



**INSPECTING THE IMPACT OF
FINANCIAL INCLUSION ON
EMISSIONS IN INDIA:
THE BANKING CHANNEL**

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PAPER

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Abstract

The urgent need to address climate change has placed environmental degradation and sustainable development at the centre of policy discussions. This highlights the importance of examining how the financial system directs funds toward green investments or emission-intensive industries. Expanding financial inclusion integrates more individuals into the formal financial system, influencing capital allocation.

India has introduced several initiatives in recent years to enhance financial inclusion. In this context, this study explores the impact of financial inclusion on carbon emissions in India from 1990 to 2018. It also examines the interplay of financial inclusion and financial development on carbon emissions in India. The study uses the ARDL bounds testing approach to find a long-run relationship between financial inclusion and carbon emissions. However, the interaction between financial inclusion and financial development does not significantly impact emissions in the long run. These findings contribute to understanding the role of financial inclusion in shaping India's environmental trajectory.

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Inspecting the impact of financial inclusion on emissions in India: The Banking Channel

Saon Ray* and Vasundhara Thakur

1. Introduction

The growing exigency of addressing the climate change concern has brought the issue of environmental degradation and sustainable development to the forefront. The 29th United Nations Climate Change Conference (COP29) in Baku, Azerbaijan, highlighted the importance of climate finance and carbon emission strategies. A key outcome was the agreement to triple climate finance for developing nations, increasing annual commitments from \$100 billion to \$300 billion by 2035, alongside plans to mobilize an additional \$1.3 trillion. However, this fell short of the \$500 billion target sought by many vulnerable nations. The conference also established international standards for carbon markets under Article 6.4 of the Paris Agreement, enhancing global carbon credit trading and investment in emission reduction projects. Countries committed to reducing greenhouse gas emissions by 42% by 2030 (compared to 2019) and accelerating the transition from fossil fuels to renewable energy to meet the 1.5°C warming limit. Discussions also focused on building climate-resilient societies, ensuring sustainable resource use, and promoting equitable climate action benefits. These decisions reinforce the importance of integrating financial inclusion with carbon reduction efforts, ensuring fair resource distribution to combat climate change effectively.

Advancements in climate science and economics and understanding of catastrophic risks have led to significantly higher estimates in recent assessments. Tol (2022) shows an increasing trend in the social cost of carbon (SCC) estimates over time, reflecting growing concerns about climate change impacts. Tol emphasizes incorporating updated data, broader economic impacts, and ethical considerations into SCC calculations. Higher SCC estimates underscore the urgency of implementing robust climate policies and reducing greenhouse gas emissions.

At the Glasgow COP26, India announced it will achieve net-zero emissions by 2070. In this context, two key questions arise: what will be the likely pathways? How will these transition pathways be financed? The role of banks and financial institutions comes into play here. In this regard, the extant literature has analyzed the influence of financial development on emissions, with various studies considering other aspects such as foreign investment (Ali et al., 2015; Shahbaz et al., 2018) and poverty (Ali et al., 2015). A related strand of this literature is studies dealing with assessing the impact of financial inclusion on emissions. The influence of financial development on emissions has been better investigated in the extant literature. Research examining the impact of financial inclusion on emissions nexus is still being developed and remains relatively underexplored. Bringing more individuals under the ambit of the financial system equips financial institutions with more funds. These funds can either assume the form of green investments or be channelized to encourage emission-intensive industries or sectors.

This context warrants closely investigating the broader financial system's role in nudging funds avenues that attenuate emissions instead of those that exacerbate emissions. Against this backdrop, this paper tries to understand financial inclusion's impact on emissions in India. It also explores the relationship between financial inclusion and financial development on emissions in India. The paper is organized as follows: the next section discusses the extant literature on financial development and emissions and highlights the gap in the literature concerning financial inclusion and emissions. Section 3 presents the theoretical underpinnings of the paper and the recent policies in India on financial inclusion. Section 4 discusses the data and methodology used in the paper. The results of the empirical exercise and the model diagnostics are presented in Section 5. Section 6 concludes with some policy implications of the paper.

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2. Literature Survey

2.1 Emissions and Development

The literature on financial development and emissions includes several studies that examine the relationship between financial development and emissions groups of countries (Lee et al., 2015; Shahbaz et al., 2018; Tsurai, 2019; Jiang and Ma, 2019; and Bayar et al., 2020) and in individual countries (Boutabba, 2014; Sehrawat et al., 2015; and Ali et al., 2015). Jiang and Ma (2019) assess the relationship between financial development and carbon emissions for a large set of 155 countries. They examine the relationship between these variables for a subset of developed economies, emerging markets, and developing countries. The study finds that financial development enhances carbon emissions for the entire sample. Financial development exercises a positive influence on carbon emissions in the case of emerging markets and developing countries. In such countries, financial sector growth often leads to increased industrial activities and energy consumption, thereby elevating emissions. In contrast, in developed countries, the impact of financial development on carbon emissions is statistically insignificant, suggesting that these nations may have more effective environmental regulations and cleaner technologies that mitigate the environmental impact of financial growth. The authors recommend that policymakers in emerging and developing economies implement strategies to balance financial development with environmental sustainability, such as promoting green financing and enforcing environmental regulations to ensure that economic growth does not come at the expense of environmental degradation.

