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TESTING ENVIRONMENTAL KUZNET CURVE IN NIGERIA (1990-2022) THE ROLE OF TRADE OPENNESS ON ENVIRONMENTAL POLLUTION

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Abstract: Using data from 1990 to 2022, this study examines how trade openness affects environmental contamination and evaluates the Environmental Kuznets Curve (EKC) hypothesis in Nigeria. The results, which were obtained using the Autoregressive Distributed Lag (ARDL) model, demonstrate that trade openness has a substantial long-term and short-term impact on environmental pollution. In particular, over time, there is a 0.07% increase in environmental pollution for every 1% increase in trade openness. The EKC hypothesis, which contends that initial economic expansion causes environmental degradation but ultimately leads to improvements, is supported by the positive and considerable impact that economic development has on environmental pollutants. Deforestation has a beneficial but negligible impact on the environment, whereas urbanisation has a positive correlation with pollution. Urbanisation, economic growth, and trade openness all have a major short-term impact on pollution, whereas deforestation has little effect. In order to lessen the detrimental environmental effects of trade openness and economic growth, the study suggests the implementation of cleaner production technologies, stronger environmental regulations, the encouragement of sustainable urban planning, and initiatives to stop deforestation.

Keywords: *Trade Openness, Environmental Pollution, Environmental Kuznets Curve (EKC), Economic Development, ARDL Model*.

Introduction

Both the volume of international trade and the export to GDP ratio of each nation have significantly increased as a result of trade openness. More prospects for income, employment, and investment have been made available, especially for developing nations (Ammani et al., 2023). The movement of money and labour, the sharing of norms, values, and information, as well as the mobility of goods and services, have all been made easier by trade openness. Even though trade openness has many known benefits, its consequences on the environment are a significant but sometimes disregarded factor.

Due to insufficient infrastructure, regulatory frameworks, and public ignorance of environmental issues, trade liberalisation has made environmental problems worse in many developing nations, particularly those in Sub-Saharan Africa (Malefane & Odhiambo, 2018). Rapid economic growth has been accompanied by an increase in industrial activity brought on by trade openness, but this expansion has frequently come at a high environmental cost. Global environmental problems, especially those associated with carbon-based pollution, have gotten worse over the last 20 years, speeding up climate change (Ugwu et al., 2020). Rapid economic growth has been accompanied by improved industrial activity brought about by trade openness, but occasionally this expansion has come at a high environmental cost.

Over the past 20 years, environmental problems—especially those involving carbon-based pollution—have gotten worse worldwide, which has accelerated climate change (Ugwu et al., 2020). Economic activity rises in tandem with trade volume, and this scale impact typically results in higher pollution and environmental deterioration. As a result, while trade may contribute to economic growth, it can also significantly harm the environment.

Sub-Saharan African countries that have liberalised trade and assimilated into the global economy face serious environmental challenges.

Particularly, an increase in industrial activities such as mining, manufacturing, and energy production—all of which are major contributors to the generation of hazardous waste, greenhouse gas emissions, and pollution of the air and water—has been linked to trade openness (Kim & Chin Lin, 2020). Free trade agreements frequently result in increased CO2 emissions and significantly strain local ecosystems (Andriamahery et al. 2020). In many countries, it is difficult to reduce these environmental.

Serious environmental issues confront Sub-Saharan African nations that have liberalised trade and integrated into the global

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economy. Free trade agreements and growing foreign direct investment (FDI) put a great deal of burden on local ecosystems and often result in increased CO2 emissions (Andriamahery et al. 2020). In many countries, the absence of institutional restrictions makes it difficult to reduce these environmental problems. In particular, trade openness has been connected to a rise in industrial operations including mining, manufacturing, and energy production—all of which contribute significantly to the generation of hazardous waste, greenhouse gas emissions, and pollution of the air and water (Kim & Chin Lin, 2020). Sub-Saharan African countries that have liberalised trade and assimilated into the global economy face significant environmental challenges.

For instance, the Economic Community of West African States (ECOWAS) and other regional integration initiatives have been connected to the swift industrialisation of West African nations like Nigeria. ECOWAS aims to promote commercial liberalisation, regional integration, and economic cooperation among its member nations.

However, trade impediments, institutional capacity limitations, and infrastructure deficiencies significantly impede the implementation of regional trade agreements and the harmonisation of trade policies (ECOWAS, 2020).

