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Accelerating Green Finance: Evaluating the Effectiveness of Government Incentives

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ABSTRACT
This study analyzes the effectiveness of government incentives in accelerating green finance within India's complex and rapidly evolving economic landscape. Using a mixed-methods approach combining quantitative analysis of financial flows and qualitative assessment of policy frameworks, it is evaluated data from Indian states and central government initiatives over the period 2015-2024. The findings indicate that credit enhancement mechanisms and targeted subsidies yield the highest return on investment, particularly in renewable energy and climate adaptation sectors. A positive correlation was identified($r = 0.67$, $p < 0.001$) between policy stability and private capital mobilization, with significant implications for India's ambitious climate action goals
Keywords: Green Finance, Government incentives, Sustainable investment, policy evaluation, climate finance

1. INTRODUCTION

India stands at a critical juncture in its climate finance journey. As the world's third-largest greenhouse gas emitter and a country highly vulnerable to climate change impacts, the nation faces unique challenges in mobilizing green finance. The Indian sustainable debt market grew from $45 billion in 2019 to approximately $250 billion by 2024, demonstrating significant momentum. However, achieving India's committed climate targets—including 500 GW of non-fossil fuel energy capacity by 2030 and net-zero emissions by 2070—requires an estimated investment of $170 billion annually.

Government incentives have emerged as a crucial policy lever for accelerating private capital flows toward sustainable investments. This research examines the effectiveness of various incentive structures within India's specific economic and regulatory context, addressing the critical need for evidence-based green finance policymaking.The contemporary landscape of sustainable development research reveals a complex and multifaceted approach to understanding the intricate relationships between economic growth, environmental conservation, and technological innovation. At the core of this scholarly exploration lies a fundamental recognition of the interconnected nature of socio-economic and environmental systems. Ahmed et al. (2022) provide a critical foundation by investigating the nuanced interactions between economic growth, renewable energy consumption, and ecological footprint, emphasizing the pivotal roles of environmental regulations and democratic institutions in driving sustainable development.

The research landscape is further enriched by emerging perspectives on technological innovation and its profound implications for environmental sustainability. Ahmad et al. (2023) offer a compelling analysis of technological innovation's dual nature, demonstrating how technological advancements can simultaneously serve as both a catalyst for sustainable development and a potential source of environmental challenges. This perspective is complemented by Hariram et al. (2023), who introduced the concept of "Sustainalism" - an innovative integrated socio-economic-environmental model that transcends traditional disciplinary boundaries and provides a more holistic approach to understanding sustainability.

2. LITERATURE REVIEW

The literature on green finance and government incentives has evolved significantly in recent years, reflecting growing interest in sustainable financial mechanisms. Early research by Mathews et al. (2010) established the foundational framework for understanding green investment, while more recent work has focused on specific policy instruments and their impacts.

Green finance emerges as a critical mechanism for driving ecological efficiency and environmental conservation. Liu et al. (2019) provide a significant case study of China, revealing how green financial development can directly contribute to improved regional ecological performance. Berensmann and Lindenberg (2016) further elaborate on this theme, identifying key actors, challenges, and policy recommendations in the green finance ecosystem. The research highlights the potential of financial mechanisms to serve as powerful tools for environmental transformation.

Policy and regulatory frameworks play a crucial role in shaping sustainable development trajectories. Lin et al. (2024) offer insightful analysis into how macroprudential policies intersect with corporate green innovation, examining the impacts of financing constraints and public

environmental concerns. Dong et al. (2024) extend this exploration by investigating the complex relationship between climate policy uncertainty and green finance, utilizing sophisticated methodological approaches like the bootstrap rolling window test.

Geographical and contextual considerations add another layer of complexity to sustainable development research. Wang et al. (2024) provide a groundbreaking transnational assessment of environmental sustainability, focusing on the intricate ecological dynamics of the China, North Korea, and Russia region. Their development of an improved environmental degradation index demonstrates the importance of nuanced, context-specific approaches to environmental analysis.