Lee et al. (2015) assess the linkage between carbon emissions, energy use, GDP, and financial development for 25 OECD countries. Financial development negatively influences carbon emissions for Austria, Denmark, Germany, Ireland, the Netherlands, Norway, Portugal, and the U.S. Utilizing panel Fully Modified Ordinary Least Squares (FMOLS) and cross-sectional dependence regression methods, the study finds no evidence supporting the Environmental Kuznets Curve (EKC) hypothesis, which posits that economic growth initially leads to environmental degradation but improves after reaching a certain income level. Interestingly, the research reveals that financial development correlates with reduced CO₂ emissions in eight countries: Austria, Denmark, Germany, Ireland, the Netherlands, Norway, Portugal, and the

United States. This suggests that in these nations, financial development may facilitate investments in cleaner technologies and more efficient energy use, contributing to lower emissions. The findings imply that financial development can play a role in adjusting CO₂ emissions, but the effects are not uniform across all OECD countries. The study suggests policymakers should consider country-specific factors when designing strategies that leverage financial development to achieve environmental objectives.

Using pooled ordinary least squares and fixed and random effects (lagged as well as non-lagged models), Tsurai (2019) examines how carbon emissions are affected by financial development for a panel of 12 West African countries from the period 2003-2014. The paper employs three financial development indicators and other explanatory variables: GDP per capita, population, trade openness, renewable energy consumption, FDI, natural resource rents, and infrastructure development. The analysis in the paper indicates that domestic credit provided by the financial sector positively influences carbon emissions in West African countries in the pooled OLS method, lagged and non-lagged, and the effect is statistically significant.

Shahbaz et al. (2018) distinguish the impact that foreign capital and financial development have on clean energy consumption as well as emissions using panel estimation methods for BRICS and Next-11 countries, namely Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, South Korea, Turkey, and Vietnam. For BRICS, their empirical analysis reveals that financial development decreases clean energy consumption and that foreign investment and financial development increase carbon dioxide emissions. For the next 11 countries, foreign investment increases clean energy consumption, and financial development increases carbon dioxide emissions, according to their analysis.

Bayar et al. (2020) examine the impact of financial development, primary energy consumption, and economic growth on carbon emissions in 11 post-transition European economies from 1995 to 2017. Utilizing panel cointegration and causality analyses, they find that, in the long run, both financial development and primary energy consumption significantly increase CO₂ emissions. At the same time, economic growth correlates with a reduction in emissions. Short-term analyses reveal bidirectional causality between primary energy

consumption and CO₂ emissions and economic growth and CO₂ emissions, but no significant causal relationship exists between financial development and CO₂. They suggest that financial development may facilitate increased production and energy use without sufficient investment in energy-efficient technologies, leading to higher emissions. The authors recommend that policymakers implement country-specific strategies to balance financial sector development with environmental protection, ensuring that financial growth does not come at the expense of increased CO₂ emissions.

Ali et al. (2015) estimate two models for examining the effect of financial development, economic growth, energy consumption, and trade openness on carbon emissions in Pakistan from 1975-2011. The first model in the paper ascertains the impact of economic growth, energy consumption (proxied by the road sector's diesel fuel consumption), and FDI on carbon emissions while accounting for poverty. The second model ascertains the effect of economic growth, trade openness, financial development, and energy consumption proxied by electricity generation from oil, gas, and coal on carbon emissions. Among other findings, the paper's results underline the significance of poverty for carbon emissions, as an increase in poverty leads to more emissions. In the long run, poverty and financial development positively impact carbon emissions, while FDI negatively impacts carbon emissions, as per the empirical evidence in the paper. Further, they find evidence of unidirectional causality from poverty to carbon emissions.

In the case of India, the relationship between financial development and emissions has been examined by Boutabba (2014) and Sehrawat et al. (2015). Boutabba (2014) analyses the influence of financial development, energy, trade openness, and economic growth on carbon emissions in India. The study employs cointegration and Granger causality tests within a multivariate framework and finds that financial development, as proxied by domestic credit to the private sector, drives up per capita carbon dioxide emissions in the long run. Further, evidence of unidirectional causality exists between financial development and per capita carbon emissions. Further, the findings indicate that financial development has a significant long-term positive effect on carbon emissions, suggesting that environmental degradation intensifies as India's financial sector expands. Additionally, unidirectional causality runs from financial development to carbon emissions and energy consumption, implying that

financial sector growth leads to increased emissions and energy use without reciprocal effects. The study also confirms the Environmental Kuznets Curve (EKC) hypothesis for India, indicating that economic growth initially exacerbates environmental degradation but leads to improvements after reaching a certain income threshold. These results highlight the need for India's financial system to integrate environmental considerations into its operations. Policymakers are advised to develop energy and financial policies that mitigate carbon emissions while sustaining economic growth.

