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A STUDY ON MACROECONOMIC FACTORS INFLUENCING GREEN BONDS IN INDIA

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ABSTRACT

Green bonds have emerged as a critical financial instrument to fund environmentally sustainable projects, aligning with global efforts to combat climate change and promote green infrastructure. This study examines the macroeconomic factors influencing green bond issuance in India, focusing on key determinants such as GDP growth, inflation, interest rates, ESG scores, and bond ratings. By analysing sectoral trends in green finance, the study identifies clean transportation as the leading recipient of green bond investments, followed by renewable energy and waste & water management.

The research employs a quantitative approach, utilizing regression and correlation analysis to assess the impact of macroeconomic variables on green bond issuance. The findings suggest that GDP growth has a positive influence, while inflation acts as a deterrent. ESG scores and credit ratings significantly affect investor confidence, with well-governed firms attracting higher investments. Despite regulatory advancements by SEBI and adherence to Green Bond Principles (GBP), challenges such as greenwashing risks, policy inconsistencies, and market volatility persist.

The study concludes that green bonds hold immense potential to support India's transition toward a low carbon economy, macroeconomic stability is ensured. Encouraging standardization in ESG assessments, enhancing transparency, and incentivizing underfunded sectors like waste management can further accelerate the growth of green finance. The research contributes to the existing literature by providing country-specific insights into India's green bond market and offering findings to enhance its effectiveness in sustainable financing.

KEYWORDS: *Green bonds, Environmentally Sustainable Projects, India's Green Bond Market, Sustainable Development Goals, Green Finance, ESG Scores, Macroeconomic factors, Climate change, GDP growth, Sustainable financing.*

INTRODUCTION

Green bonds are specialized financial instruments designed to raise capital exclusively for projects with environmental and climate benefits. Functioning like traditional bonds, green bonds allocate their proceeds to initiatives such as renewable energy, clean transportation, energy efficiency, sustainable water management, and biodiversity conservation. By channelling investments into these green projects, they play a vital role in combating climate change, reducing carbon emissions, and fostering sustainable economic growth. The growing adoption of green bonds reflects their importance as a tool to drive environmental progress while contributing to economic resilience.

Since their inception in 2007 with the European Investment Bank's issuance, the global green bond market has expanded exponentially. Governments, corporations, and financial institutions increasingly leverage green bonds to support environmental objectives and align with international climate commitments like the Paris Agreement. The rise in investor interest, driven by alignment with Environmental, Social, and Governance (ESG) principles, has spurred the development of standards such as the Green Bond Principles (GBP) by the ICMA and the Climate Bonds Initiative (CBI), ensuring transparency and accountability. Despite these advancements, challenges like greenwashing risks, regulatory ambiguities, and monitoring gaps persist. In India, the Securities and Exchange Board of India (SEBI) has established guidelines for green bond issuance to enhance transparency and ensure proper utilization of funds, furthering the potential of green bonds to support sustainable development.

Role of ESG Score and credit Ratings:

ESG (Environmental, Social, and Governance) and credit ratings play a crucial role in green bond markets by influencing investor confidence and bond pricing. ESG scores assess a company's sustainability practices, determining its commitment to environmental and social responsibility. Higher ESG ratings often attract more investors and can lead to lower financing costs. Credit ratings, assigned by agencies like Moody's and S&P, measure an issuer's financial health and ability to repay debt. Bonds with higher credit ratings (AAA, AA) are perceived as lower risk, while lower-rated bonds (BB, B) may offer higher yields but carry greater risk. Together, ESG and credit ratings

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enhance transparency, mitigate risks, and drive sustainable investment decisions.

Brief History

It all started in 2007 by European Investment Bank when they issued pound 600 M Climate Awareness Bond (CAB) and still remains the largest green bond issuer with about pound 23.5 billion across 11currencies till 2017. Global green bond issues have risen to USD 40 Billion. Green bonds issuance is towering all around the globe. It has reached USD 167.3 Billion in 2018 which is shows a 3% rise from the previous year. The U.S., China and France remain the leaders of green bond issuance in the year 2018. Fannie Mae remains the global leader with USD 20.1 B from U.S. Industrial Bank Co. from China issued $9.6 Billion followed by Republic of France with $ 6 Billion Issue.

