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Environmental Performance and Renewable Resources: The Impact on Economic Growth in the Emerging and Developing Economies

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Abstract: This study investigates the impacts of environmental performance measured by CO_2 emission from industrial processes and renewable capacity measured by electricity production from renewable sources excluding hydroelectric on economic growth in emerging and developing economies. The analysis uses time-series data over the period 2000–2025 and three World Bank aggregates based on historical series of income levels (low, lower-middle, and upper-middle). Foreign direct investment inflows, trade openness, urbanization, and in an original way, the country policy and institutional assessment (CPIA) index—as a proxy for the quality of the institutional and business environment—were included as control variables. The results show that the growth effects of environmental performance, renewable capacity, and institutional quality differ markedly across income levels. Growth persistence emerges only in upper-middle-income economies, whereas in low- and lower-middle-income aggregates growth does not depend significantly on its previous levels. Carbon intensity from industrial processes is positively and significantly associated with growth only in the lower-middle-income group, indicating that carbon-based industrial production still fuels expansion at intermediate development stages. Renewable capacity does not exert significant growth effects in any group. Trade openness promotes growth in lower-middle- and upper-middle-income economies but not in low-income ones, foreign direct investment inflows are never significant, and urbanization hinders growth in the upper-middle-income group, where the CPIA index is marginally growth-enhancing. Overall, the findings confirm that the growth-environment nexus is strongly conditioned by income levels and institutional contexts. Growth remains carbon-dependent at lower-middle income levels, renewables do not deliver growth dividends, and sound institutions and openness support growth only beyond certain development thresholds. Decarbonization should therefore be paired with structural reforms, institutional strengthening, and staged integration into global markets to foster sustainable and inclusive growth.

Keywords: sustainable development; growth; governance

JEL Codes: O44; Q43; Q56

1. Introduction

After decades of slow progress in tackling the environmental concerns globally, some significant progress in the fight against climate change has recently been made, both technologically—with the advancement of renewable technologies—and societally.

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Sustainable development has become pivotal in the global agenda [1,2], extending well beyond environmental issues, increasingly encompassing inclusive growth and institutions [3], to the purpose of reducing social inequalities and increasing the efficient use of resources by 2030 [4]. Achieving the Sustainable Development Goals (SDGs) requires a deeper understanding of how environmental concerns, economic initiatives, and countries' governance climate impact on the transition toward green and sustainable development.

Emerging and developing economies stand out due to their growth potential [5]. However, this potential is often shadowed by unsound governance fostering indiscriminate resource exploitation and environmental degradation. In this socioeconomic systems, rethinking development trajectories around the principles of sustainable and inclusive growth has become extremely important [6]. This means that sustainable development refers not only to increases in economic growth but also to the preservation of environmental boundaries, improvements in social welfare, and a balanced use of resources [7].

Inclusive growth also refers to the equitable distribution of these resources across all societal stakeholders [8]. In light of this, the study aims to empirically investigate the structural factors affecting per-capita growth in emerging and developing economies in relation to environmental performance and renewable resources.

According to the ecological modernization theory, industrial and economic systems may bring environmental concerns and economic growth [9–11]. This theory views environmental concerns as strictly intertwined with economic and societal issues, highlighting how policy efforts, innovation, and sound institutions can contribute to the sustainable development of countries.

This means that economic actors can be more resource-efficient through the adoption of environmental-friendly policies. Nevertheless, green investments and environmental regulations may initially impose costs, however, they can improve productivity and competitiveness over time [12]. Therefore, the effectiveness of this multiplier in emerging and developing countries depends on the simultaneous presence of technical capacity, institutional quality, and access to credit [13].

The effects of renewable resource use, carbon-related environmental performance indicators, foreign direct investment (FDI) inflows, trade openness, urbanization, and the quality of institutional and business environments on economic growth are tested in this study.

By considering these control variables ensure that both environmental and economic dimensions are caught, providing an insightful perspective for assessing green growth dynamics within the sustainable development framework.

The study considers the CO_2 emissions from industrial processes as a proxy for the efficiency in manufacturing systems. In original way, it also considers the country policy and institutional assessment (CPIA) index as a proxy for the quality of institutional and business environments.