Sehrawat et al. (2015) assess the influence of financial development, economic growth, and energy consumption on India's carbon emissions and environmental degradation from 1971 to 2011. Utilizing time series analysis, including unit root tests and cointegration techniques, ARDL bounds testing approach, VECM, and variance decomposition for India, they find a long-run relationship between these variables. Emissions are used as a proxy for gauging environmental degradation. The study finds that financial development significantly contributes to short- and long-term environmental degradation. Economic growth and energy consumption are also primary contributors to environmental degradation. The variance decomposition analysis reveals that financial development explains a significant variation in carbon emissions. The authors suggest that India's financial sector expansion may facilitate investments that lead to increased pollution, possibly due to inadequate environmental regulations or a lack of emphasis on sustainable practices. The study recommends that policymakers implement strategies to ensure financial development aligns with environmental sustainability, such as promoting green financing and enforcing stricter environmental regulations on investments. Additionally, the findings highlight the need for energy-efficient technologies and sustainable economic policies to mitigate the adverse environmental impacts associated with economic growth and energy consumption in India.

Financial development plays a crucial role in shaping the outcomes of financial inclusion. Enhanced financial literacy enables individuals to make informed decisions regarding investments in sustainable practices. Studies suggest that individuals are more likely to invest in green technologies and practices that mitigate environmental impacts as financial literacy improves. This relationship underscores the importance of integrating financial education into broader strategies promoting sustainable economic growth.

Klapper and Lusardi (2019) investigate the relationship between financial literacy and financial resilience, emphasizing the importance of understanding basic financial concepts. The authors find that only one in three adults globally is financially literate, defined as knowing at least three key concepts: interest rates, compounding, inflation, and risk diversification. This lack of financial knowledge is particularly prevalent among women, low-income individuals, and those with less education, affecting both developing and developed countries. The research highlights that low financial literacy exacerbates risks in consumer and financial markets, especially as complex financial products become more accessible. Many consumers struggle to navigate high-interest credit options and intricate terms, leading to potential over-indebtedness. Furthermore, the study identifies financial capability as a critical mediator between financial literacy and resilience. Individuals with higher financial literacy are better equipped to manage economic shocks and avoid debt traps, enhancing their financial resilience. The authors recommend integrating financial literacy education into various programs to empower individuals, particularly young adults entering the workforce. This approach is essential for fostering a financially literate society capable of effectively managing financial challenges and achieving long-term stability. The authors advocate for policies to protect borrowers and promote saving behaviour among account holders.

2.2 Emissions and Financial Inclusion

The relationship between financial inclusion and emissions appears to be influenced by several mediating factors such as economic development, digital financial inclusion, and policy frameworks. Financial inclusion refers to the accessibility of financial services to individuals and businesses, particularly those traditionally excluded from the formal financial system. Recent literature has explored the complex relationship between financial inclusion, carbon emissions, and environmental sustainability, highlighting both positive and negative effects depending on various contexts. This literature examining the linkage between financial inclusion and carbon emissions is still evolving.

Zaidi et al. (2021) assess the relationship between financial inclusion, energy consumption, and carbon emissions for 23 OECD countries. Their study employs advanced econometric techniques to analyze the interplay between financial inclusion,

energy consumption, and carbon emissions while considering corruption and infrastructure development. They find a positive impact of financial inclusion on carbon emissions, primarily due to the facilitation of energy consumption and industrial activities. However, the study also indicates that the impact of financial inclusion on carbon emissions is nuanced and can be influenced by the quality of governance and the level of infrastructure development in a country. The authors recommend that policymakers promote financial inclusion strategies aligned with environmental sustainability goals, such as supporting green financing initiatives and implementing regulations encouraging environmentally friendly investments. Improving governance and infrastructure can also mitigate the potential adverse environmental effects of increased financial inclusion.

Ullah et al. (2022) examine the environmental implications of financial inclusion and economic policy uncertainty (EPU) within globalization, focusing on 33 OECD countries categorized into low and highly globalized economies. Employing advanced econometric techniques that account for cross-sectional dependence and heterogeneity, the study reveals that financial inclusion significantly reduces CO₂ emissions, indicating its role in promoting environmentally friendly investments and sustainable economic activities. They have divided their sample into lower and highly globalized economies. They find a negative impact of financial inclusion on CO₂ emissions and in interaction with globalization in both sets of countries. Conversely, increased EPU correlates with higher CO₂ emissions, suggesting that uncertainty in economic policies may hinder environmental protection efforts. The analysis also highlights that globalization intensifies the impact of both financial inclusion and EPU on environmental outcomes. These findings underscore policymakers' importance in enhancing financial inclusion strategies and stabilizing economic policies to achieve environmental sustainability, especially in an increasingly globalized world.

Over the past two decades, financial inclusion has significantly improved access to financial services, driving economic growth. However, its environmental impact remains a critical concern. Shabir (2021) examines the relationship between financial inclusion and CO₂ emissions in APEC countries from 2004 to 2018, considering the moderating roles of technological innovation and economic globalization. Using advanced econometric techniques, he finds that financial

inclusion and renewable energy consumption reduce CO₂ emissions, while economic growth and globalization worsen environmental quality. The study suggests that APEC nations should integrate financial inclusion with technological innovation and align globalization with climate policies for sustainable development.