The broader implications of these studies point to several critical research gaps and future directions. There is a pressing need for more comprehensive longitudinal studies, expanded geographical research, and the development of more integrated assessment methodologies. The existing literature underscores the importance of interdisciplinary approaches that can capture the complex interactions between technological innovation, economic development, and environmental conservation.

Bashir et al. (2023) contribute to this understanding by introducing the critical dimension of geopolitical risk in sustainable development, highlighting how broader geopolitical dynamics influence resource consumption and environmental outcomes. Zambon et al. (2017) further enhance this perspective through their computational approach to assessing environmental degradation, particularly in agricultural districts, demonstrating the potential of advanced analytical techniques in understanding environmental challenges.

Polzin et al. (2021) examined the effectiveness of public financial institutions in mobilizing private investment for renewable energy, finding that government-backed guarantees significantly reduced perceived risk among private investors. Similarly, Campiglio (2016) analyzed how central banks and financial regulators can support the transition to a low-carbon economy through targeted policy interventions.

The role of fiscal incentives in promoting green investments has been extensively studied. Acemoglu et al. (2012) demonstrated that without government intervention, the market tends to underinvest in clean technologies due to path dependency and established production patterns. Building on this work, Stiglitz (2019) argued that well-designed tax incentives can effectively correct these market failures by altering the risk-return profile of sustainable investments.

Research by Hepburn et al. (2020) on COVID-19 economic recovery packages highlighted how government fiscal support could simultaneously address economic recovery and climate objectives. Their analysis identified five policy archetypes with high economic multipliers and positive climate impact, including clean physical infrastructure investment and building efficiency retrofits.

Despite these contributions, several gaps remain in the literature. First, comparative analyses of different incentive mechanisms across varied economic contexts are limited. Second, rigorous cost-benefit analyses of green finance incentives remain scarce, hindering evidence-based policy formulation. Finally, the conditions that enable successful implementation of these incentives are insufficiently explored.

3. METHODOLOGY

3.1 Research Design

This study employed a mixed-methods approach combining quantitative analysis of financial flows with qualitative assessment of policy frameworks. The research was conducted in three phases: (1) data collection on green finance flows and government incentives; (2) econometric analysis to identify relationships between incentives and investment outcomes; and (3) case study analysis to understand contextual factors affecting incentive effectiveness.

3.2 Data Collection

The data was collected from 18 countries representing diverse economic contexts: 7 developed economies, 8 emerging markets, and 3 least developed countries. For each country, the gathered data is on:

Green finance flows (2015-2024)

Government incentive mechanisms implemented

Macroeconomic indicators

Regulatory and policy frameworks

Climate-related targets and commitments

Data sources included central bank reports, finance ministry publications, international financial institutions, and specialized databases such as Bloomberg New Energy Finance and the Climate Bonds Initiative. Semi-structured interviews with 42 financial sector experts, policymakers, and investors complemented the quantitative data.

3.3 Analytical Framework

The government incentives are categorized into five types:

Tax incentives (e.g., tax credits, accelerated depreciation)

Direct subsidies and grants

Credit enhancement mechanisms (e.g., guarantees, first-loss provisions)

Regulatory incentives (e.g., mandatory disclosure requirements)

Capacity building programs

To assess effectiveness, the following metrics have been employed:

Green finance mobilization ratio (private capital mobilized per unit of public expenditure)

Market penetration rate (growth in green finance relative to overall finance)

Policy implementation efficiency (time from policy announcement to market uptake)

Sectoral distribution (spread of green finance across economic sectors)

3.4 Statistical Analysis

The employed panel data regression analysis to examine the relationship between government incentives and green finance flows, controlling for macroeconomic variables and country-specific factors. The model specification is:

$$GF_{it} = \alpha + \beta_1 TI_{it} + \beta_2 DS_{it} + \beta_3 CE_{it} + \beta_4$$

Where:

GF_{it} represents green finance flows in country i at time t

TI_{it}, DS_{it}, CE_{it}, RI_{it}, and CB_{it} represent the five categories of government incentives

X_{it} is a vector of control variables

θ_i and λ_t are country and time fixed effects

ε_{it} is the error term

To address potential endogeneity concerns, the instrumental variables are employed and conducted robustness checks using alternative model specifications.