However, as demonstrated by programs such as the ECOWAS Environmental Policy and the West Africa Biodiversity and Climate Change (WA BiCC) program, environmental sustainability continues to be a shared goal throughout West Africa.

Through the implementation of trade liberalisation, Nigeria has improved its global competitiveness, drawn international investment, and increased economic growth. Nigeria is the most populous country in Africa and has an abundance of natural resources, but increased trade openness has led to an increase in industrial activity and, consequently, environmental damage, particularly in the oil and gas sector (Ajayi et al. 2020). These programs aim to improve environmental governance and resilience

The main driver of Nigeria's economic growth has been increased oil production and exports. However, there has been substantial environmental harm brought on by the extraction, processing, and transportation of oil, including contamination of the air and water. Pollutants such sulphur dioxide, nitrogen oxides, and volatile organic compounds are produced during industrial operations related to oil drilling and refining, lowering air quality and endangering the health of persons nearby. In addition, pipeline failures and oil spills have harmed ecosystems and ways of life in oil-producing countries, contaminating water sources and having a major detrimental impact on the environment (Ajayi et al. 2020).

Additionally, trade openness affects consumer preferences and behaviour by influencing patterns of consumption. Importing goods with significant environmental impacts, such as textiles, electronics, and agricultural products, can result in indirect pollution during the stages of production, transportation, and disposal of a product. Trade also creates new consumption habits that may have negative environmental effects by increasing access to a wide range of goods and services from global market places.

Nigeria's oil and gas industry, industrial growth, and changing consumer patterns have exacerbated environmental issues like air and water pollution, deforestation, and the creation of hazardous waste. Therefore, this study aims to investigate the relationship between trade openness and environmental harm and test the Environmental Kuznets Curve in Nigeria.

Literature Review

1. Theoretical frame work

According to the Environmental Kuznets Curve, the first outcome of economic development is environmental degradation; however, after attaining a certain level of economic growth, a society begins to improve its relationship with the environment, resulting in a reduction of environmental impact. This may seem to indicate that economic expansion is beneficial for the environment, but critics argue that there is no guarantee that it will lead to better environmental outcomes (Pata & Caglar, 2020).

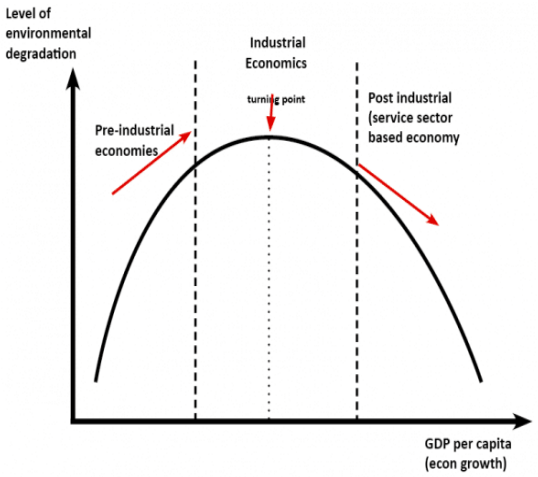

Figure 2.1 illustrates the Environmental Kuznets Curve, showing the rise, peak, and decline of pollution as the economy takes measures to mitigate the harmful effects of economic growth on the environment.

A paradigm for examining the connection between environmental pollution, trade openness, and economic growth—particularly in the context of Nigeria—is offered by the Environmental Kuznets Curve (EKC). According to the EKC, pollution starts to decrease once an economy reaches a particular degree of economic development, while environmental damage initially rises as economies expand. This is justified by the idea that nations may invest in more sustainable sectors, adopt cleaner technologies, and enact stricter environmental laws as their incomes increase (Mahmood et al, 2019).

The EKC can be used to analyse how trade openness affects environmental pollution in the Nigerian context. Generally speaking, trade openness entails more imports and exports, which can raise industrial activity, output levels, and energy consumption—all of which have the potential to initially worsen environmental degradation. This is in line with the EKC's rising phase, when trade liberalization-driven economic expansion frequently results in more emissions, deforestation, and other environmental problems.

