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Corruption, Environmental Sustainability and Economic Performance in Emerging Economies: Evidence from Nigeria

***Nkemdilim Iheanachor[1]**
Chris Ike Ogbechie[1]
Azuka Elvis Ozegbe[2]

[1]Lagos Business School, Lagos, Nigeria
[2]Dept. of Economics, Lagos State University, Lagos, Nigeria

This study was aimed at examining the linkages between corruption, environmental sustainability, and economic performance. It was motivated by the quest to test the validity of the Environmental Kuznets Curve (EKC) hypothesis in Nigerian. The EKC hypothesis explains the nexus between economic activities and environmental degradation. Therefore, this current study investigated the interconnections between corruption, environmental sustainability and economic performance in Nigeria using the modern Autoregressive Distributed Lag Model (ARDL) approach for the period from 1981 to 2020. The study revealed that corruption has negative and statistically significant effects on environmental quality and Nigeria's economic performance. In addition, the study showed that corruption has direct and indirect effects on environmental quality and asserted that corruption raises the level of C02 emissions and worsens the overall quality of environment, these empirical finding are in tandem with the postulation of the Environment Kuznets Curve (EKC) hypothesis. This shows that economic performance responds to the changes in corruption and carbon emission in the long-run in a negative and statistically significant manner. Therefore, the concerned regulatory agencies must be strengthened to firmly address violators of environmental regulations and enhance energy efficiency.

Keywords: Corruption, environmental degradation, economic performance, energy consumption, autoregressive distributed lag (ARDL)

JEL: C10, F43, H10

The ongoing debate on air quality, global warming and other environmental challenges has shifted the focus of policymakers from conventional economic growth and developmental issues to sustainable development and the Green economy (Nanok and Onyango, 2017; Iheanachor and Ozegbe, 2021).

Extensive inquiries have long been conducted to highlight the theoretical and empirical underpinnings of growth and the environment. Nevertheless, the groundbreaking work of Grossman and Krueger (1991), now known as the Environmental Kuznets Curve (EKC) hypothesis has been the dominant theoretical proposition that explains the linkages between environmental degradation and economic performance in the last three

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*Corresponding author: elvisozegbe@gmail.com

decades. The EKC model suggests that there is an inverted U-shaped linkage between environmental degradation and economic performance. It asserts that pollution and degradation rises in the early stages of economic growth, however, beyond the threshold of a certain level of per capita income, the trend reverses. Therefore, economic growth propels improved environmental quality as income level increases (Akadırı *et al.*, 2021; Egbetokun *et al.*, 2019; Isik *et al.*, 2019). The magnitude of carbon dioxide (C02) emissions in Nigeria has fluctuated since the early 1970s and remained unabated. However, the gross domestic product per capita rose persistently from the early 2000s until around 2016 when the economy fell into recession. Although the EKC model suggests that the nexus between economic activities and environmental degradation has an inverted U-shape, there have been some empirical studies that reported contrary findings. Some studies have aligned with EKC (Masron and Subramaniam, 2018; Sinha *et al.*, 2019; Zhang *et al.*, 2019), moreover, some others have not (Jebli and Youssef, 2015; Zambrano-Monserrate *et al.*, 2018; Adu and Denkyirah, 2019). Furthermore, some other studies have mixed findings (Shaw *et al.*, 2010; Cetin, 2018). As such, this study was motivated by the desire to test the validity of the EKC model in the Nigerian context by examining the nexus between corruption, environmental degradation, and economic performance.

Therefore, it is imperative to raise some research questions to guide the investigation. Does the EKC model exist in Nigeria? What are the effects of corruption on Nigeria's environmental sustainability? Does economic performance impede environmental sustainability in Nigeria? The answers to these questions would provide policymakers, researchers and all stakeholders with essential insights on the nexus between corruption, environmental sustainability and Nigeria's economic performance.

The specific goal of this study is to determine whether corruption distorts Nigeria's economic growth and accelerates the level of environmental degradation. The Nigerian economy has been adjudged to be suffering from high corruption with acute pollution problems in the last four decades (Dada and Ajide, 2021). Therefore, this study contributed to extant empirical literature by exploring the nexus between corruption, environmental degradation and economic performance in Nigeria, having some relevance for environmental policy.

Following the above introductory section, the next section examines the literature review while the third and fourth sections outline the method of analysis, results and discussions, while the final section contains the conclusion of the study.

LITERATURE REVIEW

The Environmental Kuznets Curve (EKC) Hypothesis

In the last three decades, the Environmental Kuznets Curve hypothesis has emerged as the dominant model for explaining the nexus between economic performance and environmental degradation (Egbetokun *et al.*, 2018; Demissew and Kotosz, 2020).

