

An Impact Study of Green Financing on CO₂ Emissions in India: An Empirical Study

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ABSTRACT

This study examines the impact of green financing on CO₂ emissions in India using an empirical and econometric approach. With increasing environmental concerns and rising carbon emissions due to industrialization, energy consumption, and economic growth, green finance has emerged as a crucial tool for promoting sustainable development. The study analyzes the relationship between green bond issuance, renewable energy investment, energy consumption, GDP per capita, and carbon emissions using secondary time-series data. Statistical techniques, including multiple regression analysis through SPSS, are applied to evaluate the influence of green financial instruments on environmental outcomes.

The findings reveal that green bond issuance has a statistically significant relationship with CO₂ emissions, indicating that financial instruments can influence environmental sustainability. However, renewable energy financing does not show a significant impact during the study period, possibly due to limited investment scale and delayed policy effects. Energy consumption is identified as a major determinant of emissions, while economic growth shows minimal direct influence. The study concludes that green finance has considerable potential to support emission reduction and sustainable development in India, but its effectiveness depends on increased investment, policy support, and long-term implementation. The research provides valuable insights for policymakers, financial institutions, and environmental planners in strengthening climate finance strategies and promoting a low-carbon economic transition.

Keywords: Green Financing, Emissions, Sustainability, Implementation, Transition.

Introduction

Environmental sustainability has become one of the most important challenges of the modern world as rapid industrialization, urbanization, and economic expansion continue to exert pressure on natural resources and ecological systems. The rise in greenhouse gas emissions, particularly carbon dioxide (CO₂), has intensified concerns regarding climate change, environmental degradation, and long-term economic stability (World bank, 2020). Countries across the globe are now recognizing the urgent need to adopt development strategies that balance economic growth with environmental protection. In this context, financial systems are increasingly being viewed as powerful instruments for promoting environmentally responsible development through the concept of green finance (Schoaltens, 2006).

Green finance refers to financial activities and investments that support environmentally sustainable projects, reduce pollution, and encourage efficient use of resources. It includes instruments such as green bonds, renewable energy financing, climate funds, and sustainable investment practices (Labatt & White, 2007). The primary aim of green finance is to channel financial resources toward initiatives that contribute to environmental protection while sustaining economic development. By aligning financial decisions with environmental goals, green finance plays a crucial role in facilitating the transition toward a low-carbon economy.

India is among the leading emitters of carbon dioxide globally, largely due to its energy structure and growing industrial base. Coal remains a dominant source of energy, and the expanding manufacturing and transportation sectors continue to contribute significantly to emissions. At the same time, the country faces environmental issues such as air pollution, climate vulnerability, and resource depletion. These challenges highlight the importance of adopting sustainable financial and economic strategies that promote clean energy and environmentally friendly production systems. In response to these challenges, India has undertaken several initiatives to promote green finance and environmental sustainability (Reserve Bank of India, 2021). Green bonds have emerged as a major financial instrument in India's green finance landscape. These bonds are issued to raise funds for projects that deliver environmental benefits, including renewable energy, pollution control, and sustainable urban infrastructure. The growth of the green bond market reflects rising investor interest in sustainable investment opportunities and the recognition of environmental risks within financial systems. Similarly, renewable energy financing has gained importance as the country seeks to diversify its energy mix and reduce dependence on fossil fuels.

Energy consumption continues to be a major determinant of carbon emissions in India. The increasing demand for electricity, transportation, and industrial production has resulted in higher energy use, which in turn contributes to environmental degradation. Although renewable energy capacity is expanding, fossil fuels still dominate the energy sector. This creates a complex situation where economic development and environmental sustainability must be managed simultaneously. Green finance plays an important role in facilitating this transition by supporting investments in clean energy and energy-efficient technologies.

