THE IMPACT OF ECONOMIC GROWTH, FOREIGN DIRECT INVESTMENT, AND ENERGY ON CLIMATE CHANGE IN WEST AFRICA

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Abstract

This paper examines the relationship between economic growth, foreign direct investment (FDI), energy consumption, and carbon emissions in West Africa, testing the Environmental Kuznets Curve (EKC) hypothesis. Employing panel data from 16 countries over the period 1990–2023, the study utilizes the Pooled Mean Group (PMG) estimator within the panel ARDL model to differentiate short-term dynamics from long-term relationships. The findings support the EKC hypothesis, demonstrating that carbon emissions initially increase with economic growth but decline after reaching a certain threshold. Energy consumption is identified as the primary driver of emissions, exhibiting significant positive effects in both the short and long term. Conversely, FDI appears to have no significant long-term influence, indicating that foreign investment does not facilitate environmental improvement under current conditions. The error correction mechanism suggests a stable long-run adjustment process. These results emphasize the importance of transitioning to renewable energy sources and enhancing environmental regulations to promote sustainable development.

Keywords:economic growth, FDI, energy consumption, carbon emissions, EKC, West Africa

1. Introduction

Global warming and climate change, primarily driven by rapid economic development and escalating energy consumption, have led to widespread environmental disturbances. In response, international frameworks such as the Paris Agreement and the United Nations 2030 Agenda for Sustainable Development have been established to limit the rise in global temperatures to below 2 degrees Celsius above pre-industrial levels. Nonetheless, current projections suggest that, without substantial mitigation initiatives, global temperatures could increase by as much as 5.8 degrees Celsius by 2100 (IPCC), thereby posing significant environmental and economic risks, including potential GDP reductions of 5 to 20 percent risks, including potential GDP losses of 5–20 percent(Acheampong et al., 2019).

West Africa, home to over 400 million people, is experiencing rapid economic expansion, population growth, and urbanization (Asiedu et al., 2021). Although the region contributes only about 0.6 percent of global carbon emissions, its share within Africa has risen significantly, reaching approximately 15 percent by 2023, (IEA, 2024).

This growth is largely driven by heavy reliance on fossil fuels, industrial activities, and increasing energy demand in countries such as Nigeria, Ghana, and Senegal. As illustrated in Figure 1, both absolute emissions and West Africa's share of continental emissions have risen steadily, underscoring the tension between economic development and environmental sustainability.

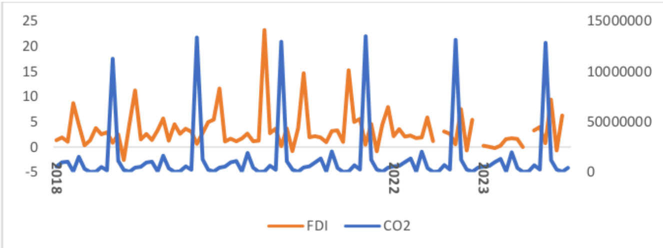

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Figure 1. Trends in Carbon Emissions and FDI Inflows in West Africa (2018–2023)

The region's developmental trajectory is further shaped by highly volatile foreign direct investment (FDI). As depicted in Figure 1, FDI inflows into West Africa exhibit significant instability, rising sharply to a peak of over 55 percent of total African FDI in 2022, followed by a drastic collapse to under 9 percent in 2023. This volatility highlights the region's vulnerability to global economic fluctuations and internal structural limitations. The environmental implications of such investment inflows are complex and contingent on regulatory quality and sectoral allocation. FDI can spur industrial expansion and employment Chen et al. (2024), yet it also risks aggravating carbon emissions if directed toward pollution-intensive activities under weak environmental governance (Omri et al., 2014). Conversely, the Pollution Halo hypothesis posits that FDI may facilitate the transfer of cleaner technologies and enhance energy efficiency, according toZhou et al. (2020),a prospect that remains inadequately examined in the West African context.

Concurrently, energy consumption, a fundamental driver of carbon emissions,has risen steadily, surpassing 920 kWh per capita by 2021, predominantly met through fossil fuels. This pattern underscores the region's continued dependence on carbon-intensive energy and its lagging adoption of renewables (Bhattacharya et al., 2017; Gielen et al., 2019). The observed trends in West Africa appear inconsistent with the Environmental Kuznets Curve (EKC), which anticipates a decline in emissions beyond a certain income level (Grossman & Krueger, 1991). Instead, as in other developing regions, emissions continue to scale with economic growth (Al-Mulali & Ozturk, 2015; Aslan et al., 2021), highlighting the limitations of universal theoretical models and necessitating context-specific inquiry.

