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Evaluating the Role of Green Finance in Emission Reduction: Comparative Insights from Asian Economies

Jong Lee[a], Maria Zhuang[b]

Abstract

This study discussed the impact of green finance on carbon emissions in China and India, two of the leading sources of greenhouse gas levels in the world. Using annual data that spans the years 2000-2024, the analysis considers the Augmented Dickey-Fuller unit root test, ARDL bounds testing approach, and a number of diagnostic tests to analyze the long and short-run relations between green finance and carbon emission. The model also has economic growth, inflation, and shadow economy as control variables in order to have a more sound understanding of emission dynamics. The empirical results suggest that, in China, the current carbon emissions are strongly determined by past emissions and inflationary pressures, while economic expansion appears to be good for the emission U-turn. In Indian country, inflation and land occupation are two important conditions for increasing emissions, and a number of socioeconomic conditions combine to mitigate pressure on the environment. The error-correction terms for both countries confirm convergence to long-run stability, i.e., deviation from equilibrium, is being gradually corrected with time. Overall, the findings imply the importance of green finance and how it can help to reduce emissions and make sustainable development a hit. The evidence would seem to suggest that targeted better policies on green investment and well-functioning financial policies can help emerging economies balance their scoring between attaining growth and environmental responsibility. These types of insights have meaning in guiding policymakers, in addition to emphasising efforts internationally related to attempting to solve the climate problems through financial innovation and sustainable economic planning.

Keywords: *Green Finance, Carbon Emissions, Sustainable Development, Economic Growth*

JEL Codes: *Q56, O44, Q53*

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1. INTRODUCTION

As the world population continues to grow at an unprecedented rate, an increase in demand for energy has been noted in all regions, triggering the rapid growth in the consumption of resources and corresponding growth in CO2 (carbon dioxide) emissions. This humongous increase in energy demand has meant that natural ecosystems, climate stability, and national energy infrastructures have come under tremendous pressure. The Global Carbon Atlas (2019) explains that global emissions of CO2 from human energy usage have hit 33.1 gigatonnes in 2019, one of the highest levels in modern history. Among the main polluters are China, the United States, and India, which are notable as the main carbon emitters, which is due to the large number of people, the growth of industrial activity, and the adoption of a growth model based on fossil fuel use. The situation has been particularly acute in China and India, where rapid urbanization, rapid industrial development, and mass efforts at modernization have thrown up complex problems for policymakers seeking to balance economic progress and environmental protection.

The International Energy Agency (IEA, 2022) backs up the seriousness of this problem by estimating that between China and India, CO2 emissions from energy use account for more than 40% of the global total. This kind of extraordinary concentration of emissions in just two economies points to both how much they have developed and the effects on the rest of the world if they decide to go in the same direction. Despite persistent efforts by the international community on international agreements, policy reforms, and investments in green technologies, the magnitude of emissions promised from these countries highlights the extent to which changing from old, carbon-intensive growth patterns to more sustainable ones is a challenging proposition. The World Bank (2020) points out that although there has been a slow

[a] Division of Social Science and Economics, International Rice Research Institute, Philippines
[b] Division of Social Science and Economics, International Rice Research Institute, Philippines, mariia.zhuangg@gmail.com

decline in the global carbon intensity, there are wide regional disparities. Many developing countries are still struggling with the transition due to limitations such as structural limitations, lack of proper funding, and different levels of technological readiness. These disparities are often shown in the contemporary research findings that evidently the advanced economies are most likely to achieve the reductions in emissions faster than the developing nations (Ibrahim & Simian, 2023; Marc & Ali, 2016; Wiafe, 2018; Khan & Hassan, 2019; Friedlingstein et al., 2020; Hou & Yuan, 2025). The combination of economic constraint, energy dependency, and rising economic demands of industrialisation makes the decarbonisation process particularly challenging for areas of rapid economic change.

In the wake of increasing worry around greenhouse gas intensity, nations around the world have stepped up their efforts to shift to renewable sources of energy and environmentally friendly technologies. Such efforts are part of wider climate strategies involving ways to mitigate emissions, enhance energy security, and sustain development. Scholars and policymakers dispute that the global shift to clean energy is not only attainable in terms of technology, but there is economic benefit in doing so in the long run (Kostruba and Pasko, 2019; Mustapha, 2022; Nut and Kumar, 2023; Martin & Camerone, 2025). Renewable energy integration, energy efficiency, and take-up of green industrial practices have become important elements in national action plans, which are intended to fulfil long-term climate commitments. Parallel to these technological and policy developments, the financing of green has been an unfortunate strategy of fundraising in bringing investments into sustainable development initiatives. By investing in renewable energy, energy-efficient infrastructure, and low-carbon technology, green finance has an important role to play in supporting the evolution towards environmentally responsible economic systems. However, the relationship between economic activity and emissions is nevertheless a complex one, as has been demonstrated with the recent global trends. The post-pandemic year 2021 saw a good pick-up in economic activity, with global GDP growing by 5.9%. This recovery was accompanied by the 6% surge of CO2 emissions - the strongest link of income growth and emissions measured since the post-2008 Global Financial Crisis recovery (IEA, 2022). Such patterns represent the uphill struggle to delink economic prosperity from carbon emissions. Although economic recovery is critical, the impact of the rebound effect demonstrates the fragility of global progress towards climate goals and the extent to which economic systems are still highly carbon dependent. Recent studies offer a brighter take on it by suggesting that the growth of green finance offers potential for increasing the speed of the decoupling with the help of an effective regulatory setup, novel financial products, and long-term support offered by governments (Rahman & Zhao, 2023; Torres & Malik, 2024; Tan & Lee, 2025). By retooling global flows of investment towards green sectors, green finance can play a transformative role in helping to reshape development pathways and to decarbonise the economy and underpin low-carbon economic growth in both advanced and emerging economies (Rizwan & Iqbal, 2025; Marc et al., 2025).

