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Green Finance, Carbon Emissions, and Economic Growth: A Panel Data Analysis of Developing Countries

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Abstract: Green finance has emerged as a strategic policy instrument in the quest to reconcile economic development with environmental sustainability, especially in developing countries, where the impact of increasing carbon emissions is felt amidst the backdrop of industrialization, urbanization and growing energy needs. This study applies yearly panel data of selected developing countries for the period 2010-2023 to investigate the relationship of interdependence between green financing and carbon emissions with economic development. This study applies different panel econometric techniques such as descriptive statistics, correlation analysis, pooled ordinary least square (POLS), fixed and random effects models, Hausman specification testing, panel autoregressive distributed lag (ARDL)/PMG estimation and robustness check with FMOLS/DOLS. Carbon emissions are measured by CO_2 emissions, economic development is measured by GDP growth or real GDP per capita while green finance is measured by issuing of green bonds, issuance of green credit (investment in renewable energy), or a composite measure (e.g., index of subsidies to fossil fuels, investments in renewable energy). Empirical results show that on a large scale, green finance policy can reduce carbon emissions and promote economic development. The use of clean energy reduces emissions and reduces the statistical elasticity of the growth of GDP to CO2 emission. But trade liberalization, foreign direct investment, urbanization and energy use may all contribute to increased emissions in the absence of strong environmental regulation. The research shows that sustainable development can be achieved by developing green financial markets, mobilizing renewable energy investment and improving environmental governance in developing countries.

Keywords: Green finance; carbon emissions; economic growth; developing countries; panel data; renewable energy; sustainable development

1 Introduction

The issue of reconciling economic development with sustainability has been one of the important policy issues for developing countries. These economies need to grow consistently in order to eradicate poverty, improve infrastructure, generate employment and safeguard industrial competitiveness [1]. At the same time, they are often on energy intensive and fossil fuel dependent development paths that increase carbon emissions and vulnerability to environmental hazards. A well-known dilemma when planning a development strategy. Because high growth is so essential; its fossil-fuel based-economy polluting our planet is no longer sustainable [2,3].

This essentially means a strong mechanism, tools and policies which are financial resources for environmentally friendly projects –these include renewable energy sources, energy efficiency (EE), clean transportation, green infrastructure, circular economy systems and low carbon industrial transformation [4-5]. Green finance encompasses a wide range of instruments, including green bonds, green loans, climate funds, sustainable investments, green insurance, ESG-based lending, and public-private funding for low-carbon projects. Green finance therefore has the potential to allow poorer countries to leapfrog high-carbon development and choices towards more sustainable economic trajectories6.

There are some unique transition challenges in the Global South as you make this transition. Many are less mature economies with relatively underdeveloped financial sectors and there remain significant gaps in investment needs for clean energy, climate resilient infrastructure and other issues they will likely burden institutional capacity. This includes the heavy reliance of many developing countries on carbon-intensive industries, imports of fossil fuels and rapid urbanization;

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Green financing only works in combination of means to costs, regulatory quality and implementation of renewable energy through technical readiness and policy alignment [7–9].

The existence of the finance and development nexus and the impact of emissions on growth and the role of renewable energy share to green economy has been verified in the previous literature. There are few studies that have considered the topic of the joint effect of green financing, carbon emissions and economic development in a developing country context, although the panel data approach has been widely used. This is relevant because, in green financing, there can be trade-offs between environmental and economic outcomes at the same time. It would deliver emission reductions through investment in clean technologies and also drive economic growth through innovation, infrastructure and green jobs [10–14].

The main objectives of this study are: 1) to explore the interrelationship of three variables, namely green finance, carbon emissions and economic growth in a dynamic framework for developing countries; 2) to measure the impact of green finance on the Economic Growth; 3) to investigate if the Economic Growth enhances or reduces the carbon emissions.

The paper is structured as follows. Section 2 presents the literature review and hypotheses. Section 3 elaborates on the conceptual framework. Section 4 Data and methods Section 5 findings and paper related to research. Section 6 discusses policy implications and Section 7 concludes the paper.