However, trade openness may eventually lead to environmental gains as Nigeria's economy develops. Nigeria might achieve the EKC's peak, where trade's positive environmental effects outweigh its drawbacks, with increased access to cutting-edge technologies, cleaner production techniques, and ecologically friendly products. Furthermore, in line with the EKC's declining phase, Nigeria's rising wealth levels may result in stronger pollution-reduction measures and greater public awareness (Mahmood et al, 2019). Therefore, the relationship between trade openness and

environmental pollution in Nigeria can be understood through the Environmental Kuznets Curve, where the trajectory of environmental impact depends not only on economic growth but also on the policies and measures taken to mitigate the environmental effects of trade and industrial activity.

2. Empirical Review

In recent years, there has been a lot of discussion on the connection between environmental damage and trade openness. The effects of increased global commerce and economic liberalisation on the environment have emerged as a major worry. Numerous studies indicate that trade openness, particularly in developing nations, is associated with higher levels of environmental pollution. This is mostly due to the fact that these nations frequently have laxer environmental laws and are more prone to draw in polluting industries. According to Andriamahery et al. (2022), trade in Sub-Saharan Africa (SSA) increased CO2, CH4, and N2O emissions across all income levels in the region, with lower-income countries experiencing the worst effects.

The idea that trade liberalisation can worsen environmental problems in underdeveloped nations because of a lack of institutional capacity to control environmental repercussions is supported by this data. However, Khan & Nadeem (2021) discovered that urbanization deteriorated the quality of the environment and that trade openness was linked to increased CO2 emissions in Pakistan. These results imply that commerce may, in some circumstances, actually degrade environmental quality, particularly in nations with weak environmental regulation.

This anticipated trade might unintentionally promote environmental damage in underdeveloped countries, which struggle with issues like lax regulations and inadequate pollution control equipment.

Several studies have found that other factors, such as the use of renewable energy, financial openness, and technological advancement, can lessen or even reverse the negative environmental effects of trade, in contrast to the literature mentioned above that suggested trade is inherently harmful to the environment.

In their study, Thi Thuy Pham & Nguyen (2024) discovered that while financial openness and the use of renewable energy were important factors in improving environmental quality and lowering CO2 emissions, trade openness by itself did not have a statistically significant impact on environmental pollution in 64 developing nations. This implies that nations can increase trade while lowering their carbon footprints, particularly if they give sustainable energy and financial reforms top priority.

In his study, Khan (2021) discovered that trade openness had a negative impact on emissions in developed countries. This suggests that trade can result in lower pollution in wealthier countries where there are more stringent environmental regulations, cleaner technologies, and higher levels of renewable energy consumption. This research casts doubt on the notion that trade openness invariably degrades environmental quality, indicating that the impact can vary depending on the degree of advancement and uptake of clean technologies. As a result, it becomes clear that trade openness is not always bad for the environment.

The wider economic, technological, and environmental policies that govern trade will determine the result. Trade may actually lower emissions in wealthy and technologically advanced nations. Advocates of trade openness highlight how trade can reduce environmental pollution indirectly through stricter regulations and technical advancements. Trade may promote the adoption of stricter environmental legislation and greener technologies, especially with high-income nations. Kim and Chin Lin (2020) showed that while trade with wealthy nations (the Global North) may decrease environmental standards, especially in regions with medium stringency, trade with emerging nations (the Global South) tends to strengthen them. This demonstrates how trade relations with various partners can influence a nation's environmental policy, with commerce having the ability to promote more stringent environmental governance under the correct conditions.

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The study by Wang and Zhang (2020) demonstrated that trade openness decreased carbon emissions in high-income and upper-middle-income countries, but had no discernible effect in lower-middle-income countries and actually increased emissions in low-income countries. The relationship between trade openness and environmental quality is heterogeneous, with effects that vary significantly depending on the country's income level, development status, and institutional capacity. The idea that trade can have varying impacts based on a nation's economic structure, regulatory framework, and technological capabilities is supported by this research.

The direction and extent of trade's environmental impact can differ based on whether the nation is a net exporter or importer, as well as whether the goods traded contribute to pollution, according to Haug & Ucal (2019), who claimed that trade and foreign direct investment (FDI) have asymmetric effects on CO2 emissions in Turkey. According to this viewpoint, trade's effects on environmental quality are not consistent and instead differ depending on the institutional and economic circumstances of each nation. Depending on variables like income levels, the uptake of new technologies, and the efficacy of policies, trade may be advantageous for the environment in some situations but detrimental in others.