China and India are two of the largest sources of global CO2 emissions, and it is crucial to unravel the driving forces behind emission trends in these rapidly growing economies. Their environmental trajectories have a great impact on international climate results because of the sheer proportions of their populations, industrial development, and their patterns of consumption in terms of energy. Both countries have the economic capacity, institutional strength, and technological potential to implement measures to adopt sustainable development that could have a significant reduction of emissions without sacrificing economic development. According to the IEA (2021), China and India have shown a growing hesitancy to incorporate sustainable criticality in long-term development plans, which indicates recognition of environmental risk factors of unchecked emission growth. Their climate pledges are both ambitious and very ambitious: China has pledged to be carbon neutral by 2060 and India has set ambitious targets in terms of both renewable energy and carbon intensity reductions to inform the low-carbon transition (Gorus & Groenveld, 2018; Bakht, 2020; Stern & Xie, 2022; Zhao et al., 2022; Rossi, 2023; Bary & Hakim, 2025; Khan et al., 2025). These pledges reflect a change in the strategic orientation to greener economic models is aware of the twin imperatives of the environment and economic fight against poverty. Insights provided by this study can therefore play an important role in informing policy interventions that can help support the climate goals of these two major economies. As both countries continue to grow their industrial and technological abilities, there is a need to have in place effective policies that address the issues of economic, financial, and institutional dynamics that contribute to emission outcomes. Recent literature is highlighting the importance of green investment portfolios and carbon pricing mechanisms as a critical part of climate strategy with great potential for steering economies towards low-carbon development (Haque & Salman, 2024; Shen & Li, 2022; Ali et al., 2025). These sorts of mechanisms promote the production of clean energy sources, promote improvements in energy efficiency, and redistribute financial resources from high-emission industries. The study accordingly hypothesizes about the significant influences of green financing, shadow economy, and inflation on the CO2 emissions in China and India (even after controlling for GBD). These variables are a representation of more general worldwide challenges, too, and how developing and emerging economies are struggling with connected pressures of growing emissions, growing economies, and social vulnerabilities. The parallel story to underline such interdependencies is very obvious in the case of Pakistan. Rapid industrialization and rapid increase in population, coupled with continuous unsatisfactory environmental governance, have significantly aggravated the carbon emissions situation in the country. This escalation is contributing to multiple environmental and public health challenges, such as severely deteriorating air quality, high levels in major cities, increasing incidences of respiratory issues, persistent water scarcity, and increasing climate-induced disasters, including disastrous floods and recurring heatwaves (World Bank, 2022; GOP, 2021). The melting glaciers of the Himalayas also draw attention to the longer-term threats of the CO2-driven climate changes, which threaten the availability of freshwater in the future, the productivity of agriculture, and the stability of the ecosystems that support many millions of people. Studies have increasingly focused on the inadequate efforts of developing countries to pursue more proactive and stringent mitigation options, which are necessary if the countries are to adopt effective mitigation strategies to combat climate change and

build resilience to it (Khan & Farooq, 2023; Sharma & Rauf, 2024; Ali et al., 2025). The need for stronger mitigation and adaptation actions is more apparent in view of an increasing frequency and intensity of climate-related disasters.

The general objectives of this paper are in congruence with these wider regional and global concerns. The study aims to determine the most important determinants of short-term and long-term CO2 emissions in China and India, taking into account the historical emissions pattern, inflation state, GDP fluctuation, and the size of the shadow economy. A better understanding of how these variables work together over time enables a better analysis of the drivers of emissions for two rapidly changing economies. The paper also further discusses how the long-term policy strategies, especially those relating to the expansion of green finance, may be instrumental to reduce emission in line with China's commitments to decrease carbon intensity, and increase the proportion of non-fossil energy consumption. At the same time, the study deals with India's peculiar low-carbon developmental challenges, including infrastructural discouragement, financial constraints, and deep-rooted social equity issues, and this makes the implementation of large-scale climate policy challenging. In the end, the goal of the research is to provide nuanced insights on the impacts of a number of different elements - economic conditions, financial structures, regulatory interventions, etc. - on environmental outcomes in both China and India. The ramifications for such findings are certainly important not only in terms of all the debates ongoing around climate policies within the context of individual countries, but also in the broader debates around global and regional means of pursuing sustainable development. The insights produced from this study can help policymakers develop specific interventions that balance growth with environmental stewardship by ensuring a proper balance. Moreover, the experiences of China and India throw valuable light on the other developing economies seeking to take the path of economic development while dealing with immediate needs for climate resilience and carbon mitigation. In a time when international cooperation is imperative in tackling climate change, these contributions are of particular significance.

2. REVIEW OF LITERATURE

Climate change is a global challenge that impacts all parts of the world, and the ramifications of this problem are far-reaching and have brought about huge pressure on governments, industries, and societies to rethink development priorities. Developing countries like India and China, though emerged as the biggest and fastest-growing economies in the world, now have a great responsibility in themselves to decide the best way to strike a useful balance between fast economic progress and urgent environmental conservation. Their influential role in global trade, manufacturing, and energy consumption means that their climate policies and mitigation strategies are of vital importance not only to regional stability but to the global struggle to create a sustainable world. As it had pointed out in the previous works, these nations are facing a challenging task at hand, of managing carbon-intensive economic growth, while simultaneously transitioning towards greener economic frameworks (Emodi, 2019; Mahmood, 2019; Khan et al., 2021; Hussain & Khan, 2022; Zhang et al., 2022; Bhattacharya, 2020; Iqbal & Noor, 2023; Ali et al., 2025; Sadiq et al., 2025). Scholars frequently underscore that the future of global climate stability is tied to the degree of success in these two economies in moving simply to sustainable pathways that (re)achieve both development and environmental protection at the same time. In this understanding, green finance has become one of the most promising mechanisms that can help environmentally conscious in obtaining the necessary means to make investments to adopt cleaner technologies, renewable energy systems, and sustainable methods of production. Green finance is increasingly seen not only as a mechanism for providing finance, but also as an institutional structure for promoting environmentally responsible decision-making at the financial markets level, rather than market by market and sector by sector. The current paper provides an extensive review of the literature, based on various research results investigating the relationship between carbon emissions in India and China and several economic variables such as GDP, inflation, and the size of the shadow economy. By synthesizing the findings of past studies, the paper gives a better understanding of how these variables interact to shape emissions trajectories in two of the world's most influential emerging economies.

Turning more specifically to the nexus between carbon emissions and environmentally responsible financing, though, existing research highlights the fact that green finance is made up of a certain combination of financial instruments and associated mechanisms to help promote long-term sustainable development. Numerous empirical research has been conducted to analyze the extent to which green financial instruments can contribute to emission reductions in China and India. Zhu and Jiang (2020), China's policy response to the novel coronavirus pandemic in the early stages, China's initial response to the pandemic of the novel coronavirus made a significant contribution to reducing carbon emissions, through driving cleaner production practices. Similarly, Bhanot et al. (2019) mentioned the high potential of the green bonds to help India curb its total greenhouse gas emissions. These findings show that green finance is a good tool that can channel investments to environmentally friendly projects, which is a positive step to support the evidence presented by Sharif et al. (2022). Beyond this, the available literature offers some suggestions on wider macroeconomic implications. For example, the link between the quantity of CO2 emission and the rate of inflation therefore means that the measures for economic policies will have to carefully balance between ecological sustainability and price stability. Vision 2030 strategic alignment underscores the importance of reducing emission levels, which is followed by labor participation, foreign direct investment, and foreign trade openness to ensure a stable economic growth rate while minimizing the inflationary forces (Bilal et al., 2024; Ali et al., 2025).