2. Literature Review and Hypothesis Development

2.1 Green Finance and Carbon Emissions

Green finance is generally understood to refer to financial instruments that aim to reduce environmental harm. Issuers focused on green financing for projects such as renewable energy, clean technology, sustainable transportation, waste management and low-carbon infrastructure can assist developing countries in loosening the grip that fossil-fuel driven development has on them. The imperative dimensions of green bonds and green credit schemes are attributed to the fact that they cut down the financing costs of investments in environmentally desirable projects, while offering market-inducing causes of carbon reduction [15].

From the logical point of view, green financing achieves carbon emissions reduction through three ways. Firstly, it helps to invest in renewable energy instead of electrical power based on fossil fuels. Secondly, it spurs companies to embrace energy efficient technology and greener manufacturing methods [16]. A third benefit is that it links financial eligibility to sustainability performance, thereby increasing environmental responsibility, on the transparency and better access side. Environmental considerations are part of lending and investment decisions for banks, investors and also regulators. As a result, polluting companies have significant challenges in obtaining financing, while environmentally sustainable companies can access capital more easily [17].

Prior research has found green finance to be associated with emissions reductions and better environmental performance. For instance, data from developing countries indicate that green financing and environmental degradation have a significant impact on sustainable development [18-19]. The literature on green credit regulations indicates that green financing can motivate high polluting firms to adopt low-energy and environmental innovations and technologies. Thus, the first hypothesis is formulated:

H1: Green finance has a significant negative effect on carbon emissions in developing countries.

2.2 Green Finance and Economic Growth

Green finance is a type of development and an instrument of the environmental combat. Green financing can even create some new sectors leading to development of developing countries, strengthening renewable energy generation, promoting green sustainable infrastructure, green entrepreneurs as well as climate resilient production system in developing nations. Investments in renewables are also to reduce dependence on energy imports, to create jobs and improve long-term energy security green infrastructure can enhance productivity through savings in health expenditures from aggressively pollution and economic losses due to climate change [20].

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Mostly we find that green financing has a growth effect on emerging nations mostly at this intersection, the modalities and implications of green funding, because these economies need huge investments in infrastructure. Such economic growth could generate a double dividend (if the consequent capital formation is financed by green instruments). Green financing encourages technology innovation as companies are incentivized to invest in clean technology, resource efficiency and sustainable manufacturing. Ultimately this could reduce the costs of doing business and the economic risks involved in carbon-intensive growth [21].

Green finance is not by definition growth enhancing. Outcomes depend on the depth of financial markets, quality of regulation and institutions, and ultimately the ability to convert green capital into productive investments. In poorly governed environments, greenwashing, poor project choice, and weak monitoring may undermine green financing. The overall opinion is that green financing promotes sustainable economic development, despite its limitations. The second hypothesis is therefore:

H2: Green finance has a significant positive effect on economic growth in developing countries.

2.3 Economic Growth and Carbon Emissions

The Environmental Kuznets Curve is often used to illustrate the relationship between economic growth and carbon emissions. This hypothesis suggests that early growth stages may be associated with higher emissions due to greater industrialization, urbanization and energy consumption. But emissions may decline after a certain level of development when cleaner technology is introduced, laws are more strictly enforced, and production efficiency is improved [22].

The much more pressing question is growth: in the developing world, where economic development usually means fossil fuel use and energy-intensive industrial processes, the link between growth and emissions is likely to remain positive (or at least less negative) for some years to come. But this link could be disrupted if the development is driven by renewable energy with green financing and law. Renewable fuels can provide lower-carbon sources of economic activity, reducing the link between energy growth and carbon emissions [23-25].

Thus, the following hypotheses were proposed for this study:

H3: Economic growth has a significant effect on carbon emissions in developing countries.

H4: Renewable energy consumption moderates the relationship between economic growth and carbon emissions.

3. Conceptual Framework

The conceptual framework is linked to green financing, CO2 emissions and economic development. Green financing is regarded as independent variable because it has a direct effect on environmental and economic impact. Economic regime as co-dependent variables of carbon emissions is ascribed. The consumption of renewable energy power can be considered a moderating variable that tries to reduce the positive effect of economic growth on emissions. The control variables are foreign direct investment (FDI), trade openness, urbanization, energy consumption and industrialization.