In emerging and developing economies, growth may be achieved through polluted productions when economic systems lack updated technologies and adequate institutional capacities to lead sustainable development, prioritizing short-term gains at the expense of long-term purposes [14]. Therefore, carbon intensity is a meaningful indicator to assess the trade-off between development and environmental performance, especially in many emerging and developing economies, where structural adjustment programs are often incomplete [15–18].

The study also considers the pivotal role of FDI inflows and trade openness in shaping per-capita growth. While trade openness is expected to promote growth, the direction and magnitude of its effect often vary across emerging and developing economies based on structural and institutional conditions [19].

Mechanisms such as liberalization, technology spillovers, and foreign capital inflows may stimulate economic growth but can also cause risks related to resource endowment, income inequality, and exposure to external shocks [20,21].

The panel data covers the period 2000–2025, affected by the Great Recession in 2008–2009 and by the pandemic shock of COVID-19 in 2020–2023, and the recent wars that reshaped the geoeconomic and geopolitical landscape over the latest period 2024–2025.

Emerging and developing countries were clustered by income levels in low, lower-middle, and upper-middle economies. However, within each cluster, the countries' classification can vary in the years in accordance with the World Bank Group's historical series. Please, refer to the dedicated WB's historical classification by income: https://ddh-openapi.worldbank.org/resources/DR0095334/download.

Despite this issue, studying these three income-group series is informative because they can provide a consistent representation of the progress made by countries in their development-paths over time, while ensuring a certain homogeneity within them. As far as is known, this approach can be considered a novelty in studies. Finally, the estimation strategy adopted has used ARIMAX (1,1) models, suitable for analysis with time-series data.

The remainder of the work is structured as follows: Section 2 provides a literature background and research hypotheses; Section 3 details variables, estimation strategy, and functional form; Section 4 presents and discusses

the empirical outcomes; and Section 5 reports concluding remarks and contribution, policy implications, limitations, and suggestions for future research directions.

2. Literature Background and Research Hypotheses

The environmental sustainability of growth in lower-income economies should require more attention [22–24], as the Sustainable Development Goals signed in 2015 explicitly encompassed climate action and emissions reduction. The macroeconomic dynamics and digital transformation in emerging and developing economies can be shaped by their institutional and business environments. In light of this, "green growth" may represent the most suitable pathway towards sustainable development.

Growth theory offers two competing accounts of the fundamental drivers of long-term output. In the neoclassical model, output is explained by capital accumulation and exogenous technological progress [25]. In endogenous models, growth is instead driven by internal forces, such as human capital formation and knowledge capital accumulation [26–28]. The evidence broadly supported this viewpoint and attributed a crucial role to human and knowledge capital in cross-country growth performance [29–32]. Therefore, the following research hypothesis was tested.

H1. *In emerging and developing economies, to what extent does growth depend on its previous levels, which summarize the human, knowledge, and physical capital accumulation?*

The evidence suggests that long-term income convergence tends to be unsustainable in resource-based economies that lack adequate sources of capital, generating only weak inclusive wealth creation [33]. The variable that matters for sustainability is thus not the pace of accumulation per se, but its composition between reproducible physical capital and intangible assets.

Neo-institutional theories assign a decisive role to property rights and the rule of law [34–38], which appear particularly important for understanding structural adjustment in emerging and developing economies [39].

A broad body of literature suggests that sound governance, quality institutions, and better business environments foster growth, reducing poverty over time, both within and across countries [40–47]. Within this framework, the Country Policy and Institutional Assessment (CPIA) constitutes a suitable synthetic proxy for the quality of governance and the institutional and business environment, summarizing with equal weights the quality of institutions, economic policies, structural and social reforms [48]. In accordance with this analytical framework, the following research hypothesis was tested:

H2. *Is the quality of governance and institutions, proxied by the CPIA score, positively associated with sustainable growth in emerging and developing economies?*

Evidence suggests that institutions can condition not only outcomes but also the feasible policies. Achieving the SDGs requires policymakers to choose among feasible policies under existing constraints [49,50].

For instance, in the short-term, focused fiscal policy and effective regulatory frameworks appear to be the most readily implementable instruments, as they can be enacted through rapid institutional decisions and arrangements [51,52].

Therefore, the institutional quality operates both as a direct driver of long-run sustainable growth and as a precondition for effective short-term policy action.