Arshad and Parveen (2023) empirically examine the impact of financial inclusion on CO₂ emissions in developing countries. Using annual data from 29 developing nations between 2004 and 2018, they apply pooled ordinary least squares (OLS), fixed effects, and CS-ARDL techniques. Their findings suggest that financial inclusion positively correlates with CO₂ emissions, aligning with existing literature. Additionally, higher income, foreign direct investment, urbanization, and population growth contribute to rising emissions, while trade openness helps reduce them. Increased financial inclusion drives industrial and manufacturing activities, escalating energy demand across sectors like transportation and residential, ultimately leading to higher CO₂ emissions.

Hussain et al. (2023) explore how financial inclusion impacts carbon emissions globally, revealing a nuanced and dual relationship. Based on cross-country data, the study emphasizes the relationship between financial inclusion and carbon emissions varies between countries. In high-income countries, financial inclusion tends to support cleaner technologies, while in low- and middle-income countries, the push for growth often increases emissions. Financial inclusion, which provides individuals and businesses affordable access to financial services, affects carbon emissions directly and indirectly, depending on regional and economic contexts. On the one hand, increased financial inclusion drives economic growth and consumption, leading to higher carbon emissions. Financial inclusion allows businesses to expand production and households to purchase energy-intensive goods and services by enabling access to credit, loans, and savings. This is especially pronounced in developing economies, where improved financial access accelerates industrialization, urbanization, and reliance on fossil fuels. Consequently, greater financial access can contribute to environmental degradation by increasing energy consumption and carbon footprints. On the other hand, financial inclusion also creates opportunities for promoting sustainable development. It facilitates investments in renewable energy, energy-efficient technologies, and cleaner production methods. Financially

inclusive mechanisms like micro-loans and green bonds enable small businesses and households to adopt low-carbon solutions. Moreover, increased access to financial education and digital tools helps promote awareness of sustainable practices and incentivizes eco-friendly behaviors. The findings suggest integrating environmental considerations into financial inclusion policies, particularly for developing nations, to balance economic development with sustainability. Promoting green finance, subsidizing renewable energy investments, and fostering financial literacy with an environmental focus are crucial to achieving a harmonious balance between financial inclusivity and environmental sustainability.

Several studies indicate that digital financial inclusion can reduce carbon emissions. For instance, a study in China found that financial inclusion enhances carbon sequestration by increasing vegetation coverage and improving industrial structures through better financial support. This research utilized county-level data and fixed-effect panel regression, revealing a significant negative correlation between financial inclusion and regional carbon emissions (Yang et al. (2022)). Similarly, another study suggests that digital financial inclusion provides funding for green technologies, thereby limiting fossil fuel consumption and reducing emissions (Salman and Ismael, 2022). Conversely, other research highlights that increased financial inclusion can contribute to higher carbon emissions. A comprehensive analysis of sub-Saharan Africa revealed that financial inclusion is linked to a substantial rise in CO₂ emissions due to enhanced economic activities and energy consumption associated with easier access to credit. This study also noted the presence of the Environmental Kuznets Curve (EKC), where economic growth initially leads to environmental degradation before improvements occur at higher income levels (Said et al. (2022)). Additionally, some studies argue that greater access to finance encourages demand for durable goods, leading to increased energy consumption and emissions (Salman and Ismael, 2022).

Yang et al. (2022) study how digital financial inclusion influences household carbon emissions. Digital financial inclusion, characterized by widespread access to financial services through digital platforms, plays a dual role in affecting household energy consumption and carbon emissions. Using data from Chinese households, the study finds that the overall impact of digital financial inclusion on carbon emissions is nuanced, varying by income level

and region. While high-income households tend to increase emissions, low-income groups often benefit from cleaner technologies due to targeted policies. Increased digital financial inclusion enables households to access loans, credit, and online shopping, leading to higher consumption of goods and energy-intensive appliances. This contributes to greater carbon emissions as households upgrade lifestyles and expand energy usage. The ease of e-commerce further amplifies this effect, with rising demand for products and logistics services. Conversely, digital financial inclusion can also promote environmentally friendly behaviours. Access to green finance products and subsidies for energy-efficient appliances encourages households to adopt low-carbon technologies. Digital platforms also provide financial literacy tools and awareness campaigns that foster sustainable consumption patterns. The study emphasizes the need for policy interventions to promote green financing and carbon-neutral digital ecosystems to ensure balanced outcomes.

Said et al. (2023) examine the causal relationship between financial inclusion and CO₂ emissions. Using panel data from 15 Latin American and 10 MENA countries spanning 2004–2018, they apply the Generalized Method of Moments (GMM) and Generalized Least Squares (GLS) econometric models. Financial inclusion is measured through four indicators: the number of ATMs and commercial bank branches per 100,000 adults and outstanding deposits and loans from commercial banks as a percentage of GDP. Controlling for factors such as energy supply, industry value added, and economic growth while addressing endogeneity and cross-sectional dependence, their findings diverge from existing literature. They find that financial inclusion significantly increases CO₂ emissions in Latin America, whereas, in MENA countries, its impact on emissions is statistically insignificant.