One of the most commonly used gauges of economic growth is that of the GDP, which has traditionally been linked to an increase in carbon emissions, particularly among fast-developing economies. Both China and India have been very focused on learning the connection between economic growth and increasing CO2. Li et al. 2021 revealed that China's GDP growth is positively sloping to emissions; however, the relationship could be gradually decreasing as China starts to change to renewable energy and cleaner technology. This would lead to the joint proposition that although economic

advancement has led to an increase in carbon emissions in the first instance, there would be a chance that there would be structural changes eventually leading to a decoupling effect. Sahoo and Singh 2018 also confirms on positive relationship between GDP and carbon emissions in India. However, they also argue that the use of renewable energy in India's energy mix can also lead to mitigating this relationship and finding an effective path to decouple economic growth and environmental degradation. These results suggest that sustained reductions in carbon emissions are not yet possible without wide-ranging economic reforms as well as technological improvements.

Another key variable in the carbon emissions is inflation. A general increase in the price level can indirectly have increased abating effects due to its influence on the use of energy. For example, people might expect to pay more for electricity due to inflation, and will respond by increasing the intensity of using certain types of machinery or equipment with more carbon emissions. Although there are several studies that allude to macroeconomic drivers of environmental change, there is little literature on the synthesis of the impact of inflation on carbon emissions in the case of China and India. Chen et al. (2022) note that this gap in the literature constitutes an important research opportunity as inflationary pressures may be complex and of different magnitudes in the environmental sector in countries with rapidly expanding economies.

The shadow economy is another large and important factor that could affect carbon emissions, or more accurately, the underground economy. The concept of shadow economic activities encompasses all unregulated economic processes that are not recorded officially in the national statistics (Schneider, 2022; Modibbo & Saidu, 2023; Wang & Li, 2024; Arshad et al., 2025). Several researchers say that the shadow economy can lead to a high number of carbon emissions because the activities of working in a shadow economy often rely on older, less efficient, and more polluting technologies. Moreover shadow sectors have a low compliance with environmental regulations and thus a disproportionate environmental impact. Because the shadow economy often has a much higher reliance on fossil fuels than the formal one, its expansion adds another threat to carbon mitigation efforts (Willy, 2018; Skhirtladze and Nurboja, 2019; Camara and M, 2022). Understanding this is a crucial element in the desire of policymakers to design climate strategies that consider not only the formal economy, but also the informal economy.

3. DATA AND METHODOLOGY

To meet the objectives of this research, different analytical procedures were used to analyze the relationships between green finance and gross domestic product, inflation, shadow economy, and carbon emissions in India and China. Existing studies exhibit a wide range of methodologies and can be divided into case assessment studies using different structured questionnaires or econometric estimation studies looking into the interaction between policy variables and emissions. These findings collectively suggest that to reduce carbon emissions in high-impact economies like India and China, what is required is a blend of policy interventions and targeted investments, especially in High-impact areas such as green finance and renewable energy initiatives (Hassan et al., 2022; Majid et al., 2023). Evidence from various bodies of literature also shows that multidimensional environmental and financial reforms provide general conditions for sustainable emissions reductions (Chen et al, 2024; Rahman et al, 2021). The reviewed studies suggest that green finance makes a meaningful contribution to reducing carbon emissions in both countries by environmentally aligned financial mechanisms in shifting and directing investment portfolios towards cleaner technologies and energy efficiency programs (Khan et al, 2024; Raza et al, 2022). However, empirical evidence on the link between inflation and emissions is lacking for the case of India and China, and literature on the environmental consequences of the shadow economy is rather limited. This gap calls for more in-depth analysis on the role of informal economy activities and price fluctuation in degrading the environment in a fast-growing economy (Dhar et al., 2023; Ullah et al., 2024). Overall, the collective findings highlight how a successful evolution of policy needs to combine financial, regulatory, and technological dimensions to succeed in achieving the sustainability goal in the long term.

The research uses a regression analytical approach to understand the relationship between carbon dioxide emissions, green finance, shadow economy, inflation, and gross domestic product for China and India. Annual data for the period from 2000 through 2020 were collected from the World Development Indicators and the International Renewable Energy Agency to ensure consistency and comparability between the two economies. The predictive model of consumer price index elasticities includes each independent variable in a logarithmic form for better interpretation and to reduce the frequency of heteroscedasticity (Siddiqui et al, 2022).

An adjusted autoregressive distributed lag (ARDL) model in the spirit of Jordan and Phillips (2018) is used to explore the reactions between the dependent and the independent variables in terms of generating carbon emissions in the short and long run. Before the ARDL estimation is applied, several diagnostic procedures are applied to ascertain the stationarity and variance of the Chinese behavior of each data series, so as to assist in the proper integration order. Non-stationary variables can bias the results of the regression; hence, a unit root test is done at both level and first differencing, level and first difference, respectively, to determine whether each of the variables becomes stationary after the differencing (Iqbal et al., 2023). A variable which shows a unit root at the level but is stationary at 1st difference is treated as integrated of order one, I(1). The ARDL framework allows the inclusion of variables that are I(0) or I(1) and excludes variables that are integrated at order two, I(2), as proposed by Pesaran (2001).

In order to achieve the robustness of the stationarity test, Dickey and Fuller (1979) used the Augmented Dickey-Fuller test to help distinguish between stochastic trends and difference-stationary processes. This procedure makes it clearer whether the series is characterised by a linear stochastic trend or stabilizes following differencing (Khalid et al., 2024). Based on these methodological steps and for the demonstration of the central objective of the study, the following

functional structure of the model is formulated. The following functional structure for the model has been built so that it may effectively demonstrate the primary objective of our research:

$CO_2 = f\ (GF, SE, Inf, GDP)$ *(i)*

By taking the natural logarithm of the variables on both sides, the equation transforms as follows:

$lnCO_{2t} = \beta_0 + \beta_1\ lnGF_{\ t} + \beta_2\ lnSE_t + \beta_3\ lnInf_t + \beta_4\ lnGDP_t + \varepsilon_t$ *(ii)*

Table 1: Variables of the study and their descriptions

Variables	Symbol	Measurement	WDI
CO2 emission	CO2	Metric tons	WDI
Green finance	GF	Green finance in renewable energy projects (Bn US$)	WDI
Shadow economy	SE	MIMIC	WDI
Inflation	INF	Consumer price index	WDI
Gross domestic product	GDP	Per capita (constant US$ 2015)	WDI

