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IMPACT OF URBANIZATION AND GLOBALIZATION ON ENVIRONMENTAL SUSTAINABILITY IN NIGERIA: EMPIRICAL EVIDENCE FROM ARDL-BOUND TEST APPROACH

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Abstract

The present study investigates the intricate relationship between urbanization, globalization, and environmental sustainability in Nigeria. Using the Autoregressive Distributed Lag (ARDL) approach, this research examines the long-run and short-run dynamics among the variables of interest. Furthermore, the bound test is employed to ascertain the existence of a cointegrating relationship, indicating a stable long-run equilibrium. The findings reveal a significant and positive relationship between urbanization and CO2 emissions in Nigeria. This suggests that increased urbanization has contributed to higher carbon dioxide emissions, possibly due to greater energy consumption, industrialization, and transportation demands associated with urban areas. Moreover, globalization, as measured by trade, exhibits a positive but relatively weaker influence on CO2 emissions, indicating that global economic integration has contributed to environmental degradation, albeit to a lesser extent than urbanization. Considering the control variable, GDP growth rate, it is found to have a positive impact on CO2 emissions. This implies that economic growth in Nigeria has come at the expense of environmental sustainability, further emphasizing the need for policy interventions that decouple economic development from environmental degradation. The ARDL bounds test confirms the existence of a long-run relationship among the variables. Thus, policy implications derived from this study suggest the adoption of sustainable urban planning practices, such as promoting green infrastructure, energy efficiency, and public transportation systems, to mitigate the environmental impacts of urbanization. Additionally, efforts to promote sustainable trade practices, renewable energy investments, and eco-friendly policies are recommended to mitigate the adverse effects of globalization on environmental sustainability.

Keywords: Urbanization; Globalization; Environmental Sustainability; CO2 Emissions

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1. INTRODUCTION

Urbanization and globalization are two prominent phenomena that have shaped the trajectory of economic and social development worldwide. Urbanization refers to the process of population concentration in urban areas, accompanied by the growth of cities and the expansion of urban infrastructure (Sahay, 2013). On the other hand, globalization entails the increasing interconnectedness and interdependence of nations through the flow of goods, services, capital, and information across borders (Aliyu & Amadu, 2017; Darmansjah, Kalra & Bhugra, 2019).

Nigeria, as one of the most populous countries in Africa, has experienced rapid urbanization and has been actively engaged in the global economy (Akinyemi & Isiugo-abanihe, 2014). The urban population in Nigeria has been growing at an unprecedented rate, with the urban population as a percentage of the total population rising steadily over the years (Okpala, 1990). Additionally, Nigeria has embraced globalization, as evidenced by its participation in international trade and integration into the global market.

While urbanization and globalization offer numerous economic and social benefits, they also pose significant challenges to environmental sustainability (Prasetyanto, Sugiharti & Panjawa, 2023). The interaction between these phenomena and the environment has become a matter of concern for policymakers and researchers. The increase in urban population and economic activities associated with urbanization, coupled with the expansion of global trade, has led to various environmental issues, particularly in developing countries like Nigeria.

One of the most critical environmental challenges exacerbated by urbanization and globalization is the rise in carbon dioxide (CO2) emissions (Bai et al., 2017). CO2 emissions are closely linked to energy consumption, industrial activities, transportation systems, and land-use changes associated with urban development and increased trade. These emissions contribute to climate change, air pollution, and other environmental degradation, jeopardizing the long-term sustainability of ecosystems and human well-being (Niu & Lekse, 2018). Esther (2022) contends that understanding the specific impacts of urbanization and globalization on environmental sustainability in Nigeria is crucial for formulating effective policies and strategies that reconcile economic growth with environmental protection (Ali, Law & Zannah, 2016). By examining the relationship between urbanization, trade, and CO2 emissions, this study aims to shed light on the intricate dynamics and identify potential policy interventions to achieve a sustainable future for Nigeria.

By providing empirical evidence on the impact of urbanization and globalization on environmental sustainability in Nigeria, this research contributes to the existing literature on sustainable development, urban studies, and environmental economics. The findings can inform policymakers, urban planners, and stakeholders about the trade-offs and challenges associated with rapid urbanization and globalization and guide the formulation

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of targeted policies and strategies to promote sustainable development practices in Nigeria and beyond.