The literature presents a nuanced view of the interplay between financial inclusion, carbon emissions, and economic development. While financial inclusion has the potential to contribute positively to emission reductions through improved access to green financing, there are also significant risks associated with increased economic activity leading to higher emissions. Policymakers must consider these dynamics when designing interventions promoting economic growth and environmental sustainability.

3. Research Gaps

However, the impact of financial inclusion on emissions remains unexplored in India, a gap that the present study aims to bridge.

Our paper will address two research questions:

1. What is the extent and nature of the impact of financial inclusion on carbon emissions in India?
2. What is the extent and nature of the impact of the interaction of financial inclusion and financial development on carbon emissions?

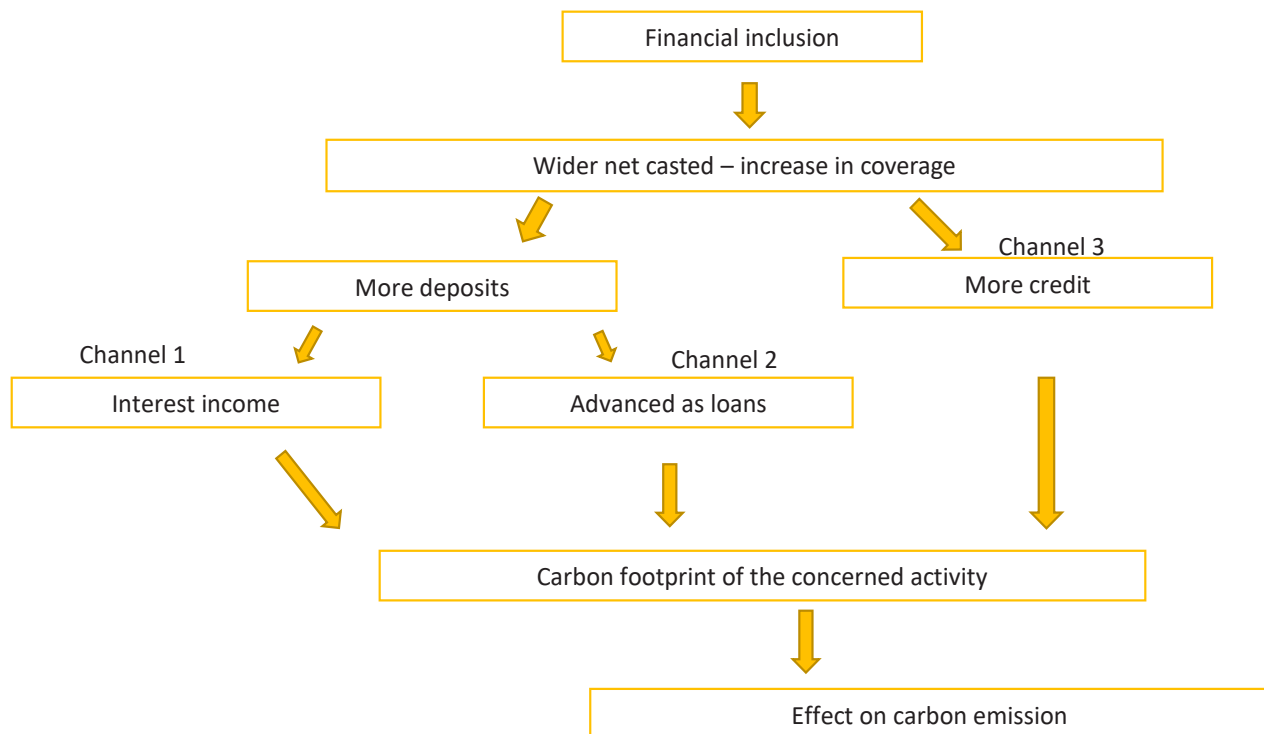
The paper significantly contributes to the literature in two ways. First, it adds to the growing literature on financial inclusion's impact on carbon emissions. Second, it fills the gap in the extant literature regarding this assessment of the impact of financial inclusion on emissions in the case of India.

3.1 Theoretical Underpinnings

Broadly, we can trace the influence of financial inclusion on carbon emissions via the linkage in Figure 1. Note that we focus only on the banking channel here. The theoretical underpinning of these research questions relates to the fundamental concept of financial inclusion. Increasing financial inclusion implies bringing more individuals under the ambit of the financial system. As more people are brought under the financial system's umbrella, more funds will be available with the financial institutions. A portion of these funds is then disbursed back into the system via the lending activity of the financial institutions. At this juncture, the borrowed funds can be channeled into activities that increase emissions or reduce them. *A priori*, the impact of financial inclusion on carbon emissions can go either way.

With this theoretical framework underpinning our analysis, we attempt to provide empirical evidence regarding the impact of financial inclusion on carbon emissions in India. We also look at the impact of the interplay of financial development and financial inclusion on carbon emissions to determine whether financial development has any bearing on the relationship between financial inclusion and carbon emissions. While financial inclusion deals with access, financial development deals with allocation. The interaction of both will help us understand whether the funds available via increased access are allocated to greener uses.

