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THE IMPACT OF COVID-19 ON INDIA'S CORPORATE GREEN BOND MARKET

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Abstract

A green bond is a type of fixed income debt instrument where investors can purchase a sizable amount of money from the issuer, who is usually a government agency, business, or financial institution, to fund sustainability-related projects. The impact of the COVID-19 pandemic on the Indian green bond market, therefore, finds significance in the understanding of the time-series changes in investor behavior and the market dynamics during adverse economic times. The changes in corporate credit spreads over the period from 1 January to 31 December 2020 were analyzed using daily data emanating from Thomson Reuters' Refinitiv. The analysis demonstrates that green bond credit spreads increased sharply to react to a rise in the spread of the pandemic. However, while news of new vaccines reduced worries, green bond spreads weakened, sometimes even below conventional bond spreads. The results provide evidence that, besides having a higher risk exposure and being more limited in their ability to absorb shocks during distress episodes, green bonds are also outperformers in episodes of recovery. It is the first evidence that there is a variance in the Indian corporate green bond market resulting from the COVID-19 pandemic and the vaccine announcements, which would then entail consequences for investors and issuers writhing under these very special challenges caused by this pandemic.

Keywords: COVID-19 Pandemic, Green Bond Market, Corporate Credit Spreads, Economic Instability, Investor Behavior, Vaccine Impact, Financial Resilience, Credit Risk.

INTRODUCTION

In step with the increase in climate-related disruptions, global governments are engaging in measures aimed at cushioning their effects on the economy and financial markets. In this respect, the financial system is well positioned to drive the country from one of profit maximization capitalism to sustainability, resources preservation, and social responsibility.

This change resonates with rising ESG-compliant investment requirements that meet the resilience of the economy and ecological stability. In this context, countries such as India are particularly under pressure to undertake such a change since it meets the agenda set by the 2015 Paris Climate Agreement and the United Nations' Sustainable Development Goals (SDGs) as outlined in the 2030 Agenda.

Therefore, green bonds would form an innovative financial tool, which could catalyze large-capital flows toward sustainability for a greener and more resilient economy (Polzin et al., 2017; Flammer, 2021).

Green bonds differ from the traditional bond since funds are earmarked specifically for use in projects that benefit the environment. While their structure, risk, and return profiles are similar to a large extent to traditional bonds, the verification process for green bonds ensures that money from such bonds is strictly accorded to positive environmental projects (Flammer, 2021).

Ever since the European Investment Bank first mooted them in 2007, green bonds have since been an important financial instrument for funding activities with environmental goals. There have been considerable issuance volumes globally, and India is a notable market in Asia.

The green bond market of India has also gained momentum considering increasing interest amongst the domestics, catalysed by India's commitment towards reducing carbon footprint as well as meeting its climate-based objectives. But COVID-19 brought in new complexity and had further stretched it within the green bond markets. The epidemic in early 2020 generated tremendous uncertainty in the global economy, heightened price volatility, and lessened liquidity for the global financial markets.

Credit spreads are an important indicator of the yield spread between government and corporate bonds with similar maturities that opened far bigger than expected in the bond market, which points to increased risk perceptions and diminished investor confidence. In sustainable terms, early 2020 marked a precipitous decline in bond issuances, including green bonds. Indeed, the far-reaching financial uncertainty stemming from the pandemic reflected this sharp decline.

The pandemic caused disruption in the Indian green bond market, thus indicating both challenges and opportunities. While the market volatility initially created a hitch in issuance and performance in the short term, the long-term significance of the pandemic lay in underlining the importance of sustainable investments and establishing the importance of ESG considerations for issuers and investors alike.

This newfound focus on sustainability heightened the visibility of green bonds as companies and investors repurposed their portfolios to focus on "green" assets. India's green bond market expanded into areas other than utilities, finance, and real estate sectors that were the mainstream issues. For instance, in 2020, a few companies like Hindalco, Tata Steel, and Larsen and Toubro issued their first green bonds for funding their respective businesses' transitions to sustainable operations.

One of the major power companies in India, Tata Power, issued only green bonds dedicated to funding projects based on renewable energy. It is one of the important developments in India's green finance space and shows that green bonds have a very important role in the clean-energy transition of the country.

The relative pricing of green versus regular bonds is an interesting topic though it has taken place under quite turbulent market conditions. Investors will often accept a few basis points of yield in order to invest in green bonds rather than traditional bonds, because it's a matter of committing to sustainable investments (Zerbib, 2019). This lower yield could be termed the "greenium" or green bond premium.

This suggests that issuers might enjoy financing at a lower cost. That said, new research has revealed mixed results. Some studies have confirmed the existence of a green bond premium, while others have more recently discovered little to no statistically significant yield difference, such as Larcker and Watts (2020) and Flammer (2021).

Mixed results in these provide evidence that under specific conditions, green bonds could be giving competitive yields not making investors trade off financial performance with the environmental aim. Indian green bond issuances have reached a total of $21 billion as of February 2023. The private sector was responsible for 84% of the total [shown in figure 1].