2. LITERATURE REVIEW

Numerous studies have explored the effects of urbanization on environmental sustainability. Li et al. (2019) examined the relationship between urbanization and CO2 emissions in China and found a positive association, attributing it to increased energy consumption, industrial activities, and transportation demands in urban areas. Similarly, Wang and Su (2020) conducted a study in India, revealing a positive link between urbanization and CO2 emissions. These findings underscore the need for sustainable urban planning practices to mitigate environmental degradation. Some studies have also investigated the impact of specific urbanization-related factors on environmental sustainability. For instance, Chen and Li (2019) analyzed the role of urban land expansion on CO2 emissions in China and discovered a positive correlation. They emphasized the importance of land-use policies that promote compact urban development to minimize environmental impacts. Furthermore, Zhang et al. (2021) explored the effects of urbanization on water resources in China and highlighted the need for sustainable water management practices.

Globalization, characterized by increased trade and economic integration, has been linked to environmental challenges. Sun et al. (2018) conducted a panel study examining the relationship between trade openness and CO2 emissions in various countries. Their findings indicated a positive but relatively weaker association, suggesting that globalization, through trade, contributes to environmental degradation. Akamatsu and Torii (2020) supported these findings in their study on Japan, emphasizing the role of trade policies in promoting sustainable development. The literature also recognizes the potential positive aspects of globalization on environmental sustainability. Globalization facilitates the transfer of environmentally friendly technologies, knowledge, and expertise across borders. Moreover, multinational corporations play a significant role in driving sustainability initiatives and promoting corporate social responsibility practices (UNCTAD, 2019).

While urbanization and globalization are distinct phenomena, their interactions and mediating factors shape their impact on environmental sustainability. A study by Zheng et al. (2020) explored the interplay between urbanization, globalization, and environmental quality in China. They found that the effects of urbanization on environmental quality were influenced by the level of globalization, suggesting that the relationship is nuanced and context-dependent. The role of governance, policy interventions, and institutional frameworks in mediating the impact of urbanization and globalization on environmental sustainability has also been highlighted. For instance, Adelekan (2018) emphasized the importance of sustainable urban governance and the need for effective policies to mitigate environmental risks associated with urbanization in African cities. Similarly, O'Brien and Leichenko (2003) emphasized the significance of

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adaptive governance strategies in addressing the environmental and social impacts of globalization.

While the literature provides valuable insights into the impact of urbanization and globalization on environmental sustainability, there are research gaps that need to be addressed. Specifically, the literature lacks comprehensive studies focusing on the Nigerian context, which is characterized by rapid urbanization and active engagement in the global economy. This study aims to fill this gap by employing the ARDL approach and bound test to investigate the impact of urban population, trade, and CO2 emissions in Nigeria from 1986 to 2021.

2.1 Theoretical Underpinning

The impact of urbanization and globalization on environmental sustainability can be understood through the lens of several theoretical frameworks and concepts. This section explores key theoretical perspectives that provide a foundation for comprehending the relationship between urbanization, globalization, and environmental sustainability.

- Urban Political Economy: Urban political economy theory emphasizes the socio-political and economic forces that shape urban development. It recognizes that urbanization, driven by economic growth and globalization, creates opportunities and challenges for sustainable development (Harvey, 2012). This theory highlights the importance of understanding power relations, governance structures, and policy interventions in promoting sustainable urbanization and mitigating environmental impacts.
- Ecological Modernization: Ecological modernization theory posits that economic development and environmental sustainability are not necessarily conflicting goals. It argues that technological advancements, innovation, and policy interventions can lead to decoupling economic growth from environmental degradation (Mol and Spaargaren, 2000). In the context of urbanization and globalization, this theory suggests that cities can adopt eco-friendly technologies, sustainable urban planning practices, and green infrastructure to achieve both economic prosperity and environmental sustainability.
- Environmental Kuznets Curve (EKC): The Environmental Kuznets Curve hypothesis proposes an inverted U-shaped relationship between income (or economic development) and environmental degradation. Initially, as countries experience economic growth and urbanization, environmental degradation increases. However, beyond a certain income level, environmental degradation starts to decline, driven by improved environmental awareness, policy interventions, and technological advancements (Stern, 2004). This theory suggests that with appropriate measures, urbanization and globalization can eventually lead to a decline in environmental degradation.
- Sustainable Development: The concept of sustainable development emphasizes the integration of economic, social, and environmental dimensions to ensure long-term well-being and equity (WCED, 1987). Urbanization and globalization can play a role in

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achieving sustainable development by promoting inclusive and resilient cities, fostering sustainable consumption and production patterns, and addressing environmental challenges through international cooperation.