Given West Africa's modest but expanding carbon footprint,coupled with erratic investment flows and rising energy demand, critical questions emerge regarding the sustainability of its current development paradigm. It is uncertain whether economic growth and FDI inflows conform to the EKC hypothesis or instead intensify environmental degradation. This study seeks to address this gap by empirically examining the dynamic interrelationships between economic growth, foreign direct investment, energy consumption, and carbon emissions in West Africa, while assessing the applicability of the EKC framework in the region.

The research offers dual contributions. Theoretically, it enriches the environmental economics literature by interrogating underexplored regional dynamics and challenging the generalizability of the EKC. Practically, it provides evidence-based guidance for policymakers aiming to reconcile economic advancement with sustainability, identifying feasible pathways to decarbonize without stifling development.

2. Literature Review

The EKC hypothesis has become the dominant framework for analyzing growth and environmental dynamics. It proposes that environmental degradation initially rises with income but eventually declines, producing an inverted U-shaped relationship (Grossman & Krueger, 1991). At low levels of development, growth drives energy use and emissions through the scale effect. As income rises, structural transformation bringsa composition effect, while higher income also enables cleaner technologies and stronger regulations,the technique effect (Dinda, 2004; Stern & I., 2004). However, critics argue that the EKC is not universally applicable. For pollutants such ascarbon, which accumulate and have long-term effects, the idea that growth alone will eventually reduce emissions may be unrealistic (Arrow et al., 1995). Moreover, some declines observed in advanced economies may result from the relocation of polluting industries abroad, raising questions about the Pollution Haven Hypothesis.(Copeland & Taylor, 2004).

Furthermore, the relationship between economic growth and carbon emissions is particularly important in developing regions. Growth spurs energy demand for transportation, infrastructure, and industry, which in many cases depends on fossil fuels. Without policy intervention, this creates a risk of carbon lock-in, where economies become structurally tied to high-emission pathways (Stern & I., 2004). In West Africa, where growth is often resource-based, the scale effect tends to dominate, and weak environmental institutions limit the potential for decoupling growth from emissions (Avenyo & Tregenna, 2022). Consequently, economic growth in the region may intensify rather than alleviate environmental degradation.

Moreover, FDI introduces another dimension to the debate over emissions. According to the Pollution Haven Hypothesis, multinational firms may shift their polluting activities to countries with weaker regulations(Huang et al., 2022; Khan et al., 2023). However, the alternative Pollution Halo effect suggests that FDI can also bring cleaner technologies, management practices, and capital that improve efficiency and reduce emissions (Adom et al., 2019). The direction of impact depends heavily on hostcountry conditions, including institutional strength and regulatory enforcement. In West Africa, where enforcement remains weak, the net environmental effects of FDI are ambiguous, making empirical investigation essential (Owusu et al., 2023; Wang et al., 2023).

In addition, energy consumption is the most direct determinant of emissions. Nearly all economic activity requires energy, and fossil fuels still dominate the energy mix in most developing countries. This makes energy use closely tied to rising emissions (Dinda, 2004). However, the EKC suggests that a shift to renewables and cleaner energy can eventually reduce carbon intensity. For West Africa, achieving such a transition remains constrained by financial, technological, and infrastructural barriers (IEA, 2023). Nevertheless, experiences from other regions show that diversifying the energy mix can reconcile growth with environmental sustainability.

On the empirical side, studies examining the nexus among growth, emissions, FDI, and energy consumption yield mixed results. Several confirm that economic growth initially raises emissions, though some suggest a turning point in the long run (Baajike et al., 2022). Similarly, while some studies find that FDI worsens emissions consistent with the Pollution Haven Hypothesis, others find that it reduces emissions in line with the Halo effect (Acheampong, 2018; Adom et al., 2019). Energy–growth relationships are also inconclusive, with different studies finding unidirectional, bidirectional, or no causal links (Omri et al., 2014; Singh & Kaur, 2022). However, many of these studies use static or bivariate models that fail to adequately capture non-stationarity, dynamic interdependence, or cross-country heterogeneity, raising doubts about their robustness.(Apergis et al., 2018).