The idea behind the environmental Kuznets curve (EKC) hypothesis emerged from the groundbreaking work of Grossman and Krueger (1991), using the Kuznets (1955) concept as a benchmark for the postulation of the hypothesis. Although Grossman and Krueger (1991) initially assessed the effects of North America Free Trade Agreement (NAFTA) on the environment. However, the background work by Shafik and Bandyopadhyay (1992) for the world development reports 1992 remains the starting point of the EKC concept. Therefore, the EKC model posits that "the view that increased economic activities inevitably harm the environment is based on static assumptions about tastes, technology and environmental investment, and that "as the level of income increases, the demand for improvement in environmental quality will increase, just as the resources available for investment". Similarly, Beckerman (1992) contended that evidence abounds in that economic activities usually lead to environmental degradation in the early stages of the process. In the end, the only way to attain a sustainable environmental quality is for most nations to become rich. As such, espousing the EKC hypothesis, Grossman and Krueger (1991) and Grossman and Krueger (1995) affirmed the existence of an inverted U-shape in the linkage between per capita income and environmental degradation. Several scholars have attempted to examine the linkages between economic activities and environmental degradation by adopting the EKC model as the theoretical base. In the view of Arminen and Menegaki (2019) majority of EKC studies pointed their search light on C02 emission, probably because of data availability and greenhouse gas emission in the environmental sustainability debate on climate change. For instance, Ali *et al.* (2017)

investigated the validity of the EKC hypothesis in Malaysia. The study used an ARLD approach to ascertain the long-term relationship between GDP per capita, trade openness, financial development, energy consumption and foreign direct on C02 emission. Similarly, Al-Mulali *et al.* (2016) examined the validity of the EKC hypothesis across seven regions of the world which includes Western Europe, Central and Eastern Europe, Middle East and North Africa, Sub-Saharan Africa, East Asia and the Pacific, South Asia and the Americas. The study employed Pedroni and Fisher cointegration test, dynamic ordinary least square (DOLS) analytical technique. The study found the existence of the EKC hypothesis in five regions except Sub-Saharan Africa, the Middle East, and North Africa. Also, Lin *et al.* (2016) suggested that the EKC model does not exist in Africa after examining the relationship between economic performance and environmental quality in DR. Congo, Kenya, Nigeria, South Africa, and Egypt.

Corruption and Environmental Degradation Nexus

The menace of corruption may affect environmental degradation directly by reducing the stringent environmental regulations, destroying the level of environmental quality through the rising level of emissions (Arminen and Menegaki, 2019; Yahaya *et al.*, 2020). In addition, corruption has been linked to weak enforcement of environmental regulations (Sundström, 2013; Oliva, 2015) which further affirms its rising effects on emissions. Therefore, petty and grand corruption is associated with environmental degradation from the purview of the level of effectiveness of environmental regulations (Sundström, 2013; Oliva, 2015). In the view of Cole (2007), corruption could also influence environmental degradation directly through its effects on economic structure. For instance, firms' level of trade protection and subsidies received from the state could be influenced by corruption.

Corruption also has an indirect impact on environmental degradation through its effects on income level (Arminen and Menegaki, 2019; Bakare and Ozegbe, 2022). As stated earlier, corruption is likely to impede economic performance and might therefore reduce environmental degradation because of the scale effects. According to (Arminen and Menegaki, 2019) the increasing direct effect and decreasing indirect effect on environmental degradation, aggregate effect of corruption on environmental degradation is undefined.

Akhbari and Nejati (2019) employed the panel threshold model to examine the link between corruption and environmental degradation in 61 countries comprising developed and developing economies. The result revealed that corruption raises the level of carbon emission in developing countries while corruption has no influence on the level of carbon emission in developed countries. Wang *et al.* (2018) investigated the moderating role of corruption in the relationship between environmental factors and the economy of BRICS countries (i.e., Brazil, Russia, India, China and South Africa) between 1996 and 2015 using the partial least square regression model as its analytical technique. The study suggested that corruption as a moderating variable is essential in determining the nexus between economic growth and CO_2 emissions. It concluded that CO_2 emissions reduce when corruption is controlled. The study added that there is a significant relationship between CO_2 and urbanization among BRICS nations, which indicated poor environmental quality among these countries. Meehan and Tacconi (2017) conducted a field research to find out how diverse ranges of corruption affect environmental degradation and economic growth in Indonesia. The result shows that the effect of a diverse range of corruption on forest management can be indirect, direct, negligible and also complicated. Anticorruption policies should concentrate more on specific types of corruption, which are increasing the level of deforestation along with degradation. Corruption influences the dysfunctional environmental regulatory systems that lead to the over-exploitation of natural resources, contributes to the extinction of species, the degradation and pollution of ecosystems, wildlife habitats and spread of diseases and invasive species. Corruption creates socially sub-optimal and unbalanced environmental governance and violates extant rules (Uroos *et al.*, 2022). Ozturk and Al-Mulali (2015) examined the effect of control of corruption on CO_2 emissions in Cambodia and revealed that control of corruption can aid in the reduction in CO_2 emissions. The import from this finding is that less corruption, a good governance system can aid the reinforcement of environmental regulations and induce firms to comply with environmental laws. Effective governance promotes political freedom and sensitizes the public to environmental sustenance (Bildirici, 2022). Biswas and Thum (2017) asserted that corruption affects the environment by passing through the informal sector channels. Similarly, Sekrafi and Sghaier (2018) suggested that stringent environmental regulations may drive firms towards the informal sector of the economy to maximize profit. The capacity of regulatory agencies to prevent firms from violating environmental regulations and production in the informal system will aggravate the level of pollution and induce environmental degradation (Sekrafi and Sghaier, 2018). Zhang *et al.* (2018) investigated the direct and indirect impacts of corruption on C02 emissions and asserted that corruption raises CO_2 emissions and may continue to damage the environmental quality of Asia-Pacific Economic Cooperation (APEC) nations.

