

Pricing Green Bonds and Measuring Climate Risk in India's Sovereign and Corporate Debt

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ABSTRACT

The quick development of the green finance in the emerging economies has put the green bonds at the center stage of the capital mobilization strategy towards climate-resilient infrastructure. India is a fast-growing bond market in the world where the sovereign and corporate green bonds have been on the increase following the launch of the Sovereign Green Bond Framework in 2023. Nevertheless, even with this development there are still problems in pricing these instruments appropriately and how to incorporate the risks associated with climate in the forecasting of the value of debt-market instruments. This paper focuses on the dynamics of prices of green bonds in India, investigates into the existence of the so-called greenium (green premium), and assesses the role of climate properties on the yield of sovereign and corporate debt. The paper determines gaps in climate-risks disclosures, integration of credit-ratings and investor perceptions by using a qualitative review of the recent issuances, market data and international benchmarks. The results point out that systematic climate-risk pricing is not well developed although greenium of Indian green bonds is sometimes small. The research is concluded with the policy recommendations to promote transparency, risk modelling and regulatory standards to promote the long-term sustainability of India debt market.

Keywords: Green Bonds, Climate Risk, India, Sovereign Debt, Corporate Debt, Greenium, Sustainable Finance, Environmental Risk Pricing.

Introduction

Climate change has become one of the most important financial and economical threats of the 21 st century that is defining the investment trends of nations and how they can secure capital to invest in a sustainable development. Speaking specifically of the case of emerging economies, such as India, the situation is especially complicated: the country has to maintain the high economic rates and at the same time, it also needs to increase its moving to low-carbon and climate-resilient future. India has made a pledge to go into a net-zero state of emissions by the year 2070 and reach a goal of non-fossil fuel capacity capacity of 50 percent by the year 2030, a benchmark that requires immense investment in the form of finances. Green bonds in this regard have also gained a fundamental status as a way of directing the investment on renewable energy, clean transportation, sustainable agriculture and climate-adaptation infrastructure.

The field of bond market in India has changed greatly over the last ten years, and the development of the Sovereign Green Bond Framework in 2023 became a huge milestone in bringing national financing in accord with environmental priorities. Green bonds have also increased usage by corporate issuers especially in the renewable energy, utility and financial sectors to access

the global pools of sustainable-finance. In spite of these developments, the main questions to answer include how are the green bonds priced in India and the extent to which the climate risk factors have been incorporated into the valuation of the sovereign and corporate bonds.

The greenium phenomenon, which in many instances has been observed in the pricing of green bonds, is where green bonds are all priced at low yields compared to similar conventional bonds because of intense investor demand and belief in reduced long-term climatic risk. In India, however, the picture is not so consistent with some of the issues having a small greenium on them and some being evidently not in a pricing position. Also, climate risk, both physical (heat waves, floods and cyclones) and transition (policy changes and technological changes) are not fully integrated in both credit-rating practices of the country and secondary-market prices.

When climate risks grow faster and stronger as they do now, the underpricing of these risks may subject the Indian financial system to the sudden repricing effects, higher financing risks, and less confidence of the investors. The concept of the impact of climate vulnerabilities on sovereign and corporate debts is hence very important insofar as financial health and the

attainment of sustainable economic development are concerned.

The paper will fill these in by looking at the pricing mechanisms of Indian green bonds, and considering whether there is any greenium, as well as looking at how climate risks are being currently measured and incorporated into debt instruments. The research provides an overview of the advancement of regulatory matters, market trends, and the standards that are emerging in the world thus indicating where enhanced policies and institutions are needed in India. The findings can be used to inform current debates on sustainable finance and guide regulators, issuers, investors, and policymakers interested in making equity-pricing of climate-risk more effective in the Indian debt markets.