Recent geopolitical tensions have heightened national security concerns and reinforced the need for an energy transition towards sustainable development, enhancing renewable resource capacity [53,54]. The recent literature converges on renewable energy as the fundamental variable through which growth and decarbonization may be reconciled [55]. Overall, the evidence suggests that renewables improve environmental performance in developing and emerging economies, resulting in decisive policies supporting them [56,57]. Greater energy intensity appears to push emissions upwards, whereas using renewables reduces them in the long-term [58,59], which suggests that decarbonization does not follow automatically from the expansion of output. Furthermore, renewables are found to promote growth, while fossil fuels prove detrimental to it [60,61].

Renewable capacity, green innovation, and institutional quality appear to act jointly in supporting long-term green growth [62], and the energy transition is reported to reduce emissions while simultaneously supporting growth [63]. Obviously, endowment conditions can moderate this relationship [64], and the trade-off between growth and environmental sustainability can be mediated by foreign investment [65]. Therefore, this assumption reflects in the following research hypothesis:

H3. *Does renewable capacity, especially from the use of removable resources reducing CO_2 emissions, support rather than hinder economic growth in emerging and developing economies?*

Additionally, in the environmental studies, some considerations can be traced with reference to the efficiency of indicators [66–68]. This directly leads to the following research hypothesis:

H4. *Does carbon intensity impact growth, especially in economies where it depends on carbon-based industrial processes?*

Finally, a relationship between openness, foreign investment inflows, and economic growth can be traced. The empirical literature returns heterogeneous results. For instance, a bidirectional causality between foreign investment and economic growth has been found [69]. A sound institutional and business environment has been found to be a decisive driver of growth [70].

However, foreign investment inflows may hinder growth in low-income economies while yielding positive outcomes in high-income ones [71]. Additionally, openness can promote development in emerging and developing economies, but excessively low trade barriers may reverse this relationship and generate negative effects [72]. For instance, increased openness has positively contributed to growth across the BRICS [73]. Furthermore, urbanization can foster productivity gains by expanding productive sectors and improving labor productivity [10], but the growth impact is strictly linked to factors such as infrastructural investment, governance quality, and market efficiency [11], as indiscriminate urban expansion may hinder sustainable development.

These patterns suggest that openness, foreign investment, and urbanization should be considered as variables whose effects are conditioned by context [74]. Consequently, this assumption leads to the last research hypothesis:

H5. *How do trade openness, foreign direct investment inflows, and urbanization process impact growth in emerging and developing economies, conditioned by the countries' institutional and business environments?*

Concluding, the evidence suggests that the environmental performance and economic growth relationship is affected by the income levels and institutional quality of countries and that carbon intensity by industrial processes can be an effective indicator of environmental efficiency when growth depends on carbon-dependent production structures [75].

3. Variables, Estimation Strategy, and Functional Form

By using a panel dataset over the period 2000–2025, it adequately considers the transitory shocks, such as the Great Recession, the global pandemic, and recent war shocks. This latter caused a significant contraction of GDP growth in most of the countries, as well as a reduction of global CO_2 emissions, FDI inflows, and global trade [76,77].

The analysis focuses on growth, proxied by real per-capita GDP, and environmental efficiency of production systems, captured through carbon-dioxide intensity. Data source is the World Development Indicators (WDIs) database.

The dependent variable is the real per-capita GDP. Control variables are: (i) trade openness, (ii) FDI inflows, (iii) carbon intensity from industrial processes, (iv) renewable capacity measured as electricity production from renewable sources excluding hydroelectric, and (v) the country policy and institutional assessment (CPIA) index as a proxy for the quality of institutional and business environment.

A discussion on control variables follows. It is noteworthy that the environmental series for low- and lower-middle-income economies are among the weakest in the WDIs dataset. A critical issue regarding the measurement of CO_2 emissions in many low- and lower-middle-income economies is that these can be estimated based on apparent fuel consumption in energy balances that are themselves partly modeled and gap-filled [78–80]. In this study, instead, the CO_2 emission from the manufacturing industry was used.

This provided a measure of annual emissions by industrial processes according to the standards defined by the Emissions Database for Global Atmospheric Research (EDGAR) and the Joint Research Centre (JRC), with data updated to 2024. Global greenhouse gas emissions are currently not directly measurable, but reliable approaches for their estimation exist in literature [81]. The estimated accuracy from fossil fuel combustion and industrial processes is quite high, as quantities of fossil fuels and other emissive materials, such as cement and steel, produced are well-known. For these sectors, emissions estimates are roughly accurate to within 10% when aggregated to the global level and in a range of 4–35% at the country level, while for non-combustion and non-industrial process emissions, the accuracy can be lower.

