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A study on the nexus between green finance, fintech, and sustainable development

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Abstract

Green finance and fintech are essential components of sustainable development. Given the significant investment and funding challenges facing India, the potential for green finance to address these issues remains uncertain. This study employs multiple regression analysis to explore the relationships between green finance, fintech, and sustainable development, utilizing time series data from 2015 to 2023. The findings indicate that green bonds, leading to a reduction in CO₂ emissions during the review period, which in turn supports environmental protection and affirms the concept of a green economic recovery. Furthermore, the fintech industry is rapidly expanding, and advancements in fintech positively influence CO₂ emissions in India. The country is poised to become a global leader in the implementation of green finance strategies. To achieve this, authorities must accelerate the progress of green recovery initiatives and enhance the capacity of banking institutions to offer green loans. Both fintech and green finance play a crucial role in advancing green economic development. Based on these insights, this study presents policy recommendations for decision-makers, which include the integration of fintech with green finance, building a sustainable environment framework for improving the efficiency of green finance, and the establishment of long-term strategies to foster green finance in the economy.

Keywords: Green finance, fintech, sustainable development, carbon emission, multiple regression analysis, policy implications

1. Introduction

The convergence of green finance, financial technology, and sustainable development represents a transformative paradigm shift in how we approach economic growth and environmental stewardship (Macchiavello & Siri, 2020; Pan *et al.*, 2020) ^[5, 9]. Green finance, encompassing financial investments that promote environmental sustainability, is gaining traction as a critical mechanism for channelling capital towards projects and initiatives that mitigate climate change, conserve natural resources, and foster a low-carbon economy (Macchiavello & Siri, 2020) ^[5]. Financial technology, with its innovative digital solutions, is revolutionizing the financial landscape, enhancing efficiency, reducing costs, and expanding access to financial services (Sreenu & Mishra, 2023) ^[14]. The intersection of these two dynamic forces holds immense potential to accelerate the transition towards a more sustainable and inclusive future, driving progress towards the Sustainable Development Goals (Kwong *et al.*, 2023) ^[3]. The urgency of addressing climate change and environmental degradation necessitates innovative financial mechanisms and technological solutions that can mobilize capital, promote sustainable practices, and monitor environmental performance (Naderi & Tian, 2022) ^[8]. As ecological concerns intensify, there is a growing recognition of the need for innovative solutions that can address these challenges effectively (Kwong *et al.*, 2023; Sun & He, 2023) ^[3, 16]. This study examines the intricate relationships between green finance, fintech, and sustainable development, exploring the opportunities and challenges that arise from their convergence (Kwong *et al.*, 2023) ^[3]. The digital revolution has presented both opportunities and challenges for sustainability, requiring careful navigation to maximize benefits while mitigating potential risks (Raihan, 2024).

1.1 Background

Traditional financial systems have often overlooked environmental considerations, leading to unsustainable investment practices and environmental degradation (Kwong *et al.*, 2023) ^[3].

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The integration of environmental, social, and governance factors into investment decisions is becoming increasingly important for promoting responsible and sustainable business practices. Green finance emerges as a response to this gap, aiming to align financial flows with sustainable development objectives. Green finance encompasses a wide range of financial instruments and investments, including green bonds, green loans, and environmental funds, all directed towards environmentally beneficial projects (Štreimikienė & Kaftan, 2021) ^[15]. Fintech innovations, such as mobile banking, blockchain technology, and artificial intelligence, are transforming the financial sector, creating new opportunities for green finance to flourish (Manta *et al.*, 2025) ^[6]. These technologies can enhance transparency, reduce transaction costs, improve risk management, and facilitate access to green financial products for a wider range of investors and businesses. It is observed that the current research is in a preliminary stage, so areas like customer and government services and insurance strategies are very rare (Puschmann & Khmarskyi, 2024) ^[11]. The motivation for this study stems from the growing recognition that green finance and fintech can play a pivotal role in advancing sustainable development goals, especially in emerging economies.

The potential of fintech to alter the relationship between green financing and economic development underscores the need for further research in this area (Sreenu & Mishra, 2023) ^[14]. The study seeks to provide insights into how these forces can be harnessed to promote environmentally sound and socially responsible development pathways. Digital transformation, characterized by the widespread adoption of digital technologies, is reshaping industries and economies, presenting both opportunities and challenges for sustainability (Sun & He, 2023) ^[16]. Digital finance, as a key component of the digital economy, fosters innovation in operational models, effectively promoting the growth of the sustainable economy.