Lastly a number of studies contend that trade liberalisation may raise environmental risks in the absence of sufficient environmental control. Without strict environmental regulations, commerce can result in pollution and resource depletion even while it can make cleaner technologies and efficient production techniques more accessible. According to Ajayi et al. (2020), environmental degradation in Nigeria was a result of both trade openness and population increase, highlighting the need for more efficient regulatory frameworks to control the detrimental effects of trade. The empirical research shows that trade openness and environmental quality have a complex relationship. On the one hand, trade liberalisation has been associated with higher levels of

pollution, especially in developing nations with lax environmental laws. Nonetheless, there is strong evidence that trade can also result in better environmental outcomes, particularly in industrialised nations or when combined with the use of renewable energy, financial growth, and technical advancement.

Methodology

To investigate the relationship between Nigerian environmental pollution and trade openness. Following the work of Mahmood et al. (2019), the empirical model used in this study is based on the environmental kuznet curve with minor adjustments to account for the influence of trade openness. The following is the formulation of the model:

EP= f (TO, ED, DF, ED, UB)……..……(1)

From Equation (1), EP is environmental pollution (measured by Co2 emission per 100 metric tons) ED represents economic development (proxies by gross domestic product per capita), DF, is Deforestation (Measured by Agricultural Land Area), UB indicates Urbanization (Measured by Urban Population). In order to reduce skewness in the data, we transform Equation (1) into a log-linear functional form, as shown in Equation (2).

$InEP_t=\alpha_0+\alpha_1 TO_t + \alpha_2 ED_t + \alpha_3 DF_t + \alpha_4 UB_t + \mu_t$…….(2)

As denote in Equation (2), α0 is the intercept of the model. α1, α2, α3 and α4, are the partial slope coefficients to be estimated, whereas μ is the stochastic term subscript of t is the series of time.

1. Technique of Estimation

Following a stationarity test, the study estimates the association between EP and TO, ED, DF, and UB using the Autoregressive Distributed Lag (ARDL) limits test approach to co-integration, which was proposed by Pesaran, Shin, and Smith (2001). Compared to previous co-integration methods, the ARDL approach has a few desirable statistical advantages. The ARDL test procedure yields reliable results regardless of whether the variables are I(0), I(1), or mutually co-integrated, and it produces highly effective and consistent estimates in both small and large sample sizes, unlike other co-integration techniques that require all the variables to be integrated of the same order (Pesaran, Shin & Smith, 2001). Since all of the series are either I(0) or I(1), this method thus becomes pertinent to this investigation.

The ARDL bound test model is specify

$$\Delta InEP_t = \beta_o + \sum_{i=3}^{k} \beta_1 \Delta InTO_{t-i} + \sum_{i=3}^{k} \beta_2 \Delta ED_{t-i} + \sum_{i=3}^{k} \beta_3 \Delta DF_{t-i} + \sum_{i=3}^{k} \beta_4 \Delta UB_{t-i} + \delta_1 InEP_{t-i} + \delta_2 ED_{t-i} + \delta_3 DF_{t-i} + \delta_4 UB + \mu t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Ho: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ (there is no co-integration among the variables)

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ (there is co-integration among the variables)

The non-standard critical limits values stated in Pesaran et al. (2001) are then compared with the calculated F-statistic. The critical values for the lower and upper bounds are predicated on the regressors being simply I(0) and I(1), respectively. The null hypothesis that there is no long-term link can be rejected and it can be concluded that there is co-integration among the variables under investigation if the F-statistic is higher than the upper critical value. On the other hand, the null hypothesis cannot be disproved if the test statistic is less than the lower critical value; hence, it will be assumed that the variables are cointegrated (Narayan, 2004; Narayan, 2005; and Pasaran et al., 2001).

2. Long Run ARDL Modeling

$$EP_t = \delta_i + \sum_{i=1}^{M} \theta_i \, lnTO_{t-1} + \sum_{i=1}^{M} \theta_i \, lnED_{t-2} + \sum_{i=1}^{M} \theta_i \, lnDF_{t-3} + \sum_{i=1}^{M} \theta_i \, lnUB_{t-4} + \mu_{it} \; (4)$$

stands for the natural logarithm sign, θ_0 is the drift parameter, $\theta_1 \ldots \theta_4$ are the long-run coefficients, $\sum$ is the summation sign, **M** is the maximum lag, *t* is the time trend, μ is the error term.