Another concern affecting the low-income group regards the renewable energy consumption. It consists overwhelmingly of traditional solid biomass—such as fuelwood, charcoal, and dung—which is rather CO_2 intensive and with consumption that is rarely measured directly. As disposable incomes rise, households move from the consumption of these unconventional renewable resources to use the more conventional fossil energy and grid electricity. As a result, the renewable energy consumption falls [82,83]. This is also known in the literature as the "energy ladder effect".

Therefore, to adequately consider the effect of renewable capacity, the electricity production from non-hydro renewable resources was used as an effective proxy variable. This measure accounts for electricity production from renewable sources, excluding hydroelectric, but includes geothermal, solar, tides, wind, biomass, and biofuels.

The International Energy Agency (IEA) compiles data on energy inputs used to generate electricity. IEA data for countries that are not members of the Organization for Economic Cooperation and Development (OECD) are based on national energy data adjusted to conform to annual questionnaires completed by OECD member governments. In addition, estimates are sometimes made to complete major aggregates from which key data are missing, and adjustments are made to compensate for differences in definitions. In other words, the IEA makes these estimates in consultation with national statistical offices, oil companies, electric utilities, and national energy experts. The latest released data are in 2025. Additionally, the IEA occasionally revises its time series to reflect political changes. In recent years, energy statistics have also undergone continuous changes in coverage or methodology, as more detailed energy accounts have become available.

Overall, renewable capacity is essential for reducing greenhouse gas emissions and contrasting climate change. They help decrease dependence on fossil resources and enhance energy security, as well as price stability. The sector also drives economic growth by creating jobs and attracting investment. Technological advancements in renewables can support manufacturing innovation in storage, smart grids, and infrastructural capital. These resources can also improve energy access in urban and suburban areas, ultimately fostering sustainable socioeconomic development. For instance, Marzi et al. [1] reveals that, among the possible global shared pathways, the one characterized by high emissions and socioeconomic fragmentation forecasts significant increases in exposure to natural disasters, such as droughts or floods, pandemics, and conflicts.

Therefore, governance in emerging and developing economies should dedicate more attention to environmental issues and sustainable growth in development policies [84,85]. The integration of SDGs with the use of innovative technologies in creating ecosystems that are feasible and socially responsible can be a smart way to respond to global changes and challenges [86]. On the one hand, firms may reduce waste and emissions, optimizing resources and enhancing their organizational efficiency. Innovation technology may strengthen supply chain management by improving adaptability to market uncertainty and failures, as well as changing customer habits. Studies highlight that sustainable growth is a prerequisite for a successful transition toward renewables, while reducing carbon-dioxide emissions requires socioeconomic-enhancing structural reforms rather than reliance on productivity gains alone [87,88]. As a result, domestic investment and trade policies should prioritize the absorptive capacity of countries, including urban expansion planning, and pay more attention to institutional and business environment quality to foster sustainable development and environmental performance [2,89].

Similarly, global value chains operate as adaptive socio-technical systems shaped by uncertainty and interdependence. In other words, they are complex systems with rapid transformations across organizational, technological, and societal domains. Recent global crises and environmental challenges have emphasized the necessity for resilient and accountable global value chains to better adapt to changing contextual and global conditions through coordinated and systemic responses [90,91]. As a result, governing these socio-technical systems can require policies integrating business purposes with sustainable operational decisions.

Sustainability goal becomes an important economic growth purpose, along with environmental performance, corporate social responsibility, ethical decision-making, and a long-term view [92]. This means that understanding the different dimensions of development is pivotal and requires comprehensive and system-integration oriented managerial frameworks to effectively grasp the global complexity, market trade-offs, and system-wide impacts [93]. Innovation in operational tasks and management practices, especially with attention to ecosystems, is crucial in enabling resilient and sustainable global value chains focused on reducing environmental impacts and responding to societal issues [94]. For instance, studies highlight the pivotal role of transformative technologies in promoting business growth, especially emphasizing improvements in supply chain management, operational efficiency, and cost reduction [95–97]. Other studies also recognize the capacity to recombine knowledge in a novel way for sustainable growth goals, generating productivity gains and innovation opportunities in product and business models [98–100].