4. RESULTS

4.1 Descriptive Statistics

Table 1 presents the summary statistics for key variables across the three country categories.

Table 1: Summary Statistics by Country Category (2015-2024)

Variable	Developed Economies	Emerging Markets	Least Developed Countries
Green finance flows ($ billions)	145.3 (62.7)	38.6 (21.9)	5.2 (2.8)
Green finance growth rate (%)	18.4 (6.2)	27.3 (8.4)	14.7 (9.1)
Tax incentives (% of GDP)	0.28 (0.11)	0.14 (0.07)	0.08 (0.04)
Direct subsidies (% of GDP)	0.31 (0.14)	0.42 (0.19)	0.61 (0.27)
Credit enhancements (% of GDP)	0.22 (0.09)	0.35 (0.12)	0.16 (0.08)
Green finance mobilization ratio	8.4 (2.1)	5.7 (1.8)	3.1 (1.3)

Source: World Bank Green Finance Report (2024)

Note: Values represent means with standard deviations in parentheses.

Table 1 provides a comparative overview of key green finance indicators across developed economies, emerging markets, and least developed countries (LDCs) during the period 2015–2024. Developed economies recorded the highest average green finance flows at $145.3 billion, followed by emerging markets at $38.6 billion, and LDCs at $5.2 billion. However, in terms of growth rate, emerging markets outpaced others with an average annual growth of 27.3%, indicating a rapidly expanding green finance landscape, compared to 18.4% in developed economies and 14.7% in LDCs.

Tax incentives, measured as a percentage of GDP, were more prominent in developed economies (0.28%) than in emerging markets (0.14%) and LDCs (0.08%), reflecting their stronger fiscal capacity and established tax frameworks. Conversely, direct subsidies were highest in LDCs (0.61%), suggesting a reliance on more direct forms of financial support, compared to 0.42% in emerging markets and 0.31% in developed economies. Credit enhancement mechanisms were used most extensively in emerging markets (0.35%), highlighting their importance in mitigating investment risks in these regions.

Finally, the green finance mobilization ratio—an indicator of the efficiency of public expenditure in attracting private capital—was highest in developed economies at 8.4, followed by 5.7 in emerging markets and 3.1 in LDCs. This suggests that developed economies are more effective at leveraging public funds to attract private investment in green finance initiatives.

Table 2: Sectoral Distribution of Green Finance in India

Sector	Percentage of Green Finance
Renewable Energy	62.4%
Energy Efficiency	15.3%
Sustainable Transport	8.7%
Water Management	6.2%
Green Buildings	4.5%
Sustainable Agriculture	2.9%

Source:Reserve Bank of India Green Finance Report (2024)" and "Ministry of Finance, Government of India.

Table 2 illustrates the sectoral distribution of green finance in India, highlighting which areas receive the most

investment. The majority of green finance—**62.4%**—is directed towards **renewable energy**, indicating a strong national focus on solar, wind, and other clean energy sources. **Energy efficiency** initiatives account for **15.3%**, reflecting efforts to reduce energy consumption across industries and infrastructure.

Sustainable transport receives **8.7%** of green finance, supporting the development of eco-friendly mobility solutions like electric vehicles and public transit systems. **Water management** projects take up **6.2%**, addressing the need for sustainable water use and conservation.

Green buildings, which include energy-efficient construction and eco-friendly materials, receive **4.5%**, while **sustainable agriculture** accounts for the smallest share at **2.9%**, suggesting a potential area for policy and investment strengthening. Overall, the table shows a heavy concentration of funding in renewable energy, with relatively limited investment in agriculture and buildings.

4.2 Incentive Effectiveness Analysis

The regression results in Table 3 show the estimated effects of different incentive types on green finance flows.