Consequently, while existing literature offers important insights, it leaves unresolved the applicability of the EKC and the role of FDI and energy use in the West African context. The region's dependence on fossil fuels, volatile investment flows, and weak regulatory systems creates dynamics that remain underexplored. Addressing these gaps requires a methodological approach that can capture both short-run adjustments and long-run equilibrium relationships.

Therefore, this study employs a panel ARDL framework to investigate the dynamic interrelationships among economic growth, FDI, energy consumption, and carbon emissions in West Africa. This method accounts for mixed integration orders and heterogeneity across countries, while distinguishing between short-run and long-run effects. The research thus makes two main contributions: theoretically, it tests the generalizability of the EKC in a region where evidence is scarce, and practically, it provides policy-relevant insights on how to balance growth with sustainability.

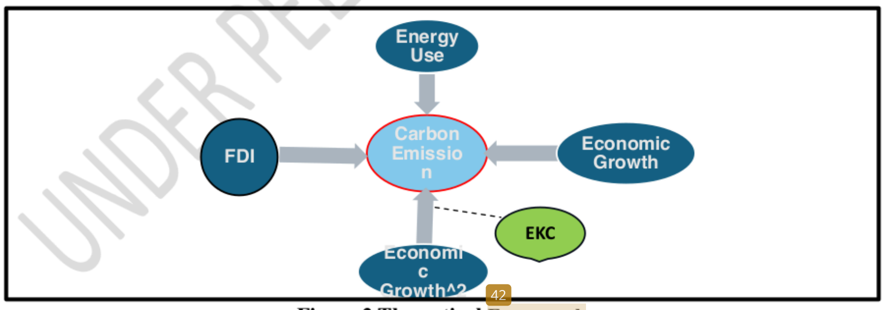


Figure 2.Theoretical Framework

The conceptual framework presented in Figure 2 serves as the guide for this study. Itconsiders carbon emissions as a function of economic growth, FDI, and energy consumption, with GDP squared included to test for an EKC effect. Based on this, the following expectations are set: growth is hypothesized to influence emissions; the growth–emissions relationship is expected to follow an inverted U-shape; FDI is anticipated to have a significant impact, although the direction remains uncertain; and energy consumption is expected to increase emissions.

3. Research Method

The analysis relies on balanced panel data covering 16 countries over the period 1990–2023, a timeframe that captures profound economic transformations, increasing globalization, and evolving environmental challenges in the region. Data were obtained from the Our World in Data database, ensuring reliability and comparability across countries. To stabilize variance and address heteroscedasticity, all variablesexcept FDIwere transformed into their natural logarithms, a widely accepted econometric practice (Gujarati & Porter, 2010).

Furthermore, the variablescapture both economic and environmental dynamics. Carbon emissions (LCO2), expressed in total metric tons, serve as the dependent variable and reflect environmental degradation. Economic growth is measured by GDP per capita (PPP, constant 2021 international dollars), while its squared term (LGDP2) is included to test the nonlinear relationship proposed by the Environmental Kuznets Curve (EKC). To avoid multicollinearity, GDP per capita was mean-centered before squaring, following the approach of Enders & Tofighi (2007). FDI is measured as net inflows as a percentage of GDP, representing international capital flows and possible technology transfer. Energy consumption, expressed in kilowatthours per capita (LEC), captures industrial and economic activity.

Moreover, to model both short-run dynamics and long-run equilibrium effects, the study employs the Panel Autoregressive Distributed Lag (ARDL) framework, estimated using the Pooled Mean Group (PMG) estimator (Pesaran et al., 1999). This approach is particularly suited for regional studies, as it allows short-run heterogeneity across countries while assuming homogeneity in the long-run relationships, an appropriate assumption for West African economies that share structural characteristics and face similar environmental pressures. The functional form of the model is expressed as:

$$\Delta lnCO2_{it} = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta lnCO2_{t-i} + \sum_{i=0}^{p} \alpha_2 \Delta lnGDP_{t-i} + \sum_{i=0}^{p} \alpha_3 \Delta lnGDP_{t-i}^2 + \sum_{i=0}^{p} \alpha_4 \Delta FDI_{t-i} + \sum_{i=0}^{p} \alpha_5 \Delta lnEC_{t-i} + \gamma_1 lnCO2_{t-1} + \gamma_2 lnGDP_{t-1} + \gamma_3 lnGDP_{t-i}^2 + \gamma_4 FDI_{t-1} + \gamma_5 lnEC_{t-1} + \varepsilon_t \quad (1)$$

where i denotes the country and t the year. The ARDL error correction representation further captures deviations from the long-run equilibrium and the speed of adjustment following short-run shocks.