Therefore, incentivizing policies and regulations can accelerate the overall growth effects [52,101,102], and recent evidence suggests that the adoption of transformative technologies may be positively associated with the

firms' sustainable growth and improved environmental performance [103–106]. However, it is necessary that firms in developing and emerging economies characterized by a lack of institutional quality, governance, and digital infrastructure operate effectively [107–109]. In such contexts, accelerating digital transformation and foreign investments may significantly improve market transparency and facilitate cross-border operations, but their economic benefits depend on countries' institutional quality and macroeconomic conditions [86,110].

Finally, as the World Bank publishes CPIA scores since 2005, the missing values from 2000 to 2004 in the series were obtained using those in 2005. Sound policies and quality institutions lead, over time, to favorable sustained growth and poverty reduction outcomes. The CPIA measures the extent to which a country's policy and institutional framework supports sustainable growth and poverty reduction, and consequently the effective use of development assistance. The CPIA scores yield both an overall score and scores for all the sixteen criteria that compose the CPIA. Additionally, the CPIA scores help to determine the relative size of aids to low-income countries, provided by the International Development Association (IDA) under advantageous conditional terms with significant grace periods, long repayments, and low interest rates.

The summary of the variables and their correlations are reported in Tables 1 and 2, respectively. The estimation strategy has employed ARIMAX (1,1) models. This means that the dependent variable enters the models with one order of lags and all variables enter in first difference to prevent non-stationary processes and to limit multicollinearity among regressors. Especially, one order of lags for the dependent variable is significant in showing the persistent effects of growth. The following functional form in implementing models was used:

$$\Delta GDPper = f(\Delta GDPper_{t-1}, \Delta Carbon, \Delta Renew, \Delta Openness, \Delta FDI, \Delta Urban, \Delta CPIA, d_Shocks).$$

For per-capita GDP (GDPper), the PPP was considered to account for the different price levels across countries, allowing for more suitable comparisons of both economic outputs of emerging and developing economies and the average material well-being of their residents than exchange-rate based measurements. All variables are expressed as logarithms. In addition, to prevent data with negative values in the Renew series, the following transformation was used: $\ln[x_i - \text{Min(series)} + 1] + 1$. d_Shocks is a binary dummy variable to prevent shocks caused by the Great Recession, the COVID-19 pandemic, and conflict effects. Finally, only 5.5% of the data of the whole sample was estimated, resulting in a panel reliability of 94.5%. The statistical software used in the analysis is the latest released version of the open-source package gretl.

Table 1. Main descriptive statistics and descriptions of the variables.

Variables	Main Statistics			Descriptions and Codes
	μ	σ_w	σ_b	
GDPper	6732	3704	5724	Gross domestic product divided by midyear population. (PPP current international USD, WDI-WB: NY.GDP.PCAP.PP.CD)
Carbon	606.1	264.4	813.1	Annual CO_2 emissions from industrial processes. (Mt CO_2 eq, WDI-WB: EN.GHG.CO_2.IP.MT.CE.AR5)
Renew	2.887	2.644	2.119	Electricity production from renewable sources, excluding hydroelectric. (% of total electricity production, WDI-WB: EG.ELC.RNWX.ZS)
Openness	49.05	5.329	2.441	Sum of exports and imports of goods and services. (% GDP, WDI-WB: NE.TRD.GNFS.ZS)
FDI	2.525	0.716	0.815	Net inflows in the reporting economy from foreign investors. (% GDP, WDI-WB: BX.KLT.DINV.WD.GD.ZS)
Urban	43.07	4.481	14.78	People living in urban areas. (% of population, WDI-WB: SP.URB.TOTL.IN.ZS)
CPIA	2.969	0.120	0.508	Index measuring the extent to which a country's governance supports growth. (range 1–6, WDI-WB: IQ.CPA.PROP.XQ)
d_Shocks	0.308	0.471	0.000	Binary dummy for 2008–2009 and 2020–2025 periods. (0, 1)

Note: non-differenced variables.

Table 2. Correlation matrix.