Path Way to India

In India, INR 1000Cr green bonds entered the financial world in 2015 with Yes Bank followed by INR 600 Cr issuance by CLP India. The first internationally certified green bond issue being Axis Bank Limited with USD 500 Million issue. This market has risen to INR 50000Cr by 2018.In 2016, SEBI launched Green Bond Guidelines followed by major issuances in the bond market. As of 2018, SBI issued $650 Million from green bonds market and they received over subscription for this issue, power producers like Renew Power and Greenko have been other players among many to tape green finance in India. Greenko issued USD 950 M recently. It is expected that the green bond issuance in India will cross USD 200 Billion mark. It rose to USD 198 B in 2018. Kerala Industrial Infrastructure Fund Board (KIIFB) is planning to raise USD 250 Million which would be the first issuance by a government entity. The pressure to be green on businesses is growing day by day, since only two Indian companies were in the top 200 and 10 in the top 500 green companies of the world in 2016. Out of 149 nations, India positions at 110 in fulfilling Sustainable Development Goals (SDG). The SDG Bond Framework that came in 2018 vividly separates environmental projects and social projects which helps investors to invest accordingly.

LITERATURE REVIEW

Green bonds have become essential financial tools for governments, corporations, and institutions to fund environmentally sustainable projects such as renewable energy, green buildings, and clean transportation **(Agarwal & Singh, 2018)**. These bonds offer a dual benefit: enabling issuers to raise capital while addressing global climate change goals. India, facing an urgent need to transition from coal to renewable energy, is incorporating green bonds into its sustainable finance framework. The introduction of robust regulations and transparent reporting mechanisms is critical to this transition, alongside innovative strategies like carbon pricing, carbon taxes, and Emissions Trading Systems **(Ch Srinivas, 2024).**

The role of green bonds extends beyond financing, influencing the environmental, social, and governance (ESG) performance of issuers. High-quality disclosures and regulatory support have proven vital for fostering investor confidence and driving market growth **(Broadstock et al., 2019).** In India, bond attributes such as ratings, maturity, and certification labels significantly affect yields. Higher-rated bonds attract greater demand due to their collateral value, while certified bonds result in lower yields because of their perceived security, highlighting their role in shaping green finance strategies **(Abhilash et al., 2023).**

Global analyses, such as those of the Borsa Italiana market, indicate that green bonds exhibit unique characteristics, including negative autocorrelation and limited influence from stock markets. However, during periods of financial turbulence, their volatility mirrors that of conventional bonds **(Aboura & Chevallier, 2013)**. India's green bond market, although dominated by private sector investments, faces challenges like inadequate standardization, limited investor awareness, and insufficient disclosure practices. Addressing these gaps through enhanced transparency and alignment with global best practices could unlock the full potential of India's green finance ecosystem **(Lobo et al., 2023).**

Several studies identify barriers to market expansion, including non-labelling, high issuance costs, and poor issuer creditworthiness. Effective policy interventions, active stakeholder engagement, and financial incentives can address these issues and support India's renewable energy and sustainable development goals **(Adekoya et al., 2023; Ahmadi et al., 2017).** Meanwhile, research on retail investor attitudes toward green bonds highlights the importance of intrinsic factors such as perceived control and attitudes over external factors like government policy. This underscores the need for financial and environmental alignment to attract diverse investors **(Shauki, 2014).**

Event studies reveal limited stock market reactions to green bond announcements, suggesting the need for better education and promotion of green bonds' environmental benefits **(Agliardi & Agliardi, 2019).** In the post-pandemic era, green bonds are considered a pathway to economic recovery, with targeted investments in renewable energy and sustainable infrastructure **(Kostoglodova, 2018).** Globally, green bond market dynamics are intertwined with energy prices, gold prices, and green energy stocks, showing bidirectional causality and a long-term impact on market behaviour **(Rasoulinezhad, 2020).**

Region-specific studies in Europe and India reveal that renewable energy growth is positively linked with GDP per capita and technological innovation, while financial development and carbon emissions pose challenges. Policymakers are encouraged to harness international trade and innovation to bridge the gap between renewable and non-renewable energy consumption **(M., Topcu et al., 2020).** Research using bibliometric and econometric analyses highlights the influence of regulatory frameworks, investor demand, and green finance indices in advancing green initiatives. Additionally, comparative studies on green banking practices in India and Bangladesh identify their contributions