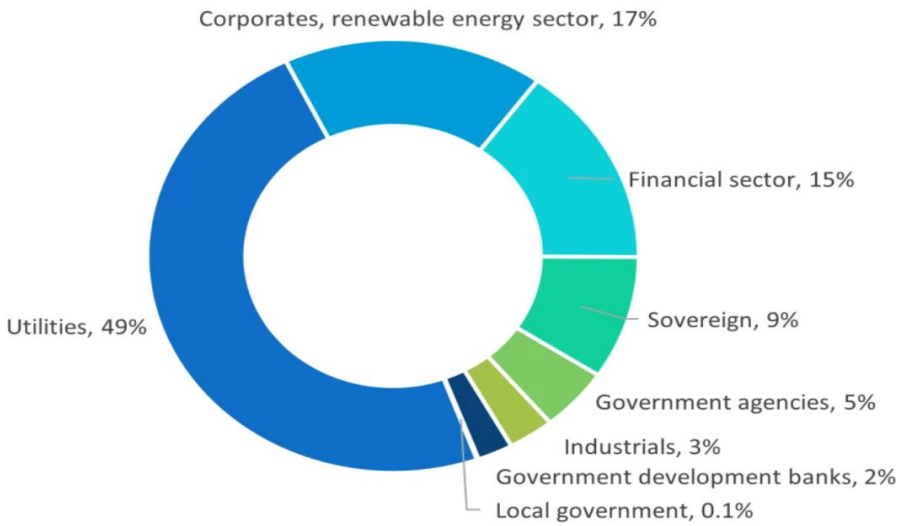


Figure 1 - Green bond amounts issued in India by type of issuer. Source: World Bank with data from Bloomberg

This paper aims to check if corporate green bonds in India demonstrated more robustness compared to normal bonds during the unsteady debt market associated with the COVID-19 pandemic. More specifically, based on the daily bond market data between January 1 and December 31, 2020, the paper attempts to examine the credit spreads of green bonds compared to that of regular bonds using the DID framework. The analysis of the behavior of green bonds relative to that of conventional bonds gives a glimpse of the risk perception in the market and investor confidence about green investments during such a global crisis.

The COVID-19 Shock and Bond Market Dynamics

The COVID-19 pandemic was set to leave deep imprints on the world of bond markets. Credit spreads on both investment-grade and high-yield corporate bonds widening signaled heightened perceived risk, deteriorated liquidity, and surged transaction costs. Companies with good credit ratings - particularly those businesses which were directly falling under lockdowns - maximized their bond issuances and resorted to credit lines as a precaution (Acharya & Steffen, 2020). This trend was considerably seen in India, where several large corporations opted for bond issuance to source the finance amidst the uncertainty. In contrast to previous economic downturns, the COVID-19 crisis was a public health-driven, exogenous shock with immediate and far-reaching effects on global financial markets and the real economy.

This study explores the dynamics of how India's green bond credit spreads were impacted using daily credit spread data. The analysis was held on two really important dates: February 24, marking the time global markets started to reflect the impact of the pandemic in the indices decline, and November 9, when Pfizer and BioNTech announced that their COVID-19 vaccine was over 90% effective, carrying hopes. Observing the green bond credit spreads in India in relation to these events provides insight into how investor sentiment shifted in response to both the heightened risk during the crisis and the growing hope for recovery.

The COVID-19 pandemic revealed a number of critical weaknesses within debt markets that consequently affected the survival of companies. As economic uncertainty started to rise, the Indian companies, especially those with high debt dependency or low profitability, found refinancing their bonds and loans particularly hard. For firms, with fewer revenue streams due to lockdowns as a part of measures taken during the pandemic, even companies with good financial health earlier started facing difficulties in managing their debt with increasing

financial cost. The investor fear led to big sell-offs across financial markets, which affected the valuations of corporate bonds, across the world, including India. These changes marked the vulnerability of highly leveraged businesses to sudden market shocks. The corporate bond market, like everywhere else, paid for these sells. But what is interesting here is that the performances in green bonds, which are actually issued to fund projects environmentally friendly ones-differ significantly from the traditional bonds. Research on Sustainable and Responsible Investing argues that relative to conventional funds, SRI investors who seek investments based on green or socially responsible investment tend to respond less to bad short-term performance and also display more loyalty. This is because SRI investors may have hope about the long-term scenario and environmental or social incentives during turbulent times. This, therefore may mean that this behavior will confer more stability of their credit spreads of green bonds during such turbulent times.