In addition, the estimation procedure followed a structured approach to ensure robustness. First, descriptive statistics and correlation analysis were conducted to summarize the data and identify potential multicollinearity. Next, Pesaran's CD test was used to detect cross-sectional dependence, while unit root tests, such as the ADF and IPS, confirmed that the series were not integrated of order two, thereby validating the suitability of the ARDL approach. Optimal lag lengths were then selected using the Akaike Information Criterion (AIC), ensuring a parsimonious specification. To confirm the existence of cointegration, the Pesaran et al.

(2001)bounds testing procedure was applied. Once established, the PMG estimator was employed to generate both long-run coefficients and short-run adjustment dynamics.

However, estimating the model is only meaningful if it is stable and free from econometric flaws. To this end, a range of diagnostic and stability tests were conducted. These included the BreuschGodfrey LM test for serial correlation, the BreuschPaganGodfrey test for heteroscedasticity, and the JarqueBera test for normality of residuals. Model stability was further assessedto confirm whether the estimated coefficients remain stable over time.

The hypotheses of the study were tested directly through the estimated coefficients. The relationship between economic growth and emissions (H1) is supported if GDP is statistically significant. The EKC hypothesis holds if GDP enters positively while its square enters negatively, suggesting an inverted U-shaped pattern. The effect of FDI is assessed by the sign of its coefficient: a positive sign indicates support for the Pollution Haven Hypothesis, while a negative sign suggests a Pollution Halo effect. The impact of energy consumption is validated if the coefficient of LEC is positive and significant. Crucially, the significance and negativity of the error correction term further confirm the presence of a stable long-run relationship and the speed at which deviations are corrected. The methodology used integrates robust econometric tools, theoretically grounded variables, and rigorous diagnostic testing to ensure that the findings provide credible insights into the interplay of growth, FDI, energy use, and carbon emissions in West Africa.

4.Results and Discussion

4.1 Descriptive Statistics

Table1. Descriptive Statistics (1990–2023)

Variable	*Mean*	*Median*	*Max*	*Min*	*Std. Dev.*	*Obs.*
LCO_2	6.3286	6.2688	8.1306	5.1767	0.6623	490
LGDP	3.4494	3.4237	3.9596	2.7282	0.2172	490
$LGDP^2$	11.9453	11.7219	15.6784	7.4431	1.4960	490
LEC	0.9949	0.9744	2.7354	–0.4636	0.6490	490
FDI	3.9129	1.5287	167.33	–202.82	16.5604	490

Source: Estimated Results, 2025.

The descriptive statistics reveal important features of the dataset. Carbon emissions appear relatively stable across West Africa, averaging 6.33 (log units) with moderate variation, largely influenced by differences in industrial activity, energy structures, and environmental regulation. GDP per capita averages 3.45, reflecting modest but uneven economic progress across countries, while its squared term exhibits greater variability, underscoring its nonlinear role in testing the Environmental Kuznets Curve (EKC). Energy consumption exhibits considerable heterogeneity, ranging from –0.46 to 2.73, indicating divergent national energy use patterns influenced by infrastructure and resource availability. Foreign direct investment (FDI) is the most volatile variable, with negative flows signaling capital flight in some years and unusually high inflows linked to large-scale projects in others. These dynamics underscore the heterogeneity of the region and justify the application of robust econometric techniques such as panel ARDL to capture both short-run and long-run relationships.

4.2 Preliminary Data and Model Diagnostics

4.2.1 Unit Root and Cross-Sectional Dependence

Stationarity was tested using the Pesaran et al. (2001) CIPS panel unit root test, which accounts for crosssectional dependence. Results indicate that the variables are integrated of mixed orders, I(0) and I(1), but none are I(2), meeting the requirements for panel ARDL estimation.

Table 2. Unit Root Test Results (CIPS)

Variable	*Level Stat*	*Decision*	*First Difference*	*Decision*
GDP	–1.108	Nonstationary	–2.867	Stationary I(1)
FDI	–2.084	Nonstationary	–3.415	Stationary I(1)
Energy	–3.178	Stationary I(0)	—	—
CO_2	–2.976	Stationary I(0)	—	—

Source: Estimated Results, 2025.

Cross-sectional dependence (Pesaran CD test) was significant, reinforcing the appropriateness of PMG, which allows heterogeneous short-run dynamics but assumes homogeneous long-run equilibrium relationships.