Economic growth is another factor that significantly influences environmental outcomes. Higher income levels often lead to increased consumption and industrial activity, which may raise emissions. However, economic growth also provides opportunities for investment in cleaner technologies, environmental regulation, and sustainable infrastructure. The relationship between economic development and environmental sustainability is therefore dynamic and requires careful analysis (Grossman & Krueger, 1995). Green finance can help bridge this gap by promoting investments that support both economic progress and environmental protection.

The present study seeks to examine the impact of green financing on CO₂ emissions in India by analyzing key variables such as green bond issuance, renewable energy investment, energy consumption, and economic growth. By adopting an empirical approach, the study aims to provide insights into whether green finance contributes significantly to emission reduction and environmental sustainability. It also attempts to understand the extent to which financial mechanisms support India's transition toward a low-carbon economy.

Review of Literature

Grossman and Kruegar (1995) in their study examined the relationship between economic growth and degradation of environment using the framework of Environmental kuznet Curve. They used panel data for the developed and developing economies through techniques of econometrics, such as regression and panel data analysis. The result concluded that environmental degradation increases in the early stages of economic growth and starts declining after a threshold of income is reached. The study highlighted that the reduction in emission is also due to structural transformation. **Scholtens (2006)** studied the promotion of environmental sustainability in context of financial institutions. For the study secondary data from investment institutions and banks were used for the analysis. This study concluded that the sustainable practices were witnessed in the bank's decision of lendings and green investments were also encouraged by the investment institutions.

Labatt and White (2007) in their study on environmental finance and carbon markets used policy analysis method for the research. The analysis of data on financial instruments and environmental markets concluded that carbon emissions witnessed reduction due to green financial products and carbon trading. The study pointed out the importance of innovation in financial institutions and their products, and saw it as a tool for sustainable development. **Bowen and Fankhauser (2011)** studied developing economies regarding the climate finance. Policy analysis and macroeconomic data were used for the study under which techniques applied were comparative analysis and regression. The analysis of the study concluded that climate finance promotes the adoption of renewable energy and also highlighted the economic benefits of green investment. It also found positive impacts on employment and infrastructure.

Stern (2013) in his study on the impact of financial investment on climate change highlighted the importance of investment in low – carbon technologies. For the analysis of the study cost – benefit analysis and economic modelling were used, under which data on emissions, economic growth, and investment were taken. Findings showed that early investment reduces long-term environmental damage, need of financial support for clean energy, and emphasized

on the policy – driven financial mechanisms. The research supports sustainable finance as a growth strategy which is relevant for India's emission reduction policies. **Eyraud et al. (2013)** analyzed green investment and economic growth. The objective was to examine the relationship between environmental investment and macroeconomic performance. The study used panel data from multiple countries. Econometric models were applied to evaluate investment impacts. Findings indicated that green investment promotes sustainable growth. It also contributes to emission reduction. The study highlighted the role of fiscal policies in green financing. However, investment efficiency varied across countries. Institutional capacity influenced outcomes. The research supports integrating green finance into economic policy.

Clark et al. (2015) studied sustainable investment and environmental performance. The objective of the study was to assess ESG-based investment strategies. The study used financial market data under which portfolio analysis and statistical methods were applied for the analysis of the data. Findings showed that sustainable investments improve environmental outcomes, companies who adopted ESG reduced carbon intensity, and financial markets influenced corporate sustainability decisions.

Significance of the Study

Green finance has emerged as an important policy and financial instrument for addressing environmental challenges and promoting sustainable development in India. With rising industrialization, urbanization, and energy consumption, India is experiencing increasing levels of carbon emissions, making environmental sustainability a critical national priority. In this context, understanding the effectiveness of green financing in reducing CO₂ emissions is essential for policymakers, financial institutions, and environmental planners.

The significance of this study lies in its attempt to empirically examine the relationship between green finance and carbon emissions in India. The study provides insights into whether financial instruments such as green bonds and renewable energy investments are contributing to environmental improvement. It also highlights the role of economic growth and energy consumption in influencing emission patterns.