Conversely, Cole (2007) reported a positive effect of corruption on environmental quality. The study revealed that corruption promotes environmental quality through its adverse effect on economic growth. It asserted that declining economic growth reduces the rate of pollutants emitted. Sahli and Rejeb (2015) examine the nexus between corruption and the environmental Kuznets Curve in the Middle East and North African (MENA) region from 1996 to 2013 using the panel dynamic regression model as its analytical technique. The study revealed that a direct positive effect of corruption on both carbon emissions and economic growth.

Stemming from the empirical examination of the relationship between corruption and environmental degradation, hypothesis one is stated below.

H_1: Corruption has no significant relationship with environmental degradation.

Corruption and Economic Performance Nexus

There is a 'chicken and hen paradox' in the relationships between corruption and economic performance in the economic and social literature. Similarly, the nexus between corruption and economic performance has been extensively examined by several scholars.

Some scholars assume that corruption serves as "sand in the wheel of economic performance". This school of thought considers corruption to lead to theft and embezzlement by public officials, leading to a net capital loss (Bahoo *et al.*, 2021). Due to corruption, government expenditure on productive projects, such as health care provision and public education, may nosedive as they offer greater possibilities for rent-seeking for public servants (Cieślik and Goczek, 2018; d'Agostino *et al*., 2016). Several empirical studies support this point of view.

Nguedie (2018) examined the channels of transmission of corruption to growth. They specifically concentrated on the human capital channel demonstrate that corruption diverts resources from education investments to power-seeking activities or political capital investments, thus jeopardizing long-term growth.

In a recent study, Truong (2020) analyzed the relationships between corruption and economic growth using linear regressions, the study revealed that the harmful impact of corruption on economic growth is 81 percent through indirect effects. The study also investigated the channels of transmission of corruption on economic growth, and the results obtained show that investment would be the most critical channel with a contribution of 32 percent.

Ugur (2014) found 327 estimates of corruption's direct effect on per capita GDP growth from 29 studies. The inquiry findings indicate that corruption has a negative effect on per capita GDP growth, but the severity of the effect is minor and more adverse in low-income countries. Campos *et al.* (2016) employed meta-regression analysis to a sample of 41 empirical studies comprising 460 comparable estimates of the effect of corruption on economic growth. Approximately 32 percent of those estimates support a significant and negative impact of corruption on growth. 62 percent suggest a statistically insignificant relationship, while approximately only 6 percent support a positive and significant relationship. Kurniawan *et al.* (2020) examined the impact of corruption on the economic growth of 14 Organization of Islamic Cooperation (OIC) from 2003 to 2017. The study employed endogenous growth theory and economic freedom index for analysis. The findings revealed that corruption had a negative impact on the economic growth of the selected OIC countries. Chowdhury and Audretsch (2021) argue that corruption can positively affect economic growth. According to this school of thought, corruption would act as a "fat needed for the squeaking of wheels of a rigid administration".

It can be used to "oil the wheels" of economic growth in a context where regulation is omnipresent and cumbersome (weak governance). Bureaucratic corruption is the second-best solution that can effectively reduce the burden of excessive regulation and has positive effects on growth (Miah *et al.*, 2021; Sharma and Mitra, 2019). In imperfect competition, where several market failures prevail because of weak governance measures, corruption can induce positive change by distorting the distorted market, thus bringing dynamic and allocative efficiency (Erum and Hussain, 2019). Proponents of this theory of "functionalism" opine that corruption can be socially beneficial and promote economic growth through multiple mechanisms (Gans-Morse *et al.,* 2018). First, corruption can raise bureaucratic efficiency by decreasing barriers to economic growth. Second, in countries characterized by complex state regulations and low motivated bureaucrats, corruption sometimes serves as a solution to reduce bureaucracy. Third, it would help entrepreneurs circumvent expensive delays, circumvent heavy and rigid government regulations and reduce waiting costs (Bitterhout and Simo-Kengne, 2020; Trabelsi and Trabelsi, 2020).