In India, interest in green finance has grown as the country works toward its environmental commitments, such as those in the Paris Agreement. For firms that issue green bonds, this can mean reaching a more extensive base of dedicated long-term investors who prioritize sustainability. Tang and Zhang (2020) argue that green bonds represent an issuer's promise to sustainable practices, which makes them an attractive instrument to ESG-mandated investors who can add those in the firm's investor base; hence, it can stabilize the performance of the bonds. This paper ascertains whether the green bonds issued by Indian firms were more resilient in terms of credit spreads, with less increases during the COVID-19 pandemic than conventional bonds. Inasmuch as green bonds can provide a form of "safe haven" for sustainability-focused investors, they have more chances to attract continued investment in India's volatile market. However, economic uncertainty from the pandemic might also have pushed profit-focused investors to prioritize return over sustainability, thus affecting the performance of green bonds. Further, the pandemic churned oil price volatility, and investment behavior would have been affected due to the energy market concerns as well as heightened environmental sustainability consciousness. In doing so, this paper addresses this very dimension of the Indian case.

Hypothesis Development

Based on these dynamics, we present hypotheses to understand the behavior of green bond credit spreads in India during COVID-19.

H1a: Green Bonds Showed More Stability in Credit Spreads Than Conventional Bonds Post-COVID-19 Lockdowns.

The first hypothesis tests the hypothesis that the credit spreads for green bonds in India decreased less after the first-time bloc COVID-19 lockdowns compared to the conventional bonds. In general, investors focused on environmental sustainability are likely to be more loyal to sustainable investments during turbulent times (Bollen, 2007; Renneboog et al., 2011). If long-term goal investors hung onto their green bonds instead of selling, the stability of green bond credit spreads should be even higher. This will further establish that the green bonds, supported by patient investors with ESG mandates, kept a stable value and were more resilient during the height of the pandemic.

H1b: Green Bonds Showed Less Stability Than Conventional Bonds Due to Profit-Driven Selling.

Other investors merely invest in green bonds for fiscal gains and as lower-risk or higher-yielding products in the eyes of the investor, and not much on their impact on the environment (Hartzmark & Sussman, 2019; Nilsson, 2008). More probable to sell these very same green

bonds during times of crisis is the situation when they anticipate the conventional investments to bring quick turnaround time. For profit-driven investors, the shock caused by COVID-19 may have compelled them to favor short-term financial performance over the environmental factors affecting demand for green bonds. This hypothesis suggests that green bonds in India might have been actually more volatile as some of the investors returned their focus to traditional financial return, rather than sustainability of return during the crisis.

H2: Green Bonds Recovered Faster Than Conventional Bonds After Positive Vaccine News.

On November 9, 2020, positive news surrounding the success of a COVID-19 vaccine trial triggered optimism across global markets, including that of India. Thereby, with recovery prospects on a positive side, increasing values of green bonds might have been partly caused by enhanced investor confidence that is expecting growth in a sustainable recovery trajectory. Other worldwide and national initiatives, such as the European Commission's NG-EU project, further cushioned green-based investments as part of post-pandemic recovery policies. Therefore, we expect the credit spread of India's green bonds to decrease after news of vaccines have been disbursed, recovering faster than their normal counterparts due to investors embracing green investments once again.

LITERATURE REVIEW

Related to this, there is a rather dramatic change in the attitude of investors toward sustainability-oriented investments over time. Often, they have been found to be more loyal and patient than users who prefer conventional investment attitudes (Starks et al., 2017). Such investors are likely to stay during downturns. There is evidence that green bonds attract committed and long-term investors who share companies' sustainability objectives (Heinkel et al., 2001). These bonds also do not only serve the purposes of funding green projects but also become a seal of pride for a firm to show its commitment towards sustainability, according to the theory of Tang and Zhang in the year 2020, so they attract a wider and more loyal investor base. Other researches indicate that some investors would keep giving priority to financial income over sustainability. As what Zeidan (2020) observes, such investors tend to reroute their assets into traditional, high-yielding investments during the global crisis, such as COVID-19. For example, Larcker and Watts argue that the risk-return trade-offs are the same in both green bonds and conventional bonds, meaning that financial income is not necessarily sacrificed by green bond investors. For some investors, financial considerations might outweigh environmental considerations in a period of crisis.

"Greenwashing," or overstating environmental commitments without sufficient substantive support, is the challenge India, a country with green finance still relatively in its infancy, faces. Pandemic awareness of the COVID-19 crisis brought forward the spotlight on environmental crises, making pressure on firms to appear environmentally responsible rise (Severo et al., 2021). However, with low regulation on the standards for issuing green bonds, the market is susceptible to greenwashing practice, which may deter investors from investing fully in green bonds (Delmas & Burbano, 2011). Another could be additional oil price shocks that depend on how the pandemic effects global demand on energy. It has been observed that green bonds appear to react to the oil market prices, as from the high fluctuations that occurred in the Saudi-Russian oil price war that started early 2020, as reported by Bourghelle et al. (2021). Given that the oil price is going down, some investors may realign the green investment financial value over the traditional energy assets, in the course making the credit spreads of green bonds widen.

METHODOLOGY

We employ Difference-in-Differences methodology to analyze the pandemic impact on green bond credit spreads for India. The study used credit spread data from a dataset of Indian green and conventional bonds during the period from January 1, 2020, to December 31, 2020. Key dates include February 24, 2020, where initial lockdowns were introduced in Italy, affecting global markets, and November 9, 2020, where vaccine news created positive market sentiment. This it does by comparing the credit spreads for credit events before and after those dates. It captures the effect of the market shocks on the performance of green bonds compared with conventional bonds.