Table 1 offers the conceptual basis for the empirical model through operationalization of the relationship between carbon dioxide emissions and the main macrofinancial determinants of these emissions in the context of Asian economies. Carbon dioxide emission is measured in metric tons, and the dependent variable reflects the pressure on the environment generated by energy consumption and economic activity. This measure is in line with global monitoring practices, monitoring the territorial emissions from fossil fuel combustion and industrial processes, offering a similar basis for different countries and periods (Friedlingstein et al., 2020). By using data in World Development Indicators of the World Bank, the study also matches its environmental indicator with commonly used international statistics, which is critical when comparing high-emission and fast-growing Asian economies. For these economies, therefore, the path of carbon dioxide emissions is closely linked with that of structural transformation, industrialization, and energy demand: as shown by empirical research on emerging and developing countries (Emodi, 2019; Hussain & Khan, 2022). In particular, Asian economies such as China, India, and other states undergoing quick economic growth have been viewed as central players in global climate governance given their rising role in global emissions and strategic position in international climate negotiations (Ibrahim & Simian, 2023; Zhang & Wang, 2022). The inclusion of this emissions indicator, therefore, enables the study to assess whether financial, institutional, and macroeconomic channels are playing their role in the decoupling of economic growth from environmental degradation, which is an overriding aim highlighted in global carbon budget assessments and international energy reviews (Global Carbon Atlas, 2019; IEA, 2022).

Green finance is defined as the amount of green finance invested in renewable energy projects in billion United States dollars, and is the central explanatory variable linking the financial system with the results of emission reduction in this model. Conceptually, green finance includes financial instruments, credit line and investments directed explicitly towards environmentally friendly projects, including renewable energy, energy efficiency, and low-carbon infrastructure (Liu et al, 2020). In the context of Asian economies, government-supported green credit schemes, green bond markets, and specific lending to renewable energy projects have emerged as an important mechanism of diverting capital away from carbon-intensive activities and instead channeling it to cleaner technologies (Ren et al., 2020; Wang & Luo, 2021). Empirical studies on China, for example, reveal that green credit policies and green financial reforms can play an important role in achieving carbon emissions reductions by increasing the cost of financing polluting sectors and reducing the cost of capital to firms investing in clean technologies (Wei et al., 2019; Niu et al., 2020). Similarly, the available literature on high-impact economies indicates that there are significant reductions in emissions that are linked to higher levels of green financial depth, which may suggest that green finance can provide an effective policy leverage when coupled with coherent regulatory frameworks (Sharif et al., 2022). The decision to quantify green finance through renewable energy investments is therefore very relevant in that renewable energy capacity additions represent one of the directest and most observable pathways in which green financial flows manifest to reduce dependency on fossil fuels. Evidence from India's experience with green bonds and clean energy finance also makes it all the more clear that well-structured green finance instruments can mobilise investment for solar, wind, and other renewables, while supporting the emission reduction goal without compromising any development goal (Bhanot et al., 2019; Pachauri and Spreng, 2019).

The inclusion of the shadow economy, inflation, and gross domestic product as other explanatory variables reflects a commonly accepted larger perspective that emission dynamics in Asian economies are conditioned not only by formal financial flows but also by informal activities and the stability of macroeconomic conditions, as well as by the level of the economic development process. The shadow economy variable measured with the approach that uses the Multiple Indicators Multiple Causes approach accounts for unregistered or informal economic activity that can either serve as a cover for environmental damage or create incentives for dodging regulation and environmental standards (Schneider, 2022). Studies that have explicitly shone the light onto the size of the shadow economy in relation to environmental outcomes have found that larger informal sectors can be linked to higher carbon dioxide emissions, as firms outside formal regulatory oversight may bypass environmental controls and put less effort into cleaner technologies (Rois et al., 2012; Shi et al., 2019). Recent evidence for economies of Africa and West Africa also suggests that the shadow economy could confuse terms of economic and emission dynamics, implementing formal environmental and fiscal policies (Camara, 2022). Inflation - measured by the consumer price index - is included as a form of macro-economic control, capturing price instability and more general economic conditions which may affect investment decisions, energy affordability, and the cost structure of low-carbon technologies. Persistent inflationary pressures may have real consequences throughout

on long-term investment in green investments and interact with energy prices, giving way to changing incentives for both firms and households to switch to cleaner energy sources (Bilal et al., 2024). Finally, gross domestic product or gross national product per capita in constant United States dollars is the most important index of development, representing a scale and system of economic activity. A substantial amount of empirical studies have concluded that increased incomes are generally accompanied by increased emissions in low stages of development records, yet structural change, technology upgrading, and environmental policies can help diminish or reverse this link (Rahman & Kashem, 2017; Mahapatra & Singh, 2020). Studies on emerging Asian economies such as India, China, and Bangladesh document complex relationships between economic growth and energy consumption and emissions, where industrialization and urbanization, along with policy interventions, determine the compatibility between growth and environmental sustainability (Mishra et al., 2019; Xu and Lin, 2020). By jointly specifying carbon dioxide emissions as a function of green finance, shadow economy, inflation, and gross domestic product, the specification in Table 1 enables the paper to capture both formal and informal, financial and real economy drivers of emissions, which provides nuanced comparative understanding on how Asian economies can mobilize green finance and at the same time address structural constraints that shape the path towards low carbon development.

4. RESULTS AND DISCUSSION

The descriptive statistics and correlation structure that is provided in Table 2 provide important insights into the comparative environmental and financial dynamics of China and India in the theme of the broader question of assessing the role of green finance in reducing emissions among the Asian economies. The mean values reveal that China has higher levels of carbon dioxide emissions compared to India which indicates the more energy intensive industrial structure and the continued reliance on fossil fuels which is in concordance with the previous evaluations reflecting that China has a large carbon footprint and is an economic powerhouse of the world due to its rapid industrialization and expansion of heavy manufacturing industries (Lin et al., 2019; Li et al., 2021). The dispersion measures for the same suggest that the variation in China's emissions is less in comparison to the emissions of India, which implies that the emissions profile of China should be relatively stable and that it is primarily driven by structural factors rather than short-term economic fluctuations. It is a pattern that is consistent with long-run evidence that carbon dioxide emissions in China are strongly linked with persistent characteristics of industrial and energy systems (Xu & Lin, 2020). In comparison, the broader range of variation in India's inflation and the shadow economy points to a larger volatility in the macroeconomic environment that could have an effect on the ability of green finance to provide measurable emission reductions. The skewness and kurtosis value for both economies indicates that the underlying distributions of these economies might exhibit discrepancies from normal distribution, that is, the underlying distributions of the above variables are asymmetrical and peak higher than normal distribution, which often occur in emerging economies because of change in financial variables, macro economic variables and environmental outcomes due to periodical structural reforms and policy changes (Chen et all, 2022; Khan & Hassan, 2019).

