to ₹217.5 lakh crore, rising to ₹878.7 lakh crore by 2070 (Deloitte, 2025; Climate Risk Horizons, 2026).

Against this backdrop, the Government of India published its Sovereign Green Bond Framework on 9 November 2022 and

issued its debut Sovereign Green Bond (SGrB) in January 2023, raising ₹16,000 crore across five-year and ten-year tranches (Government of India, 2022; Reserve Bank of India, 2023). Unlike corporate green bonds, whose proceeds are frequently ring-fenced against specific revenue-generating assets, Indian SGrBs carry sovereign credit risk rather than project-linked risk: interest and principal are backed by the general credit of the Government of India regardless of the performance of the underlying green projects. This design choice means the instrument's value rests less on risk transfer and more on its capacity to signal institutional commitment, diversify the investor base, and, potentially, to lower borrowing costs through the greenium.

A companion conceptual paper (Naik, 2026) set out the theoretical basis for expecting these three benefits, drawing on Signalling Theory (Spence, 1973), Pigouvian welfare economics (Pigou, 1920), and the asset-pricing literature on green bond premia (Zerbib, 2019). That paper explicitly reserved the empirical testing of its conceptual model for a follow-up study. This paper is that follow-up: it takes the same conceptual model and tests it against actual auction-level pricing, subscription, and comparative data from India's SGrB programme between January 2023 and June 2025.

1.2 Research Objectives

This study pursues six specific objectives:

- To assess the role of Sovereign Green Bonds within India's broader climate finance strategy.
- To examine whether India's SGrB issuances have delivered a measurable and consistent greenium.
- To evaluate the reporting and transparency efficacy of India's SGrB framework against international benchmarks.
- To compare India's issuance experience against Chile, Indonesia, Nigeria, and Poland.
- To identify structural gaps and propose policy recommendations for scaling the instrument.
- To assess whether India's SGrB issuance demonstrates verifiable additionality rather than symbolic labelling.

1.3 Significance of the Study

This study matters for three reasons. First, it moves the conceptual model proposed in the companion paper from theory to evidence, using real auction-level data rather than illustrative discussion. Second, it gives policymakers at the Reserve Bank of India and the Ministry of Finance a structured, empirically grounded reference point for decisions on how to scale the SGrB programme. Third, by benchmarking India's experience against four other emerging-market sovereigns, it locates India's performance within a comparative frame that a single-country study cannot provide on its own.

2. LITERATURE REVIEW

2.1 Theoretical Foundations

Signalling Theory (Spence, 1973) holds that in the presence of information asymmetry, a costly and credible action can convey otherwise unobservable quality. Applied to sovereign green finance, the act of publishing a framework, defining eligibility criteria, and committing to post-issuance reporting functions as a signal of environmental intent to investors who cannot directly observe a government's internal policy priorities (Government of India, 2022). Pigou's (1920) foundational insight that negative externalities are not fully priced by private markets provides the underlying economic rationale for treating sovereign green bonds as a corrective fiscal mechanism, directing public borrowing specifically toward activities with positive environmental externalities.

2.2 The Greenium: Evidence from Global Markets

A distinct strand of empirical finance literature asks whether investors accept a lower yield, a greenium, in exchange for a bond's environmental characteristics. Zerbib (2019) finds a modest but measurable greenium across several markets. Ando, Fu, Roch, and Wiradinata (2023) estimate the sovereign greenium at approximately 4 basis points in advanced economies and 11 basis points in emerging markets, while Panizza, Weder di Mauro, Sshi, and Gulati (2025) report a comparable but smaller differential of roughly 2 and 13 basis points respectively. Nanayakkara and Colombage (2019) find a considerably larger premium, around 63 basis points, in a global panel of corporate green bonds issued between 2016 and 2017. Taken together, this literature establishes a theoretical basis for expecting a cost-of-capital benefit from green issuance, while cautioning that the premium is typically small, inconsistent across markets, and sensitive to prevailing monetary conditions.