	GDPper	Carbon	Renew	Openness	FDI	Urban
GDPper	1.000					
Carbon	0.917 ***	1.000				
Renew	0.865 ***	0.672 ***	1.000			
Openness	0.914 ***	0.188 **	−0.105	1.000		
FDI	−0.468 ***	−0.287 **	−0.572 ***	0.385 ***	1.000	
Urban	0.920 ***	0.989 ***	0.685 ***	0.225 **	−0.265 **	1.000
CPIA	0.778 ***	0.915 ***	0.502 ***	0.264 **	−0.273 **	0.906 ***

Note: (***) significance at $\alpha = 0.01$; (**) significance at $\alpha = 0.05$; non-differenced variables.

4. Outcomes and Discussion

In Table 3, results from models show that growth persistence, summarized by the lagged dependent variable $GDPper_{t-1}$, is significant only in the upper-middle-income group (0.714, significant at $\alpha = 0.01$), while it is positive but insignificant in the low- (0.238) and lower-middle-income (0.153) aggregates. This evidence partially supports H1, suggesting that only in relatively more advanced emerging and developing economies does growth depend on its previous levels, in accordance with growth theory attributing a crucial role to the cumulative human, knowledge, and physical capital [25–27,29,32].

In poorer aggregates, instead, capital accumulation may still be insufficient to generate self-sustaining growth paths, as long-term income convergence tends to be unsustainable in resource-based economies lacking adequate sources of capital [33], and transitory shocks, such as the Great Recession, the pandemic, and recent conflicts, may have repeatedly interrupted growth episodes [76,77].

Carbon intensity (Carbon) from industrial processes is positively and significantly associated with growth only in the lower-middle-income group (0.328, significant at $\alpha = 0.01$), while it is insignificant in the low- (−0.109) and upper-middle-income (0.055) aggregates. This result supports H4 and suggests that, at intermediate development stages, growth still relies on carbon-based industrial processes, in line with studies arguing that polluted productions drive expansion when economic systems lack updated technologies and adequate institutional capacities to lead sustainable development [14–18,75].

The insignificant coefficient of the low-income group may reflect the limited weight of industrial processes in economies largely based on subsistence activities and traditional biomass [82,83], whereas in the upper-middle-income aggregate the ongoing structural transformation towards more efficient and less carbon-intensive productions, together with the measurement caveats of emission series discussed in Section 3, may have weakened the link between carbon intensity and growth [81].

Renewable capacity (Renew), measured by electricity production from renewable sources excluding hydroelectric, returns negative but insignificant coefficients in all the aggregates (−0.021, −0.003, and −0.064, respectively), thus H3 is not supported by the data. This evidence suggests that non-hydro renewable capacity does not exert significant short-term growth effects in emerging and developing economies, in accordance with the literature stating that decarbonization does not follow automatically from the expansion of output [58–60]. Rather, renewables appear to support growth jointly with green innovation and institutional quality [62], while the energy transition may reduce emissions and simultaneously sustain growth only under enabling endowment and institutional conditions [63,64]. In the low-income group, the prevalence of traditional solid biomass in renewable consumption, which is rarely measured directly and is rather carbon-intensive, may further blur the growth effects of the series [82,83], while transition costs, grid constraints, and the still-limited share of non-hydro renewables may offset the productivity gains of new installations in the middle-income aggregates [54,56].

Trade openness (Openness) is positively associated with growth in the lower-middle- (0.118, significant at $\alpha = 0.05$) and upper-middle-income (0.223, significant at $\alpha = 0.01$) groups, while it is insignificant in the low-income one (0.051), thus providing support to H5. This pattern confirms that the direction and magnitude of the openness effect are conditioned by structural and institutional conditions [19,21], as increased openness has positively contributed to growth across the BRICS [73], while excessively low trade barriers may reverse this relationship and generate negative effects in weaker contexts [72].

Foreign direct investment inflows (FDI) are never significant, in accordance with the heterogeneous evidence on the investments-growth nexus, whose benefits materialize only in the presence of adequate absorptive capacity and sound institutional and business environments [5,30,31,69–71].

Urbanization (Urban) is negatively and significantly associated with growth in the upper-middle-income group (−1.791, significant at $\alpha = 0.01$), suggesting that indiscriminate urban expansion may hinder sustainable development when infrastructural investment, governance quality, and market efficiency lag behind [10,11], while it is insignificant in the other aggregates, although this result may be partly driven by the weight of the largest economies within the group, notably China.