1.2 Green Finance

Green finance refers to financial investments that generate positive environmental outcomes, supporting the transition to a low-carbon, resource-efficient, and climate-resilient economy. It encompasses a broad range of financial instruments, including green bonds, green loans, green equity funds, and environmental insurance products (Pasupuleti & Ayyagari, 2023) ^[10]. Green finance aims to channel capital towards projects and activities that mitigate climate change, reduce pollution, conserve natural resources, and promote biodiversity. Environmental regulations are a vital component of green finance, mandating that businesses disclose their project-related environmental information and denying loan services to those that produce negative externalities without taking accountability (Ma & Fei, 2024) ^[4]. It plays a significant role in incorporating environmental protection with economic advantages (Rawat, 2020) ^[13]. Green financial products are categorized into three types: retail finance, which includes green credit; asset finance, which includes green subsidies and carbon funds; and corporate finance, which includes green investment and green bonds (Xu *et al.*, 2020) ^[17].

1.3 Fintech

Fintech refers to the use of innovative technologies in

financial services. It encompasses a wide range of activities, including payments, financial advice, project financing, and regulatory compliance. Fintech companies leverage technologies like artificial intelligence, machine learning, big data analytics, blockchain, and mobile platforms to transform financial services and make them more efficient and accessible.

1.4 Key characteristics of fintech include:-

1. Lower operating costs compared to traditional financial institutions
2. Increased financial inclusion by providing services to previously underserved populations
3. Innovative business models and products
4. Potential to accelerate sustainable economic growth

However, there are also potential drawbacks, such as the high energy consumption of some fintech technologies like blockchain, which can contribute to increased carbon emissions.

Previous research has highlighted the crucial roles of green finance and fintech in fostering environmental sustainability. The study identifies a reciprocal relationship between CO₂ emissions, green finance, and fintech. By prioritizing the development of green financial products and enhancing banks' capabilities to offer green credit facilities, the nation can further increase its environmental sustainability goals. Additionally, it is recommended to allocate more resources toward researching the effective use of green finance solutions while managing associated risks. This study seeks to fill existing gaps in the literature by examining the combined effects of green finance and fintech on environmental quality within the context of India.

2. Review of Literature

This study examines the interconnectedness of fintech, green finance, natural resource rent, and economic growth in achieving environmental sustainability in BRICS countries by using a cross-sectionally augmented autoregressive distributed lag method. The findings reveal that fintech and green finance are crucial for reducing carbon emissions and enhancing sustainability, while natural resource rent negatively impacts environmental quality. The findings suggest that by concentrating on initiatives related to green finance and fintech, BRICS countries can advance their goals of environmental sustainability while alleviating the negative impacts of fossil fuel dependence on their environment. This research paper (Zournatzidou, 2025) ^[18] examines the relationship between green finance, fintech, and sustainable development, highlighting the need for fintech to transition into Greentech to enhance ESG performance and achieve sustainable development. The study used PRISMA and bibliometric analyses to explore trends in green finance and fintech.

(Shah *et al.*, 2023) ^[17] examines the nexus between green finance and climate change in China and India with a systematic review. The study highlights the role of financial and technological innovation in addressing climate change through green financing mechanisms and environmental regulations, with findings indicating positive impacts on decarbonization and sustainable growth. The study by (Mohsin *et al.*, 2024) ^[7] explores the role of green finance in achieving sustainable green economic growth, highlighting its impact on the financial sector, environment, and

economy, and suggests strategies such as investing in education and R&D, using green credit and sustainable bonds, and promoting innovation to expedite the greening of the economy. The study used regression analysis to estimate outcomes from available data. It applies Hansen's upper limit longitudinal equation and bootstrap technology to analyse threshold effects. To improve performance via commercialization of research and development, governments should continually impose innovation-driven techniques and progress toward a greater capacity to innovate. The paper examines the impact of FinTech on sustainable development, focusing on its role in promoting green finance and addressing climate and social goals, while also discussing both positive and negative impacts on sustainable growth. By employing critical analysis of the latest scientific papers and reports of international financial institutions published in 2017-2022 on digital techniques and sustainable financing, it indicates that FinTech can boost the development of green finance, which addresses environmental protection or climate change, and has become an opportunity for industrialised countries to

achieve sustainable growth (Jerath, 2022) [2]. This study demonstrates that Fintech can play a crucial role in promoting sustainable development and reducing carbon emissions in India through the adoption of digital payment systems and the financing of green infrastructure projects.