4.2.2 Classical Assumption Tests

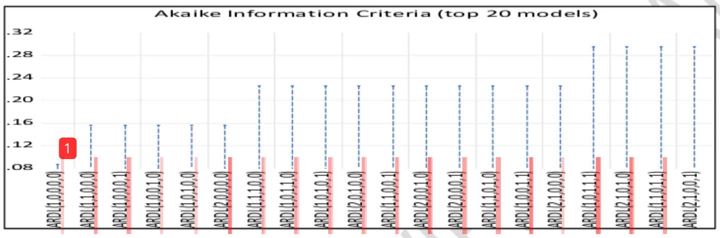
Table 3. Classical Assumption Tests

Normality Test		**Heteroscedasticity Test** *Fixed Effect Model (Panel Least Squares, White Robust SE)*		**Autocorrelation**	
JarqueBera	Prob.	Adjusted RSquared	Prob (FStat)	Coefficient on the remaining residual	Prob (FStat)
121.4292	0.0000	0.9948	0.0000	0.0046)	0.9228
	Multicollinearity Test				
	R_Sq	**VIF**	**Interpretation**		
FDI	0.0132	1.013376119	NoMulticollinearity		
PDRB	0.585863	2.414657057	Mild Multicollinearity		
LEC	0.367675	1.581465672	No Multicollinearity		
LGDP2	0.408282	1.689993937	No Multicollinearity		

Source: Estimated Results, 2025.

The diagnostic tests confirm that the classical assumptions of the regression model are broadly satisfied, ensuring the reliability of the estimated results. As shown in table 4.3, the Jarque–Bera test indicates minor deviations from normality, but these are acceptable in large panel samples and further addressed with White robust standard errors. Heteroskedasticity concerns are mitigated through robust estimation, while the Variance Inflation Factor (VIF) values remain well below the critical threshold, confirming the absence of serious multicollinearity. Moreover, the Durbin–Watson statistic of approximately 2.02, together with the high probability value from the residual test, demonstrates that autocorrelation is not an issue. Collectively, these results strengthen confidence in the robustness of the ARDL–PMG framework applied in this study.

Following the diagnostic checks, the optimal lag structure was determined using the Akaike Information Criterion (AIC). As reported in figure 4.1, the preferred specification is PMG–ARDL (2,1,0,1,0), which balances shortrun dynamics and longrun stability without overfitting.



Source: EViews output

Figure3. lag optimum criteria

Finally, the Kao panel cointegration test confirms the existence of a stable longrun relationship among carbon emissions, GDP, GDP², energy consumption, and FDI. The Augmented DickeyFuller statistic (t = −2.58, p = 0.0049) is significant at the 1% level, rejecting the null hypothesis of no cointegration. These findings, which can be presented in table 4.4, provide strong justification for applying the panel ARDL model to capture both equilibrium adjustment and dynamic shortrun interactions.

Table 4. Cointegration test (Kao)

	tStatistic	Prob.
ADF	2.58324	0.004894
Residual variance	0.00237	
HAC variance	0.002086	

Source: EViews output

4.3 ARDL Estimation Results

4.3.1 LongRun Effects (PMG Estimator)

Table 5. ARDL–PMG LongRun and ShortRun Results

Variable	LongRun Coeff.	pvalue	ShortRun Coeff.	pvalue
LGDP	–0.606***	0.0000	0.367**	0.036

$LGDP^2$	−2.571***	0.0000	—	—
LEC	1.041***	0.0000	0.271***	0.0001
FDI	0.0097	0.151	—	—
ECT	—	—	−0.126***	0.0000

*Note: *** p<0.01, ** p<0.05*

Source: EViews output

4.3.2 Discussion of Findings

The ARDLPMG estimation, selected via the Akaike Information Criterion PMG (2,1,0,1,0), provides strong evidence of both short and longrun dynamics of emissions in West Africa. The results confirm the Environmental Kuznets Curve (EKC) hypothesis, with GDP (−0.606, p = 0.0000) and GDP^2 (−2.571, p = 0.0000) both negative and significant, indicating an invertedU relationship where growth initially increases emissions but reduces them beyond a certain income threshold. This finding is consistent with Grossman et al. (1994), Panayotou (1993), and Dinda (2004), though it contrasts with Acheampong (2018), who found limited EKC evidence in SubSaharan Africa due to persistent reliance on polluting energy sources.