The CPIA index (CPIA) is positive and marginally significant only in the upper-middle-income group (0.445, significant at $\alpha = 0.10$), thereby providing partial support to H2. This evidence suggests that the quality of governance and institutions operates as a direct driver of growth only beyond a certain development threshold, in line with neo-institutional theories assigning a decisive role to property rights and the rule of law [34–36,38,47], and with the CPIA constituting a suitable synthetic proxy for the quality of institutions, economic policies, and structural and social reforms [3,48,74]. In low- and lower-middle-income aggregates, institutions may instead condition the feasibility of policies rather than directly stimulating growth [49,50].

It is also underlined that the shock dummy is negative and marginally significant in the upper-middle-income group (−0.024, significant at α = 0.10), confirming the temporary growth contractions caused by the Great Recession, the COVID-19 pandemic, and recent conflicts [1,21,76,77], while the positive and significant constants across all the aggregates suggest a baseline growth trend in emerging and developing economies.

Table 3. The ARIMAX (1,1) models estimated.

	Low Income	**Lower-Middle Income**	**Upper-Middle Income**
		ΔGDPper	
$\Delta GDPper_{t-1}$	0.238	0.153	0.714 ***
	(0.256)	(0.318)	(0.146)
ΔCarbon	−0.109	0.328 ***	0.055
	(0.119)	(0.099)	(0.119)
ΔRenew	−0.021	−0.003	−0.064
	(0.019)	(0.011)	(0.044)
ΔOpenness	0.051	0.118 **	0.223 ***
	(0.082)	(0.049)	(0.066)
ΔFDI	−0.015	0.012	−0.028
	(0.025)	(0.018)	(0.021)
ΔUrban	−0.427	−2.913	−1.791 ***
	(0.366)	(2.656)	(0.589)
ΔCPIA	−0.078	−0.702	0.445 *
	(0.310)	(0.606)	(0.260)
d_Shocks	−0.011	0.007	−0.024 *
	(0.014)	(0.010)	(0.013)
Constant	0.052 ***	0.077 **	0.098 ***
	(0.010)	(0.033)	(0.017)
Standard error	0.028	0.025	0.029
Log-likelihood	59.158	68.499	68.539
$VIF_i < 10.0$	yes	yes	yes
|AR-root 1| > 1.0	4.202	6.525	1.401
Normality-test for residuals	2.155	0.606	0.203
(*p*-value)	(0.340)	(0.739)	(0.904)
Autocorrelation LM-test (13)	14.519	12.108	8.118
(*p*-value)	(0.269)	(0.437)	(0.776)
ARCH Effects-test (11)	8.282	10.327	9.995
(*p*-value)	(0.688)	(0.501)	(0.531)
No. of Observations	25.00	25.00	25.00
R-squared	0.295	0.603	0.731

Note: (***) significance at $\alpha = 0.01$; (**) significance at $\alpha = 0.05$; (*) significance at $\alpha = 0.10$. The nulls of the diagnostic tests are for the normality-test: the error is normally distributed; the autocorrelation LM-test: there is no autocorrelation up to order (*n*); the ARCH effects-test: there are no ARCH effects of order (*n*).

Finally, the explanatory power of the estimated ARIMAX (1,1) specifications rises with the income level of the aggregates, as the R-squared increases from 0.295 in the low-income group to 0.603 in the lower-middle-income and 0.731 in the upper-middle-income group. All the models pass the diagnostic tests, as the nulls of the normality-test, of no autocorrelation up to order thirteen, and of no ARCH effects of order eleven are never rejected at conventional levels, the variance inflation factors remain below the critical threshold of ten, and the AR roots exceed unity in modulus, supporting stable specifications.

5. Conclusions

5.1. Concluding Remarks and Contribution

In an original way the study has employed ARIMAX (1,1) models on three World Bank aggregates of emerging and developing economies, clustered by historical income levels over the period 2000–2025, jointly considering carbon-dioxide emissions from industrial processes as a proxy for the environmental efficiency of production systems, electricity production from non-hydro renewable sources as a measure of renewable capacity, and the Country Policy and Institutional Assessment (CPIA) index as a synthetic proxy for the quality of the institutional and business environment. As far as is known, the combination of these variables with the income-based clustering of countries, which ensures a certain homogeneity within the groups while consistently representing their development paths over time, represents a novelty in the literature on the growth-environment nexus.