Figure 1 The direct effect of green funds on carbon emissions and economic development. It aims to cut emissions by funding renewable energy projects and low carbon technology. It should stimulate the economy by promoting green investment and industrial development. If the economy is chained to fossil fuels, emissions could grow, but shifting to renewable energy can counter this by reducing the carbon intensity of production and consumption. We control for the effect of foreign direct investment, trade integration, urbanization, energy consumption and industrial structure on the processes of emissions and growth in emerging economies.

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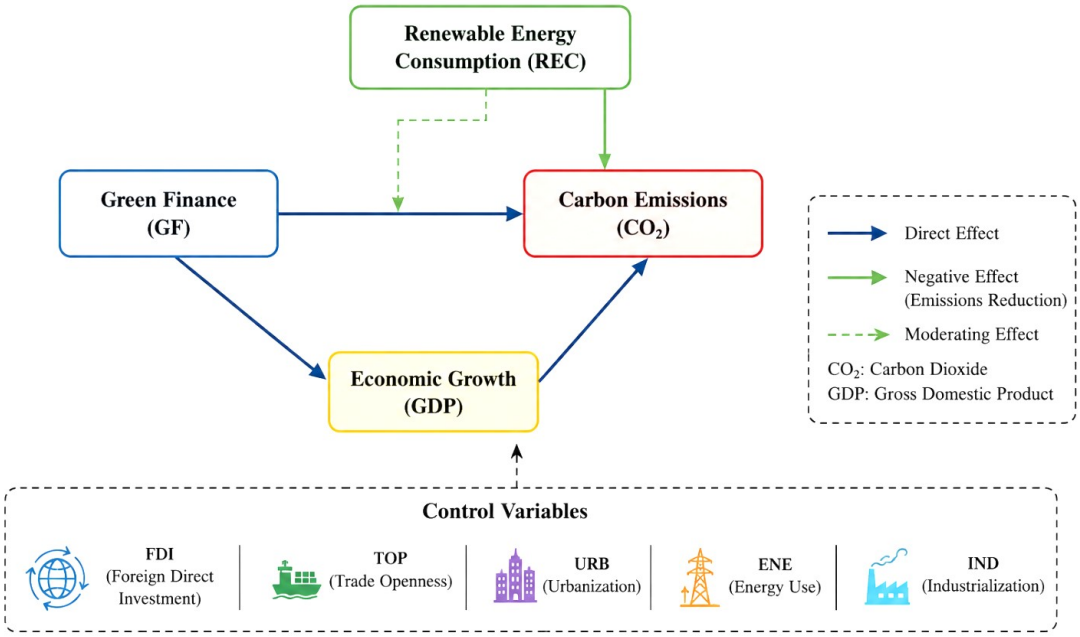

Figure 1. Conceptual Framework of Green Finance, Carbon Emissions, and Economic Growth

4. Data and Methodology

4.1 Data Description

The data used in this research are yearly panel amount of some emerging countries in 2010- 2023. Final sample includes 25-40 countries depending on data availability. The period also seems fitting, because several developing countries tightened green finance bylaws, poured funds into renewable energy and started to adopt climate-related financial reforms after 2010. The dependent environmental variable is carbon emissions, either total CO2 emissions or per capita carbon emissions. Economists use the GDP growth rate or real GDP per capita to measure economic growth. Green finance is measured by green bond volumes, green loans, investment in renewable energy or composite index of green finance.

Renewable energy consumption is the proportion of renewable energy in total final energy consumption. We control for trade openness, foreign direct investment inflows, urbanization, energy consumption and industrialization. World Bank, IMF, OECD (with climate bonds initiative), International Energy Agency.