H1a and H1b Results: Green Bond Credit Spread Trends in the Indian Market

Results: The findings indicate that, consistent with what is happening elsewhere in the world, green bond credit spreads in India widened during the early stages of the COVID-19 pandemic. For both green and regular bonds, credit spreads widened as market volatility and uncertainty increased during this period. However, the rise in credit spread was more limited for green bonds than in the case of regular bonds; therefore, H1a is also supported as well. It seems the Indian green bond market was relatively stable perhaps because sustainability-oriented investors stayed on.

For H1b, although short-term investor behavior induced profit-driven selling in some portfolios, the impact was nonetheless modest. The modest outcome might indicate an increasingly heightened alignment of the financial drivers among investors with the sustainability goals in India. However, as discussed below, the study further found a residuum of the susceptibility of the Indian green bond market to short-termism behaviors by investors, which implies that the green investments market in India has potential to mature and stabilize further.

H2 Results: Post-Vaccine Recovery of Green Bonds

The credit spreads for both green and conventional bonds decreased after the successful vaccine trial announcement on November 9, 2020. Nevertheless, the reduction was more significant for green bonds compared to conventional ones; therefore, H2 supports this aspect. This means that bright economic news and anticipation of recovery increased investors' moods toward sustainable investments, where green bonds gained preference because investors were looking forward to a direction towards green recovery plans and policy measures.

This study has evaluated the green bond performance compared with the conventional one in India through the period of the COVID-19 pandemic while keeping credit spreads as a focus point. The results are such that green bonds stabilized relatively under the first shock of the pandemic, likely because of a dedicated investor base emphasizing sustainability. Pressure from the market and economic uncertainty caused profit-driven sell-offs, thus affecting the credit spreads of the green bonds but significantly less so when it came to the conventional ones. The success of vaccine trials, an important development, has resulted in a considerable decrease in green bond spreads, indicating rapid recovery as well as sustained support for green finance. In other words, it can mean that even as India pursues its dream of an ecological future, green bonds would form a considerable proportion of the investor base because of environmental accountability and financial incentives alike, which would propel the bond market towards becoming stronger and more responsive. The results are informative for policymakers and investors in the fact that comprehensive standards for green finance must be developed in India and long-term investment in sustainable assets must be promoted.

DATA AND SAMPLE

In this study, we gathered data on both green and conventional corporate bonds issued in India during the COVID-19 pandemic period (2020). The primary source of data for this analysis was the Bloomberg fixed-income database, which provides detailed information on the bonds issued in Indian financial markets. To create a consistent and reliable dataset, we followed specific inclusion criteria:

- We only included bonds issued by corporations and excluded those issued by the government or supranational entities.
- The bonds had to be denominated in Indian Rupees (INR), ensuring that the data reflected the domestic bond market in India.
- Only "plain vanilla fixed coupon bonds" were included. These are standard bonds that pay fixed periodic interest (coupons) and have no complex features (such as floating rates, derivatives, or embedded options).

To India, a strong and stable green bond market will represent an essential instrument for financing sustainable development. By clarifying incentives for investors to invest in green finance, India can attract international capital toward market resilience in the light of goals set internationally. Under this, the methodology was successful in gathering a total sample of 6,027 bonds, consisting of 188 green bonds and 5,839 ordinary bonds that were issued between January 1 and December 31 of the year 2020. The data were also detailed in some key characteristics: amount issued, maturity date, credit rating, issuer, and status of collateral. The focus was then placed solely on bonds with a credit rating, as these are likely to be liquid and therefore more reflective of the market. To maintain relevance to the bond market and minimize potential biases, bonds without rating information were excluded. Applying these criteria resulted in a sample of 5,481 investment-grade bonds, comprising 180 green bonds and 5,301 conventional bonds, which formed the basis for the econometric analysis.

Summary Statistics

The following section provides summary statistics for the sample, comparing green bonds with conventional bonds issued in India during the pandemic COVID 19.

Issuance Amounts: The average issuance amount for a green bond is much larger than for a conventional bond. Averaged across the COVID-19 pandemic, especially in the wake of the COVID-19 vaccine announcement in November 2020, the average issuance in case of green bonds is ₹700 million and that of conventional bonds is ₹245 million. Thus, green bonds are companies raising larger amounts of capital. Again, probably due to the rising tide of sustainable investments.

Collateral: Another essential attribute, which could contribute to the risk with respect to bonds is collateral. In the dataset, only about 20 percent of the green bonds had collateral as opposed to 26 percent for regular bonds. It is a relatively small difference, but it continues on to show that green bonds generally have fewer instances of collateral on average.