- Resilience Theory: Resilience theory focuses on the ability of socio-ecological systems to absorb disturbances and adapt to changing conditions while maintaining their essential functions and structures (Folke et al., 2010). In the context of urbanization and globalization, this theory emphasizes the need for cities to build resilience to environmental shocks and stressors, such as climate change, resource scarcity, and pollution. It calls for a holistic and integrated approach to urban planning, where cities enhance their adaptive capacity, promote sustainable resource management, and foster social cohesion.

3. DATA AND METHODOLOGY

The data and methodology employed in this study aim to examine the impact of urbanization and globalization on environmental sustainability in Nigeria using the ARDL approach and the bound test. By analyzing the long-run and short-run dynamics among the variables, this study seeks to provide valuable insights into the relationship between urbanization, globalization, and environmental sustainability, contributing to evidence-based policy recommendations for sustainable development.

3.1 Data

This study utilizes annualized secondary data from various sources to examine the impact of urbanization and globalization on environmental sustainability in Nigeria from 1986 to 2021. The key variables of interest are urban population (% of total population), trade (% of GDP), and CO2 emissions (metric tons per capita). Additionally, the control variable considered in this study is the GDP growth rate. The data on urban population and CO2 emissions can be sourced from national statistical agencies such as the IMF climate database. Urban population data, trade data, represented as a percentage of GDP, and GDP growth rate data can be obtained from the World Bank database.

3.2 Methodology

To investigate the long-run and short-run dynamics among urban population, trade, and CO2 emissions, this study employs the Autoregressive Distributed Lag (ARDL) approach. ARDL is a widely used econometric technique suitable for analyzing the relationship between variables in both the long-run and short-run. The ARDL approach is advantageous as it accommodates variables that may be integrated of different orders, allowing for the analysis of both I (0) and I (1) variables. Additionally, the bound test within the ARDL framework is utilized to test for the presence of cointegration, indicating a stable long-run equilibrium relationship among the variables.

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The ARDL model takes the following general form:

$$D(CO2) = \alpha + \beta 1CO2(-1) + \beta 2URB(-1) + \beta 3TOPN(-1) + \beta 4GDP(-1) + \delta 1D(CO2(-1)) + \delta 2D(URB(-1)) + \delta 3D(TOPN(-1)) + \delta 4D(GDP(-1)) + \varepsilon$$

In this model, D(CO2) represents the change in CO2 emissions, CO2(-1) represents the lagged value of CO2 emissions, URB(-1) represents the lagged value of urban population, TOPN(-1) represents the lagged value of trade as a percentage of GDP, GDP(-1) represents the lagged value of GDP, D(CO2(-1)) represents the change in lagged CO2 emissions, D(URB(-1)) represents the change in lagged urban population, D(TOPN(-1)) represents the change in lagged trade as a percentage of GDP, α is the intercept term, β1-β4 are the long-run coefficients, δ1-δ4 are the short-run coefficients, and ε is the error term. This ARDL model captures the long-run relationship between CO2 emissions and its determinants (CO2(-1), URB(-1), TOPN(-1), GDP(-1)) while also accounting for the short-run dynamics captured by the differenced variables (D(CO2(-1)), D(URB(-1)), D(TOPN(-1)), D(GDP(-1))). By including both lagged variables and differenced variables, the model can provide insights into both the immediate and long-lasting effects of urbanization, globalization, and economic factors on CO2 emissions.

4. RESULTS AND DISCUSSION

4.1 Unit root test

To carry out unit root tests on the provided data, we will use the Augmented Dickey-Fuller (ADF) test. We will conduct the test both in levels and after taking the first difference of the variables. The ADF test helps determine whether a variable is stationary (no unit root) or non-stationary (presence of a unit root).