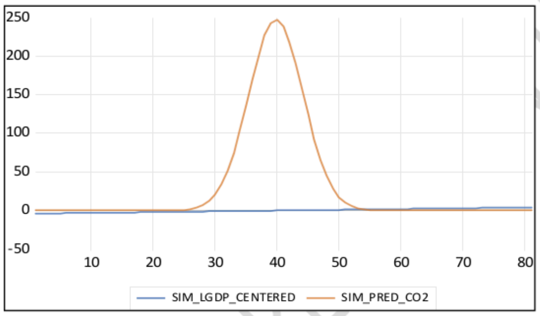
Energy consumption is the strongest driver of emissions, with longrun elasticity close to unity (1.041, p = 0.0000) and a positive shortrun effect (0.271, p = 0.0001). These results align with Shahbaz et al. (2013), who highlight energy use as the main emissions driver in developing economies, but diverge from findings in advanced regions where energy efficiency and renewables mitigate such impacts (Ang et al., 2007).

By contrast, foreign direct investment (FDI) shows no significant effect (0.0097, p = 0.1506), implying a neutral or mixed role. This differs from Pao & Tsai (2011), who report a pollutionhaven effect in Asia, but supports Omri et al. (2014), who argue that FDI's impact depends on hostcountry institutions, environmental policies, and sectoral composition. In West Africa, the mixed nature of FDI inflows likely cancels out any consistent long-term effect.

The error correction term (−0.126, p = 0.0000) indicates that about 12.6% of disequilibria are corrected annually, confirming stable longrun adjustment, consistent with findings by (Apergis & Payne, 2010). Shortrun results further reveal that growth still exerts upward pressure on emissions (0.367, p = 0.036), echoing Halicioglu (2009) and Stern (2004), who highlight transitional costs before structural transformation reduces environmental stress. Meanwhile, the lagged dependent variable is insignificant, suggesting weak short-term inertia in emissions, likely due to volatility in energy supply, policy responses, or external shocks.

4.3.3 EKC Visualization

The visual validation of the Environmental Kuznets Curve (EKC) is presented in Figure 4.1, which simulates the longrun relationship between carbon emissions (LCO2) and economic growth (LGDP) using coefficients from the ARDLPMG model. The simulation, constructed in EViews with centered GDP values and their squared term, predicts log emissions which are then exponentiated to actualemission levels for clearer interpretation. The curve displays a distinct invertedU shape: at lower income levels, emissions rise sharply with growth, reflecting the early development phase characterized by fossil fuel dependence, weak regulation, and energyintensive industrialization. The curve reaches a turning point near the midpoint of the simulation, after which further growth correlates with declining emissions, signaling a transition toward cleaner technologies, stronger policies, and more efficient resource use. The use of anti-log transformation emphasizes the steepness of the peak and the relatively lower emissions on either end, enhancing the realism of the results for policy interpretation. Overall, this visual pattern strongly reinforces the statistical evidence for the EKC in West Africa, underscoring that with structural transformation and targeted policy measures, economic growth can eventually align with environmental improvement and sustainable development pathways.



Source: Author's Compilation

Figure 4. Simulated Environmental Kuznets Curve for West Africa

4.4 Robustness and Model Stability

Robustness checks (residual diagnostics, MG estimates, and Pedroni cointegration test) confirm the stability of results. Despite Hausman test favoring MG, PMG was chosen as the preferred estimator, consistent with regional economic realities and the EKC literature.

5. Conclusion and Recommendation

This study reaches several important conclusions. First, the relationship between economic growth and carbon emissions in West Africa follows an invertedU shape, thereby confirming the Environmental Kuznets Curve (EKC). Second, energy consumption is the most influential factor driving emissions, with increases in energy use directly linked to higher carbon output both in the short and long run. Third, foreign direct investment (FDI) does not exert a significant longrun impact on emissions, suggesting that its environmental effects are mixed or neutral within the region's current development structure.

From these findings, several policy implications emerge. Governments in West Africa should prioritize expanding renewable energy infrastructure to gradually shift away from fossil fuel dependence. Stronger environmental standards must guide incoming FDI to ensure alignment with lowcarbon objectives. At the same time, energy efficiency programs in highemission sectorssuch as industry, transport, and constructionshould be promoted through regulatory measures and targeted incentives. Finally, deeper regional cooperation under ECOWAS is essential to harmonize climate policies, strengthen monitoring systems, and attract international financing for sustainable development.