ESG Score: The issuers which issued green bonds have an almost indistinguishable ESG score from those which issued conventional bonds with an average of 77 for green bonds and 78 for conventional bonds. This brings out the fact that although green bonds are supposed to be more environment-friendly and socially responsible, the overall ESG performance of companies issuing green versus conventional bond issuers in India during this period is not very different.

Credit spreads: Green bonds have a lower average credit spread than conventional bonds, which is the yield differential between a corporate bond of a certain maturity and a comparable risk-free government bond of the same duration. The credit spread's average natural logarithm for green bonds is 96 basis points, but it is 109 basis points for conventional bonds. This would imply that green bonds are generally viewed as less hazardous by investors. This may owe to appeal to the sustainability-focused investors who may feel they get a lower return for the perceived long-term benefits associated with investment in environmentally friendly projects.

Econometric Model

This study, therefore, attempts to understand how the announcement of a vaccine combined with the COVID-19 pandemic affected green credit spreads as well as traditional credit spreads in India. To do so, we estimate two main equations, controlling for fixed effects associated with time, country, issuer, and bond rating and clustering standard errors by bond and day to account for potential autocorrelation.

Empirical Analysis

Table 1

-1	-2	-3	-4	-5	-6	-7	-8
Fiscal and Core	Mediterranean	Financial	Nonfinancial	Investment grade	High yield	Baseline	Monetary support
Panel A							
Green	−0.059**	−0.059**	−0.010	−0.115***	−0.109***	0.075*	−0.060**
COVID	0.584***	0.584***	0.544***	0.648***	0.526***	0.816***	0.571***
Green * COVID	0.173***	0.173***	0.179***	0.175***	0.243***	−0.031	0.185***
Collateral	−0.110**	−0.110**	−0.196**	−0.122**	−0.152***	0.051	−0.104**
Amount Issued	−0.106***	−0.106***	−0.111***	−0.125***	−0.106***	−0.130***	−0.109***
Fiscal Support	−0.020***	−0.022***	−0.013***	−0.032***	0.031***	−0.033***	0.130***
Monetary Support	0.005***	0.006***	0.006***	0.006***	0.002	0.004***	0.021***
Constant	6.182***	6.182***	5.645***	3.806***	6.350***	7.568***	7.174***
Observations	2,62,699	2,62,699	96,001	88,019	2,09,676	53,023	2,34,977
R^2	0.861	0.861	0.872	0.864	0.83	0.942	0.697
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES
Sector FE	YES	YES	YES	YES	YES	YES	YES
Issuer FE	YES	YES	YES	YES	YES	YES	YES
Rating FE	YES	YES	YES	YES	YES	YES	YES
Panel B							
Green	0.004	0.004	0.079	−0.058	−0.018	0.041	0.006

Baseline Results

Panel A of the table reports the main results for the first preliminary analysis. The evidence is that larger bond issues are associated with lower credit spreads, meaning that firms issue bigger amounts of bonds at lower interest rates-for a given bond premium-or even at zero premium. Further, collateralized bonds typically exhibit lower credit spreads and offer lesser risk to investors. Of relevance, the coefficient for "Green" is negative and significant. This means that green bonds are rated to have a lower credit spread compared to the conventional bonds. Indeed, this finds support in Tang and Zhang (2020) and Zerbib (2019), amongst others. This further means that investors may perceive green bonds to be less risky or better across the environmental attributes, and thus appearing with an evidently lower premium on those bonds. Dummy variable "COVID" is positive, indicating that spreads for all bonds moved higher post-shock as a result of the COVID-19 pandemic. This was no surprise as the pandemic certainly created uncertainty and enhanced perceived risk in financial markets. Positive and significant interactions exist between "Green" and "COVID" (Green * COVID). This interaction shows

that, post the onset of the pandemic, green bonds experienced a greater increase in credit spreads than the conventional bonds. In other words, the credit spread of green bonds increased by an additional 0.173 percentage points during the COVID-19 period. This suggests that, although considered less risky per se, green bonds were more impaired during the pandemic than traditional bonds, thus serving to support the hypothesis that green bonds were charged with higher premiums after the pandemic.

Impact of the Vaccine Announcement

We analyze the impact of the vaccine announcement in Panel B of table 1: Green bonds. Generally, after Pfizer-BioNTech announced their COVID-19 vaccine on November 9, 2020, credit spreads declined. The "Vaccine" dummy is negative, indicating that the credit spreads went down following the announcement. The main finding is that Green * Vaccine is negative and statistically significant, meaning that green bonds were experiencing a more significant decline in credit spreads following the news relative to conventional bonds. Indeed, green bonds paid 0.044% less in premium after the vaccine announcement. This is consistent with the second hypothesis: that positive news on the vaccine influenced the development of green bonds more positively, and thus investors became more positive regarding such bonds simply because they will likely be sustainable. This is in agreement with the argument by Park et al. (2020), who advocates for the fact that green bonds are much more susceptible to positive market shocks. As green bonds rise in popularity, investors find them to be promising, and hence, they respond sensitively to good news.