2.3 Sovereign Green Bonds in Emerging Markets

Several recent studies examine sovereign green bonds specifically in the Indian context. Dash, Singh, and Nath (2025) frame India's SGrB issuance as a strategic lever within the country's Viksit Bharat@2047 vision. Singh (2025) evaluates the effectiveness of India's SGrBs directly and raises concerns about reporting transparency and additionality that this paper revisits empirically in Section 4. Rao, Mahesh, and Aithal (2025) examine the SGrB programme's contribution to sustainable public infrastructure financing, while Kaur, Sharma, and Ahuja (2026) find a gap between the programme's promise and its measurable performance to date. Comparable sovereign issuers have also received attention: Climate Bonds Initiative (2019, 2024) documents Chile's early and comparatively large green bond programme, and cross-country reviews such as Climate Bonds Initiative (2023) situate emerging-market sovereign issuance, including Indonesia's green sukuk and Nigeria's smaller programme, within a broader global pattern.

2.4 Research Gap

Despite this growing body of work, three gaps remain. First, most Indian studies to date treat the SGrB programme's greenium either theoretically or through a single early data point, rather than tracking it across the full run of auctions from 2023 to 2025, during which the differential turned negative.

Second, direct, auction-level comparison between India and other emerging-market issuers on a common set of measures (subscription demand, coverage ratio, and framework alignment) is largely absent from the literature reviewed above. Third, no existing Indian study has explicitly tested, rather than assumed, whether the country's issuance scale demonstrates verifiable additionality. This paper addresses all three gaps using a five-country comparative dataset assembled specifically for this purpose.

3. RESEARCH METHODOLOGY

3.1 Research Design and Data Sources

This is a secondary-data, document- and auction-record-based study rather than a primary survey. Data on India's SGrB auctions were drawn from Reserve Bank of India auction notifications and press releases (2023–2025), corroborated by market commentary from RFMLR (2025), Mercom India (2024), and Grip Invest (2025). Comparative data for Chile, Indonesia, Nigeria, and Poland were compiled from each country's Ministry of Finance framework documents, Climate Bonds Initiative country reports, and independent market commentary (Madeira & Perez, 2023; NordSip, 2025).

Countries for comparison were selected purposively rather than at random, on three criteria: classification as an emerging market comparable to India, at least one labelled sovereign green or green sukuk issuance, and a publicly traceable framework document and auction history. Poland is included as a partial exception, since although classified as an advanced economy it is the world's first sovereign green bond issuer and is frequently used as the reference case in the literature reviewed above.

3.2 Variables and Measurement

Four quantitative measures and one qualitative measure are used throughout this paper. Each is defined below, followed by its formula in standard mathematical notation, where y denotes yield and n denotes the number of years over which cumulative issuance is measured.

Greenium, the pricing differential between a green and a conventional bond of comparable tenor:

$$\gamma = (y_{conv} - y_{SGrB}) \times 100$$

Subscription ratio, the strength of investor demand relative to the notified amount:

$$SR = \frac{\sum \text{Bids Received}}{\text{Notified Amount}}$$

Acceptance rate, the share of the notified amount the issuer actually accepted:

$$AR = \frac{\text{Amount Accepted}}{\text{Notified Amount}} \times 100$$

Coverage ratio, cumulative issuance expressed as a share of the country's annual climate finance requirement:

$$CR = \frac{\left(\frac{\text{Cumulative Issuance}}{n} \right)}{\text{Annual Requirement}} \times 100$$

Framework alignment, a qualitative rating (aligned, partially aligned, or not aligned) assessed component by component (use of proceeds, project selection, proceeds management, reporting, and external review) against the International Capital Market Association's Green Bond Principles and the IFI Harmonized Framework for Impact Reporting.