3. ARDL Model (Short run and Error Correction)

$$EP_t = \gamma_i + \sum_{i=1}^{M} \beta_1 \, \Delta lnTO_{t-1} + \sum_{i=1}^{M} \beta_2 \, \Delta lnED_{t-1} + \sum_{i=1}^{M} \beta_3 \, \Delta lnDF_{t-1} + \sum_{i=1}^{M} \beta_4 \, \Delta lnUB + \varphi ECT_{t-1} + \varepsilon_t \; (5)$$

Where: $\beta_1 - \beta_4$ are the short-run values, δ is the value of error term, Δ is the short-run sign or the change parameter, A is the maximum or optimum lag length and $\sum$ is the summation or sigma.

4. Diagnostic Tests

The diagnostic tests will also be applied to test the accuracy of the model which includes the serial correlation LM test, the heteroscedasticity test, the normality test, the Ramsey Reset test for specification and the stability test.

Result and Discussion

1. Unit Root test

To begin the estimation, the time series properties of the data were first tested using Augmented Dickey Fuller (ADF) test statistic and the result of ADF is presented in table 1 below.

Unit Root Result

Variables	ADF Statistics	Critical value 1% 5% 10%			Order of Integration	Prob.
*In*ED	-5.949636	-3.661661	-2.960411	-2.619160	I(1)	0.0000
*In*TO	-6.258987	-3.661661	-2.960411	-2.619160	I(1)	0.0000
*In*ED	-6.340580	-3.670170	-2.963972	-2.621007	I(1)	0.0000
*In*DF	-1.794452	-3.670170	-2.963972	-2.621007	1(0)	0.0059
*In*UB	-4.686548	-3.670170	-2.963972	-2.621007	I(0)	0.0008

Table 1

Table 1 shows that every variable integrated at I(1), with the exception of InDF, which integrated I(0), and that every variable was stationary at 1%, with the exception of the natural logarithm of DF at 5%. The choice was made by looking at the probability values and comparing the absolute values to the corresponding ADF statistic.

2. Lag Length Selection Criterion

To prevent false regression, it is crucial to determine the ideal lag to employ prior to testing for co-integration among the variables. The outcome of the ideal lag selection is shown in table 2 below.

Lag length selection criteria result

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-47.670	NA	2.305	3.511	3.744	3.586
1	48.427	153.755	2.077	-1.228	0.172	-0.780
2	153.137	132.635*	1.199*	-6.542*	-3.973*	-5.720*
3	174.588s	20.024	2.329	-6.305	-2.569	-5.110

Table 2

From table 2 the optimum lag was selected using akaike information cretiria AIC and the optimum lag selected by AIC is lag two.

3. ARDL Bound test

Having selected the optimum lag, ARDL bound test was conducted to find if there is evidence of co-integration among the variables, the result of bound test is presented in table 3 below.

ARDL Bound test result

Model	F-statistic	lag	Level of Significance	Bound test critical values (constant level)	
GDPPC=f(FDI,CPF,EXR,INF)	12.58317	**2**		**1(0)**	**1(1)**
			10%	2.45	3.52
			5%	2.86	4.01
			2.5%	3.25	4.49
			1%	3.74	5.06

Table 3

The calculated F-statistic of 12.58317 is higher than the upper bound critical values, which are 3.52 at the 10% significance level, 4.01 at 5%, 4.49 at 2.5%, and 5.06 at 1%, according to the data in Table 3. This suggests that there is cointegration between the variables. The null hypothesis that there is no cointegration between Environmental Pollution (EP), Trade Openness (TO), Economic Development (ED), Debt

Financing (DF), and Urbanisation (UB) can thus be definitely rejected, indicating that there is a long-term equilibrium relationship between these variables.

4. ARDL Long-Run Model

Following the detection of a cointegrating relationship among the variables, the long-run and short run model has been estimated, and the results are presented in Table 4.