The correlation matrix offers additional insight into the behaviour of major determinants vis-à-vis carbon dioxide emission, which shows unique patterns in the two countries. For China, the same positive correlation between carbon dioxide emissions and inflation indicates that periods of price instability could overlap with higher carbon dioxide emissions, and this could be attributed to rising costs of production leading companies into an economic strategy of using cheaper and carbon-intensive fuels (Bilal et al., 2024). The negative link between carbon dioxide emissions and gross domestic product is potentially the first sign of relative decoupling, where economic growth becomes progressively less emission-intensive, which occurs for countries making structural reforms to shift towards cleaner energy systems (Zhao et al., 2022). This possible decoupling complements the national-level policies that are increasingly emphasizing green credit schemes, low carbon investments, and scaling up of renewable energy as a means to lower the growth's environmental footprint (He et al., 2020; Ren et al., 2020). The weak association between green finance and emissions in China may suggest that although green finance has seen an expansion, its magnitude may be still too little to start to decline emissions from established carbon-intensive industries, which is reflected in studies that have argued that it takes green financial mechanisms time and scale to produce a significant impact on the environment (Wang & Luo, 2021; Wei et al., 2019).

In India, the configuration of the correlation structure differs, showing that the correlation between emissions and green finance might be stronger, which would imply a more immediate effect on the country's emission patterns of green financial flows. This relationship is in line with India's growing reliance on green bonds, renewable energy investments, and financial incentives designed towards accelerating the rate of deployment of clean energy technologies (Bhanot et al., 2019; Pachauri & Spreng, 2019). The negative relationship between emissions and shadow economy indicates that informal activity manifests at less direct scales to large-scale industrial emissions, or informal sectors operate on relatively smaller scales with lower energy intensities - even the latter can partially undermine the regulation of environmental protection by evading and non-compliance (Shi et al. 2019; Schneider, 2022). Moreover, a positive correlation between inflation and emissions in India shows that an increase in prices may be accompanied by a higher level of production and consumption of energy, signalling the sensitivity of energy demand in India to wider macroeconomic variables. The near-unity correlation between inflation and gross domestic product, as shown in the descriptive values, suggests the possibility of a high degree of macroeconomic nexus between the dynamics of prices and economic performance, captured in many studies exploring the growth-inflation-energy nexus in India (Mishra et al., 2019; Mahapatra and Singh, 2020). This interdependence implies that macroeconomic stability may be an important precondition for India to fully harness the potential of green finance in managing emissions.

Table 2: Descriptive Statistics and Correlation Matrix

	China	China	China	China	China	India	India	India	India	India
	CO2	GF	SE	Inf	GDP	CO2	GF	SE	inf	GDP
Mean	6.106	2.8232	0.793	2.1851	6.7196	6.1105	2.9202	1.5014	1.9741	1.9741
Medain	2.4215	0.6737	1.8824	7.8189	6.3821	2.7104	1.8013	1.8137	1.8137	0.2628
Std. Dev	0.6163	0.404	0.2968	0.8676	0.0434	0.4243	0.2924	0.2924	-1.3003	1.1624
Skewness	-1.5108	--0.2204	0.1116	0.0319	0.4627	-1.1859	-1.1859	4.1997	5.5468	3.2207
Kurtosis	1.8522	1.943	2.0325	1.7799	2.8337					
CO2					CO2	1.1416				
GF				GF	0.2206	0.8974				0.8723
SE			SE	-1.0121	-0.2634	1.0824			-0.9599	-0.7874
inf		inf	0.3102	-0.2335	-0.2009	0.9929		0.1264	0.0082	0.0755
GDP	GDP	-0.3972	-0.4579	0.3424	0.1234	1.0117	0.1218	0.017	-0.2046	0.0215

Overall, the descriptive and correlation findings show that the interaction of green finance with various economic structures, informal sectors, and macroeconomic environments in China and India existed, which resulted in various implications in terms of carbon dioxide emissions. These results further support the overarching idea that green finance cannot be considered in isolation but should be considered in the context of countries, which are affected by economic structure, policy frameworks, institutional capacity, and population pressures (Zhang and Wang 2022; Ibrahim and Simian 2023). The contrasts between the two economies also highlight the need for differentiated policy approaches: China may need more profound structural reforms to energy systems and more stringent enforcement of regulations to increase the environmental benefits of green finance, while India may benefit from more widespread scaling up of renewable financing mechanisms and improving macroeconomic conditions that will strengthen the level and permanence of the effects of green financial flows. These results support the earlier scholarly findings that even though the occurrence of green finance can be transformative in facilitating emission reductions, it relies highly on how well it is embedded into a broader set of economic, regulatory, and institutional dynamics within each specific country (Sharif et al., 2022; Liu et al., 2020).

The results presented in Table 3 show the order of integration for every variable in China and India and provide the ground-level justification for the use of estimation techniques appropriate for mixed integration properties. The results show that the variables are a mix of stationarity at the level and at first difference for both economies, indicating the rather heterogeneous structures of the macroeconomic and environmental pressures in China and India. For China, a result of "no unit roots" of carbon dioxide emission and green finance indicates that these variables are not subject to unit root issues and are stationary, implying that these variables keep the same stable patterns over time which is in accordance with the evidence that China's environmental and financial measures are commonly observed to have consistent patterns due to the effective institutional supervision and continuity of its policies (He et al., 2020; Ren et al., 2020). Conversely, the shadow economy, inflation, and economic growth are stationary only after the first difference, which is in line with previous empirical studies showing that macroeconomic indicators in China are often evolving upon the structural reform, cyclical adjustment, and long-term growth transition, introducing stochastic trends (Lin et al., 2019; Xu and Lin, 2020). This combination of stationary and non-stationary variables makes it appropriate to apply cointegration-based methods, such as the autoregressive distributed lag modelling, with variables integrated at different orders, as developed by Pesaran et al. (2001), reinforcing the idea that the analytical framework is in line with the established econometric theory.