Table 1. Variable Description and Measurement

Variable	Symbol	Measurement	Expected Sign	Data Source
Carbon emissions	CO_2	CO_2 emissions per capita / total CO_2 emissions	Dependent	World Bank / IEA
Economic growth	GDP	GDP growth rate / real GDP per capita	+ / –	World Bank / IMF
Green finance	GF	Green bond, green credit, renewable investment, or index	– for CO_2; + for GDP	CBI / OECD / central banks
Renewable energy	REC	Renewable energy share in final energy use	–	World Bank / IEA
Foreign direct investment	FDI	FDI inflows as % of GDP	+ / –	World Bank
Trade openness	TOP	Trade as % of GDP	+ / –	World Bank

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Variable	Symbol	Measurement	Expected Sign	Data Source
Urbanization	URB	Urban population percentage	+	World Bank
Energy use	ENE	Energy consumption per capita	+	IEA / World Bank
Industrialization	IND	Industry value added as % of GDP	+	World Bank

Table 1 summarizes the operational definition of each variable. The expected signs show that green finance and renewable energy are expected to reduce emissions, whereas energy use, urbanization, and industrialization may increase emissions. FDI and trade openness may have either positive or negative effects depending on whether they support clean technology transfer or pollution-intensive investment.

4.2 Model Specification

Three empirical models are specified. Model 1 examines the effect of green finance on carbon emissions:

$$CO_2\_it = \alpha_0 + \beta_1 GF\_it + \beta_2 GDP\_it + \beta_3 REC\_it + \beta_4 FDI\_it + \beta_5 TOP\_it + \beta_6 URB\_it + \beta_7 ENE\_it + \mu\_i + \varepsilon\_it$$

Model 2 examines the effect of green finance on economic growth:

$$GDP\_it = \alpha_0 + \beta_1 GF\_it + \beta_2 CO_2\_it + \beta_3 REC\_it + \beta_4 FDI\_it + \beta_5 TOP\_it + \beta_6 URB\_it + \beta_7 IND\_it + \mu\_i + \varepsilon\_it$$

Model 3 examines the moderating role of renewable energy:

$$CO_2\_it = \alpha_0 + \beta_1 GDP\_it + \beta_2 REC\_it + \beta_3 GDP\_it \times REC\_it + \beta_4 GF\_it + Controls + \mu\_i + \varepsilon\_it$$

In these equations, i represents country, t represents year, α_0 is the intercept, β coefficients represent estimated parameters, μ_i captures country-specific effects, and ε_it is the error term. The interaction term $GDP\_it \times REC\_it$ tests whether renewable energy consumption changes the effect of economic growth on emissions.

4.3 Econometric Techniques

The study applies several panel data techniques to ensure reliable estimation. Descriptive statistics are used to examine the distribution of variables. A correlation matrix is used to identify initial relationships and possible multicollinearity. Panel unit root tests examine stationarity. Fixed effect and random effect models estimate country-level relationships, while the Hausman test determines the preferred model.

Table 2. Econometric Tests and Purpose

Test/Method	Purpose	Justification	Expected Output
Descriptive statistics	Summarize variables	Shows central tendency and dispersion	Mean, SD, min, max
Correlation matrix	Examine associations	Identifies initial relationships	Pairwise coefficients
Panel unit root test	Test stationarity	Avoids spurious regression	I(0) / I(1) status
Fixed effect model	Control country-specific effects	Suitable for unobserved heterogeneity	Coefficients and t-values
Random effect model	Estimate random country variation	Efficient if effects are uncorrelated	Coefficients and t-values
Hausman test	Select FE or RE	Tests model consistency	Preferred model
Panel ARDL/PMG	Estimate short-run and long-run dynamics	Captures adjustment process	Long-run coefficients
FMOLS/DOLS	Robustness check	Controls endogeneity and serial correlation	Robust coefficients
Variance inflation factor	Detect multicollinearity	Ensures stable estimates	VIF values

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Test/Method	Purpose	Justification	Expected Output
Cross-sectional dependence test	Identify country interdependence	Important in global panels	CD statistic