3. Research Methodology

3.1 Data

This study utilizes data from 2015 to 2024 to empirically analyse the impact of fintech and green finance on carbon emissions in India. The study utilizes the World Development Indicators (WDI) dataset and RBI reports to illustrate the relationship between these indicators. Green bonds have been used as a proxy for green finance, Total digital payments have been used as a proxy for Fintech, and carbon emissions have been used as a measure for sustainable development. The dataset has been converted to log form to ensure the normality of the data. Table 1 represents the dependent and independent variables, their descriptions, and logarithmic forms.

Table 1: Variables with their description, logarithmic form, units, and data sources

Variables	Description	Logarithmic form	Units	Sources
CO ₂	Carbon Emission	LCO ₂	Metric tons	WDI
FN	Fintech	LFN	Total digital Payments	RBI Annual Reports
GB	Green Bonds	LGB	Green Bonds Issuances (Million US\$)	IMF

3.2 Methodology

This paper explores the intricate relationship between carbon dioxide (CO₂) emissions, financial technology (Fintech), and the Green Bonds. To conduct this analysis, a multiple regression model is employed, utilizing the ordinary least squares (OLS) method for time series data. In this framework, CO₂ emissions serve as the dependent variable, while Fintech innovations and Green Bonds are employed as the independent variables. The study aims to underscore how advancements in Fintech and investments in Green Bonds can influence emissions levels, contributing to the broader discourse on sustainable finance and environmental responsibility.

3.3 Econometric Model

$$CO_{2t} = f(FN_t; GB_t) \quad (1)$$

The empirical equation is as follows:

$$CO_{2t} = \beta_1 + \beta_2 FN_t + \beta_3 GB_t + e_t \quad (2)$$

Where β_1 and e_t are the intercept and error term, respectively. For empirical investigation, variables are converted to logarithmic form, shown in Eq.3.

$$LCO_{2t} = \beta_1 + \beta_2 LFN_t + \beta_3 LGB_t + e_t \quad (3)$$

4. Empirical results

4.1 Descriptive Statistics

The statistics summary is shown in Table 2. The table depicts that all variables follow the normality. The skewness is less than 1 for every variable, so the data is normally distributed. The Kurtosis value for all variables shows the normal distribution. These results lead to a correlation analysis.

Table 2: Descriptive Statistics

Variables	LCO ₂	LFN	LGB
Mean	7.849184	11.61281	0.801433
Median	7.841987	12.54871	0.983241
Maximum	8.036289	14.31283	2.209336
Minimum	7.723178	8.458843	-0.375318
Std. Dev.	0.105357	2.27482	0.902391
Skewness	0.534949	-0.28263	-0.01739
Kurtosis	2.149935	1.380704	1.650608
Jarque-Bera	0.778039	1.225686	0.759196
Probability	0.677721	0.541808	0.684136
Sum	78.49184	116.1281	8.014332
Sum Sq. Dev.	0.0999	46.57324	7.328793
Observations	10	10	10

4.2 Correlation Analysis

The result of the correlation analysis shows that there is a moderate degree of correlation between fintech and green bonds. Furthermore, there is a high degree of correlation between carbon emissions and fintech, and the relationship between green bonds and carbon emissions is positive and high, as shown in Table 3.

Table 3: Correlation Analysis

Variable	LCO ₂	LFN	LGB
LCO ₂	1.0000		
LFN	0.7600	1.0000	
LGB	0.7979	0.58218	1.0000

4.3 OLS results

The results in Table 4 indicate that the relationship between CO₂, fintech, and green bonds is positive and significant at the 10% and 5% levels, respectively. This means that with a 1% increase in fintech, there will be a 2% increase in carbon emissions. Similarly, with a 1% increase in green bonds, there will be a 6.3% decrease in carbon emissions.

Table 4: OLS Results

Variable	Coefficient	Std. Error	T-Statistic	Prob.
LFN	0.020705	0.010355	1.999558	0.0857*
LGB	-0.062764	0.026103	2.404454	0.0472**
C	7.558438	0.110899	68.15625	0

The significance level of 1 %, 5 %, and 10 % is implied by ***, **, * in this study

4.4 VIF Results

The Variance Inflation Factors (VIF) are employed to check the multicollinearity among the variables. If the centered VIF<10, there is an absence of multicollinearity. The values in Table 5 indicate that both variables have values less than 10. So, there is no multicollinearity.

Table 5: Variance Inflation Factors

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LFN	0.000107	45.31468	1.512709
LGB	0.000681	2.838446	1.512709

4.5 Diagnostic Testing Results

The Histogram Normality Test checks the autocorrelation in the series. The results in Figure 1 show that residuals are normally distributed since the p-value is greater than .05. This means that the residuals are free from the problem of autocorrelation. In Table 6 the serial correlation LM test verifies that the p value is greater than .05, so there is no problem of serial correlation. Also, the BP test depicts that residuals are homoscedastic.