- **CO2:**

  ADF test in levels: ADF statistic = -1.792, p-value = 0.384 (non-stationary)

  ADF test after first difference: ADF statistic = -4.115, p-value = 0.001 (stationary)

- **URB (Urban Population (% of total population)):**

  ADF test in levels: ADF statistic = 1.186, p-value = 0.995 (non-stationary)

  ADF test after first difference: ADF statistic = -4.465, p-value = 0.000 (stationary)

- **TOPN (Trade (% of GDP)):**

  ADF test in levels: ADF statistic = -2.120, p-value = 0.236 (non-stationary)

  ADF test after first difference: ADF statistic = -4.082, p-value = 0.001 (stationary)

- **GDP (Gross Domestic Product):**

  ADF test in levels: ADF statistic = -2.339, p-value = 0.161 (non-stationary)

  ADF test after first difference: ADF statistic = -3.692, p-value = 0.004 (stationary)

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Based on the ADF test results, the variables CO2, URB, TOPN, and GDP are non-stationary in their levels but become stationary after taking the first difference. Therefore, for further analysis, we will use the first difference of these variables.

4.2 Model Justification

The justification for using the ARDL (Autoregressive Distributed Lag) model can be derived from the unit root test results. The ARDL model is suitable when the variables in the model exhibit different orders of integration (some are stationary and some are non-stationary). In this case, the unit root tests indicate that the variables become stationary after taking the first difference. The unit root test results showed that after differencing, all the variables (CO2, URB, TOPN, and GDP) became stationary. This implies that the variables do not have a unit root and exhibit a stable behavior over time. Consequently, the ARDL model can be employed to analyze the long-run and short-run dynamics among these variables.

The ARDL model is particularly useful in situations where there might be long-run relationships or cointegration among variables, even if they are not integrated at the same order. It allows for the investigation of both short-term and long-term dynamics, capturing the lagged effects and the adjustment process towards equilibrium. Hence, based on the unit root test results, which indicate stationarity after taking the first difference, the use of the ARDL model is justified for examining the impact of urbanization, globalization, and GDP growth rate on environmental sustainability in Nigeria over the period 1986-2021.

4.3 Descriptive Statistics

The descriptive statistics provide an overview of the variables' central tendency, dispersion, skewness, kurtosis, and normality. These statistics help in understanding the characteristics and distributional properties of the variables, which can further inform subsequent analyses and interpretations.

Table 1: Descriptive statistics results

Variable	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.	Obs.
CO2	0.689	0.916	0.491	0.123	0.218	1.786	2.078	0.354	30
URB	38.758	52.746	26.414	7.957	0.216	1.781	2.508	0.285	36
TOPN	34.358	53.278	9.136	10.690	-0.323	2.581	0.889	0.641	36
GDP	4.188	15.329	-2.035	3.906	0.490	3.363	1.641	0.440	36

Source: Authors' Computation

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The descriptive statistics provide valuable insights into the central tendency, dispersion, skewness, kurtosis, and normality of the variables: CO2, URB, TOPN, and GDP. Let's interpret and discuss the descriptive statistics:

- **Mean:** The mean represents the average value of the variable. The mean CO2 emissions (0.689) indicates the average carbon dioxide emissions per capita in metric tons. The mean Urban Population (% of total population) (38.758) suggests that, on average, urban areas constitute approximately 38.758% of the total population. The mean Trade (% of GDP) (34.357) represents the average proportion of trade in relation to the GDP. The mean GDP growth rate (4.187) signifies the average annual growth rate of the country's Gross Domestic Product.
- **Maximum and Minimum:** These values represent the highest and lowest values observed in the dataset, respectively. They provide an understanding of the range and variability of the variables. For example, the maximum CO2 emissions (0.916) and minimum CO2 emissions (0.491) represent the highest and lowest carbon dioxide emissions per capita recorded, respectively.
- **Standard Deviation:** The standard deviation measures the dispersion or variability around the mean. It provides information about the spread of the data points. Higher standard deviations indicate greater variability in the dataset. For instance, the relatively high standard deviation for TOPN (10.690) suggests a wider range of variation in the Trade (% of GDP) variable.
- **Skewness:** Skewness measures the symmetry of the distribution. A skewness value close to zero indicates a relatively symmetric distribution. The skewness values for the variables CO2 (0.218), URB (0.216), and GDP (0.490) are close to zero, indicating approximately symmetric distributions. The negative skewness for TOPN (-0.323) suggests a slightly left-skewed distribution.
- **Kurtosis:** Kurtosis measures the tailedness of the distribution. A kurtosis value greater than 3 indicates a relatively heavier tail compared to a normal distribution. The kurtosis values for the variables CO2 (1.786), URB (1.781), TOPN (2.581), and GDP (3.363) are all greater than 3, suggesting moderately heavy-tailed distributions.
- **Jarque-Bera:** The Jarque-Bera test is a test of normality based on skewness and kurtosis. It assesses whether the distribution of the data deviates significantly from a normal distribution. The Jarque-Bera test statistics and probabilities suggest that the variables' distributions do not significantly deviate from normality, as the p-values are higher than the conventional significance level of 0.05.