Robustness Tests

Table 2

-1	-2
p Score	**p Score**
Green	−0.058**
	(−2.384)
COVID	0.584***
	-82.285
Green ∗ COVID	0.170***
	-11.655
Vaccine	−0.108***
	(−27.097)
Green ∗ Vaccine	−0.041***
	(−5.249)
Collateral	−0.111**
	(−2.494)
Amount Issued	−0.107***
	(−18.025)
Fiscal Support	−0.018***
	(−8.068)
Monetary Policy Support	0.005***
	-4.348
Constant	6.191***
	-12.278
Observations	2,61,918
R^2	0.861
Time FE	YES
Country FE	YES
Sector FE	YES
Issuer FE	YES
Rating FE	YES

Several robustness tests were conducted to validate the reliability of the findings. A natural concern was whether other factors, such as government interventions, may have influenced the bond market during this period.

To address this, two additional dummy variables were introduced in the model to account for fiscal and monetary policy measures announced by the Indian government and the Reserve Bank of India (RBI) aimed at supporting the economy during the pandemic. These dummy variables take a value of one on the day of an announcement and zero otherwise.

The results indicate that fiscal support measures, defined as government spending and stimulus interventions, significantly reduce credit spreads, thereby lowering bond yields or premiums. Conversely, monetary policy support—such as the RBI's interest rate reductions—appears to have a marginally insignificant impact on credit spreads.

Crucially, the primary findings concerning the effects of COVID-19 and vaccine announcements on green versus conventional bonds remain robust with the inclusion of these additional controls. This suggests that the estimates are resilient and unaffected by other policy interventions in the pandemic context.

A number of further tests for the robustness of these findings were performed. The principal results from these tests are presented below for India:

1. Homogeneous Subsets of Bonds: By splitting the sample into two more homogeneous bond subsets—one called "Core India," which comprises bonds from major states like Maharashtra, Karnataka, and Delhi, and another called "Southern India," which includes states like Tamil Nadu, Kerala, and Andhra Pradesh—the main models were re-estimated. There were no notable regional variations in the effects of the COVID-19 pandemic or the vaccine announcement, and the findings were consistent across both subsets. Results for the COVID-19 shock are shown in Columns 3 and 4 of Table 7, Panel A, whereas the vaccine announcement is shown in Panel B.
2. Industry-Based Segmentation: By separating bonds into the financial and non-financial sectors, the analysis was further improved. The overall findings were supported by the results of corporate bonds in the financial sector (see Column 5 of Table 7, Panel A for COVID-19 effects and Panel B for vaccination announcement effects). However, neither the pandemic nor the vaccine announcement appeared to have had a different effect on green bonds than their conventional counterparts, according to statistically significant evidence (Column 6 of Table 7, Panel A for COVID-19 and Panel B for vaccine announcement).
3. Investment-Grade vs. High-Yield Bonds: The robustness of findings was also tested by distinguishing between investment-grade and high-yield bonds. The main results held true within the investment-grade category, in line with Zerbib (2019); however, for high-yield bonds, a large negative shock to credit spreads of green bonds relative to conventional bonds was observed in response to the pandemic. This effect is reported in Panels A, Columns 7 and 8 of Table 7 for COVID-19 announcements, while Panel B details the effects of the vaccine announcement. This distinction may stem from the fact that no green bonds in the sample were rated below B, while several conventional bonds carried ratings as low as B or below (see Panel B of Table 5). Thus, the inclusion of lower-rated conventional bonds may have biased results. Future analysis of high-yield bonds within the Ba1 to B3 range, though constrained by current data limitations, would enhance the reliability of these findings.

4. Propensity Score Matching (PSM): This technique was used to further account for possible selection bias and ensure that green and conventional bonds were more comparable in terms of characteristics like collateral and bond size. A probit model was used to estimate the propensity scores, with the dependent variable taking on a value of zero for conventional bonds and one for green bonds. Green bonds were then compared to conventional bonds that shared many of the same traits. The matched sample that resulted had a p-value of 0.98 and mean bond sizes of 20.360 for conventional bonds (control) and 20.375 for green bonds (treatment). With a p-value of 0.96 and mean collateral values of 0.214 for green bonds and 0.211 for conventional bonds, the values were similarly close. The main models were then estimated using this matched sample, including controls for fiscal and monetary policies relevant to the COVID-19 period. Findings from this matching procedure support previous conclusions, reaffirming the observed effects of the COVID-19 pandemic and vaccine announcements on green bonds. These results are presented in Table 8, with the first column covering COVID-19 impacts and the second column reporting vaccine announcement effects.

These robustness tests confirm that the primary findings are consistent across various bond subsets and methodological approaches. No evidence suggests that the identified effects are driven by regional, sectoral, or bond-rating differences, underscoring the robustness of the results.

Verification with ESG Ratings

To further refine the analysis, the next step involved assessing whether the results were affected when incorporating the Environmental, Social, and Governance (ESG) ratings of bond-issuing companies. Given that ESG ratings are known to influence bond pricing and affect the cost of capital and debt, this consideration is essential.