Objectives of the Study

This research is mainly aimed at analyzing the pricing behaviour of the green bonds in India and determining to what degree the risks associated with climate change are priced in the sovereign and corporate debt markets. In order to do this, the study pays attention to the following particular goals:

1. To examine the sovereign and corporate green bond pricing mechanisms as well as the trend in their yields, market performance, and performance relative to their conventional counterparts.
2. To estimate the existence and size of the greenium (green premium) in recent issues of being issued in India under green bonds in different industries and varying maturity dates.
3. To assess the extent of the integration of climate risks (physical and transition) into debt prices, credit rating and investor risk ratings in India.
4. To determine the regulatory, disclosure, and market-based issues that affect proper pricing of climate risks and prevent the effective operating of the Indian green-bond market.
5. To test how well India has in place frameworks of green-bonds (both Sovereign Green Bond Framework and Securities and Exchange Board of India (SEBI) regulating Green Debt Securities) promote transparent and credible green-finance practices.
6. To recommend the policies and financial solutions to increase the better performance of the green-bonds pricing, integration of the climate risks and resilience of the sovereign and corporate debt market of India.

Research Methodology

This research takes a qualitative, analytical, and comparative research design to implement the research aim of analyzing the pricing nature of the green bonds in India and to assess the inculcation of climate risk to the sovereign and corporate debt markets. Since the Indian green finance ecosystem is dynamic, and only a few long-term quantitative sources of data are available, a qualitative approach will enable a holistic analysis of

the current market practices, regulatory environment, and future tendencies.

Research Design

The study is organized in exploratory and descriptive study. It combines the data provided by various secondary sources, cross-referring market practices among issuers, and examining the role of India in the global best practices with respect to pricing green-bonds and evaluating climate-risks.

Data Sources

The study relies on secondary data collected from credible and authoritative sources, including:

- Reports from the Climate Bonds Initiative, World Bank, IMF, and OECD
- India's Sovereign Green Bond Framework (2023)
- Regulations and disclosures from SEBI and the Reserve Bank of India (RBI)
- Corporate green-bond issuance documents, annual reports, and sustainability disclosures
- Research articles published in peer-reviewed journals
- Market data from financial databases, rating agencies, and bond indices
- Global climate-risk assessment frameworks such as NGFS and IPCC reports

These sources provide insights into pricing patterns, regulatory standards, climate-risk metrics, and investor behaviour.

Analytical Approach

The analysis is conducted in three stages:

1. **Comparative Pricing Assessment:** Increase in yield, occurrences of greenium and price actions of Indian green bonds are examined and contrasted with similar conventional bonds and international resources.
2. **Climate-Risk Evaluation:** The transition risks and physical risks are risk-mapped on internationally accepted global standards and assessed based on the inclusion in credit ratings, cost of capital, and the perception to investors in India debt markets.
3. **Regulatory and Market Gap Identification:** The green-bond frameworks, disclosure standards and market mechanisms of India are under scrutiny with the view of identifying inefficiencies in the market structures to make green-bonds trade more effectively and to integrate the risks posed by climate.

Scope and Delimitations

- The research paper concentrates on sovereign and corporate India-based green bonds of 2021-2024.
- The fact of analysis is qualitative and it does not utilize econometric modelling because of the limitation of the data.

- Only publicly available data are used to ensure transparency and replicability.

Reliability and Validity

To ensure academic rigor:

- The data are obtained in respected institutions and literature published in peer-reviewed journals.
- Several sources are cross-examined to reduce bias.
- The India market practices are put in perspective and made more comparative with global benchmarks.

Literature Review

The research on green bonds, sustainable finance, and climate-risk pricing has increased significantly in the previous decade, as the importance of the environment in financial markets has risen. In this subfield, literature on the international and Indian studies concerning green-bond pricing, greenium presence, and integration of the climate-risk in the debt market as well as regulatory instruments that influence the development of the green-finance are examined.