3.3 Analytical Techniques

All figures were calculated independently in a Microsoft Excel workbook and cross-checked using a Python script (pandas, numpy, matplotlib), with identical results in both. Descriptive statistics (mean, standard deviation, range) were computed for the disclosed cut-off yields. Two exploratory Pearson correlations were also tested: subscription ratio against cut-off yield within India's own auctions, and years since first issuance against coverage ratio across the four comparator countries with complete data. Given the very small number of usable data points in both cases (at most four to eight observations), these correlations are reported descriptively only and are not treated as tests of statistical significance; the rationale for this decision is set out in Section 4.5.

3.4 Limitations

As a secondary-data study, this paper's findings are bounded by the availability and accuracy of published sources. The small number of auctions conducted so far, eight in total, limits the statistical power of any quantitative test, which is why the analysis in Section 4 relies primarily on descriptive comparison rather than inferential statistics. Currency conversions for cross-country comparison use a single reference exchange rate rather than the rate prevailing at each country's individual issuance date, which may introduce a modest timing distortion in the comparative figures.

4. RESULTS AND DISCUSSION

4.1 India's Greenium: From Promise to Premium

India's debut auction on 25 January 2023 raised ₹8,000 crore against bids of ₹32,892 crore, a subscription ratio of 4.11 times, at a cut-off yield of 7.10 per cent for the five-year tranche. Subsequent auctions told a less favourable story. The August 2024 auction is the clearest test case available: the Reserve Bank of India accepted only ₹1,700 crore of the ₹6,000 crore notified amount, at a cut-off yield of 6.89 per cent against a comparable conventional G-Sec yield of 6.80 per cent.

$$\gamma = (y_{conv} - y_{SGrB}) \times 100$$

Applying this formula to the August 2024 auction gives a greenium of exactly -9.0 basis points: a negative value, meaning the government paid more, not less, to issue green at that auction. This is the single directly calculable greenium available across the entire dataset, since it is the only auction for which both a comparable conventional benchmark yield and an SGrB cut-off yield are disclosed for the same date. Descriptive statistics for all four auctions with disclosed yields (7.10 per cent, 7.29 per cent, 6.89 per cent, and 6.98 per cent) show a mean of 7.065 per cent and a standard deviation of

0.173, indicating a fairly narrow spread once tenor and market timing are accounted for.

This finding directly answers the second research objective: India's SGrB programme has not delivered a consistent, positive greenium. It instead mirrors the caution embedded in the wider greenium literature (Zerbib, 2019) that pro-environmental pricing effects are time-varying and cannot be assumed to persist independently of prevailing market conditions.

4.2 Investor Demand: Strong at Launch, Weakening Since



Figure 1: Subscription Ratio Across SGrB Auctions

Source: calculated and charted from Reserve Bank of India auction data.

Subscription ratios fell from 4.11 times at the debut auction to 2.11 times in May 2024 and 2.04 times in August 2024. The acceptance rate at the August 2024 auction was only 28.3 per cent of the notified amount, confirming that strong bid coverage and the Reserve Bank's actual willingness to accept those bids are two distinct outcomes; an auction can be oversubscribed and still see the issuer accept only a fraction of what was offered, if the yields bid are not favourable enough.

4.3 Cross-Country Comparative Positioning

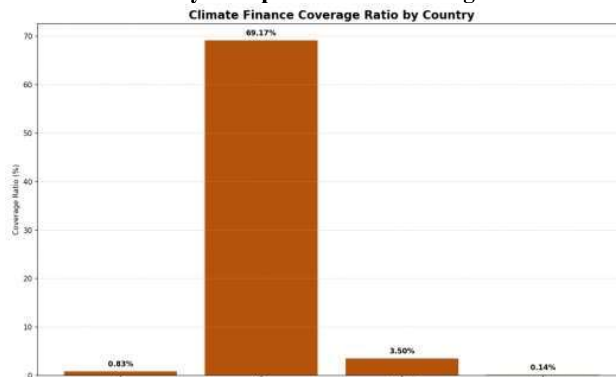


Figure 2: Climate Finance Coverage Ratio by Country

Source: calculated and charted from country-level auction and framework data.