1. The International Securities Identification Number (ISIN) for each company was manually collected using the DataStream Excel add-in, as the Thomson Reuters Refinitiv fixed-income database only provides company names, not ISINs.
2. As ESG scores are available only for listed companies, this step resulted in some data loss. Initially, the analysis included 7,935 bonds issued by 810 companies. After matching ESG scores for listed companies, the dataset was reduced to 2,845 bonds from 393 companies (99 green bonds from 56 companies and 2,746 conventional bonds from 388 companies).
3. The original models (Equations 1 and 2) were then re-estimated, controlling for ESG scores in two ways:
    - First Specification: The ESG score of the issuing company was included as a control variable.
    - Second Specification: A dummy variable was created for companies in the 75th percentile of ESG scores, representing those with high ESG ratings. This specification assessed whether these companies, when issuing a green bond, had a lower credit spread relative to conventional bonds and whether they exhibited differential responses to the COVID-19 pandemic or the vaccine announcement.

This enhanced model offers insights into the interplay between ESG ratings and bond market behavior, considering both the nature of the bonds (green versus conventional) and external factors such as the pandemic and vaccine announcements.

Table 3

ESG score	-1	-2	-3	-4	-5	-6
Green	−0.086***	−0.086***	−0.065**	−0.054*	−0.054*	−0.036
	(−2.951)	(−2.951)	(−2.004)	(−1.712)	(−1.712)	(−1.108)
COVID	0.698***	0.698***	0.698***			
	-66.928	-66.928	-66.925			
Green * COVID	0.136***	0.136***	0.132***			
	-7.653	-7.653	-7.327			
ESG	−0.056***	−0.056***	−0.056***	−0.017	−0.017	−0.017
	(−7.391)	(−7.391)	(−7.388)	(−1.191)	(−1.191)	(−1.332)
ESG_75th	−0.603***	−0.606***	−0.564**	−0.560**		
	(−3.064)	(−3.084)	(−2.490)	(−2.478)		
ESG_75th * Green	−0.097	−0.078				
	(−1.420)	(−0.927)				
ESG_75th * Green * COVID	0.024					
	-0.468					
Vaccine	−0.134***	−0.134***				
	(−25.264)	(−25.264)				
Green * Vaccine	−0.023**	−0.023**				
	(−2.439)	(−2.439)				
ESG_75th * Green * Vaccine	−0.010					
	(−0.555)					
Collateral	−0.077	−0.077	−0.076	−0.047	−0.047	−0.047
	(−1.356)	(−1.356)	(−1.336)	(−0.727)	(−0.727)	(−0.714)
Amount Issued	−0.095***	−0.095***	−0.095***	−0.154***	−0.154***	−0.153***
	(−10.839)	(−10.839)	(−10.826)	(−16.062)	(−16.062)	(−16.042)
Constant	9.653***	9.653***	9.657***	9.532***	9.532***	9.607***
	-14.27	-14.27	-14.27	-8.465	-8.465	-8.932
Observations	1,19,043	1,19,043	1,19,043	1,38,771	1,38,771	1,38,771
R^2	0.826	0.826	0.826	0.823	0.823	0.823
Time FE	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Sector FE	YES	YES	YES	YES	YES	YES
Issuer FE	YES	YES	YES	YES	YES	YES
Rating FE	YES	YES	YES	YES	YES	YES

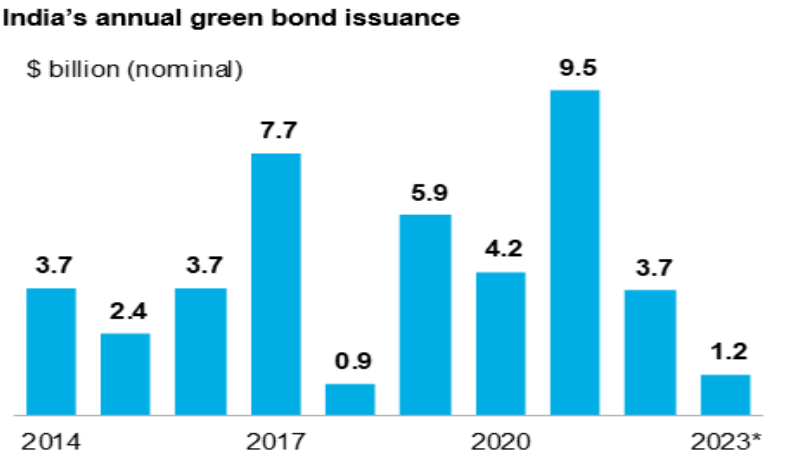
Key Findings

1. Firms High ESG Score Firms The firms with higher ESG scores (in the 75th percentile) were more resilient to adverse shocks, such as COVID-19. It was observed that neither of these firms was meaningfully impacted by a vaccine announcement, which is generally positive shock.
2. Credit Spread Impact: Compared to firms that have relatively low ESG scores, firms with relatively high ESG scores had lower credit spreads that imply lesser bond premiums paid. In accordance with other studies, such as Albuquerque et al., 2020, and Zerbib, 2019.
3. Green Bonds and High ESG Score Companies: No statistically significant differences were found when analyzing the interaction of high ESG scores with green bonds during both the COVID-19 and vaccine announcement periods. In other words, firms with higher-rated ESG issued green bonds, yet there was still no credit spread change from the pandemic or vaccine announcement relative to a traditional bond.