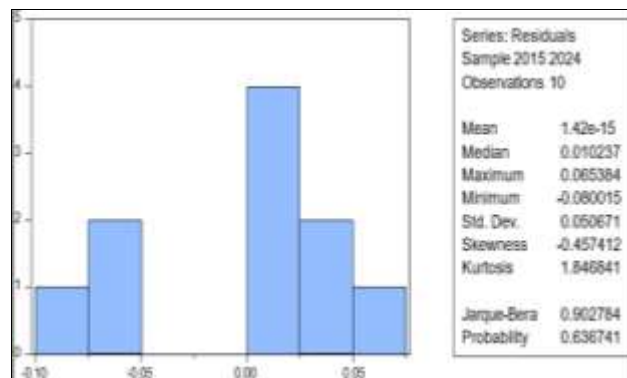


Fig 1: Show that residuals are normally distributed since the p-value is greater than .05

Table 6: Diagnostic test results for model residuals

Diagnostic Test	Chi-Square (P-Value)	Observation
Breusch-Godfrey Serial Correlation LM Test	0.2701	No serial correlation exists
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.5368	Residuals are homoscedastic

4.6 Stability Diagnostics

The stability of the model is checked by a CUSUM plot in Figure 2. The blue line shows the values of residuals; red lines depict the confidence levels. Since the blue lines remain within the confidence levels, which shows model stability.

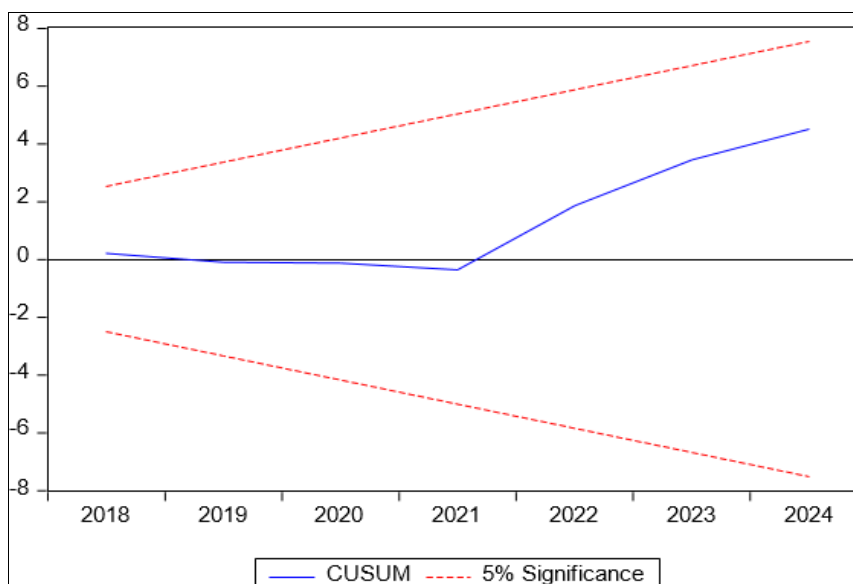


Fig 2: CUSUM Plot with 5% Significance Level

5. Conclusions & Policy Implementation

This research paper examines the impact of green finance and Fintech on the green environment in India from 2015 to 2024. To explore this relationship across various time intervals, the OLS methodology was utilized. The principal findings are as follows: (1) Green finance exerts a statistically significant positive impact on carbon emissions, with significance at the 10% level. (2) Fintech has a significant positive relationship with environmental quality over time. Finally, the adverse impacts of fintech on environmental issues in India necessitate the implementation of efficient policy actions to tackle

environmental issues. The government needs to implement comprehensive and integrated sustainable development strategies that prioritize both environmental issues and economic advancement equally. These strategies ought to include initiatives focused on minimizing pollution, preserving natural resources, and promoting sustainable practices across all sectors.

6. Limitations

The analysis of green finance, financial technology (fintech), and environmental sustainability in India has provided valuable insights into the complex relationships

among these elements. However, certain constraints must be acknowledged. Firstly, the availability and quality of data related to green finance and fintech practices related to India may be limited, making it challenging to access comprehensive and reliable information. This limitation could hinder the depth and accuracy of the analysis. Additionally, longitudinal data covering an extended period is essential for understanding the lasting impacts of green finance and fintech on environmental sustainability. Unfortunately, such data may be scarce or inaccessible, which impedes the ability to assess trends and evaluate specific interventions over time.

Overall, both fintech and green finance are seen as important tools for promoting sustainable development and addressing climate change. Their integration has the potential to accelerate the transition to a more sustainable and environmentally friendly financial system.

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