In the case of the stationarity pattern of India, there also appears diversity with inflation and economic growth as stationary at the level, while carbon dioxide emissions, green finance, and shadow economy are stationary only after the first difference. This is indicative of the greater volatility in the macroeconomy and the institutional transitions, characterizing the Indian economic scene, where inflation and growth numbers have traditionally been sensitive to the fiscal policy, energy prices, and structural constraints (Mishra et al., 2019; Mahapatra & Singh, 2020). First-difference stationarity in carbon dioxide emissions and green finance implies that these variables are changing through long-run trends of industrial development, renewable energy transitions, and financial structures, as these issues were documented in recent analyses of low-carbon development paths in India (Bhanot et al., 2019; Pachauri and Spreng, 2019). The shadow economy in India necessitates also the differencing to ensure stationarity, as has been projected in research papers that there exist persistent efforts of the informal sector responding to regulatory pressures, institutional reforms, and issues of compliance enforcement (Schneider, 2022; Shi et al., 2019). Collectively, the mixed order of integration of both countries confirms the appropriateness of adopting econometric approaches that can accommodate variables with mixed integration of both the level and first difference, and also support the validity of the long-run relationship between green finance, emission, and macroeconomic variables.

Table 3: Unit Root Results

Variables	ADF (China)	ADF (China)	Decision	ADF (India)	ADF (India)	Decision
Variables	At I(0)	At I(1)	Decision	At I(0)	At I(1)	Decision
lnCO2	-6.67776*** (0.0000)	---	I(0)	-1.984095 (0.2906)	-4.379572** (0.0032)	I(1)
lnNF	-2.6358 (0.1026)	-4.6001** (0.0020)	I(1)	-5.3929** (0.0006)	---	I(0)
lnGDP	-0.081870 (0.9383)	-6.517791** (0.0000)	I(1)	-3.543433** (0.0188)	----	I(0)
lnGF	-3.767119** (0.0109)	---	I(0)	-2.210207 (0.2089)	-4.923214** (0.0013)	I(1)
lnSE	-2.514632 (0.1270)	-3.902701** (0.0086)	I(1)	-1.269692 (0.6223)	-5.383852** (0.0005)	I(1)

Note: *,**&*** refer to rejection of the null hypothesis at 10%, 5%, and 1%, respectively.

Table 4, summary of vector autoregressive model lag selection criteria, serves the additional function of identifying the optimal lag structure that is required to include dynamic interaction among the variables by complementing the unit root results. For both China and India, the Akaike Information Criterion, Schwarz Criterion, and Hannan-Quinn Criterion converge to the second lag as the most appropriate specification. This suggests that emissions and what determines emissions are not only driven by current phenomena, but also by previous movements from two periods before, implying

the presence of persistence of time embedded in the function of the macroeconomy and environment. Such persistence is typical in fast-growing Asian economies where policy impacts, energy investments, and financial flows play a role of delayed response due to the weighting of adjustment costs, implementation delay of regulations, as well as structural rigidities (Chen et al., 2022; Zhang & Wang, 2022). For China, the lag structure is consistent with the long-term policies such as green credit guidelines and renewable energy subsidies whose impacts on economic behavior and emission outcomes take time (Wei et al., 2019). In India, the two-period lag may result from inadequately adjusted energy usage, renewable energy penetration, and responses to financial policy tools, corroborating the evidence pointing out that India's energy and financial system adjust more slowly on account of infrastructural constraints and regulatory disintegration (Mahapatra & Singh, 2020; Mishra et al, 2019). The congruence of the lag selection for both countries demonstrates the comparability of dynamic processes that govern emissions, and contributes to the larger goal of assessing the effects of green finance for both Asian economies.

Table 4: VAR lag selection criteria

	China	China	China	India	India	India
Lag	AIC	SC	HQ	AIC	SC	HQ
0.0	-1.7573	-1.8452	-1.7925	-2.5242	-2.0845	-2.2348
0.9863	-6.3653	-4.8869	-5.8788	-8.1554	-5.725	-8.1108
2.2997	-8.3449*	-5.6110*	-7.8823*	-9.1646*	-6.4307*	-8.701*

The diagnostic results in Table 5 show that the estimated models meet important statistical assumptions to ensure the reliability of the empirical results. The Breusch Godfrey test does not indicate the presence of serial correlation in China and India, which is good to get an indication that the error terms are distributed independently of each other and the model covers the structure in the data well. This adds to the robustness of the dynamic specification, as well as implying that omitting dynamic components does not bias the estimates, which is significant in the sensitivity analysis of sensitive environmental and financial variables (Ibrahim and Simian, 2023). The results obtained through the Breusch-Pagan-Godfrey test indicate that there is no heteroskedasticity in both models, i.e., there is no varying variance of the error terms through the models. This stability is associated with a higher level of confidence in the validity of statistical inference, which is congruent with previous empirical studies where energy-environment models are often found to have well-behaved residuals due to the high explanatory power (Liu et al, 2020; Ren et al, 2020). The Jarque-Bera test indicates that the residuals in both cases have a normal distribution, which is another confirmation that the econometric model is valid and hypothesis testing is reliable. Finally, the values of the coefficient of determination show that the model captures more proportion of variation in China in comparison to India which reflects relative superior influence of financial and institutional variables in emissions trajectory in China, which is consistent with a body of literature showing the more immediate effect of China's policy-driven green finance ecosystem (Sharif et al 2022; Zhang & Wang 2022).

Table 5: Diagnostic test

Test	China	India
	F-Statistics (Probability)	F-Statistics (Probability)
Breusch-Godfrey Serial Correlation LM Test	0.1468	0.3277
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.1831	0.6396
Jarque-Bera test	0.9789	0.8121
	China	India
R^2	0.972718	0.794698
Adjusted R^2	0.959076	0.692047

The results in Table 6 give substantial proof about the existence of a long-run equilibrium relationship between carbon dioxide emissions and green finance and between the shadow economy, inflation, and economic growth in both China and India. The F-statistics of both countries considerably exceed the upper critical level of significance for all the different levels of significance, which proves that the variables are cointegrated and that they are moving together toward a stable long-run path. This indicates that the persistent impact of changes in green finance, the macroeconomic indicators, and informal economic activities has a lasting influence on the emission patterns, which is consistent with the earlier studies indicating that financial development, structural reforms, and energy transitions in Asian economies influence the long-run environmental outcome (Liu et al., 2020; Ren et al., 2020). For China, the high F-statistics are consistent with the high institutional strength of the country in ensuring policy continuity, where coordinated policies in terms of green credit, renewable energy subsidies, and industrial regulation generate systematic interactions of long term trends in the financial and environmental variables (He et al., 2020; Xu and Lin, 2020). Similarly, for India, the confirmation of long-run cointegration is in line with evidence indicating that carbon emissions are structurally linked to economic expansion, inflationary dynamics, and financial constraints, especially in an economy that is rapidly increasing investments in renewables and green financial markets but is still beleaguered with systemic barriers (Bhanot et al., 2019; Pachauri & Spreng, 2019). Striking evidence of cointegration in both economies gives credence to the fact that green finance and other macroeconomic factors cannot be studied separately due to their accumulation and interaction over time and thereby

supports the broader argument that long-run environmental planning in Asian economies needs to combine financial sector reforms with economic and institutional restructuring (Zhang & Wang, 2022; Sharif et al., 2022).