Objectives of the Study

1. To examine the impact of green financing on CO₂ emissions in India.
2. To analyze the relationship between renewable energy financing and emission reduction.
3. To study the influence of green bond issuance on environmental sustainability.
4. To evaluate the role of energy consumption in determining carbon emission levels.
5. To assess the effect of economic growth (GDP per capita) on CO₂ emissions.
6. To provide policy suggestions for promoting green finance and sustainable development in India.

Research Methodology

The present study adopts a quantitative and empirical research design to examine the impact of green financing on CO₂ emissions in India. The study is analytical in nature and aims to test the relationship between green finance indicators and environmental outcomes using econometric techniques. A time-series approach has been adopted to analyze the influence of financial and economic variables on carbon emissions over a specific period.

The study is based entirely on secondary data collected from reliable national and international sources. The data has been compiled annually for India to maintain consistency and comparability. For the analysis of the data collected statistical tools like SPSS is used for the result. The sources of the data include- Reserve Bank of India (RBI) reports, Ministry of Environment, Forest and Climate Change, International Energy Agency (IEA), Green bond reports and climate finance databases, etc.

The hypotheses undertaken for the study are:

1. Green Finance has no significant impact on carbon emissions.
2. Renewable energy financing has no significant relationship with emission reduction.

Analysis of the Data

The data of dependent and independent variables collected through secondary sources are being analysed through the SPSS software. The technique is used to analyse the hypotheses:

Null Hypotheses

1. Green Finance has no significant impact on carbon emissions.
2. Renewable energy financing has no significant relationship with emission reduction.

Alternative Hypotheses

1. Green Finance have significant impact on carbon emissions.
2. Renewable energy financing has significant relationship with emission reduction.

In the model CO₂ emission is the dependent variable and energy consumption, green bonds, sustainable energy investments, and GDP per capita is considered as the independent variables.

Table 1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.994	.989	.978	.02429

In the table above of model analysed through SPSS shows R = 0.994 that shows a very strong relationship between CO₂ emission and all independent variables together. Thus, we can say that the changes in energy consumption, per capita GDP, and green financing strongly affect CO₂ emissions. The value of R² = 0.989 is a very important value which explains that 98.9% change in CO₂ emission is explained by the model and only 1.15 change is due to other factors. The value of Adjusted R square = 0.978 which is 97.8% of emission changes are explained by the model which is excellent for the research. The standard error of the estimate = 0.02429 which is very small, representing high accuracy of the research.

Table 2: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.733	.483		-1.518	.204
	India Green Bond Issuance (USD billion)	.003	.001	.342	2.823	.048
	Sustainable Energy Investment (USD Billion)	.001	.005	.017	.170	.873
	GDP pe capita (USD)	2.807E-05	.000	.055	.257	.810
	Energy Consumption	8.919E-05	.000	.673	3.536	.024
a. Dependent Variable: CO ₂ emissions per capita, India						

In the above table, we have to focus basically on two columns- B (coefficient) and Sig. (significance). Seeing the value of Green Bond Issuance b = 0.003 and p = 0.048 (<0.05) shows that it has significant impact on CO₂ emissions. The sustainable energy investment value B = 0.001 and p = 0.873 (> 0.005) which shows that there is no significant impact on emissions and signifies that investment is not yet strong enough to reduce pollution. B value of per capita GDP is very small and p value is 0.810 (> 0.052) which means that economic growth is not significantly affecting emissions.

Therefore, the hypotheses "Green Finance has no significant impact on emissions" for the two variables- green bonds and sustainable investment, result shows that the green bonds have significant impact and sustainable investment have no significant impact. Thus, the null hypotheses is partially accepted.

Table 3: ANOVA

Mode		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0.213	4	0.053	90.095	.000 b
	Residual	0.002	4	0.001		
	Total	0.215	8			

ANOVA table of the regression explains whether the model applied is statistically valid or not. The F value of 90.095 and significance value of 0.000 explains that the model is statistically significant and independent variable actually explains CO₂ emissions. The ANOVA results indicate that the regression model is statistically significant. The regression sum of squares is substantially higher than the residual sum of squares, indicating that most of the variation in CO₂ emissions is explained by the selected variables. Therefore, the model is reliable and suitable for analysing the relationship between green finance, energy consumption, economic growth, and carbon emissions.