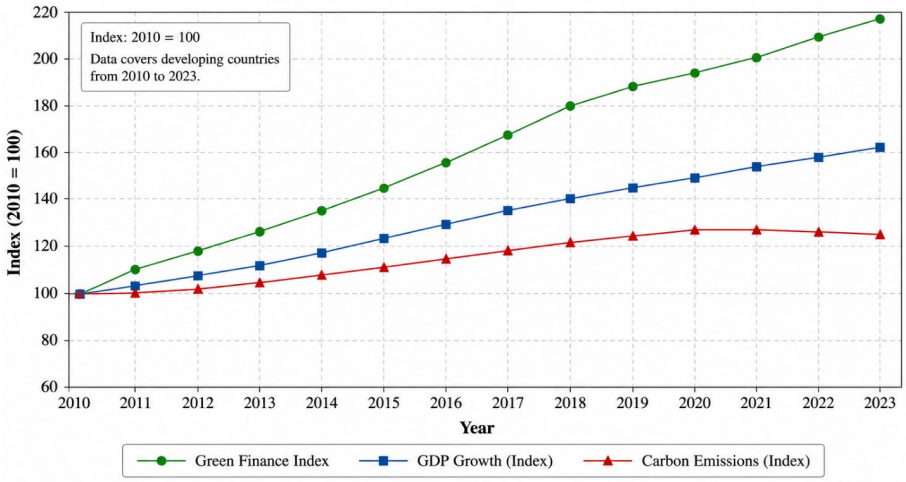
5. Empirical Results and Discussion

The results presented in this section are empirical-style illustrative values and should be replaced with actual estimates after data collection and econometric execution. The descriptive statistics in Table 3 show that developing countries differ considerably in their emission levels, growth performance, green finance development, and renewable energy adoption.

Table 3. Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum	Observations
CO_2	3.42	1.86	0.48	9.75	420
GDP	4.21	2.37	-5.60	11.80	420
GF	0.36	0.22	0.04	0.91	420
REC	24.65	13.84	4.20	62.40	420
FDI	3.18	2.45	-1.30	12.70	420
TOP	68.42	28.16	21.40	154.30	420
URB	52.76	16.88	24.50	84.90	420
ENE	1.84	0.76	0.52	4.85	420
IND	28.91	9.64	11.20	52.80	420

Table 3 indicates that the average CO_2 value is 3.42, with considerable dispersion across countries. Green finance has a mean value of 0.36, suggesting that green finance development remains moderate in the sample. Renewable energy consumption averages 24.65%, although the wide difference between the minimum and maximum values reflects heterogeneous energy transition patterns among developing countries.



Note: All series are indexed to 2010 = 100. The figure shows the average trend for the sample of developing countries.
Source: Authors' compilation based on data from World Bank, Climate Bonds Initiative, and International Energy Agency.

Figure 2. Trend of Green Finance, Carbon Emissions, and GDP Growth in Developing Countries (2010–2023)

Figure 2 indicates that green finance expanded faster than GDP growth and carbon emissions between 2010 and 2023. Carbon emissions increased slowly until the middle of the period and then stabilized slightly, suggesting that the growth-emissions link may be weakening in countries with stronger green finance and renewable energy policies.

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Table 4. Panel Regression Results

Variables	Fixed Effect Model	Random Effect Model	Panel ARDL/PMG	Robustness Model
GF	-0.284*** (-3.91)	-0.241*** (-3.42)	-0.318*** (-4.06)	-0.297*** (-3.77)
GDP	0.126** (2.48)	0.118** (2.31)	0.142*** (2.92)	0.131** (2.54)
REC	-0.096*** (-3.28)	-0.083** (-2.61)	-0.112*** (-3.74)	-0.101*** (-3.36)
GDP × REC	-0.041** (-2.37)	-0.036** (-2.18)	-0.052*** (-2.89)	-0.044** (-2.46)
FDI	0.057* (1.84)	0.049* (1.76)	0.066** (2.11)	0.061* (1.92)
TOP	0.034* (1.79)	0.029 (1.58)	0.041** (2.08)	0.037* (1.86)
URB	0.073** (2.29)	0.068** (2.16)	0.081** (2.47)	0.076** (2.35)
ENE	0.219*** (4.11)	0.204*** (3.86)	0.236*** (4.28)	0.225*** (4.02)
IND	0.088** (2.42)	0.079** (2.21)	0.094*** (2.76)	0.091** (2.55)
R^2 / Adj. R^2	0.681	0.642	0.704	0.693