Global Evolution of Green Bonds

The development of green bonds dates back to 2007 with the issuance of world bank and European investments bank green bonds to mobilize capital in climate-communicative projects. The market of green bonds has grown quickly around the world in the past years due to the development of socially responsible investment (SRI), sustainability financial taxonomies, and government-led climate commitments. Based on the sources like Flammer (2021) and Bachelet et al. (2019), it is noted that green bonds are increasingly considered by global investors as legitimate means to finance the process of low-carbon transitions.

The international standards of the market like the ICMA Green Bond Principles, the EU Green Bond Standard, and the screening of the market by external reviewers contribute to the market growth. These structures minimise the information asymmetry and improve the confidence of the investors who are proven to have a positive effect on the pricing behaviour.

Pricing Dynamics and the Greenium

One of the literature review issues that has attracted focus is whether or not a greenium- a pricing spread with green bonds having lower yields than conventional bonds- exists. Empirical studies include some evidence of a small greenium (e.g., Zerbib, 2019; Partridge and Medda, 2020): the greenium is usually between 1 and 8 basis points. The greenium can be said to have been brought about by:

- High investor demand for ESG-compliant assets
- Lower perceived long-term climate risk
- Enhanced issuer transparency
- Limited supply of certified green bonds

The size of the greenium however depends upon country, sector, currency, and the maturity of the bond.

Other studies are of the opinion that in less established markets where there is not enough awareness of the investor and disclosure standard is not high, then, there will be no greenium.

Climate-Risk Pricing in Global Debt Markets

Climate risk inclusion in sovereign and corporate debt representations is a fast developing research field. This risk of climate is generally divided into:

- **Physical risks:** extreme weather events, rising temperatures, floods, droughts, sea-level rise
- **Transition risks:** policy changes, carbon-pricing mechanisms, technological disruptions, ESG regulations

The IMF (2022) and NGFS (2023) have conducted research that shows that countries that are vulnerable to climate are likely to have higher yields in the sovereign bonds as there is more risk on the perception of the rating. Equally, in corporate research (e.g., Bolton and Kacperczyk, 2022), carbon-intensive companies tend to have a greater cost of capital and less value multiples. Although this increase in awareness is observable, the state of the world research also indicates that the risks of climate change are systematically underpriced because of a lack of information, uneven disclosures, and slow integration of the regulatory framework.

Green Bonds in Emerging Markets

A set of emergent economies has its peculiarities not only in the creation of viable green-bond markets. Investigations on Asia, Latin America and Africa can indicate that pricing green bonds tends to be affected by:

- Lower liquidity
- Higher credit risk
- Limited availability of climate-risk data
- Inconsistent taxonomies
- Weaker investor protection

Researchers such as Park (2023) observe that developing markets experience mixed evidence of greenium, largely depending on the issuer's reputation and the credibility of external verification.

India's Green Bond Market: Trends and Challenges

India joined the green bond market in the year 2015 and has since become one of the major issuers in Asia. The positive momentum in the literature on green finance in India signifies the existence of challenges.

Green Bond Pricing in India

Several Indian studies report that:

- Sovereign green bonds are expected to have a small and stable greenium which is indicative of high interest amongst investors.
- Corporate green bonds exhibit encouraging and discouraging pricing trends, and the greenium is mostly dependent on the credibility of the issuer, industry (particularly renewable energy) and the quality of certification.

Climate Risk and Financial Markets in India

According to the research the climate risk is yet to be completely internalized in the pricing of India sovereign or corporate debt. Key reasons include:

- Limited climate-risk disclosures
- Absence of standardized national green taxonomy
- Incomplete integration of climate variables into credit ratings
- Insufficient market awareness of transition risks

The presence of extreme weather conditions in India e.g. heat waves, cyclones, and inconsistency with monsoon patterns poses an increased financial risk. The literature of global studies (World Bank, 2023) cautions that in the future sudden repricing shock may appear because of underpricing of such risks.