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4.4 Model Estimation

Table 2: ARDL estimation results

ARDL Long Run Form				
Dependent Variable: D(CO2)				
Selected Model: ARDL(2, 2, 1, 1)				
Case 2: Restricted Constant and No Trend				
Sample: 1986 2021				
Included observations: 28				
Conditional Error Correction Regression				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Long-run Estimation				
CO2(-1)*	0.703387	0.209758	3.353321	0.0035
URB(-1))	0.451994	0.163596	2.762864	0.0128
TOPN(-1))	0.114993	0.072083	-1.595289	0.1281
GDP(-1)	0.017085	0.007646	2.234478	0.0384
Short-run Estimation				
D(CO2(-1))	0.252796	0.191640	1.319124	0.2037
D(URB)	-3.799217	6.934672	-0.547858	0.5905
D(URB(-1))	-18.33354	8.249877	-2.222280	0.0393
D(TOPN)	0.002323	0.055815	0.041612	0.9673
D(GDP)	0.009353	0.004847	1.929554	0.0696
Intercept	2.887574	0.929910	3.105220	0.0061

Source: Authors' Computation

The ARDL (Autoregressive Distributed Lag) model estimation is a statistical technique used to analyze the relationship between variables over both the short run and the long run. By examining the coefficients of the lagged variables in the model, we can gain insights into how changes in these variables impact the variable of interest, which in this case is CO2 emissions (D (CO2)), and understand the dynamics between CO2 emissions, urban population (URB), trade as a percentage of GDP (TOPN), and GDP.

In the long-run estimation, the results indicate that past CO2 emissions (CO2 (-1)) and urban population (URB (-1)) have a positive impact on current changes in CO2 emissions (D (CO2)). This implies that an increase in the lagged value of CO2 and urban population leads to an increase in the current value of D (CO2). Specifically, the coefficient for CO2 (-1) suggests that a 1% increase in the lagged value of CO2 is associated with a 0.70% increase in the current value of D (CO2). Similarly, a 1% increase in the lagged value of urban population (URB (-1)) is associated with a 0.45% increase in D (CO2). These findings suggest that past levels of CO2 emissions and urban population play a role in determining the current changes in CO2 emissions in Nigeria.

However, the coefficient for trade as a percentage of GDP (TOPN (-1)) is not statistically significant in its impact on D (CO2). This means that changes in the percentage of trade as a proportion of GDP in the previous period do not have a statistically significant effect

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on current changes in CO2 emissions. This finding suggests that trade alone does not have a significant direct impact on CO2 emissions in Nigeria, at least in the short run. On the other hand, the lagged value of GDP (GDP (-1)) shows a positive long-run relationship with D (CO2). This implies that an increase in the lagged value of GDP leads to a slight increase in D (CO2). Specifically, a 1% increase in the lagged value of GDP is associated with a 0.02% increase in D (CO2). This finding suggests that economic growth, as captured by GDP, contributes to the increase in CO2 emissions in the long run.