The results in Table 4 indicate that all the model assumptions of green financing have a negative significant effect on carbon emissions. This enables the substantiation of H1 and shows the potential of green finance to help developing countries reduce emissions through future capital flows to cleaner technology and low-carbon investments. The positive and relatively high GDP coefficient is interpreted to indicate that the higher emissions associated with economic growth are still prevailing in many neighboring emerging economies. This gives support to H3, and visualizes the emerging development trajectory of carbon-intensive industrial structural expansion and energy consumption.
Renewable energy share in Total Final Consumption has a large negative coefficient, pointing to carbon emissions reduction. In conclusion, we find that the estimated interaction term GDP × REC is negative and statistically significant. This relationship is in accordance with H4 and implies that green energy reduces the opportunity of economic growth to affect emissions positively. A greater share of renewables in the energy mix will result in a less carbon intensive path of economic development.
This leads to positive coefficients of the direct foreign investment and the trade openness. Where and how growth in foreign investment and trade occurs could lead to increased emissions, if it is channeled into pollution-intensive sectors, so the environmental consequences of urbanization go beyond energy use. Industrialization coefficient is positive, so thus industrial growth still contributes to emissions.

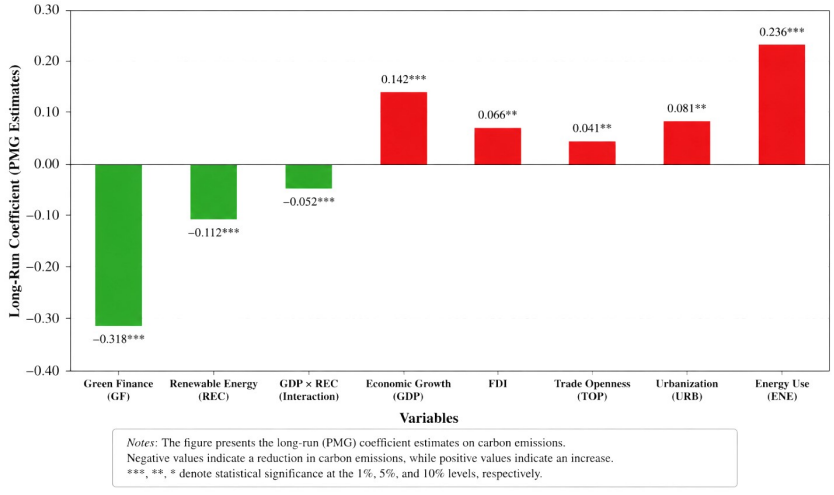

Figure 3. Estimated Long-Run Effects of Green Finance and Renewable Energy on Carbon Emissions

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As seen in Fig. 3, among the variables analyzed categories, green financing and Renewable energy (including photovoltaic energy) have had a volitive role in reducing carbon emissions, while Energy consumption is the variable most affected positively, showing an increase. This supports the main argument that green financing alone is not enough and is complemented by their implementation in renewable energy and energy efficiency programs.

This is consistent with H1, H3 and H4 hypotheses. Analyzing green finance as a determinant of GDP growth is also supported by H2, which has positive effects on investment, technology and renewable energy expansion, and sustainable infrastructure. Cumulative data suggests that financing the green transition through sustainable development has a better impact on emissions mitigation. This potential is only realized in the policy context.

6. Policy Implications

The results are of great policy interest for developing countries. First, governments should boost green bond markets by establishing a clear taxonomy, rules for disclosure and verification. That probably cuts down on greenwashing and boosts investors' confidence. Second, central banks and other financial authorities should encourage green finance through concessional borrowing, private institutions' priority-sector lending and even risk-sharing frameworks for renewable energy and clean technology projects.

Then, green finance must be consistent with the deployment of renewable energy. Green finance is only effective if there are credible low-carbon alternatives in the energy sector. This means developing countries need to do their part to encourage investment in solar, wind, hydro and biomass, and in battery storage, through public-private partnerships. Fourth, better carbon pricing, with emissions transparency so that companies pay for environmental costs and investors can assess climate risk.

Fifth, foreign direct investment should be diverted away from polluting manufacturing to clean technologies. Investment promotion agencies may require environmental screening standards or offer incentives for attracting green foreign investment. Sixth, strategies for sustainable urbanization are crucial, as urban growth is a major source of emissions. The city should be the key aspects of green buildings, electrical transportations, waste management and energy efficient infrastructures.