Figure 1: Financial Inclusion – Carbon Emissions Linkage



Source: Authors' own

3.2 Policies for Financial Inclusion

India has undertaken several policy initiatives over the years to promote financial inclusion and integrate a larger segment of its population into the formal financial system. These measures aim to improve access to banking services, credit, insurance, and digital financial products, particularly for underserved and rural populations. To bring more individuals into the financial system, and integrate a larger segment of its population into the formal financial system, initiatives in the past couple of years, include Bank nationalization, strengthening bank branch networks, priority sector lending, self-help groups. Recently digital financial inclusion efforts have also been undertaken. Schemes such as the Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri Suraksha Bima Yojana, and Atal Pension Yojana (Bhaskar, 2013; Das, 2021). Many of these financial inclusion initiatives are geared toward bolstering banking access.

1. Bank Nationalization (1969 & 1980)

One of the earliest and most significant financial inclusion policies was the nationalization of banks in 1969 and 1980. This move brought major commercial banks under government control, to expand banking services to rural and semi-urban areas, which were largely underserved. Nationalization facilitated the establishment of branches in remote areas,

increasing the reach of financial institutions and ensuring that credit was made available to small-scale industries, agriculture, and weaker sections of society.

2. Strengthening the Bank Branch Network

Following nationalization, the government and the Reserve Bank of India (RBI) encouraged the expansion of bank branches across the country. The Lead Bank Scheme (1969) was introduced to assign specific banks to districts to drive local financial development. Additionally, the RBI's mandate that banks open branches in unbanked areas helped significantly increase financial penetration, particularly in rural India. As a result, banking density improved, with more people with access to savings accounts, credit, and other financial products.

3. Priority Sector Lending (PSL)

To ensure that critical sectors of the economy receive adequate credit, the RBI introduced the Priority Sector Lending (PSL) policy. Under PSL, banks were mandated to allocate a specified percentage of their lending to sectors such as agriculture, micro, small, and medium enterprises (MSMEs), education, housing for low-income groups, and weaker sections of society. PSL was crucial in making credit accessible to those who previously struggled to secure loans from formal financial institutions.

4. Regional Rural Banks (RRBs) & Microfinance Initiatives

The government established Regional Rural Banks (RRBs) in 1975 to address the financial needs of rural areas. These banks operate at the grassroots level to serve small farmers, artisans, and laborers. The Self-Help Group-Bank Linkage Program (SHG-BLP) and microfinance institutions (MFIs) have also facilitated credit availability to women and small entrepreneurs who lack collateral for traditional loans.

5. Digital Financial Inclusion & the JAM Trinity

In recent years, India has leveraged technology to accelerate financial inclusion. The introduction of the JAM Trinity (Jan Dhan-Aadhaar-Mobile) has significantly expanded banking access. The Pradhan Mantri Jan Dhan Yojana (PMJDY) launched in 2014 has provided millions of unbanked individuals with no-frills bank accounts, enabling direct benefit transfers (DBTs) for government subsidies.

6. Unified Payments Interface (UPI) & Digital Payments

The launch of UPI and mobile banking services has deepened financial inclusion by making digital transactions easy, affordable, and accessible. Rural populations, small merchants, and gig workers have benefited from digital financial services, reducing dependence on cash transactions. These initiatives reflect India's comprehensive approach to financial inclusion, integrating traditional banking reforms with modern digital innovations to ensure wider financial access.

India's Union Budget 2023-24 prioritized environmental sustainability and financial inclusion, aligning with the country's broader development goals. Under its "green growth" agenda, the budget

promoted sustainable agricultural practices by encouraging natural farming and establishing 10,000 Bio-Input Resource Centres to support micro-fertilizer and pesticide production. Additionally, it granted customs duty exemptions on capital goods and machinery for lithium-ion battery production, boosting domestic EV manufacturing and reducing transportation-related emissions. On financial inclusion, the budget enhanced support for MSMEs through a ₹9,000 crore infusion into the Credit Guarantee Scheme, facilitating ₹2 lakh crore in collateral-free credit. It also introduced a National Financial Information Registry to improve credit flow and financial stability. For women, the Mahila Samman Savings Certificate offers a two-year savings scheme with a 7.5% fixed interest rate. At the same time, senior citizens benefited from an increased deposit limit under the Senior Citizen Savings Scheme. These measures reflected the government's commitment to inclusive financial growth and environmental sustainability.

4. Data and Methodology

The key dependent variable in our analysis is carbon emissions, and the key independent variable is the financial inclusion indicator. We use two financial inclusion indicators for our analysis: Bank branches per capita and Credit accounts per capita. Other explanatory variables used in our analysis are real per capita income, and industry value added.

The Reserve Bank of India provides data for scheduled commercial bank branches and credit accounts. We have calculated the per capita versions of these variables using population data from World Development Indicators. The remaining variables are also sourced from World Development Indicators. The time period under analysis is from 1990 to 2018.