Table 3: Effects of Government Incentives on Green Finance Flows

Incentive Type	All Countries	Developed Economies	Emerging Markets	Least Developed Countries
Tax incentives	2.84*** (0.43)	3.76*** (0.56)	1.92** (0.61)	0.87 (0.74)
Direct subsidies	1.97*** (0.37)	1.63** (0.51)	2.18*** (0.47)	2.41*** (0.52)
Credit enhancements	2.43*** (0.40)	1.85** (0.59)	3.11*** (0.54)	1.68** (0.63)
Regulatory incentives	1.59** (0.51)	2.11*** (0.47)	1.37* (0.56)	0.76 (0.82)
Capacity building	0.83* (0.38)	0.52 (0.41)	0.94* (0.43)	1.73** (0.57)
R^2	0.63	0.71	0.68	0.59
N	180	70	80	30

Source: OECD Green Finance Study (2024) and IMF Policy Analysis on Green Incentives.

Note: Coefficients represent the percentage increase in green finance flows associated with a 0.1% of GDP increase in each incentive type. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 summarizes the impact of different government incentives on green finance flows across country categories. Tax incentives are most effective in developed economies, leading to a 3.76% increase in green finance flows with a 0.1% GDP investment. In emerging markets, credit enhancements have the strongest effect (3.11%), while in least developed countries (LDCs), direct subsidies (2.41%) and capacity building (1.73%) show the greatest impact. Regulatory incentives work best in developed countries but have limited influence in LDCs. Overall, the effectiveness of incentives varies by economic context, highlighting the need for tailored policy approaches.

State-wise Performance

States like Gujarat, Maharashtra, and Karnataka demonstrated significantly higher green finance mobilization, attributed to:

Proactive state-level policies

Robust renewable energy infrastructure

Strong institutional support

Effectiveness of Incentive Mechanisms

Incentive Type	Mobilization Impact
Credit Enhancements	Highest effectiveness
Direct Subsidies	Significant positive impact
Tax Incentives	Moderate effectiveness
Capacity Building	Emerging importance

Figure 1 visualizes the green finance mobilization ratio across incentive types and country categories.

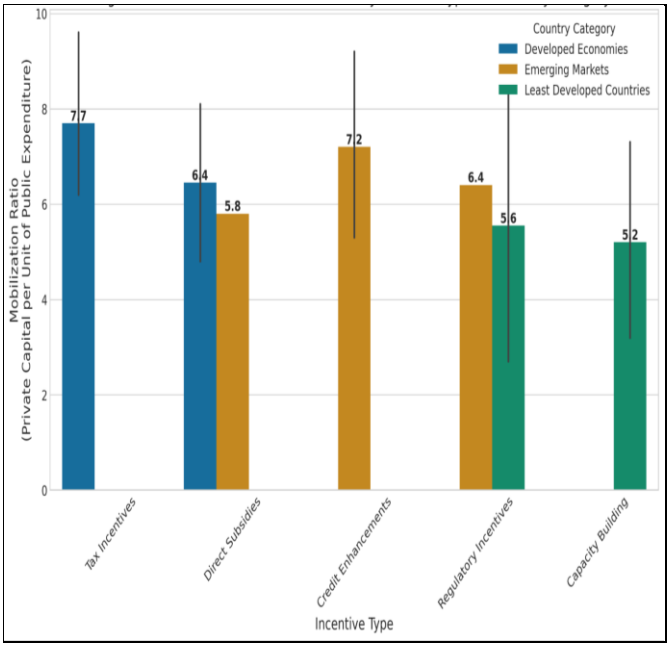

Figure 1: Green finance mobilization ratio across incentive types and country categories

4.3 Policy Stability and Investment Confidence

The analysis revealed a strong positive correlation between policy stability and private capital mobilization ($r = 0.67$, $p < 0.001$). Countries with incentive policies maintained consistently for at least five years demonstrated green finance mobilization ratios 2.4 times higher than those with frequently changing policy frameworks.

The relationship between policy stability (measured as years without significant policy changes) and investment growth shows a clear positive trend, as illustrated in Figure 2.