Estimated Long-Run and Short Run ARDL Results

	Dependent Variable: EVP	
Regressors	**Coefficients/Probabilty**	**T-statistic**
$InTO$	0.007(0.0010)***	4.445123
$InED$	0.008(0.2309)**	0.215765
$InDF$	0.074(0.0505)	2.481539
$InUB$	0.205(0.0000)***	5.262042
Constant	0.0306(0.000)***	4.542232
Short-Run		
$D(TO)$	0.138(0.0026)***	3.334711
$D(ED)$	0.002(0.0213)**	2.228181
$D(DF)$	0.020(0.1058)	1.675665
$D(UB)$	0.057(0.0547)**	2.012133
CointEq(-1)	-0.279 (0.0403)**	-2.158304
R-squire 0.715427		W statistic = 2.056393
F-statistic = 0.98898		prob (F-stat) =0.00001

Table 4

Denotes 1%, 5% and 10% significance level respectively

Table 4 findings show that trade openness (InTO) significantly and favourably affects environmental pollution (InEP) over the long term in Nigeria. In particular, environmental pollution rises by 0.07% for every 1% increase in trade openness, and this effect is significant at the 1% level. This positive relationship between trade openness and environmental pollution aligns with the findings of previous studies, such as Ajayi et al. (2020) in Nigeria, Khan & Nadeem (2021) in Pakistan, Andriamahery et al. (2022) in Sub-Saharan Africa, and Barkat et al. (2023) in OECD countries.

Furthermore, the long-term findings demonstrate that environmental pollution (InEP) is positively and statistically significantly impacted by economic development (InED). Environmental pollution rises by 0.8% for every 1% growth in economic development. According to the Environmental Kuznets Curve (EKC) hypothesis, this result validates the inverted U-shaped relationship between environmental pollution and economic development. According to the EKC, environmental degradation is initially brought on by economic development, but eventually, environmental improvements result from continued development. This outcome supports the conclusions of Pata & Caglar (2020) and Mahmood et al. (2019).

There is a statistically significant positive correlation between urbanisation (InUB) and environmental pollution (InEP), with a 1% rise in urbanisation translating into a 0.57% increase in pollution. At the 5% level, this association is substantial. Likewise, there is a positive correlation between environmental pollution and deforestation (InDF), albeit a statistically negligible one.

Environmental pollution (D(EP)) and trade openness (D(TO)) have a positive and significant association in the short run estimate; that is, for every 1% increase in trade openness, environmental pollution rises by 0.13%. At the 5% level, there is a considerable positive correlation between economic development (D(ED)) and environmental pollution, with a 1% rise in economic development translating into a 0.002% increase in pollution. Environmental pollution (D(EP)) is positively and significantly impacted by urbanisation (D(UB)), with a 1% increase in urbanisation leading to a 0.57% increase in pollution. In the short term, however, deforestation (D(DF)) has a beneficial but statistically negligible effect on environmental pollution.

A high rate of adjustment to equilibrium is suggested by the error correction term (ECT), which is negative, less than one in absolute value, and statistically significant at the 1% level. The model adjusts to equilibrium at a rate of 27%, as shown by the adjustment speed of -0.27. A strong fit for the model is suggested by the R-squared value of 71%, which shows that the independent variables account for 71% of the variation in the dependent variable. If there is no first-order serial correlation, the Durbin-Watson statistic is between 1.5 and 2.5. Additionally, it is confirmed that the independent variables are jointly important in explaining the dependent variable by the extremely significant F-statistic probability (Prob(F-stat) = 0.000001), which satisfies the criteria of being less than 0.05.

5. Diagnostic Test

To further ensure the reliability of the estimate, diagnostic test of serial correlation, heteroscedasticity and Normality were conducted and reported on table 5.

Diagnostic Test result

Test	F-statistics	Probability
Breusch-Godfrey Serial Correlation LM Test	0.103532	0.9020
Hetroskedasticity Test:	0.143101	0.7080
Normality:	2.229443	0.3280

Table 5

Table 5 shows that the outcomes of the Heteroskedasticity Test, the Normality Test, and the Breusch-Godfrey Serial Correlation LM Test all satisfy their respective criteria. We can accept the null hypothesis because the probabilities for each of these tests in the table are higher than 0.05. This indicates that there is no autocorrelation or heteroskedasticity in the data. Furthermore, the results show that the model is well-specified, suggesting that it has a normality test's negligible probability.

6. CUSUM and CUSUMSQ Tests

The model's stability during the research period was examined using the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests. The residuals must stay within the critical bounds at the 5% significance level for the duration of the sample in order for the model to be deemed stable.