Regulatory Framework and Policy Literature

The regulatory framework of sustainable finance in India has changed significantly. Key contributions include:

- Green Debt Securities Regulations (SEBI) (2022), which enforces disclosure standards with regards to the issuance of green-bonds.
- Since the product is environmentally friendly, The Sovereign Green Bond Framework (2023) that sets the rules and specifications of project selection, project proceeds management, and impact reporting.
- The climate-risk and emerging environmental stress testing expectations of RBI.

Academic and policy literature agrees that robust regulation is crucial for reducing greenwashing, improving transparency, and building investor confidence.

Synthesis of Literature Gaps

The reviewed literature identifies several gaps that justify the current study:

1. Little empirical studies on the pricing of green-bonds in India although there are new sovereign issuances.
2. Lack of knowledge on the nature of the interplay between climate risk and the cost of capital in India.
3. Absence of comparative analysis of the sovereign and corporate green bonds of India.
4. Little incorporation of climate-risk models in credit-rating procedures.
5. Policy-level information required to enhance the green-finance sector in India.

This review highlights the necessity of comprehensive research that links green-bond pricing with climate-risk measurement in the Indian context

Discussion

The results of the current research point to the intricate nature of the interconnection between the green-bond pricing, investor behaviour, and climate-risk assimilation in the context of the developing sustainable

finance in India. Although India has been on a commendable course in emerging with its green-bond market, particularly the introduction of the sovereign green bond, various constraints have remained in order to confront the pricing efficiency, quality of disclosure as well as methodology of risk assessment. These understandings are synthesized and placed in context of the global trends and the overall priorities of climate-finance in India.

Interpretation of Greenium Trends in India

A small greenium in sovereign green bonds in India is an indication that more investors believe in the credibility of instruments issued by the government in relation to climate. This has been in line with the international experience of sovereign green bonds that tend to gain high levels of demand based on the believes of reduced default risk and increased transparency. Nevertheless, the inconsistency of greenium in corporate issues shows that the benefit is not universal and unconditional. Instead, it is influenced by:

- Issuer reputation and sectoral alignment with sustainability
- Quality of external certification and second-party opinions
- Strength of project disclosure and impact reporting
- Market liquidity and investor familiarity with the issuer

These results highlight that the private sector must continue strengthening governance, sustainability reporting, and use-of-proceeds frameworks to achieve consistent pricing benefits in the green-bond market.

Climate Risk Underpricing and Market Implications

The analysis shows that the climate risk is poor in sovereign and corporate debt in India. Even though India is among the most climate-sensitive countries all over the world, yield structures and credit spreads are still largely based on such indicators as inflation, fiscal deficit, and GDP growth, and not climate vulnerability. Several implications can be made of the underpricing of physical risk, playing with heatwaves, fluctuating monsoons, cyclones, etc:

- Use of sovereign debt can be suddenly repriced as the effects of climate become more severe.
- Scientific elements in the international system: The increased costs of refinancing by corporate issuers in areas with substantial climate effects.
- Institutional investors with underestimated risks in the portfolio.
- Growing financial vulnerability caused by untested environmental shocks.

There is also poor accounting of the transition risks. With a faster decarbonization strategy in India (by expanding renewable energy supply and implementing regulatory policies) carbon-intensive industries (e.g., power, steel, cement) might see higher costs of borrowing. Nevertheless, these risks are not always a subject of credit ratings or yield of bonds. This loophole is one of the vital points that need to be addressed by policies and regulations.

Regulatory Progress and Remaining Gaps

The regulatory momentum in India via the Green Debt Securities Regulations of the SEBI and the Sovereign Green Bond Framework, has enhanced transparency, yet it still needs to be enhanced further to allow international comparability and confidence by the investor. Key gaps include:

- Absence of a unified national green taxonomy aligned with global standards
- Incomplete integration of climate-risk metrics into credit-rating agency methodologies
- Limited climate-related financial disclosures from corporate issuers
- Lack of standardized impact-reporting templates for green bonds
- Weak secondary-market liquidity reducing pricing accuracy

Strengthening these areas is essential for fostering a robust, transparent, and efficient green-bond ecosystem.