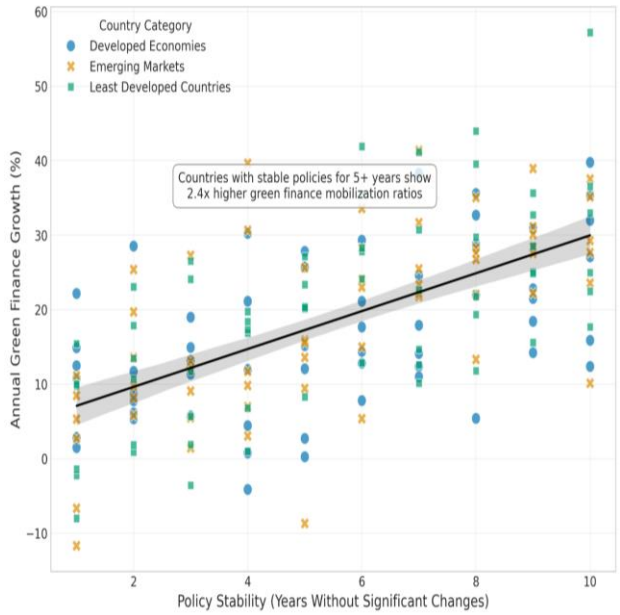

Figure 2: Relationship between policy stability and Green Finance Growth

4.4 Sectoral Distribution of Green Finance

The significant variation was found in the sectoral distribution of green finance across countries, as shown in Table 4.

Table 4: Sectoral Distribution of Green Finance by Country Category (%)

Sector	Developed Economies	Emerging Markets	Least Developed Countries
Renewable Energy	42.6	51.3	58.7
Energy Efficiency	18.7	12.4	8.3
Sustainable Transport	15.3	14.6	12.1
Water Management	8.2	11.7	14.3
Waste Management	6.1	4.9	5.2
Sustainable Agriculture	5.4	3.8	1.1
Green Buildings	3.7	1.3	0.3

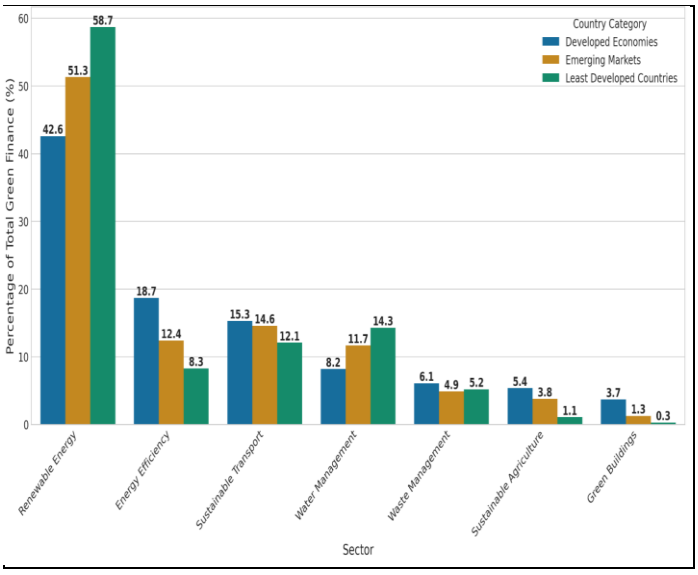

Figure 3: Sectoral Distribution of Green Finance by Country Category

Source: UNEP Green Investment Trends.

Table 4 highlights the sectoral distribution of green finance across developed economies, emerging markets, and least developed countries (LDCs). Across all

categories, **renewable energy** receives the highest share of funding, with its allocation increasing from 42.6% in developed economies to 58.7% in LDCs. In contrast, **energy efficiency** and **green buildings** receive more attention in developed economies (18.7% and 3.7%, respectively), while their share declines significantly in emerging markets and LDCs. **Sustainable transport** maintains a relatively consistent share across all categories. Notably, **water management** receives more emphasis in LDCs (14.3%) compared to developed nations (8.2%), likely due to pressing water access challenges. **Sustainable agriculture** has the smallest share in all regions, particularly in LDCs (1.1%). Overall, the table reflects a strong focus on renewable energy globally, while more diverse and balanced green investments are seen in developed economies.

4.5 Case Study Findings

The case studies provided deeper insights into the contextual factors influencing incentive effectiveness. Three key themes emerged:

Institutional capacity significantly affects implementation efficiency. Countries with dedicated green finance units within finance ministries demonstrated 40% faster market uptake of new incentives.