Table 4: Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.7261	2.2080	1.9154	.16300	9
Residual	-.02527	.02437	.00000	.01717	9
Std. Predicted Value	-1.161	1.795	.000	1.000	9
Std. Residual	-1.040	1.003	.000	.707	9

The table above shows the reliability of the regression model. It explains whether the predictions are accurate or face any problem. The mean of the residual is 0.00, residual range -0.02527 to 0.02437, and standard deviation is also small. If the residual is small, then the model is good. The residual statistics indicate that the regression model provides accurate predictions with minimal error. The mean residual value is zero, confirming the absence of systematic bias in the model. The standardized range falls within the acceptable range of -3 to +3.

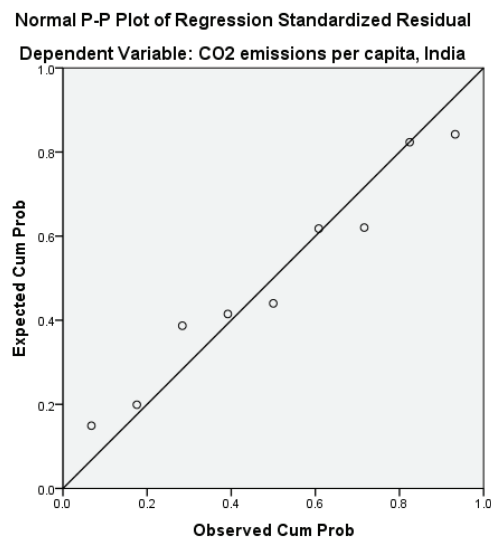


Figure 1

The normal P–P plot of standardized residuals shows that most of the data points lie close to the diagonal reference line. This indicates that the residuals of the regression model are normally distributed. Therefore, the normality assumption of regression is satisfied and the model is statistically reliable. The absence of major deviations from the line confirms that there are no serious outliers or model specification errors. Hence, the regression results can be considered valid for further interpretation.

Result and Discussion

The first null hypothesis states that green finance has no significant impact on carbon emissions. However, the regression results show that green bond issuance has a statistically significant effect on CO₂ emissions ($p < 0.05$), while sustainable energy investment does not show a significant impact ($p > 0.05$). This indicates that green finance, as a whole, does influence emissions, but its effect is not uniform across all components. Green bonds appear to have a measurable relationship with emissions, whereas sustainable energy investments have not yet produced a significant environmental impact, possibly due to their limited scale or time lag in implementation.

Therefore, the null hypothesis that green finance has no significant impact on carbon emissions is partially rejected.

The second null hypothesis states that renewable energy financing has no significant relationship with emission reduction. The regression analysis shows that sustainable energy investment has a high p-value (greater than 0.05), indicating no statistically significant relationship with CO₂ emission reduction during the study period. This suggests that renewable energy financing has not yet translated into a measurable decline in emissions, which may be due to continued dependence on fossil fuels, insufficient investment scale, or delayed effects of policy implementation.

Hence, the null hypothesis is accepted, implying that renewable energy financing has not yet significantly contributed to emission reduction in the empirical analysis.

Conclusion

The study examined the impact of green financing on CO₂ emissions in India using econometric analysis. The findings indicate that green bond issuance has a statistically significant relationship with carbon emissions, suggesting that financial instruments can influence environmental outcomes. However, renewable energy financing did not show a significant impact during the study period, possibly due to limited scale and delayed policy effects. Energy consumption emerged as a major determinant of emissions, while GDP per capita showed minimal influence. Overall, the results highlight that green finance has potential in supporting environmental sustainability, but its effectiveness depends on stronger investment, policy support, and long-term implementation for meaningful emission reduction in India.

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