Table 6: Bound test for cointegration

Test Statistics	China	China	India	India
F Statistics	10.0073	10.1401	9.5583	9.5443
Number of Independent variables-k	3.6539	4.4551	4.3024	4.5207
Critical Values (%)	Lower bound	Upper bound	Lower bound	Upper bound
0.8714	3.5662	4.2285	2.97	4.4284
4.7998	2.2996	3.4406	2.6535	3.6485
10.9568	2.1386	2.7958	2.1171	3.0036

The long-run findings shown in Table 7 help to further shed light on the different pathways in which these relationships play out in China and India, thus revealing different channels through which the financial and macroeconomic variables have an effect on emissions. For China, the positive association with temperature implies that inflation may lead to further environmental stress due to an increase in costs of production and more dependence on cheaper and carbon-intensive fuels, which is consistent with economic studies that have even observed inflationary cycles to be associated with higher energy consumption in developing economies (Bilal et al. 2024). The negative long-run effect of economic growth on emissions is of particular interest, suggesting a possible transition to relative decoupling in the growth model in China. This finding is consistent with previous evidence that China's structural transformation (signaled by the decline in the shares of heavy industries and the rise in investments in renewable energy) may be slowly decreasing the emission intensity of its economy (Lin et al., 2019; Li et al., 2021). The lack of a significant long-run impact of green finance indicates that even as China's green finance ecosystem grows, the transformation of green finance on emissions could take time to scale, consistent with the call for estimations of substantial carbon reductions arising only when financial reforms become established and ingrained (Wei et al., 2019; Wang & Luo, 2021). The shadow economy's statistically insignificant coefficient also harmonizes with studies that find that China's informal economy works on smaller scales and has weaker significance on national-level emission trends than formal heavy industries (Shi et al., 2019; Schneider, 2022).

Table 7: Long-run estimates of ARDL

Dependent Variable: CO2 emissions					
China	China	China	India	India	India
Variable	Coefficient	P-value	Variable	Coefficient	P-value
lnINF	0.271	0.0058	lnINF	0.1231	0.0092
lnGDP	-0.4569	0.0108	lnGDP	0.0747	0.4718
lnGF	0.0668	0.3439	lnGF	0.0932	0.0243
lnSE	-0.7442	0.7085	lnSE	-4.2307	0.0001
C	11.9275	0.0112	C	21.0248	0.0

In contrast, the results of the longer-run results in India point to a very different configuration. Inflation also has a persistent positive long-run impact on emissions, which is a positive feedback loop in terms of similar mechanisms as in the case of China, but in the volatile macroeconomic environment in India, inflation may also dampen investment in clean technologies, strengthening the carbon-intensive production structure (Mishra et al., 2019; Mahapatra & Singh, 2020). The lack of a substantial long-run effect of economic growth on emissions implies that growth in India is still closely coupled with energy consumption and industrial growth without any evidence of decoupling. This is consistent with the finding that India's economic structure, with its fast pace of urbanisation and manufacturing sectors, continues to be heavily dependent on fossil fuels despite the gains made by renewable energy sources (Chen et al., 2022; Xu & Lin, 2020). Green finance becomes an important long-run emission reduction effort in line with India's growing dependence on green bonds and renewable energy financing schemes, which have become key instruments to scale up solar and wind power investments (Bhanot et al., 2019; Pachauri & Spreng, 2019). The most striking is the strong negative long-run relationship between the shadow economy and emissions, implying that there is a possibility of informal economic activities in India being less carbon-intensive than the activities of the formal sector. This finding is consistent with the previous studies that suggest India's informal sector is highly concentrated in small-scale services and low technology industries, which have a low fossil fuel dependence (Schneider, 2022; Rois et al., 2012). The difference between China and India on this point demonstrates the importance of structural and institutional factors in determining the environmental implications of the informal economy, which corroborates the general arguments that it is not the size of informal economies but their composition that influences their indigenous environmental footprint across nations (Shi et al, 2019; Camara, 2022).

Overall, cointegration and long-run estimates clearly show that although both countries have stable long-term relationships between green finance, macroeconomic drivers, and emissions, the mechanisms governing the manifestation of these relationships are quite different. China's long-run emission characteristics are determined more by structural transformation and macroeconomic stability, whereas India's emission characteristics are more determined by financial development, features of the informal sector, and inflationary characteristics. These distinctions underpin the need for differentiated green finance strategies, which should be adopted for a range of Asian economies, based on their structural conditions and institutional capacities, as similar to what has been chosen to be compared, in this regard, between China and India (Zhang & Wang, 2022; Ibrahim & Simian, 2023).

The results in the short run in Table 8 are how changes in inflation, economic growth, green finance, and the shadow economy have immediate impacts on carbon dioxide emissions in China and India, and how short-run dynamics are different from long-run equilibrium relationships found earlier in the paper. For China, the positive and highly significant effect of inflation on emissions in the short run implies that short-run price increases prompt firms and households to make adjustments to patterns of energy consumption in ways that intensify carbon output. This is consistent with empirical studies finding that a particular source of technological change, short-run cost pressures in emerging economies, tends to cause producers to shift to cheaper, carbon-intensive fuels, particularly when there are high up-front costs associated with clean energy alternatives (Bilal et al., 2024; He et al., 2020). The negative and significant effect of the lagged inflation term implies that once the short-term volatility stabilizes, emissions adjust downwards, which is evidence of a correction mechanism in the Chinese economy. This behavior is not out of line with the regulatory structure in China, in which short-run fluctuations tend to be followed by policy initiatives, designed to stabilize energy demand and reduce environmental damage (Lin et al., 2019; Ren et al., 2020).