From the empirical evaluation of the corruption-growth nexus, hypothesis two is proposed to test if corruption is grease to the wheels of economic performance or otherwise.

H_2: Corruption has no significant effect on Nigeria’s economic performance.

METHODOLOGY

Sample and Data

This study ascertains the relationship between corruption, environmental degradation and economic performance in Nigerian using annual time-series data from 1981 to 2020. The data employed for the empirical investigation were obtained from the published dataset statistics of the World Development Indicators of the World Bank, the Central Bank of Nigeria (CBN) databases and the Transparency international (TI). The Description of Variables is shown in Table 1 (see Appendix-I).

Data Analysis Techniques

The empirical analysis in this study includes the preliminary analysis, estimation and post estimation. The preliminary analysis includes descriptive statistics, unit-roots test and co-integration test. Regarding the co-integration test (bounds co-integration test) and estimation, the study employed Autoregressive Distribution Lag (ADRL) to examine the short-run and long-run relationships. There is evidence of a long-run relationship if the computed F-statistics exceed the upper bound critical value. However, there is no co-integration if the F-statistic is below the lower bound, while the result is inconclusive for a value within lower and upper bounds. The post estimation tests, which include serial correlation test, heteroscedasticity test, normality test and structural stability CUSUM test, were conducted to examine the adequacy and reliability of the specified model Pesaran *et al.* (2001).

Model Specification

Following the Environmental Kuznets Curve (EKC) hypothesis espoused by Grossman and Krueger (1991), our model examined the nature of the relationship between corruption, CO_2 emission and economic performance. It was inspired by the empirical works of Wang *et al.* (2018) and Sekrafi and Sghaier (2018).

The functional form of the model is given as:

$$RGDP_t = f(CORP_t, CO2_t, OPEN_t, ENG_t, GFCF_t,) \quad (1)$$

Hence, the specific ARDL model for this study is expressed as:

$$RGDP_t = \theta + \sum_{i=1}^{p} \alpha_i \, RGDP_{t-i} + \sum_{i=0}^{q_1} \beta_{1i} \, CORP_{t-i} + \sum_{i=0}^{q_2} \beta_{2i} \, CO2_{t-i} + \sum_{i=0}^{q_3} \beta_{3i} \, OPEN_{t-i} + \sum_{i=0}^{q_4} \beta_{4i} \, ENG_{t-i} + \sum_{i=0}^{q_5} \beta_{5i} \, OPEN_{t-i} + \varepsilon_t \quad (2)$$

where p, q_1, q_2, q_3 and q_4, are the respective maximum lags of the dependent variable (*GDPG*) and the explanatory variables (*CORP*, CO_2, *OPEN*, *ENG* and *GFCF*) while α_i, β_{1i}, β_{2i}, β_{3i},β_{4i} and β_{5i} are the respective coefficients associated with the dependent variable (*RGDP*) and the explanatory variables at the respective lags.

The ARDL Error Correction Model (ECM) specification is given as:

$$\Delta RGDP_t = \theta + \sum_{i=1}^{p} \alpha_i \, RGDP_{t-i} + \sum_{i=1}^{q_1} \beta_{1i} \, \Delta CORP_{t-i} + \sum_{i=1}^{q_2} \beta_{2i} \, \Delta CO2_{t-i} + \sum_{i=1}^{q_3} \beta_{3i} \, \Delta OPEN_{t-i} + \sum_{i=1}^{q_4} \beta_{4i} \, \Delta ENG_{t-i} + \sum_{i=1}^{q_4} \beta_{4i} \, \Delta GFCF_{t-i} + \varnothing ECM_{t-i} + \epsilon_t \quad (3)$$

In equation (3), the coefficient ($\varnothing$) of the ECM term called the speed of adjustment is expected to be negative to restore the model to equilibrium, *i.e.*$\varnothing < 0$.

Given equation (4), the long run form of the ARDL is specified as follows:

$$RGDP_t = \delta_0 + \delta_1 CORP + \delta_2 CO2_t + \delta_3 OPEN_t + \delta_4 ENG_t + \delta_5 GFCF_t \qquad (4)$$

Where $\lambda_1 < 0, \lambda_2 >< 0, \lambda_3 > 0, \lambda_4 > 0, \lambda_5 > 0$

RESULTS

This section presents the results of the empirical analysis involving descriptive analysis, unit root test analysis, co-integration test, estimation, and post estimation tests.

Descriptive Statistics

This section provides the descriptive or summary statistics of the variables being examined in the study, such as real GDP (*RGDP*), corruption (*CORP*), carbon emission (CO_2), trade openness (*OPEN*), energy consumption (*ENG*) and gross fixed capital formation (*GFCF*).