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toward SDG 7 (clean energy) and SDG 13 (climate action), with recommendations for stricter regulations and increased awareness to enhance banking's role in sustainability **(Akomea-Frimpong et al., 2022).**

Advanced econometric tools like the STIRPAT and LASSO models reveal significant relationships between green finance, energy consumption, and socio-economic variables. These studies emphasize the importance of long-term policies to support CO2 emission reductions and attract private investment in green finance **(Akalpler & Hove, 2019; Alam et al., 2016).** Dynamic frameworks also link institutional pressures from regulators, investors, and advocacy groups with adaptive capacities of green bond markets, demonstrating their role in advancing sustainable finance **(MD, USA, 2017).**

RESEARCH METHODOLOGY

Research Objectives

1. To identify key macroeconomic factors influencing the green bond issuance in India.
2. To assess the role of bond ratings and ESG scores in influencing green bond issuance.
3. To evaluate sectoral trends in green bond issuance, identifying the key industries driving market growth.

Research Questions

- What are the key macroeconomic factors influencing the green bond issuance in India?
- What is the role of bond ratings and ESG scores in green bond issuance?
- Which industries are leading in green bond issuance, and what trends can be observed?

Research Gap

- Studies on global green bond markets focus on policy frameworks and climate finance but lack country-specific insights for India.
- Most studies analyse environmental and regulatory factors but do not quantify the effect of macroeconomic factors like GDP growth, inflation, and interest rates.
- There is limited research on sector-wise issuance patterns and how bond ratings & ESG scores impact investor preferences in India.

Hypothesis

- H1: GDP growth rate has a significant effect on green bonds issuance.
- H2: Interest Rate has a significant effect on green bond issuance.
- H3: Inflation Rate has a significant effect on green bond issuance.
- H4: ESG Score has a significant effect on green bonds issuance.
- H5: Bond Ratings has a significant effect on green bonds issuance.

1. Research Design

This study adopts a quantitative research approach**,** as it involves statistical analysis of numerical data related to green bond issuance and macroeconomic variables. The study follows a correlational and causal research design, examining relationships between economic indicators (GDP growth, inflation, interest rates, ESG scores, bond ratings) and green bond issuance.

2. Data Collection

Financial Databases: RBI reports, SEBI, World Bank, IMF.
Green Bond Reports: Climate Bonds Initiative (CBI), ICMA Green Bond Principles reports.
Study Period: The research covers a five-year period (2019–2023) to capture recent trends and the impact of macroeconomic changes on green bond issuance.

3. Key Variables

- **Dependent Variable:** Green Bond Issuance Amount (in million USD/INR)
- **Independent Variables:**
- GDP Growth (%)
- Inflation (%)
- Interest Rate (%)
- ESG Score (Out of 100)
- Bond Rating (AA, BBB, etc.)

4. Data Analysis Techniques

The study applies statistical and econometric analysis to evaluate the relationship between green bond issuance and macroeconomic factors.

Descriptive Analysis

- Visualization using bar charts, line graphs, and box plots.
-

Correlation Analysis

- Pearson correlation to measure the strength and direction of relationships between green bond issuance and macroeconomic variables.
-

Regression Analysis

- **Multiple Linear Regression (MLR):** Determines the impact of independent variables on green bond issuance.

Sector-wise Regression Analysis: Separate models for Renewable Energy, Clean Transport, and Water & Waste Management.

Limitations of the Study

- **Data Availability:** Limited availability of sector-specific ESG scores.
- **Macroeconomic Volatility:** External factors like policy changes or geopolitical risks may affect results.
- **Measurement Bias:** Variation in ESG rating methodologies across different agencies.