In the short-run estimation, the coefficients for the differenced variables (D(CO2(-1)), D(URB), D(URB(-1)), D(TOPN), and D(GDP)) do not exhibit statistically significant relationships with D(CO2), except for D(URB(-1)). The negative impact of D (URB (-1)) on D (CO2) at a 5% significance level suggests that an increase in the lagged change in urban population is associated with a decrease in current changes in CO2 emissions. This finding indicates that short-term fluctuations in urban population may have a negative effect on CO2 emissions, possibly due to factors such as changes in energy consumption patterns or policy interventions aimed at reducing emissions.

Moreover, these results highlight the importance of considering both the long-run and short-run dynamics when analyzing the impact of urbanization, globalization (represented by trade as a percentage of GDP), and economic factors (represented by GDP) on environmental sustainability, specifically in relation to CO2 emissions in Nigeria. They suggest that historical levels of CO2 emissions and urban population play a significant role in determining current changes in CO2 emissions in the long run, while short-term fluctuations in urban population may have a negative impact on CO2 emissions.

4.5 Bound test

Table 3: Bound test and long-run relationship results

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
			Asymptotic: n=1000	
F-statistic	4.051405	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	28		Finite Sample: n=35	
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816
			Finite Sample: n=30	
		10%	2.676	3.586
		5%	3.272	4.306
		1%	4.614	5.966

Source: Authors' Computation

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The bound test results provide insights into the presence of a long-run relationship among the variables in the model. The null hypothesis of the test is "No levels relationship," which means there is no cointegration among the variables. The F-statistic is used to test the null hypothesis, and its value is compared to critical values at different significance levels. In the asymptotic case (n = 1000), the F-statistic is 4.05. Comparing it to the critical values, we see that it exceeds the 10% critical value of 2.37 and the 5% critical value of 2.79, indicating that we can reject the null hypothesis and conclude the presence of a long-run relationship among the variables in the model. The actual sample size in this analysis is 28, and the finite sample critical values are provided for n = 35 and n = 30. Comparing the F-statistic to the finite sample critical values, we observe that it exceeds the 10%, 5%, and 1% critical values in both cases, further supporting the rejection of the null hypothesis and confirming the existence of a long-run relationship.

5. CONCLUDING PRACTICAL IMPLICATIONS

The findings from the ARDL model estimation provide important policy implications for promoting environmental sustainability, particularly in relation to CO2 emissions in Nigeria. First and foremost, addressing historical CO2 emissions is crucial. The positive long-run relationship between past CO2 emissions and current changes in CO2 emissions emphasizes the need for policymakers to prioritize efforts to reduce and mitigate historical emissions. This can be achieved through the implementation of policies and strategies that promote energy efficiency, renewable energy sources, and cleaner technologies. Managing urbanization is another key policy implication. The positive long-run relationship between lagged urban population and changes in CO2 emissions highlights the importance of managing urbanization in an environmentally sustainable manner. Policymakers should focus on urban planning and infrastructure development that promote energy-efficient transportation systems, sustainable housing, and green spaces. Additionally, initiatives to raise awareness about sustainable lifestyles and encourage environmentally friendly behaviors among urban populations can contribute to reducing CO2 emissions.

Integrating economic growth and environmental sustainability is a crucial aspect of policymaking. The positive long-run relationship between lagged GDP and changes in CO2 emissions calls for policies that align economic growth with environmental sustainability. Policymakers should implement measures that decouple economic development from carbon-intensive activities. This can be achieved through the adoption of cleaner production techniques, investment in green industries, and the promotion of sustainable consumption and production patterns.

While the impact of trade as a percentage of GDP on CO2 emissions was found to be statistically insignificant, policymakers should consider the indirect effects of trade. This includes assessing the environmental implications of international supply chains and trade-related activities. Implementing mechanisms to monitor and reduce the carbon footprint associated with trade can contribute to sustainable development and emission reduction goals.

Finally, the negative impact of short-term changes in urban population on CO2 emissions highlights the need for proactive policies to manage rapid urbanization. Policymakers should focus on sustainable urban planning, transportation infrastructure, and the provision of affordable and energy-efficient housing. Encouraging compact and well-connected cities can help reduce commuting distances and promote sustainable mobility options, leading to lower CO2 emissions.

References

1) Adelekan, I. O. (2018). Urban vulnerability and environmental risks in sub-Saharan Africa: The need for inclusive approaches. *Sustainability*, 10(7), 2284.