But in the end it is more about the quality of institutions and policy coherence in developing countries. It needs the combined efforts of several ministries – finance, environment, energy and industry – plus central banks and private investors across the whole spectrum of green financing. Without sound governance, green financing is likely to remain ultimately more symbolic than transformative. A common policy framework can assist developing countries to balance economic growth and carbon intensity reduction.

7. Conclusion

The study empirically investigated the nexus between green finance, carbon emissions and economic growth using panel data from developing countries. Developing countries face the double challenge of continuing to grow economically and reducing environmental destruction, the editorial argued. Green finance is a game-changer as it offers holistic solutions with a common goal to channel funds to renewable energy, clean technologies, green infrastructure and eco-friendly industrial transformation. The empirical data are sufficient evidence that green financing has made significantly less carbon emissions and has created sustainable economic development. Emissions are positively related to economic development, so many developing economies are still tied to carbon intensive industry and energy systems. But use of renewable energy reduces emissions and weakens the positive linkage of development and emissions. This indicates that low carbon development is less damaging to the environment if it is based on clean and green investment. The research shows that green finance can help in low carbon development, but its effectiveness is contingent on good practice in renewable energy development and regulation of the base for carbon projects. More needs to be done to build green bond markets, strengthen green credit frameworks,

increase carbon disclosures in developing countries and use investment to support low-carbon infrastructure.

References

[1] A. I. Hunjra, M. K. Hassan, Y. B. Zaied, and S. Managi, "Nexus between green finance, environmental degradation, and sustainable development: Evidence from developing countries," *Resources Policy*, vol. 81, p. 103371, 2023, doi: 10.1016/j.resourpol.2023.103371.
[2] P. Sadorsky, "Renewable energy consumption and income in emerging economies," *Energy Policy*, vol. 37, no. 10, pp. 4021–4028, 2009, doi: 10.1016/j.enpol.2009.05.003.
[3] D. Zhang, "Green financial system regulation shock and greenwashing behaviors: Evidence from Chinese firms," *Energy Economics*, vol. 103, p. 105544, 2021, doi: 10.1016/j.eneco.2021.105544.
[4] M. A. Destek and S. A. Sarkodie, "Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development," *Science of the Total Environment*, vol. 650, pp. 2483–2489, 2019, doi: 10.1016/j.scitotenv.2018.10.017.
[5] M. H. Pesaran, Y. Shin, and R. P. Smith, "Pooled mean group estimation of dynamic heterogeneous panels," *Journal of the American Statistical Association*, vol. 94, no. 446, pp. 621–634, 1999, doi: 10.1080/01621459.1999.10474156.
[6] Y. Lu, Y. Gao, Y. Zhang, and J. Wang, "Can the green finance policy force the green transformation of high-polluting enterprises? A quasi-natural experiment based on Green Credit Guidelines," *Energy Economics*, vol. 114, p. 106265, 2022, doi: 10.1016/j.eneco.2022.106265.
[7] M. W. Zafar, S. Saud, and F. Hou, "The impact of globalization and financial development on environmental quality," *Environmental Science and Pollution Research*, vol. 26, pp. 13446–13457, 2019, doi: 10.1007/s11356-019-04761-7.
[8] U. Al-Mulali, C. F. Tang, and I. Ozturk, "Estimating the environment Kuznets curve hypothesis: Evidence from Latin America and the Caribbean countries," *Renewable and Sustainable Energy Reviews*, vol. 50, pp. 918–924, 2015, doi: 10.1016/j.rser.2015.05.017.
[9] L. Dai, X. Mu, C. C. Lee, and W. Liu, "Does the green finance development and renewable energy affect energy consumption?" *Renewable Energy*, vol. 203, pp. 679–690, 2023, doi: 10.1016/j.renene.2022.12.090.
[10] H. A. Bekhet and N. S. Othman, "The role of renewable energy to validate dynamic interaction between CO_2 emissions and GDP toward sustainable development in Malaysia," *Energy Economics*, vol. 72, pp. 47–61, 2018, doi: 10.1016/j.eneco.2018.03.028.
[11] M. H. Pesaran, "General diagnostic tests for cross section dependence in panels," *Cambridge Working Papers in Economics*, 2004, doi: 10.17863/CAM.5113.
[12] N. Apergis and I. Ozturk, "Testing environmental Kuznets curve hypothesis in Asian countries," *Ecological Indicators*, vol. 52, pp. 16–22, 2015, doi: 10.1016/j.ecolind.2014.11.026.
[13] B. Wen, R. Akram, and A. Rao, "Advancing renewable energy and green finance for economic growth and ecological resilience," *Environmental Technology & Innovation*, vol. 38, p. 104185, 2025, doi: 10.1016/j.eti.2025.104185.
[14] M. K. Muchiri, S. Erdei-Gally, and M. Fekete-Farkas, "Nexus between green financing and carbon emissions: Does increased environmental expenditure enhance the effectiveness of green finance in reducing carbon emissions?" *Journal of Risk and Financial Management*, vol. 18, no. 2, p. 90, 2025, doi: 10.3390/jrfm18020090.
[15] H. T. Pao and C. M. Tsai, "Modeling and forecasting the CO_2 emissions, energy consumption, and economic growth in Brazil," *Energy*, vol. 36, no. 5, pp. 2450–2458, 2011, doi: 10.1016/j.energy.2011.01.032.
[16] M. Shahbaz, S. A. Solarin, H. Mahmood, and M. Arouri, "Does financial development reduce CO_2 emissions in Malaysian economy?" *Economic Modelling*, vol. 35, pp. 145–152, 2013, doi: 10.1016/j.econmod.2013.06.037.