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DATA ANALYSIS
CLEAN TRANSPORTATION

	Green bonds Issuance amt USD (millions)	*GDP Growth %*	*Inflation %*	*Interest rate %*	*ESG Score*	*Bond Rating*
Green bonds Issuance amt USD (millions)	1					
GDP Growth %	-0.06186	1				
Inflation %	-0.38217	-0.29469	1			
Interest rate %	-0.38271	0.170851	-0.44584	1		
ESG Score	-0.31416	0.871385	0.042242	0.336483	1	
Bond Rating	0.628806	0.261849	0.079789	-0.1459	0.353553	1

The correlation analysis reveals key relationships between green bond issuance for clean transportation projects and various macroeconomic and ESG factors. A strong positive correlation of 0.6288 with bond ratings highlights the importance of creditworthiness in driving issuance, as higher-rated bonds attract more investments. On the other hand, moderate negative correlations with inflation (-0.3822) and interest rates (-0.3827) suggest that these factors may discourage green bond issuance by lowering real returns and increasing borrowing costs. While the ESG score shows a weak negative correlation (-0.3142), its indirect influence is evident through strong correlations with GDP growth (0.8714) and bond ratings (0.3536), which in turn support green bond issuance. Despite a negligible correlation between GDP growth and green bond issuance (-0.0619), the findings stress the importance of financial performance and sustainability metrics in driving green bond issuance for clean transportation projects.

Green bonds Issuance amt USD (millions)	
Mean	279.4
Standard Error	24.35898
Median	280
Mode	#N/A
Standard Deviation	54.46834
Sample Variance	2966.8
Kurtosis	1.201494
Skewness	-0.36571
Range	150
Minimum	200
Maximum	350
Sum	1397
Count	5
Largest(1)	350
Smallest(1)	200
Confidence Level(95.0%)	67.63138

The descriptive statistics for green bond issuance amounts targeted at clean transportation projects provide valuable insights into the data's distribution and variability. The mean issuance amount is 279.4 million USD, indicating the average scale of funding for such projects. The median value of 280 million USD, being close to the mean, suggests a relatively balanced distribution of issuance amounts. However, the absence of a mode indicates no repeated issuance values in the dataset.

The standard deviation of 54.47 million USD reflects moderate variability in the issuance amounts, while the range of 150 million USD (from a minimum of 200 to a maximum of 350 million USD) highlights a considerable spread. The sample variance of 2966.8 further supports this observation. The slightly negative skewness (-0.3657) indicates a marginal lean towards higher issuance values, while the kurtosis (1.2015) suggests a distribution with somewhat heavier tails, implying occasional issuance amounts significantly above or below the mean.

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The confidence interval of ±67.63 million USD at the 95% confidence level suggests that the true average issuance amount is likely to fall between approximately 211.77 and 347.03 million USD. This indicates a reasonably reliable estimation given the data.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.742743
R Square	0.551668
Adjusted R S	-0.79333
Standard Err	72.94142
Observation	5

ANOVA								
	df	***SS***	***MS***	***F***	***significance F***			
Regression	3	6546.749	2182.25	0.410163	0.783654			
Residual	1	5320.451	5320.451					
Total	4	11867.2						
	Coefficients	***standard Err***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***	***lower 95.0%***	***upper 95.0%***
Intercept	642.0839	328.59	1.954058	0.301126	-3533.05	4817.21633	-3533.05	4817.216
GDP Growth	-144.044	625.2657	-0.23037	0.855856	-8088.8	7800.71065	-8088.8	7800.711
Inflation %	-3271.81	3441.609	-0.95066	0.516098	-47001.6	40457.9765	-47001.6	40457.98
Interest rate	-3337.04	3662.116	-0.91123	0.529546	-49868.6	43194.5486	-49868.6	43194.55

The regression analysis reveals a moderate positive relationship between macroeconomic factors (GDP growth, inflation, and interest rates) and green bond issuance for clean transportation projects, with a correlation coefficient (Multiple R = 0.7427). However, the R Square value of 0.5517 indicates that only 55.17% of the variability in green bond issuance is explained by these factors, and the negative Adjusted R Square (-0.7933) suggests the model's limited explanatory power due to the small sample size (n=5). The model's overall statistical insignificance (Significance F = 0.7837) and the negative coefficients for inflation and interest rates indicate potential inverse relationships, though the high p-values (all above 0.5) suggest these effects are statistically insignificant. The analysis highlights the limitations of the model and emphasizes the need for more robust data and additional variables, such as policy impacts and investor behaviour, to better understand the drivers of green bond issuance for clean transportation in India.