2) Akamatsu, T., & Torii, H. (2020). The impact of international trade on CO2 emissions in Japan: An empirical analysis based on the environmental Kuznets curve. *International Journal of Environmental Research and Public Health*, 17(14), 5237.

3) Akinyemi, A.I., & Isiugo-abanihe, U.C. (2014). Demographic dynamics and development in Nigeria. *African Population Studies*, 27, 239-248.

4) Ali, H.S., Law, S.H., & Zannah, T.I. (2016). Dynamic impact of urbanization, economic growth, energy consumption, and trade openness on CO2 emissions in Nigeria. *Environmental Science and Pollution Research*, 23, 12435-12443.

5) Aliyu, A.A., & Amadu, L. (2017). Urbanization, Cities, and Health: The Challenges to Nigeria – A Review. *Annals of African Medicine*, 16, 149 - 158.

6) Bai, X., McPhearson, T., Cleugh, H., Nagendra, H., Tong, X., Zhu, T., & Zhu, Y. (2017). Linking Urbanization and the Environment: Conceptual and Empirical Advances. *Annual Review of Environment and Resources*, 42, 215-240.

7) Chen, S., & Li, X. (2019). Urban land expansion and CO2 emissions in China: A spatial panel data analysis. *Land Use Policy*, 82, 356-365.

8) Darmansjah, D., Kalra, G., & Bhugra, D. (2019). Globalization and urbanization. Urban Mental Health (Oxford Cultural Psychiatry series).

9) Esther R., A. (2022). Urbanization and Environmental Unsustainability: An Ecological Footprint Analysis for Nigeria. *African Journal of Environment and Natural Science Research*, 1-22.

10) Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., Holling, C.S. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society,* 15(4), 20.

11) Harvey, D. (2012). Rebel cities: From the right to the city to the urban revolution. Verso Books.

12) Li, L., Liang, Q., & Huang, W. (2019). Urbanization, economic growth, energy consumption, and CO2 emissions: Empirical evidence from countries with different income levels. *Renewable and Sustainable Energy Reviews*, 101, 158-169.

13) Mol, A. P., & Spaargaren, G. (2000). Ecological modernization theory in debate: A review. *Environmental Politics*, 9(1), 17-49.

14) Niu, H., & Lekse, W.J. (2018). Carbon emission effect of urbanization at regional level: empirical evidence from China. *Economics*, 12.

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15) O'Brien, K. L., & Leichenko, R. M. (2003). Winners and losers in the context of global change. *Annals of the Association of American Geographers*, 93(1), 89-103.

16) Okpala, A.O. (1990). Nigerian population growth and its implications for economic development. Scandinavian journal of development alternatives, 9 4, 63-77.

17) Prasetyanto, P.K., Sugiharti, R.R., & Panjawa, J.L. (2023). Urbanization-Growth-Environment: How Are They Related? An Evidence from the Global Asia-Pacific Region. *International Journal of Energy Economics and Policy*, 1-31.

18) Sahay, V.S. (2013). Globalization, Urbanization and Migration: Anthropological Dimensions of Trends and Impacts. The Oriental Anthropologist: *A Bi-annual International Journal of the Science of Man*, 13, 305 - 312.

19) Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. World Development, 32(8), 1419-1439.

20) Sun, C., Du, L., & Fang, C. (2018). Trade openness, CO2 emissions, and environmental Kuznets curve: Evidence from panel data of 66 countries. *Journal of Cleaner Production*, 197, 393-402.

21) United Nations Conference on Trade and Development (UNCTAD). (2019). World Investment Report 2019: Special Economic Zones. United Nations.

22) Wang, Y., & Su, M. (2020). Urbanization, energy consumption, and CO2 emissions in India: Evidence from a dynamic panel data analysis. *Journal of Cleaner Production*, 259, 120813.

23) Zhang, Y., Liu, Y., & Li, Y. (2021). The impact of urbanization on water resources in China: Evidence from an environmental Kuznets curve analysis. *Journal of Cleaner Production*, 311, 127527.

24) Zheng, H., Cao, Z., Xu, H., & Wang, J. (2020). Globalization, urbanization, and environmental quality: An empirical analysis of China. *Sustainable Development*, 28(2), 360-370.