Comparison with Global Practices

India has great potential when compared to mature markets, such as EU, Japan, and the US, except that it has a less developed climate risk integration and long-term investor orientation. International markets are increasingly incorporating the risk of the environment in the pricing of bonds, regulatory stress tests and financial reporting. On the other hand, India is still at the initial stages of integrating physical and transition risks into financial models.

However, the booming renewable energy industry in India, governmental policy resolve, and growing investor attention give the country a good basis in terms of catch-up.

Strategic Implications for Policymakers and Market Participants

Based on the findings, several strategic implications emerge:

- The policymakers should enhance climate-risk disclosure regulations, progress stress-testing systems and establish a national taxonomy.
- Corporate issuers should better their sustainability reporting, implement global disclosure reporting and enhance transparency in use-of-proceeds mechanisms.
- Investors should integrate climate-risk measurements into portfolio decision-making, and talk to the issuers on how they govern their environment.
- Credit-rating agencies should be able to systematically incorporate the physical and transition risks in their procedures.
- Through which, financial institutions are compelled to invest in the climate-risk assessment tools and models of climate-related scenario-analysis.

All these measures will increase the plausibility, market liquidity and efficiency of prices in the green-bond and wider debt markets in India.

Conclusion

The relentless growth of the green finance in India is actually a response to the increased interest of the country in the sustainable development, climate strength, and low-carbon shift. Green bonds have become an essential financing tool to encourage these national priorities, especially by investing in renewable energy, clean transport, resilient infrastructure in the face of climate change, and environmental repair. This paper has investigated how the sovereign and corporate green bonds in India are priced, whether there exists a greenium, and how the risks associated with climate changes are incorporated in the pricing of the debts.

The findings indicate that the sovereign green bonds in India have a consistent low-caliber greenium, which indicates high investor interest and confidence in the government-sponsored programs dealing with climate matters. Nonetheless, the performance of corporate green bonds observes mixed pricing performances, indicating that pricing benefits are punctual upon the disposal of issuer credibility, sectoral congruence, use-of-proceeds-transparency and the strength of sustainability reporting. The findings support the fact that greenium is not merely a market practice, but a reward to issuers which have shown good environmental governance and whose climate-alignment is evident.

One key point identified during the research is that, the risks associated with climate are still underpriced in the Indian debt market. Nevertheless, Indian sovereign and corporate bond pricing is based on its traditional macroeconomic indicators in spite of its high vulnerability to extreme weather conditions and transition pressures. The partial incorporation of physical and transition risks in credit rating, yield curves and evaluation of investors promotes long-term financial susceptibility. The absence of precise pricing of climate risks may create precipitate shocks in repricing, the depletion of investor confidence and an increase in the cost of borrowing both by government and industry as India passes critical climate milestones. India has gone a great step forward in enhancing its regulatory frameworks, especially with the Green Debt Securities Regulations under SEBI and Sovereign Green Bond Framework. Nonetheless, significant loopholes still exist in climate-risk disclosure, impact reporting, external verification criterion and liquidity in the secondary market. The gaps will be critical in bridging to enhance transparency, mitigate the risk of greenwashing and increase investor trust.

India needs to improve the integration of climate risks with standardized taxonomies, compulsory disclosures in line with international standards, climate-scenario analysis and industry-specific risk modelling to have a robust and effective green-finance ecosystem. This will not only assist the correct pricing of green bonds but it will also give India the financial system stability in a climate uncertain period.

To sum up, India is at a crossroads with the potential of using green bonds well priced and sufficient climate risk measures that can swiftly change India into a sustainable climate-resilient economy. Through greater regulatory measures, by emulating international good practices and furthering the market infrastructure, India can create a position as a global South leader in green-finance, not only micromobilizing investments but also long-term financial security.

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