RENEWABLE ENERGY

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.580519
R Square	0.337002
Adjusted R	-1.65199
Standard E	91.29448
Observatio	5

ANOVA					
	df	***SS***	***MS***	***F***	***Significance F***
Regression	3	4236.518	1412.173	0.169433308	0.906620635
Residual	1	8334.682	8334.682		
Total	4	12571.2			

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Coefficients		*standard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1183.359	411.2678	2.877343	0.212939195	-4042.294219	6409.012	-4042.29	6409.012
GDP Grow	-20.4178	782.5911	-0.02609	0.983394385	-9964.180904	9923.345	-9964.18	9923.345
Inflation	-3000.94	4307.565	-0.69667	0.61262546	-57733.74865	51731.86	-57733.7	51731.86
Interest rate	-1412.12	4583.554	-0.30808	0.809742115	-59651.69325	56827.46	-59651.7	56827.46

The regression analysis of green bond issuance for renewable energy projects shows a moderate correlation (Multiple R = 0.5805) between the issuance amounts and macroeconomic factors (GDP growth, inflation, and interest rates). However, the model explains only 33.7% of the variability in issuance amounts (R Square = 0.3370), with a negative Adjusted R Square (-1.6520), indicating poor model performance, likely due to the small sample size (n=5) and potential overfitting. The high standard error (91.29) suggests substantial variability in the data. The regression model is not statistically significant (Significance F = 0.9066), and the predictors—GDP growth, inflation, and interest rates—show negative coefficients, implying inverse relationships. However, the high p- values (all above 0.6) and wide confidence intervals indicate these relationships are not statistically significant. These findings suggest that macroeconomic factors alone cannot fully explain green bond issuance for renewable energy projects, and additional factors, such as policy incentives and investor preferences, are needed for a more accurate model.

nds Issuance amt USD	
Mean	941.6
Standard E	25.0711
Median	950
Mode	#N/A
Standard D	56.06068
Sample Va	3142.8
Kurtosis	2.443778
Skewness	-1.30167
Range	150
Minimum	850
Maximum	1000
Sum	4708
Count	5
Largest(1)	1000
Smallest(1	850
Confidenc	69.60853

The descriptive statistics for green bond issuance in the renewable energy sector reveal an average issuance amount of 941.6 million USD, which is slightly below 1 billion USD. The median value of 950 million USD is close to the mean, suggesting a fairly symmetrical distribution, though some outliers may be present, as indicated by the negative skewness of -1.3017. The standard deviation of 56.06 million USD and sample variance of 3142.8 reflect moderate variability in the data. The range of 150 million USD (from 850 million to 1000 million) highlights a relatively consistent issuance pattern, despite some spread. The kurtosis of 2.44 suggests that extreme values are more likely than in a normal distribution. The 95% confidence interval of ±69.61 million USD indicates that the true average issuance likely falls between 872 million and 1011 million USD. Overall, the data shows moderate variability and a tendency for occasional lower values, while the confidence interval provides assurance that the true mean lies within a reasonable range.

Green bonds Issuance amt		**DP Growth**	**Inflation %**	**Interest rate**	**ESG score**	**Bond Rating**
Green bon	1					
GDP Grow	0.122579	1				
Inflation	-0.52249	-0.29469	1			

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Interest ra	0.007287	0.170851	-0.44584	1		
ESG score	0.412797	-0.21664	-0.62511	0.796771	1	
Bond Ratin	0.075784	-0.5233	-0.60432	0.318713	0.657794	1

The correlation analysis of green bond issuance for renewable energy projects reveals key insights into the factors driving investments. A moderate positive correlation (0.4128) between green bond issuance and ESG scores indicates that higher ESG ratings attract more funding, reflecting investor preference for sustainability. Inflation, however, shows a moderate negative correlation (-0.5225), suggesting that higher inflation may reduce the attractiveness of green bonds due to eroded real returns. GDP growth has a very weak positive correlation (0.1226), implying minimal impact on green bond issuance, while interest rates show a negligible effect (0.0073). The relationships between independent variables highlight that ESG scores are negatively correlated with inflation (-0.6251) but positively correlated with interest rates (0.7968), suggesting that higher rates may encourage sustainable investments. Additionally, ESG scores and bond ratings are moderately positively correlated (0.6578), suggesting that higher-rated bonds often exhibit better sustainability practices. Overall, the analysis underscores that ESG scores, rather than macroeconomic factors, play a more significant role in driving green bond issuance in the renewable energy sector.