Table 2 (see Appendix-II) reports the summary statistics of the variables in the study. All the variables being examined have their standard deviations below their mean values. This suggests some levels of consistency in the movement of the variables. Also, the observations of the variables cluster closely around the mean values. Apparently, the variables may have high predictive attributes. The series *RGDP*, *CORP*, CO_2, *ENG* and *GFCF* appear to be positively skewed (long right tail), having positive coefficients of skewness while only *OPEN* exhibits a negatively skewed pattern of distribution, having a negative coefficient of skewness. Series such as *RGDP*, *CORP*, CO_2, *ENG* and *OPEN* appear to have flat-topped distributions (platykurtic) having coefficients of kurtosis greater threshold level of 3. Meanwhile, only *GFCF* appear to have peaked distribution (leptokurtic) relative to the normal distribution, having a coefficient of kurtosis above the threshold level of 3. The Jarque-Bera statistics for normality test indicate that series such as *RGDP*, *CORP*, CO_2, *ENG* and *OPEN* are normally distributed having their respective p-values are greater than the 5 percent level of significance. However, only *GFCF* appears to deviate from normal distribution, having a p-value (0.0168) below the percent level of significance.

Pre-Estimation Tests

In this section, pre-tests such as unit root and co-integration tests were conducted to evaluate the statistical fitness such stationarity of the variables and existence of a linear combination among the variables being examined in the study.

Unit Root Tests

The unit root tests were conducted prior to model estimation to determine the stationarity status of the variables in being investigated. Thus, the Augmented Dickey-Fuller (ADF) test was employed to evaluate the stationarity status of the series.

Table 3 presents the result of the unit test using the ADF unit root test. Thus, series such as *RGDP* and *GFCF* appear to be integrated of order zero, they are *I(0)* series. Meanwhile, other series such as *CORP*, CO_2, *ENG* and *OPEN* are integrated of order one, they are *I(1)* processes. This suggests that the series had to be differenced once in order to become stationary. Thus, as proposed by Pesaran *et al.* (2001), the combinations of *I(0)* and *I(1)*) orders of integration of the variables validate the use of bounds co-integration test to examine the existence of a linear combination among the variables.

Bounds Co-integration Test

Having different orders of integration suggests the use of bounds co-integration test (the ARDL bounds test) to examine the existence of long-run equilibrium among the variables.

Variable	Test form	ADF- Statistics Constant	Constant & Trend	None	Order of integration *I*(*d*)
RGDP	***Level***	-0.0968	-1.4860	2.5260	***I(1)***
	1st Difference	-3.4341**	-3.3517*	-2.1580**	
CORP	***Level***	-0.6005	-3.5908**	-1.0762	***I(0)***
	1st Difference	-	-	-	
CO_2	***Level***	-2.0570	-1.9515	-0.5456	***I(1)***
	1st Difference	-6.0143***	-6.0095***	-6.0716***	
OPEN	***Level***	-1.8921	-2.0158	0.0943	***I(1)***
	1st Difference	-7.3893***	-7.3707***	-7.4322***	
ENG	***Level***	-1.1217	-2.8873	-1.1055	***I(1)***
	1st Difference	-5.8272***	-5.7497***	-5.7711***	
GFCF	***Level***	-1.9346	-2.1908	-2.4271**	***I(0)***
	1st Difference	-	-	-	

Source: Authors' computation using E-views
Note: ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively.

Table 3: Unit Root Test (Sample Period: 1981–2020)

F – Statistic:	12.0094	
Level of significance	**Lower bounds–*I(0)***	**Upper bounds–*I(1)***
1%	3.06	4.15
5%	2.39	3.38
10%	2.08	3.00

Source: Authors' computation using E-views

Table 4. Bounds Co-Integration Test (Sample Period: 1981–2020)

Table 4 presents the results of the bounds co-integration test of the ARDL approach. Thus, since the *f*-statistic (3.792) exceeds the critical value upper bounds at 5 percent and 10 percent levels of significance. This suggests that there is evidence of long run relationship or linear combination among the variables. In other words, real GDP (*RGDP*), corruption (*CORP*), carbon emission (*CO_2*), trade openness (*OPEN*), energy consumption and gross fixed capital formation (*GFCF*) appear to have a long-run relationship despite having different orders of integration among the variables. Thus, the fear of having a spurious relationship is eliminated.

Model Estimation

Since there is the evidence of co-integration among the variables, the model estimation includes both long-run and short-run estimates. Estimation involved the log transformation of all the variables.

Estimation of ARDL Short-run coefficients

Table 5 (see Appendix-III) presents the result of the short run form (error correction model) of the ARDL. The coefficient (-0.3045) of the *ECT* (error correction term) term which implies the speed of adjustment is negative and statistically significant (p*-value* = 0.0001) at 1 percent level of significance. As expected, the coefficient lies between -1 and 0 for convergence. Thus, this suggests that *RGDP* adjusts to *CORP*, CO_2, *OPEN*, *ENG* and *GFCF* in the long run. The system corrects its disequilibrium in the previous period at a speed of about 30.45 percent, thereby restoring to equilibrium in the current period. Therefore, equilibrium or long-run relationship has been restored among the variables. In addition, aside from the short-run coefficients of first lagged difference of *RGDP* and differences of *CORP*, CO_2, *ENG* and *GFCF*, all other short-run variables have statistically significant impacts on economic performance (*RGDP* as the proxy) in the short-run. In addition, the explanatory power (adjusted R-Squared) of the estimated short-run model is substantially higher (91.53 percent) and thus, suggests that *CORP*, CO_2, *OPEN*, *ENG* and *GFCF* are good predictor economic performance in the short-run.