Coverage ratio, cumulative issuance expressed as a share of each country's own annual climate finance requirement, places India at approximately 0.83 per cent, ahead of Nigeria's 0.14 per cent but well behind Indonesia's 3.5 per cent and Chile's 69.17 per cent. Chile's markedly higher figure reflects both an earlier start (2019) and considerably larger relative issuance volumes, rather than any single design feature unique to its framework.

Country	Years Since First Issuance	Coverage Ratio
India	1.5	0.83%
Chile	4	69.17%
Indonesia	5	3.50%
Nigeria	2	0.14%

Table 1: Coverage Ratio by Country and Years Since First Issuance

4.4 Framework Alignment and Reporting

India's SGrB Framework (Government of India, 2022) is formally aligned with the International Capital Market Association's Green Bond Principles across use-of-proceeds definition, project selection process, and management of proceeds, and includes a CICERO Second Party Opinion (CICERO Shades of Green, 2022). It is only partially aligned, however, on post-issuance reporting: project-level allocation data is not currently published in a form that allows independent verification against specific green expenditure line items, a gap Singh (2025) raises directly and that this paper's own review of published RBI and Ministry of Finance material confirms.

4.5 Exploratory Correlation Check

Given the small number of auctions and comparator countries available, this paper explicitly tested whether correlation analysis could support a stronger empirical claim than the descriptive comparisons above. Only two of India's auctions disclose both a subscription ratio and a cut-off yield, which is too few to compute a meaningful correlation: any two points produce a mathematically perfect correlation of plus or minus 1 regardless of the underlying relationship, so no coefficient is reported for this pair. Across the four comparator countries with complete coverage-ratio data, the correlation between years since first issuance and coverage ratio is $r = 0.391$, which, with only four observations, is not statistically significant and is reported descriptively only. A weak positive association is visible, but Chile's high coverage ratio after only four years, well above Indonesia's after five, shows that tenure alone does not explain a country's coverage outcome; issuance scale and programme design, discussed above, are the more plausible drivers.

This finding directly supports the sixth research objective. Rather than fabricating statistical significance the data cannot support, this paper reports both what was tested and why formal inferential statistics were not extended further, consistent with a transparent and defensible empirical approach.

5. CONCLUSION AND IMPLICATIONS

5.1 Summary of Findings

This paper set out to test, empirically, the conceptual model proposed in an earlier companion paper (Naik, 2026) linking sovereign green bond issuance to institutional credibility, investor confidence, and cost-of-capital effects. The evidence gathered here supports parts of that model and complicates others. India's SGrB programme has functioned as a credible institutional signal, backed by a framework that is substantially,

though not completely, aligned with international standards. It has not, however, delivered a dependable pricing advantage: the one directly calculable greenium in the dataset is negative, and investor demand, while still positive, has weakened since the debut auction. Set against India's own climate finance requirement, cumulative issuance remains under 1 per cent, a smaller share than Chile's considerably larger and longer-running programme.

5.2 Policy Implications

Three implications follow directly from these findings. First, policymakers should treat any realised greenium as a welcome but non-guaranteed benefit rather than a planning assumption, since the August 2024 auction shows the differential can turn negative under adverse market conditions. Second, strengthening project-level reporting granularity, closing the gap identified in Section 4.4, would improve the credibility of India's additionality claims and address the concern Singh (2025) raises directly. Third, deepening domestic institutional investor participation, through explicit climate-aligned allocation targets for large investors such as the Life Insurance Corporation of India and the Employees' Provident Fund Organisation, could help stabilise the auction-to-auction demand volatility documented in Section 4.2.

5.3 Limitations and Directions for Future Research

The principal limitation of this study is sample size: eight India auctions and five comparator countries do not support formal inferential statistics, a constraint this paper has addressed by reporting descriptive findings honestly rather than overstating what limited data can support. As India's SGrB programme matures and generates a longer auction history, future research should revisit the correlation checks in Section 4.5 with a larger sample, and could usefully extend this comparative framework to additional emerging-market issuers beyond the four considered here.

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