Table 1: Variables, Indicators, and Notation

Variable	Indicator	Notation
Carbon emissions	Carbon emissions in metric tons per capita	CO ₂ emissions
Financial inclusion	Scheduled commercial bank branches per capita	Bank branches per capita
	Scheduled commercial bank credit accounts per capita	Credit account per capita
Financial development	Domestic credit to private sector (% of GDP)	Domestic credit
Other explanatory variables	GDP per capita at constant local currency unit	Real GDP per capita
	Industry (including construction), value added (% of GDP)	Industry value added

Source: Authors' own

All the variables were transformed into natural log form for analysis purposes. Before proceeding toward estimation, variables are tested for stationarity. We

have employed the Augmented Dickey-Fuller (ADF) test to assess whether the variables are stationary.

Table 2: Augmented Dickey-Fuller Test Results (At level)

Variable	Critical Values			Test statistic	p-value
	1% level	5% level	10% level		
Ln (CO ₂ emissions)	-4.3239	-3.5806	-3.2253	-1.4148	0.8340
Ln (Bank branches per capita)	-3.7114	-2.9810	-2.6299	-5.8763	0.0001
Ln (Credit account per capita)	-4.3560	-3.5950	-3.2334	-4.2952	0.0114
Ln (Bank branches per capita*Domestic credit)	-4.3239	-3.5806	-3.2253	-3.2264	0.0998
Ln (Credit accounts per capita*Domestic credit)	-3.7706	-4.3743	-3.6032	-3.2380	0.0358
Ln (Real GDP per capita)	-4.3239	-3.5806	-3.2253	-2.6063	0.2804
Ln (Industry value added)	-3.7114	-2.9810	-2.6299	-2.8965	0.0594

Source: Authors' own

Table 3: Augmented Dickey-Fuller Test Results (First difference)

Variable	Critical Values			Test statistic	p-value
	1% level	5% level	10% level		
Ln CO ₂ emissions	-3.699871	-2.976263	-2.627420	-4.710737	0.0008
Ln Real GDP per capita	-3.699871	-2.976263	-2.627420	-4.956288	0.0005

Source: Authors' own

Since a combination of I (0) and I (1) is present, the ARDL bounds testing procedure has been selected for model estimation. After conducting the preliminary test to assess the variables' stationarity, we employ the ARDL bounds testing procedure developed by Pesaran et al. (2001).

We conducted ARDL bounds testing procedure on four sets of models. The following models are formulated:

Model 1: $CO_2 \text{ emissions} = f(\text{Bank branches per capita, real GDP per capita, and industry value added})$

Model 2: $CO_2 \text{ emissions} = f(\text{Credit accounts per capita, real GDP per capita, and industry value added})$

Model 3: $CO_2 \text{ emissions} = f(\text{Interaction term of bank branches per capita and domestic credit, real GDP per capita, and industry value added})$

Model 4: $CO_2 \text{ emissions} = f(\text{Interaction term of credit accounts per capita and domestic credit, real GDP per capita, and industry value added})$

Results of the ARDL bounds test (Table 4) show that the null hypothesis of no levels relationship can be rejected as the estimated F-statistic is greater than the critical values for I (1) regressors for all models at both the levels of significance, 1 per cent and 5 per cent, and the t-statistic is less than the critical value for I (1) regressors for Model 4 at 5 per cent level of significance. Further, there is indecisiveness for Models 1 and 3 in terms of the t-statistic.

Table 4: ARDL bounds test results

Test statistic	Estimated value	Critical value (1 per cent)		Critical value (5 per cent)	
		I (0)	I (1)	I (0)	I (1)
Model 1					
F-statistic	4.874	2.72	3.77	3.23	4.35
t-statistic	-2.951	-2.57	-3.46	-2.86	-3.78
Model 2					
F-statistic	6.946	4.29	5.61	3.23	4.35
t-statistic	-2.839	-3.43	-4.37	-2.86	-2.86
Model 3					
F-statistic	5.512	4.29	5.61	3.23	4.35
t-statistic	-3.022	-3.43	-4.37	-2.86	-3.78
Model 4					
F-statistic	7.766	4.29	5.61	3.23	4.35
t-statistic	-4.089	-3.43	-4.37	-2.86	-3.78

Source: Authors' own

4.1 Empirical Findings

Empirical results (Table 5) evince a long-run relationship between financial inclusion and carbon emissions. This holds for both the indicators of financial inclusion used, scheduled commercial bank branches per capita and scheduled commercial bank credit accounts per capita, with their long-run coefficients being around 0.26 and 0.18, respectively. Interestingly, the short-run coefficient of the lagged difference of scheduled commercial bank credit accounts per capita is -0.18, which is statistically significant. For both the models (Models 1 and 2), the error correction term is negative and statistically significant, indicating convergence to long-run equilibrium.

The long-run coefficient of both the interaction terms in the second set of models (Models 3 and 4) is positive but statistically insignificant. That said, the short-run coefficient of the lagged difference of the

interaction term containing scheduled commercial banks' credit accounts per capita is -0.13 and is statistically significant.

For all four models, the long-run coefficients of real GDP per capita and industry value added are positive and statistically significant. Further, the short-run coefficient of the lagged difference of industry value added is negative and statistically significant in the models with the key independent variable as scheduled commercial bank branches per capita (Model 1) and the interaction term of scheduled commercial bank's credit accounts per capita and domestic credit to the private sector (Model 4) respectively. In the case of the model with the key independent variable as the interaction term of scheduled commercial bank branches per capita and domestic credit to the private sector (Model 3), the short-run coefficient of both the first difference and the lagged difference of industry value added is negative and statistically significant.