Estimation of ARDL Long-Run Coefficient

Table 6 (see Appendix-IV) reports the result of the estimated long run form of the ARDL for the given sample period. The estimated long-run equation shows that corruption (*CORP*, δ_1 = -0.1578, p-value = 0.0006= < 0.01) and carbon emission (CO_2, δ_2 = -0.5849, p-value = 0.0053< 0.01) have a negative and statistically significant long-run impacts on *RGDP* (economic performance). Meanwhile, *OPEN* (δ_3 = 0.4672, p-value = 0.0003< 0.01), *ENG* (δ_4 = 2.1325, p-value = 0.0483< 0.05) and *GFCF* (δ_5 = 0.8608, p-value = 0.0000< 0.01) exert positive and statistically significant impact on *RGDP*.

Apparently, a 1 percent rise (fall) in corruption index (*CORP*) will, on average lead to a fall (rise) in *RGDP* by about 0.158 percent while a 1 percent rise (fall) in CO_2 will on average result in fall (rise) in *RGDP* (a proxy for economic performance) by about 0.585 percent. Consequently, both corruption and carbon emission are *RGDP* (income) inelastic.

Post Estimation Tests (Residual Diagnostics)

The post estimation tests include serial correlation test, Heteroscedasticity test, normality test, linearity or specification error test (Ramsey RESET test) and stability test (CUSUM test).

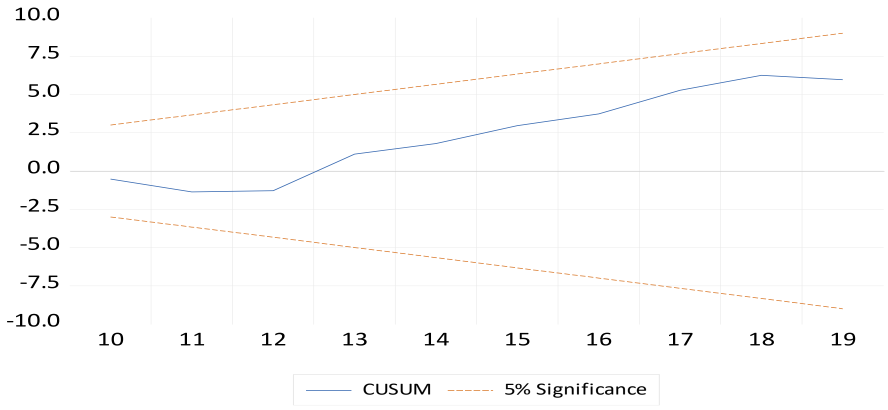
Table 7 (see Appendix-V) presents the results of the serial correlation test, Heteroscedasticity test, normality test and linearity test. For the serial correlation test, since the p-values (0.6213 and 0.1404 respectively) of both the *f*-statistic (0.5054) and LM statistic (3.9267) are greater than 10 percent level of significance, the null hypothesis of no serial correlation cannot be rejected. Thus, the model estimated does not suffer from a serial correlation for the given sample period.

The result of the heteroscedasticity test suggests the acceptance of the null hypothesis of homoscedasticity (i.e., absence of heteroscedasticity) since the *p*-values (0.3964 and 0.3535) of both the *f*-statistic (1.2024) and LM statistic (25.9925) respectively are greater than 10 percent level of significance. Thus, the model estimated does not suffer from heteroscedasticity for the considered sample period.

Similarly, the normality test result reveals that the residuals of the estimated model are normally distributed as the *p*-value (0.8647) of the Jarque-Bera statistic (0.6490) is greater than 10 percent level of significance (statistically insignificant).

The linearity test using Ramsey RESET test examines whether there is an existence of a linear relationship between the dependent variable (*RGDP* as a measure for economic performance) and the explanatory variables (*CORP*, CO_2, *OPEN*, *ENG* and *GFCF*) or whether the model is correctly specified. The null hypothesis is that the model is linear or correctly specified. Thus, since the *t*-statistic (1.0330) and *f*-statistic (1.0670) are not statistically significant (that is, having their respective *p*-values above 10 percent level of significance), the null hypothesis for linearity cannot be rejected. This suggests that the estimated model in this is linear or correctly specified.