The short series behavior of economic growth in China: an interesting dual behavior: the contemporaneous term is not very strong and is only marginally significant, while the lagged term has a strong positive influence on the emissions. This means that short-term economic growth does not significantly increase emissions, but the impacts take a long time to kick in and represent the time lag to build up industrial output and energy consumption. This delayed response is consistent with previous work indicating that China's production cycles and energy consumption patterns work through staggered adjustments between industrial processes, gradually adjusting in response to changes in economic conditions (Li et al, 2021; Xu & Lin, 2020). Green finance, despite being at the heart of long-run environmental planning, does not depict a large impact on emissions in China in the short run, indicating that the environmental impact of financial instruments such as green credit or renewable energy financing is only realized over time and not through an immediate change of behavior. Studies emphasize the fact that the green financial interventions generally have a long gestation period related to infrastructure development, technology implementation, and industrial accommodations in order to generate measurable emission reductions (Wang and Luo 2021; Wei et al. 2019). The error correction term for China is negative and highly significant, confirming high levels of short-run convergence to long-run equilibrium, in line with the possibility of dynamic adjustment mechanisms that are observed in policy-driven economies with rather rapid responses of regulatory bodies and market error corrections (Ibrahim & Simian, 2023).

A comparison of the results of the short run in India to those of China is quite contrasting because of the difference in economic structure, institutional capacity, and the characteristics of the energy system. Inflation has a negative and significant impact on emissions, which is the opposite of China's positive relationship. This means that the inflationary conditions in India have the potential to reduce industrial output and energy demand in the short run, leading to a temporary reduction in emissions. Similar patterns have also been seen in research that indicates that inflation in India has often been accompanied by a reduction in the purchasing power, energy rationing, and constrained industrial functioning, which have led to short-term reductions in fossil fuel consumption (Mishra et al., 2019; Mahapatra & Singh, 2020). Economic growth has very little effect on emissions in India in the first few years, indicating that short-run fluctuations in GDP do not have direct impacts on energy consumption levels, which may reflect a structural rigidity in the Indian energy market and reliance on long term energy contracts.

Green finance is a notable blemish on its long-run behaviour: In the short run, green finance has a positive and significant impact on emissions in India. This phenomenon, which has often been described as a transitional effect, happens when the initial green investment leads to growing industrial activities, infrastructure development, or installation processes of renewables, which leads to temporary emission growth before creating environmental benefits in the long run (Pachauri & Spreng, 2019; Bhanot et al., 2019). Such transitional dynamics are well-documented in economies that are in the process of large-scale renewable energy expansion, where manufacturing, construction, and supply chain activities increase carbon output for a short while before settling down. The lack of significance for the lagged green finance term means that this effect is not a persistent but instantaneous one.

The shadow economy is mixed short run in India. The contemporaneous term is not significant, while the lagged term has a strong positive effect on emissions, picking up informal sector expansion has had a delaying effect on environmental consequences. This corroborates studies that recognize the fact that India's informal sector often undertakes unregulated manufacturing, transport, and energy-associated activities that generate emissions and go ungoverned (Schneider, 2022; Shi et al., 2019). The delay effect could be due to reporting lags, gradual intensification of informal production, or spillovers to formal supply chains. The relatively high importance of the error correction term implies that India self-corrects quickly towards its long-run equilibrium, more strongly in fact than China, reflecting the high sensitivity of emissions to departures from macroeconomic and financial conditions.

Overall, the short-run estimates of the ARDL show that in China, the short-run emission dynamics are mainly shaped by delayed growth edge and instant inflationary pressures, while in India, the short-run emissions are shaped by the

transitional effect of green finance, inflation-induced demand changes, and lagged activities of the informal sector. These are important differences in explaining the necessity of establishing country-specific green finance policies where temporal adjustment patterns, macroeconomic volatility, and structural features particular to the economy are considered (Zhang & Wang, 2022; Chen et al., 2022).

Table 8: Short-run estimates of ARDL

Dependent Variable: CO2 emissions					
China (2,2,2,1,0)	China (2,2,2,1,0)	China (2,2,2,1,0)	India (1,1,1,2,2)	India (1,1,1,2,2)	India (1,1,1,2,2)
Variable	Coefficient	P-value	Variable	Coefficient	P-value
D(lnINF)	0.0357	0.0011	D(lnINF)	-0.0692	0.0181
D(lnINF(-1))	-0.0243	0.0078	D(lnGDP)	-0.0016	0.9015
D(lnGDP)	0.0158	0.0961	D(lnGF)	0.0291	0.032
D(lnGF)	0.0039	0.3468	D(lnGF(-1))	-0.0205	0.121
D(lnGDP(-1))	0.0891	0.0037	D(lnSE)	-0.6977	0.1287
CointEq(-1)	-0.2654	0.0	D(lnSE(-1))	2.1384	0.0051
			CointEq(-1)	-0.5868	0.0

5. CONCLUSION

This study offers a better understanding of the behavior of carbon emissions over different time horizons in India and China, two major developing economies with similar energy challenges but with differing responses to some of the key economic and financial factors. The results illustrate that the forces affecting emissions are not uniform across countries in the long run and the short run. In the long run, inflation is responsible for increases in emissions in both economies: this reflects the complexity of the interaction between price levels and industrial growth and energy use. Economic growth has an inconsistent impact on emissions, which may decrease in one setting and stay the same in the other, suggesting that the structure of the economy and the rate of development may be important factors in determining environmental outcomes. Green finance and informal economic activities are also showing different impacts, which highlights the importance of policies being context-specific for countries as well, depending on their institutional capacity and development priorities. In the short term, there is a different response of carbon emissions to changes in economic indicators. In one country, emission trends in the past, economic growth, and inflation give support to current emission levels, showing how persistent the energy demand resulting from growth is. Conversely, money feeding the fire, inflation is linked to falling emissions in the other country, and the importance of green finance and informal economic activities change, making the trajectory of relations between financial development and market structures, on the one hand, and their impact on the environment, on the other hand, more complicated. These opposite results show that countries need to go forward and address their environmental policy with a clear knowledge of the functioning of economic and financial variables over time, which is different for each country. Technological capacity, social conditions, and institutional frameworks more broadly facilitate the fate of the environment of both of these countries. One country has more space to reduce emissions through green finance and technology innovation, and the other country has structural challenges, such as a lack of infrastructure and socio-economic disparity, which constrain its ability to pursue low-carbon pathways. Despite these differences, in their efforts to develop innovative systems to promote environmentally responsible investment, there is much that both countries have in common, including improving the readiness of industry and labour forces to adapt to new technologies. The results indicate the need to develop integrated policy frameworks that will ensure that financial development is made compatible with environmental objectives, spurring the development of renewable energy sources and attempting to control inflationary pressures that might affect patterns of energy consumption. Policies to facilitate the formalization of the informal markets, to stimulate green investments, and to reduce the economic dependence on carbon-intensive activities can contribute to the transition of both countries to long-term economic sustainability. Future research would benefit from looking at specific emission sources and evaluating sector-focused environmental policies and social and economic drivers for energy use. International collaboration is important because working globally together can enhance efforts at home and contribute to better climate mitigation strategies.

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