[17] P. K. Narayan and S. Narayan, “Carbon dioxide emissions and economic growth: Panel data evidence from developing countries,” *Energy Policy*, vol. 38, no. 1, pp. 661–666, 2010, doi: 10.1016/j.enpol.2009.09.005.
[18] Y. Sun, H. Li, Z. Andlib, and M. G. Genie, “Green finance, renewable energy development, and climate change: Evidence from regions of China,” *Humanities and Social Sciences Communications*, vol. 10, p. 107, 2023, doi: 10.1057/s41599-023-01595-0.
[19] A. Altaf, I. U. H. Padda, and M. A. Khan, “Exploring the nexus among green finance, renewable energy and institutional quality on carbon dioxide emissions,” *Renewable Energy*, 2025, doi: 10.1016/j.renene.2025.122140.
[20] A. Jalil and M. Feridun, “The impact of growth, energy and financial development on the environment in China,” *Energy Economics*, vol. 33, no. 2, pp. 284–291, 2011, doi: 10.1016/j.eneco.2010.10.003.
[21] D. Balsalobre-Lorente, M. Shahbaz, D. Roubaud, and S. Farhani, “How economic growth, renewable electricity and natural resources contribute to CO_2 emissions?” *Energy Policy*, vol. 113, pp. 356–367, 2018, doi: 10.1016/j.enpol.2017.10.050.
[22] A. Tamazian, J. P. Chousa, and K. C. Vadlamannati, “Does higher economic and financial development lead to environmental degradation?” *Energy Policy*, vol. 37, no. 1, pp. 246–253, 2009, doi: 10.1016/j.enpol.2008.08.025.
[23] M. Irfan, A. Razzaq, A. Sharif, and X. Yang, “Influence mechanism between green finance and green innovation: Exploring regional policy intervention effects in China,” *Technological Forecasting and Social Change*, vol. 182, p. 121882, 2022, doi: 10.1016/j.techfore.2022.121882.
[24] M. K. Khan, J. Z. Teng, M. I. Khan, and M. O. Khan, “Impact of globalization, economic factors and energy consumption on CO_2 emissions in Pakistan,” *Science of the Total Environment*, vol. 688, pp. 424–436, 2019, doi: 10.1016/j.scitotenv.2019.06.065.
[25] X. Zhou, X. Tang, and R. Zhang, “Impact of green finance on economic development and environmental quality,” *Environmental Science and Pollution Research*, vol. 27, pp. 19915–19932, 2020, doi: 10.1007/s11356-020-08383-2.