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Reference:

Acheampong, A. O. (2018). Economic growth, CO2 emissions and energy consumption: What causes what and where? *Energy Economics*, *74*, 677–692. https://doi.org/10.1016/j.eneco.2018.07.022

Acheampong, E. O., Macgregor, C. J., Sloan, S., & Sayer, J. (2019). Deforestation is driven by agricultural expansion in Ghana's forest reserves. *Scientific African*, *5*. https://doi.org/10.1016/J.SCIAF.2019.E00146

Adom, P. K., Opoku, E. E. O., & Yan, I. K. M. (2019). Energy demand–FDI nexus in Africa: Do FDIs induce dichotomous paths? *Energy Economics*, *81*, 928–941. https://doi.org/10.1016/J.ENECO.2019.05.030

Al-Mulali, U., & Ozturk, I. (2015). The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. *Energy*, *84*, 382–389. https://doi.org/10.1016/J.ENERGY.2015.03.004

Ang, J., Ang, & James. (2007). CO2 emissions, energy consumption, and output in France. *Energy Policy*, *35*(10), 4772–4778. https://EconPapers.repec.org/RePEc:eee:enepol:v:35:y:2007:i:10:p:4772-4778

Apergis, N., Ben Jebli, M., & Ben Youssef, S. (2018). Does renewable energy consumption and health expenditures decrease carbon dioxide emissions? Evidence for sub-Saharan Africa countries. *Renewable Energy*, *127*, 1011–1016. https://doi.org/10.1016/j.renene.2018.05.043

Apergis, N., & Payne, J. E. (2010). Structural breaks and petroleum consumption in US states: Are shocks transitory or permanent? *Energy Policy*, *38*(10), 6375–6378. https://doi.org/10.1016/J.ENPOL.2010.06.015

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C. S., Jansson, B.-O., Levin, S., Maler, K.-G., Perrings, C., Pimentel, D., Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C. S., Jansson, B.-O., Levin, S., … Pimentel, D. (1995). Economic growth, carrying capacity, and the environment. *Ecological Economics*, *15*(2), 91–95. https://doi.org/10.1007/s00234-002-0921-9

Asiedu, M., Yeboah, E. N., & Boakye, D. O. (2021). Natural Resources and the Economic Growth of West Africa Economies. *Applied Economics and Finance*, *8*(2), 20–32. https://doi.org/10.11114/AEF.V8I2.5157

Aslan, A., Ozsolak, B., & Doğanalp, N. (2021). Environmental quality and renewable energy consumption with different quality indicators: evidence from robust result with panel quantile approach. *Environmental Science and Pollution Research*, *28*(44), 62398–62406. https://doi.org/10.1007/S11356-021-15181-X/METRICS

Avenyo, E. K., & Tregenna, F. (2022). Greening manufacturing: Technology intensity and carbon dioxide emissions in developing countries. *Applied Energy*, *324*, 119726. https://doi.org/10.1016/J.APENERGY.2022.119726

Baajike, F. B., Ntsiful, E., Afriyie, A. B., & Oteng-Abayie, E. F. (2022). The effects of economic growth, trade liberalization, and financial development on environmental sustainability in West Africa. The role of institutions. *Research in Globalization*, *5*. https://doi.org/10.1016/J.RESGLO.2022.100104

Bhattacharya, M., Awaworyi Churchill, S., & Paramati, S. R. (2017). The dynamic impact of renewable energy and institutions on economic output and CO2 emissions across regions. *Renewable Energy*, *111*, 157–167. https://doi.org/10.1016/J.RENENE.2017.03.102

Chen, D., Isah, A. B., & Gummi, U. M. (2024). Effect of Foreign Direct Investments on Industrialisation: The Case of China in Africa . *Journal of African Economies*. https://doi.org/10.1093/JAE/EJAD026

Copeland, B. R., & Taylor, M. S. (2004). Trade, Growth, and the Environment. *Journal of Economic Literature*, *42*(1), 7–71. https://doi.org/10.1257/002205104773558047

Dinda, S. (2004). Environmental Kuznets Curve hypothesis: A survey. *Ecological Economics*, *49*(4), 431–455. https://doi.org/10.1016/j.ecolecon.2004.02.011

Dzebo, A., Janetschek, H., Brandi, C., & Iacobuta, G. (2019). *Connections between the Paris Agreement and the 2030 Agenda The case for policy coherence*.