Table 5: Empirical results

Dependent variable: CO ₂ emissions	Model 1	Model 2	Model 3	Model 4
Long-run coefficients				
Ln (Bank branches per capita)/ Ln (Credit accounts per capita)/ Ln (Bank branches per capita*Domestic credit)/ Ln (Credit accounts per capita*Domestic credit)	0.269*	0.182**	0.091	0.041
Ln (Real GDP per capita)	0.658***	0.742***	0.666***	0.714***
Ln (Industry value added)	0.910**	0.813**	0.804**	0.611***
Error correction term (ECTt-1)	-0.615**	-0.328**	-0.599***	-0.688***
Short-run coefficients				
Ln (Bank branches per capita) (D1)/ Ln (Credit accounts per capita) (D1)/ Ln (Bank branches per capita*Domestic credit) (D1)/ Ln (Credit accounts per capita*Domestic credit) (D1)	0.512	-0.081	-0.066	-0.060
Ln (Bank branches per capita) (LD)/ Ln (Credit accounts per capita) (LD)/ Ln (Bank branches per capita*Domestic credit) (LD)/ Ln (Credit accounts per capita*Domestic credit) (LD)	-0.617	-0.186**	-0.156	-0.130**
Ln (Bank branches per capita*Domestic credit) (L2D)			-0.102	
Ln (Industry value added) (D1)	-0.361		-0.431*	-0.345
Ln (Industry value added) (LD)	-0.693**		-0.721**	-0.573**
Ln (Industry value added) (L2D)	-0.327		-0.354	-0.389
Constant	-4.629**	-3.322***	-5.540***	-6.703***
Number of observations	26	27	26	26
Adjusted R-squared	0.545	0.503	0.444	0.558

Source: Authors' own

Note: *** significant at 1 per cent; ** significant at 5 per cent; and * significant at 10 per cent

4.2 Model Diagnostics

All the models have been tested for serial correlation, heteroskedasticity, and model specification (L2) issues.

Diagnostic tests for all models (Table 6) reveal the absence of any of the aforementioned issues.

Table 6: Diagnostic test results

Diagnostic test	Estimated test statistic (p-value)			
	Model 1	Model 2	Model 3	Model 4
Breusch-Godfrey LM test (for serial correlation)	1.346 (0.2459)	2.960 (0.0853)	2.963 (0.0852)	1.727 (0.1888)
White's test (for heteroskedasticity)	26.00 (0.4076)	27.00 (0.4093)	26.00 (0.4076)	26.00 (0.4076)
Ramsey RESET test (for model specification)	1.97 (0.1680)	1.43 (0.2694)	0.71 (0.5641)	0.66 (0.5901)

Source: Authors' own

5 Conclusion and Policy Implications

The growing exigency of addressing the climate change concern has brought the issue of environmental degradation and sustainable development to the forefront. This context warrants closely investigating the broader financial system's role in nudging funds avenues that attenuate emissions instead of those that exacerbate emissions. Increasing financial inclusion implies bringing more individuals under the ambit of the financial system. These funds can either assume the form of green investments or be used in emission-intensive industries or sectors. India has embraced several initiatives in the past couple of years to bring more individuals under the financial system. Against this backdrop, this paper attempts to discern the impact that financial inclusion has on emissions in the case of India for a period from 1990 to 2018. The paper uses the ARDL bounds testing procedure to find a long-run relationship between financial inclusion and carbon emissions. Further, there seems to be no statistically significant impact of the interplay of financial inclusion and financial development on carbon emissions in India in the long run.

The findings of this paper indicate the existence of a long-run relationship between financial inclusion and carbon emissions.

While significantly contributing to the emerging literature on the impact of financial inclusion on emissions nexus, the paper's findings can be relevant for policymakers. It can assist in understanding if

additional provisions need to be made to channel funds towards emission-reducing avenues. The findings essentially imply that the widening net of the financial system in India is increasing carbon emissions and, hence, is, in a sense, inimical to the environment at large. One of the reasons behind the long-run relationship between financial inclusion and carbon emissions can be reluctance on the part of banks to advance finance for green uses owing to the presence of unknowns.

They underline that India needs to simultaneously direct the flow of finance resulting from the widened financial net toward greener purposes. The paper's findings also hold critical significance, given that India is steadily moving toward a low-carbon state, and finance will be an essential component of the transition. Further, if India wants to transition to a low-carbon state, a 'just' one, directing finance to pertinent uses becomes even more crucial.

Given the thrust on financial inclusion in India, it is key to identify and mitigate barriers facing financial institutions, particularly banks, in financing low-carbon activities. Another key suggestion in this regard pertains to financial literacy. India has launched initiatives such as establishing the National Centre for Financial Education and launching the National Strategy for Financial Education 2020-2025 to enhance financial literacy. Financial literacy can be considered a tool for not just imparting knowledge regarding the available sources of finance and how to leverage them best but also for spreading awareness on channeling funds in green avenues.

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