The study has examined the determinants of economic growth in emerging and developing economies over the period 2000–2025, reconnecting discussions on the previous identified research hypotheses, and revealing that the effects of the examined variables are strongly conditioned by the income levels of the countries.

The growth persistence hypothesized in H1 emerges only in upper-middle-income economies, where accumulated human, knowledge, and physical capital sustain self-reinforcing growth dynamics, while it remains insignificant in poorer aggregates. The institutional quality proxied by the CPIA score (H2) is marginally growth-enhancing only in the upper-middle-income group, suggesting that governance acts as a direct driver of growth beyond certain development thresholds. Renewable capacity (H3) does not exert significant growth effects in any group, indicating that the growth dividend of non-hydro renewables is not automatic and may require complementary green innovation and enabling institutions. Carbon intensity from industrial processes (H4) is significantly and positively associated with growth only in the lower-middle-income aggregate, confirming that carbon-based production still fuels expansion at intermediate development stages. Finally, trade openness, foreign direct investment inflows, and urbanization (H5) display heterogeneous and context-dependent effects, as openness promotes growth in the middle-income groups, foreign investment is neutral, and urbanization hinders growth in the upper-middle-income economies.

5.2. Policy Implications

First, since carbon intensity from industrial processes remains a significant engine of growth in lower-middle-income economies, abrupt decarbonization policies may harm their development trajectories. Environmental regulation should therefore be paired with compensating structural measures, such as technology transfer, green industrial policies, and incentives for energy and resource efficiency, following the logic that well-designed environmental policies may improve productivity and competitiveness over time [12,14,15,17,75].

Second, the absence of significant growth effects of renewable capacity suggests that renewable expansion should not be promoted in isolation. Investments in non-hydro renewables should be integrated with green innovation, storage, smart grids, and infrastructural capital, as well as with sound institutions, to unlock their joint growth and decarbonization potential [53,54,62,63].

Third, the marginal growth dividend of the CPIA in the upper-middle-income group indicates that strengthening governance quality, property rights, and business environments is a long-term investment that pays off beyond certain development thresholds. Reform efforts should therefore be persisted in, as sound policies and quality institutions lead, over time, to favorable sustained growth and poverty reduction outcomes [34,36,40,43,48].

Fourth, trade openness promotes growth in the middle-income aggregates, suggesting that further integration into global value chains may support development, provided that domestic absorptive capacity and institutional quality are strengthened [73,90,91]. Low-income economies, instead, require supply-capacity building and infrastructural investment before the dividends of liberalization can materialize [21,72]. Similarly, foreign direct investment should be attracted together with policies enhancing human capital and financial development, as its benefits depend on absorptive capacity [5,30,31].

Finally, the negative growth effect of urbanization in the upper-middle-income group calls for urban expansion planning, infrastructural investment, and improved governance to capture agglomeration benefits while contrasting congestion and environmental degradation [10,11]. As global shared pathways characterized by high emissions and socioeconomic fragmentation forecast significant increases in exposure to natural disasters, pandemics, and conflicts, building resilient and adaptive socioeconomic systems should complement growth-oriented policies [1,2].

5.3. Limitations and Suggestions for Research

Among the study's limitations, it should be noted that while clustering countries based on their annual income level can ensure a certain degree of homogeneity within the groups, such aggregation also has the effect of eliminating country-level unobserved heterogeneity, which thereby remains unmodeled.

Furthermore, it is noteworthy that the environmental series for low- and lower-middle-income economies are among the weakest in the WDIs dataset, as also highlighted in Section 3. It is also noteworthy that China accounts for much of GDP growth in the upper-middle-income group. Consequently, most of the results for this group of economies must be referred to it.

Further research may also employ other types of models suited to addressing heterogeneity in panel data, such as the Common Correlated Effects Mean Group (CCE-MG), the Augmented Mean Group (AMG), and CS-ARDL, respectively developed by Pesaran [111] and Eberhardt and Bond [112], and Chudik e Pesaran [113].

Finally, addressing these concerns effectively would require estimating the models on country-level data, also expanding the set of variables capturing the influence of external and internal factors on economic growth. Alternatively, a consistent regional framework may be used to adequately consider subregional-specific growth

effects, for instance following a geographical aggregation, as one adopted by the International Monetary Fund (IMF), or adopting the Generalized Method of Moments (GMM) models.

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Conflicts of Interest

The author declares no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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