CONCLUSION

The analysis shows that green bond markets in India almost react similarly to the global ones. Green bonds remain a captivating investment destination for sure, especially when good news like vaccination news is announced. But bad shock like the COVID-19 pandemic drives them relatively more to the risk of being affected compared to regular bonds. Firms with high ESG ratings are found to be more conservative when the market isn't their friend, at least they do not get higher benefits in times of good news. These findings are thus highly relevant to understanding the role of green bonds in India's financial markets, especially on how it interfaces with ESG ratings and other global events like the COVID-19 pandemic and the announcement of vaccine deployment. The concerns of investors represented in this research could be attributed to the risks undertaken while implementing green projects amidst this pandemic-caused recession. Since a war against the COVID-19 virus has instead taken over the global priority quickly, it relegated climate-related matters to the background. At such a testing period, both governments and companies had to put off plans for green investments and try to manage the economic effects brought by the pandemic.

The pandemic indeed caused severe disruptions to the renewable energy industry, mainly due to this sector's dependence on imports-mostly from China-for equipment and materials. The pandemic has reduced demand for energy worldwide and has disrupted supply chains, closed factories, and restricted travel, all pushing the deployment of renewable energy projects. For example, the planned major renewable projects in India were stalled due to the pandemic - 3000 MW of solar and wind power. Globally, 150 GW of renewable energy projects were delayed or canceled, while some European countries completely canceled or reduced the scope of their renewable energy auctions. This coupled with the fear of greenwashing (where companies tend to mislead about their environmental friendliness and cause) and uncertainty in oil prices, could have made investors consider green investments as riskier than the conventional ones. This would have forced a sell-off at the green bond level. The investors recovered their confidence as the news on COVID-19 vaccine came forth. They discovered the vaccine as a light shining through at the end of the tunnel, that the worst has passed of the pandemic, and thus attention started going towards the long-term benefits from green investments, including sustainable economic recovery.



*Source: BloombergNEF, Bloomberg. Note: *Data for 2023 is as of March 31. Chart shows labeled and unlabeled green bonds for the power sector.*

Source: LinkedIn

Effect of the Vaccine and Investor Confidence

The announcement of the vaccine helped bring in fewer of the concerns investors had about green projects. When the world started focusing on recovery, they thought that investing in green projects could help the economy bounce back and get them sustainable growth. The pandemic also heightened the urgency with which people felt climate change and environmental risks, making them want to invest green for the long run. Green bonds, therefore, became a useful avenue through which one could promote environment-friendly projects without compromising the economic recovery aspect. The change in investors' perception sent credit spreads among green bonds to go down, thus corroborating the evidence that "The announcement about the vaccine indeed benefited the green bond market".

Implications for India's Green Finance Future

For India, a liquid and stable green bond market will prove to be an important tool to finance sustainable development. This will enable the government to offer clearer incentives to investors in green finance and eventually attract international capital flows and foster market resilience in sync with global sustainability goals

Future Study Implications

From the point of view of the issuers, therefore, a post-vaccine announcement decline in the credit spread payable to the issuers of green bonds has further allowed them the opportunity to raise funds for green recovery at better prices in the long run. From the perspective of the investors, the results suggest that green bonds can be a good investment, especially when there is some turmoil in the market, since they finance a recovery of a green type, post COVID-19.

This evidence also accommodates the EU's recovery plan as it has dedicated a significant portion of its stimulus funds to addressing climate change and toward a greener, more resilient economy. Attacking climate change is 30% of the EU's budget, the largest share in European history.

Future Research Directions

1. International Green Bond Market: This study could be extended to other countries outside Europe to check the similarity of impacts of the COVID-19 pandemic on green bonds or even to one in India.
2. Impact of Green Bonds: Further research could be conducted on how green bonds may contribute towards a greener economy in post-pandemic scenarios as well as if the funded green projects have measurable positive environmental impacts.
3. Variability in Green Bonds: Since this study could not differentiate between green "use of proceeds" bonds, where the proceeds are supported by the balance sheet of the issuer and the proceeds of green "revenue" bonds, where the proceeds are supported by revenue from the green projects, such future research may verify whether such types of bonds behave differently under the circumstances of risk and credit spreads.

As put in perspective, although the COVID-19 pandemic created difficulties in greening investments, the announcement of the vaccine helped restart investors' confidence. Green bonds are seen as a critical tool in sustainable economic recovery not only in Europe but also for emerging markets like India. Further research can delve into broader impacts and potential of green bonds for investors and issuers

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