Result of CUSUM and CUSUM square are presented in figure 1 and figure 2

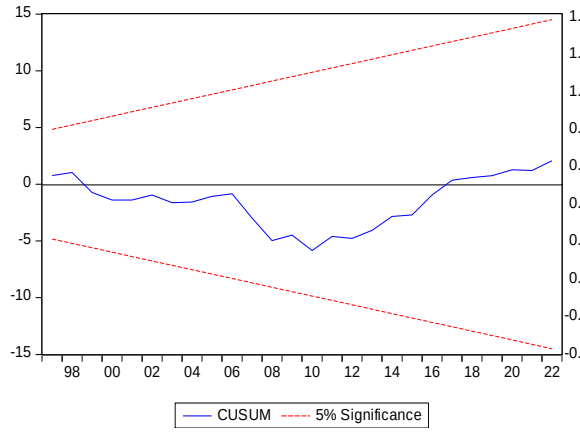

FIGURE:1

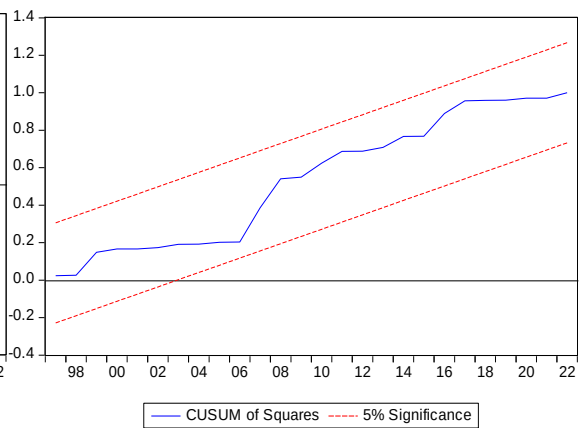

FIGURE:2

Conclusion and Recommendation

1. Conclusion

Using data from 1990 to 2022, this study investigates how trade openness affects environmental contamination and evaluates the Environmental Kuznets Curve (EKC) hypothesis in Nigeria. The findings show that, both in the short and long term, trade openness has a beneficial and statistically significant effect on environmental pollution. Additionally, because the analysis demonstrates a positive and significant association between environmental pollution and economic development in both the short and long term, it validates the existence of the Environmental Kuznets Curve in Nigeria.

2. Recommendation

Several suggestions can be made to solve Nigeria's environmental pollution problems based on the study's findings, especially in light of trade openness, economic growth, urbanisation, and deforestation. According to the findings, urbanisation, economic growth, and trade openness all have a major short- and long-term impact on environmental pollution. Given these results, the following suggestions are put forth:

The study highlights the need for more sustainable trading practices by demonstrating that trade openness has a positive and considerable impact on environmental damage. Adoption of environmentally friendly products, services, and cleaner production processes that reduce environmental impact should be promoted by policymakers.

The positive relationship between economic development and environmental pollution suggests that while development is necessary for economic progress, it can also lead to environmental degradation. Therefore, policies should prioritise investments in clean and renewable energy technologies, such as those that reduce emissions in manufacturing processes and solar, wind, and hydropower energy sources, in order to reconcile economic growth with environmental sustainability. Regulations should be put in place to ensure that industries involved in international trade

adhere to international environmental standards. Additionally, encouraging green technologies and eco-friendly industries can help mitigate the negative effects of trade on the environment.

In order to counteract the negative effects of urbanization, environmental regulations at the local and national levels should be strengthened. This includes enforcing air quality standards, waste management regulations, and encouraging sustainable urban planning practices that include green spaces, energy-efficient buildings, and sustainable transportation systems. The results underline the important role that urbanization plays in increasing environmental pollution.

Because of the strong correlation between urbanization and pollution, policymakers must encourage sustainable urban growth, which can be accomplished by incorporating environmental concerns into policies for urban development, enhancing public transportation to lower vehicle emissions, and promoting the use of sustainable building materials.

Furthermore, encouraging the idea of "smart cities," which use data and technology to improve sustainability, can aid in controlling the environmental effects of urban growth. It is important to consider the long-term effects of deforestation on biodiversity, carbon sequestration, and environmental deterioration, even while its short-term positive impact on environmental pollutants is statistically small.

Reforestation projects, forest protection legislation, and incentives for sustainable land management are examples of government programs aimed at halting deforestation. This problem can also be addressed by providing alternative livelihoods to lessen dependency on deforestation and educating local communities about the advantages of forest protection.

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