Enders, C. K., & Tofighi, D. (2007). Centering Predictor Variables in Cross-Sectional Multilevel Models: A New Look at an Old Issue. *Psychological Methods*, *12*(2), 121–138. https://doi.org/10.1037/1082-989X.12.2.121

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. *Energy Strategy Reviews*, *24*, 38–50. https://doi.org/10.1016/J.ESR.2019.01.006

Grossman, G., & Krueger, A. (1991). *Environmental Impacts of a North American Free Trade Agreement*. https://doi.org/10.3386/W3914

Grossman, G., Krueger, A., Grossman, G., & Krueger, A. (1994). *Economic Growth and the Environment*. https://EconPapers.repec.org/RePEc:nbr:nberwo:4634

Gujarati, D. N. ., & Porter, D. C. . (2010). *Basic econometrics*. https://books.google.com/books/about/Basic_Econometrics.html?hl=id&id=6l1CPgAACAAJ

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*, *37*(3), 1156–1164. https://doi.org/10.1016/J.ENPOL.2008.11.012

Huang, Y., Chen, F., Wei, H., Xiang, J., Xu, Z., & Akram, R. (2022). The Impacts of FDI Inflows on Carbon Emissions: Economic Development and Regulatory Quality as Moderators. *Frontiers in Energy Research*, *9*, 820596. https://doi.org/10.3389/FENRG.2021.820596/BIBTEX

Khan, M., Rana, A. T., & Ghardallou, W. (2023). FDI and CO2 emissions in developing countries: the role of human capital. *Natural Hazards (Dordrecht, Netherlands)*, *117*(1), 1125. https://doi.org/10.1007/S11069-023-05949-4

Omri, A., Nguyen, D. K., & Rault, C. (2014). Causal interactions between CO2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. *Economic Modelling*, *42*, 382–389. https://doi.org/10.1016/J.ECONMOD.2014.07.026

Owusu, J., Paul, I., Awudu Article, Y., Owusu Amoah, J., Paul Alagidede, I., & Awudu Sare, Y. (2023). Impact of foreign direct investment on carbon emission in Sub-Saharan Africa: The mediating and moderating roles of industrialization and trade openness. *Cogent Business & Management*, *10*(3), 1–22. https://doi.org/10.1080/23311975.2023.2266168

Panayotou, T. (1993). *WORLD EMPLOYMENT PROGRAMME RESEARCH Working Paper Technology and Employment Programme Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development*.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/JAE.616;CTYPE:STRING:JOURNAL

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, *94*(446), 621. https://doi.org/10.2307/2670182

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. *Renewable and Sustainable Energy Reviews*, *25*, 109–121. https://doi.org/10.1016/J.RSER.2013.04.009

Singh, K., & Kaur, J. (2022). Do energy consumption and carbon emissions impact economic growth? New insights from India using ARDL approach. *OPEC Energy Review*, *46*(1), 68–105. https://doi.org/10.1111/OPEC.12223;WGROUP:STRING:PUBLICATION

Stern, & I., D. (2004). The Rise and Fall of the Environmental Kuznets Curve. *World Development*, *32*(8), 1419–1439. https://ideas.repec.org/a/eee/wdevel/v32y2004i8p1419-1439.html

THE PARIS AGREEMENT. (2016). https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-

Wang, Q., Yang, T., Li, R., & Wang, X. (2023). Reexamining the impact of foreign direct investment on carbon emissions: does per capita GDP matter? *Humanities and Social Sciences Communications*, *10*(1). https://doi.org/10.1057/S41599-023-01895-5

Waqih, M. A. U., Bhutto, N. A., Ghumro, N. H., Kumar, S., & Salam, M. A. (2019). Rising environmental degradation and impact of foreign direct investment: An empirical evidence from SAARC region. *Journal of Environmental Management*, *243*, 472–480. https://doi.org/10.1016/J.JENVMAN.2019.05.001

World Energy Outlook 2023 – Analysis - IEA. (n.d.). Retrieved June 19, 2025, from https://www.iea.org/reports/world-energy-outlook-2023

World Energy Outlook 2024 – Analysis - IEA. (n.d.). Retrieved June 19, 2025, from https://www.iea.org/reports/world-energy-outlook-2024

Zhou, X., Tang, X., & Zhang, R. (2020). Impact of green finance on economic development and environmental quality: a study based on provincial panel data from China. *Environmental Science and Pollution Research*, *27*(16), 19915–19932. https://doi.org/10.1007/S11356-020-08383-2

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