Meanwhile, the CUSUM test result is presented in Figure 1 below:



Source: Authors' Presentation

Figure 1. Plot of Cumulative Sum (CUSUM) of Recursive Residuals

Figure 1 presents the result of the test of stability using CUSUM criterion. Since the plot remains within the critical bounds at 5 percent level of significant, thus, the model is structurally stable. The estimated ARDL model parameters are stable and appropriate for long run decision making. Therefore, all the post estimation test results suggest that the short-run and long-run estimates from the estimated ARDL model are valid and reliable for inferences, forecasting and policy making.

DISCUSSION

Following the groundbreaking work of Grossman and Krueger (1991) which posited that the initial development outcome of an economy lead to an increase in per capita income, which invariably translates to environmental degradation through the rising level CO_2 emission and poor environmental quality.

This present study sought to reveal how the governance system in Nigeria affects growth-environment nexus by examining the effects of corruption on the economy and also to find out how the robust economic performance affects the environment. This study revealed that corruption has negative and statistically significant effects on environmental quality and Nigeria's economic performance. Meanwhile, trade openness, energy consumption and gross fixed capital formation exerted a positive and statistically significant effect on economic performance.

The foregoing implies economic performance responds to the changes in corruption and carbon emission in the long-run in a negative and statistically significant manner. Meanwhile, economic performance has the potential for responding to changes in trade openness, energy consumption and gross fixed capital formation in the long-run in Nigerian a positive and statistically significant fashion for the given sampled period. The findings of this current study are consistent with the revelations from (Huang and Liu, 2014; Chang and Hao, 2017; Zhang *et al.*, 2018; Yan and Wen, 2020) demonstrated that corruption has direct and indirect effects on environmental quality and asserted that corruption raises the level of C02 emissions and worsens the overall quality of environment, these empirical finding are in tandem with the postulation of the Environment Kuznets Curve (EKC) hypothesis.

This result above implies that hypothesis 1 (H_1) is rejected and research question 1 is answered. On the contrary, the finding of this study is at variance with (Cole 2007; Sahli and Rejeb 2015) whose findings revealed that corruption contributes to the improvement in environmental quality through its adverse effects on economic performance. The studies posit that a decline in economic performance can translate to a reduction in the level of pollutant emitted in an environment.

The present study also reaffirms the empirical findings of earlier studies on the corruption-growth nexus which belongs to the sands to wheels school of thought (Cieślik and Goczek, 2018; Nguedie 2018; Truong, 2020). This is finding implies that the study's research hypothesis 2 (H_2), which states that corruption has no significant effect on economic performance, is rejected. In addition, the study's second research question is answered.

This school of thought posits that corruption lead to theft and embezzlement by public officials, reduction in human capital development, low investment, low productivity, which translates to poor economic performance (Ugur 2014; Campos *et al.*, 2016; d'Agostino *et al.*, 2016; Cieślik and Goczek, 2018; Nguedie 2018; Truong, 2020).

However, this study contradicts the findings of some other earlier empirical investigations which posit that corruption positively affects economic performance and serve as an engine of growth and development when bureaucratic delays and stringent rules imposed by the state enable investors to maneuver their way out of administrative bottlenecks imposed by the government (Phuong, 2020). Corruption increases the level of efficiency in an economy and injects positive impact on the overall performance (Erum and Hussain 2019; Gans-Morse *et al.*, 2018; Sharma and Mitra, 2019; Lawal *et al.*, 2020).

CONCLUSION

Attaining consistent and sustainable economic growth and development without adverse consequences on the environment has been a major concern to policy-makers, academics, and researchers in recent decades. The EKC model clearly explained the nexus between economic performance and the natural environment.

Therefore, this study examined if corruption impedes Nigeria's economic performance and accelerates the level of environmental degradation in the country. It is difficult to derive a consistent estimation of the aggregate effects of corruption on economic performance and environmental degradation. However, the result from this study's estimation revealed that corruption has negative and statistically significant effects on environmental quality and Nigeria's economic performance. Meanwhile, trade openness, energy consumption and gross fixed capital formation exerted a positive and statistically significant effect on economic performance.

The foregoing implies economic performance responds to the changes in corruption and carbon emission in the long-run in a negative and statistically significant manner. Meanwhile, economic performance has the potential for responding to changes in trade openness, energy consumption and gross fixed capital formation in the long-run in Nigerian a positive and statistically significant fashion for the given sampled period.

IMPLICATIONS

The outcome of this empirical inquiry unraveled the uniqueness of Nigeria's economy, stemming from the theoretical foundation of the study and the findings of extant literature. Based on the assertion of the EKC hypothesis (Grossman and Krueger, 1991) that initially development in terms of increase in per capita income leads to environmental degradation by increasing emissions of different pollutants in the economy. As both public and private sectors have a focus on creating employment opportunities in the economy, which means job creation is valued more than health and other costs of environmental degradation. The outcome of this current study is consistent with the postulation of the (EKC) hypothesis. Therefore, from a practical standpoint, policy-makers are expected to focus on designing growth policies that posses the potential to improve environmental quality through clean production (Hao and Liu, 2015; Arminen and Menegaki, 2019; Yahaya *et al.*, 2020).