WATER&WASTE MANAGEMENT

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.839616
R Square	0.704954
Adjusted R	-0.18018
Standard E	168.9414
Observatio	5

ANOVA								
	df	**SS**	**MS**	**F**	**Significance F**			
Regression	3	68193.61	22731.2	0.796435	0.6559			
Residual	1	28541.19	28541.19					
Total	4	96734.8						

Coefficients		**Standard Err**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	-472.901	761.0554	-0.62138	0.646046	-10143	9197.224	-10143	9197.224
GDP Grow	1517.691	1448.193	1.04799	0.485085	-16883.3	19918.73	-16883.3	19918.73
Inflation	8823.575	7971.194	1.106933	0.467718	-92460.1	110107.2	-92460.1	110107.2
Interest ra	8395.062	8481.915	0.98976	0.503276	-99377.9	116168	-99377.9	116168

The regression analysis for green bond issuance in the waste management sector shows a moderately strong correlation with macroeconomic factors (GDP growth, inflation, and interest rates), reflected in a Multiple R of 0.8396. However, the model's R Square value of 0.7050 suggests that 70.5% of variability is explained, but the negative Adjusted R Square of -0.1802 points to potential overfitting. High p-values and wide confidence intervals indicate that the macroeconomic factors are not statistically significant. The Significance F value of 0.6559 further confirms that the overall model is not statistically significant. This suggests that other factors, like regulatory influences or market trends, may have a more substantial impact on green bond issuance.

Green bonds Issuance amt USD (millions)	
Mean	524.3
Standard Error	69.54667
Median	500
Mode	#N/A
Standard Deviation	155.5111
Sample Variance	24183.7
Kurtosis	-0.5404
Skewness	0.681155

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Range	387.5
Minimum	362.5
Maximum	750
Sum	2621.5
Count	5
Largest(1)	750
Smallest(1)	362.5
Confidence Level(95.0%)	193.0925

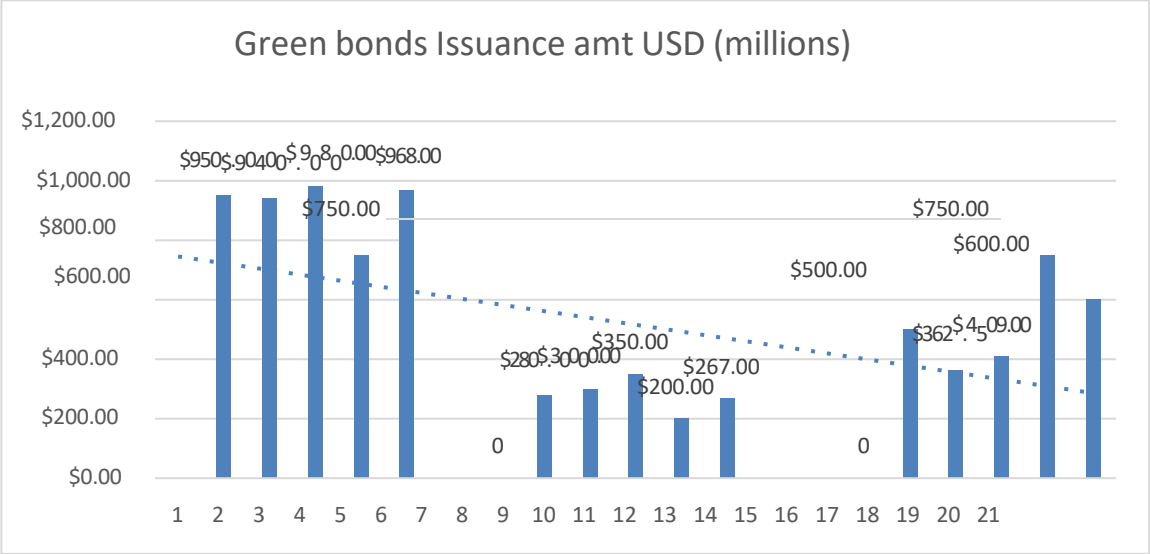
Green bond issuance amounts in the waste management sector show significant variability, with an average of 524.3 million USD. The standard error of 69.55 indicates uncertainty in estimating the mean, and the median value of 500 million USD, which is slightly lower than the mean, suggests a right-skewed distribution. This positive skewness (0.68) indicates that a few higher values are pulling the mean above the median. The standard deviation of 155.51 and sample variance of 24,183.7 highlight the wide range of issuance amounts, with a range of 387.5 million USD between the minimum (362.5 million USD) and maximum (750 million USD). The negative kurtosis of -0.54 suggests a flatter distribution with fewer extreme values. The 95% confidence interval of 193.09 million USD indicates that, with 95% confidence, the true mean lies within this range. Overall, while the average issuance is substantial, the sector experiences considerable variability in investment levels.