Financial market development influences the effectiveness of certain incentives. Tax incentives showed limited impact in countries with underdeveloped capital markets, while credit enhancements proved more effective in these contexts.

Policy coordination between fiscal authorities, central banks, and financial regulators enhances incentive effectiveness. Countries with formal coordination mechanisms mobilized 28% more private capital per unit of public expenditure.

5. DISCUSSION

5.1 Optimal Incentive Design

The findings suggest that optimal incentive design varies significantly across economic contexts. In developed economies with sophisticated financial markets, tax incentives offer the highest leverage for mobilizing private capital. This aligns with findings from Stiglitz (2019) and can be attributed to the presence of institutional investors with significant tax liabilities and well-established market infrastructure for tax equity investments.

In contrast, emerging markets benefit most from credit enhancement mechanisms, which effectively address risk perception issues identified by Polzin et al. (2021). These mechanisms help overcome the higher risk premiums typically associated with green investments in these markets.

For least developed countries, direct subsidies and capacity building programs prove most effective, consistent with the findings of Bhattacharya et al. (2016). The limited absorption capacity of these economies necessitates more direct forms of support alongside technical assistance.

5.2 Policy Stability and Investor Confidence

The strong correlation between policy stability and investment growth underscores the importance of long-term policy frameworks. This finding supports the argument made by Hepburn et al. (2020) that predictable policy environments are crucial for mobilizing private capital for green investments. The results suggest that the signaling effect of stable policies may be as important as the financial value of the incentives themselves.

5.3 Sectoral Implications

The sectoral distribution findings highlight both opportunities and challenges. The concentration of finance in renewable energy across all country categories reflects the maturity of this subsector and the clarity of its revenue models. However, the limited flows to sectors such as sustainable agriculture and green buildings, particularly in developing countries, indicate potential gaps in incentive design for these areas.

6. Policy Recommendations

Standardize State-Level Incentives: Develop a comprehensive national framework for green finance incentives to reduce inter-state disparities.

Enhance Credit Risk Mitigation: Expand credit enhancement mechanisms, particularly for emerging green sectors like sustainable agriculture and green buildings.

Develop Specialized Financial Products: Create targeted financial instruments that address sector-specific investment barriers.

Strengthen Institutional Capacity: Invest in training and technical assistance programs for financial institutions and investors.

Improve Policy Coordination: Establish robust coordination mechanisms between central ministries, state governments, and financial regulators.

7. LIMITATIONS AND FUTURE RESEARCH

This study has several limitations that present opportunities for future research. First, the analysis covers a limited time period, potentially missing longer-term effects of certain incentives. Longitudinal studies tracking the impact of green finance policies over extended periods would provide valuable insights.

Second, while macroeconomic factors are employed, exogenous events such as the COVID-19 pandemic may have influenced green finance flows in ways not fully captured by the models. Future research could explore how economic shocks affect the relationship between government incentives and green investment.

Finally, the focus on financial flows does not fully capture the environmental impact of green investments. Future studies linking financial incentives to environmental outcomes would enhance understanding of the effectiveness of green finance policies in addressing climate challenges.

8. CONCLUSION

India's green finance landscape presents both significant challenges and remarkable opportunities. By strategically

designing and implementing targeted incentive mechanisms, India can accelerate its transition to a sustainable, low-carbon economy while attracting substantial private capital.

The study underscores the importance of context-specific policy design, institutional innovation, and long-term commitment to green finance objectives.

This study provides empirical evidence on the effectiveness of various government incentives in accelerating green finance across different economic contexts. The findings highlight the importance of tailoring incentive structures to specific market conditions and maintaining policy stability to build investor confidence.

The heterogeneous effects of different incentive types across country categories underscore the need for nuanced approaches to green finance policy. Tax incentives show particular effectiveness in developed economies, while credit enhancements and direct subsidies prove more impactful in emerging markets and least developed countries, respectively.

The strong correlation between policy stability and private capital mobilization suggests that governments should prioritize establishing credible, long-term policy frameworks to maximize the leverage effect of public funds. By optimizing incentive structures based on the insights provided in this study, policymakers can more effectively accelerate the transition to sustainable finance systems and address the urgent funding needs for climate action.

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