	Green bonds Issuance amt USD (millions)	GDP Growth %	Inflation %	Interest rate %	ESG Score	Bond Rating
Green bonds Issuance amt USD (millions)	1					
GDP Growth %	0.49474	1				
Inflation %	0.24953	-0.29469	1			
Interest rate %	0.39402	0.17085	-0.4458	1		
ESG Score	-0.16787	0.236034	-0.77244	0.764159	1	
Bond Rating	-0.88463	-0.4213	-0.46391	-0.40161	0.102062	1

The correlation analysis of green bond issuance reveals several key relationships with macroeconomic factors. A moderate positive correlation exists between green bond issuance and GDP growth (0.4947), indicating that economic growth tends to drive more green bond issuance due to greater stability and investment opportunities. Green bond issuance is also moderately positively correlated with interest rates (0.3940), suggesting that higher interest rates may attract more issuance as investors seek stable returns. Inflation has a weak positive impact on issuance (0.2495), while ESG scores show a weak negative correlation (-0.1679), indicating that higher ESG scores may not directly drive higher issuance. Notably, a strong negative correlation between green bond issuance and bond ratings (-0.8846) suggests that higher-rated bonds tend to have lower issuance volumes. The analysis also reveals a strong negative correlation between inflation and ESG scores (-0.7724), implying that higher inflation may hinder sustainability efforts, while interest rates and ESG scores are positively correlated (0.7642), highlighting the potential influence of interest rates on sustainable investments. In conclusion, macroeconomic factors such as GDP growth and interest rates play a significant role in green bond issuance, but the relationship with ESG scores and bond ratings is more complex.

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OVERALL SECTORAL ANALYSIS



Green bond issuance in India has fluctuated due to various macroeconomic factors, with the renewable energy sector being a major driver, supported by government incentives and subsidies. However, challenges such as rising inflation and supply chain disruptions have increased project costs. The infrastructure and transportation sectors, including metro rail expansions and electric vehicle projects, also contribute, although high borrowing costs and regulatory uncertainties hinder growth. Financial institutions and the private sector dominate the market, and while ESG compliance is increasingly important, concerns about greenwashing call for stronger regulatory oversight. Despite a declining trend in issuance, largely due to economic slowdown and stricter compliance, green bonds remain a vital tool for financing India's low-carbon transition, with government policies and regulatory frameworks playing a key role in sustaining growth.

CONCLUSION

The study underscores the growing significance of green bonds as a sustainable financing mechanism in India, influenced by macroeconomic factors, regulatory frameworks, and investor preferences. While green bonds provide crucial capital for environmentally sustainable projects, their issuance is subject to economic conditions such as GDP growth, inflation, and interest rates. The findings reveal that while GDP growth positively influences green bond issuance, inflation acts as a deterrent, increasing borrowing costs and reducing investor confidence. Interest rates exhibit mixed effects, indicating the complex relationship between monetary policy and green finance. ESG scores and credit ratings play a pivotal role in attracting investors, as higher ESG performance is associated with increased transparency and lower risk perception. Companies with strong corporate governance frameworks and sustainability policies tend to secure better ratings, leading to higher green bond issuance. However, concerns over greenwashing highlight the need for stringent certification and monitoring mechanisms to ensure the credibility of green finance. SEBI's regulatory interventions and adherence to the Green Bond Principles (GBP) have improved market transparency, but further standardization of ESG rating methodologies is necessary to enhance investor trust. Sectoral analysis indicates that clean transportation remains a dominant recipient of green bond financing, driven by government initiatives and policy support. Renewable energy projects have seen fluctuating investment trends, reflecting broader economic uncertainties, while waste and water management remain underfunded despite their critical role in sustainability. Strengthening 38 sector-specific policies and incentivizing investments in underrepresented areas can enhance the impact of green bonds on India's sustainability goals.

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