The Nigerian government and its agents are encouraged to deal decisively with the issues surrounding environmental regulation and protection to improve the level of energy efficiency and also simultaneously attain accelerated economic performance. This study established that the Nigerian economy experienced different phases of growth and the rising income levels also led to increased energy utilization and hence the level of environmental degradation. The effect of corruption on the environment and the economic performance were found to be negative. Therefore, the anti-corruption programmes should be designed to transform the quality of public regulations.

LIMITATIONS AND FUTURE DIRECTIONS

This present study focused on examining the nexus between corruption, environmental degradation and economic performance measured by gross domestic product growth rate using the environmental Kuznets curve (EKC) hypothesis as its theoretical foundation. However, it must be admitted that this study is not free from criticisms that could provide an ample opportunity for further research exploration.

First, the limitations stem from the sample size, which could have been greater than the current size. As such, the result of the analysis would have been more accurate and reliable with a larger number of observations.

Second, the outcome of the inquiry is based on a country-specific analysis that was centered on Nigeria.

Therefore, the result may not be generalized, although the result may be consistent with that of other economies in Sub-Sahara Africa.

Future research endeavors can concentrate on exploring the linkages among governance structure, corruption, environmental quality, energy utilization and economic performance by conducting a panel analysis involving multiple countries emerging from various regions of the globe to guarantee the generalization of the findings. This study used the EKC hypothesis as its theoretical foundation. However, the hypothesis is a mere curve that explains the linkages between economic performance and environmental sustainability. Therefore, further studies in this research space can adopt a stronger theoretical base to support their research.

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Appendix-I

Variables	Definition	Sources
RGDP	Real Gross Domestic Product at 2010 constant basic prices	CBN (2020)
CORP	Corruption Perception index	TI (2020)
CO_2	CO_2 Emission (metric tons per capita)	World Development Indicator (2020)
OPEN	Trade openness (the sum of export and import as a % of Gross Domestic Product GDP)	World Development Indicator (2020)
ENG	Energy consumption per capita measured in kg of oil equivalent per capita	World Development Indicator (2020)
GFCF	Gross fixed capital formation as a % of GDP	World Development Indicator (2020)

Source: Authors' Presentation

Table 1. Description of Variables

Appendix-II

Statistics	Variable					
	RGDP	**CORP**	**CO_2**	**OPEN**	**ENG**	**GFCF**
Mean	34690.67	1.3244	0.5951	32.3005	723.3317	36.2197
Median	23688.28	1.4000	0.5800	34.0239	720.4457	34.1095
Maximum	71387.83	2.8000	0.8743	53.2780	798.6302	89.3811
Minimum	13779.26	0.1000	0.3256	9.1358	671.9069	14.9039
Std. Dev.	20237.78	1.0711	0.1669	12.4041	37.3216	19.1716
Skewness	0.673787	0.0987	0.0054	-0.3686	0.2554	1.0504
Kurtosis	1.8808	1.2847	1.9407	2.2507	1.6941	3.7827
Jarque-Bera	4.9862	4.8442	1.8237	1.7953	3.1952	8.1676
***p*-value**	0.0827	0.0887	0.4018	0.4075	0.2024	0.0168
Obs.	39	39	39	39	39	39

Source: Authors' Computation using E-views

Table 2. Results Summary Statistics (Sample Period: 1981 – 2020)

Appendix-III

Independent Variable	Coefficient	Std. Error	t-Statistic	*p*-value
$\Delta RGDP_{t-1}$	-0.0660	0.1198	-0.5510	0.5937
$\Delta RGDP_{t-2}$	-0.7433	0.0981	-7.5760	0.0000
$\Delta CORP$	-0.0031	0.0038	-0.8066	0.4387
$\Delta CORP_{t-1}$	-0.0624	0.0082	-7.5938	0.0000
$\Delta CORP_{t-2}$	-0.0521	0.0094	-5.5621	0.0002
$\Delta CORP_{t-3}$	-0.0338	0.0061	-5.5276	0.0003
ΔCO_2	0.0211	0.0252	0.8378	0.4217
$\Delta CO_{2\ t-1}$	-0.1458	0.0244	-5.9813	0.0001
$\Delta CO_{2\ t-2}$	-0.1074	0.0256	-4.1902	0.0019
$\Delta CO_{2\ t-3}$	-0.1256	0.0193	-6.5165	0.0001
$\Delta OPEN$	0.0237	0.0100	2.3690	0.0393
$\Delta OPEN_{t-1}$	-0.0937	0.0162	-5.7939	0.0002
$\Delta OPEN_{t-2}$	-0.0619	0.0103	-6.0345	0.0001
ΔENG	0.0982	0.1687	0.5818	0.5736
ΔENG_{t-1}	0.5921	0.1822	3.2480	0.0087
$\Delta GFCF$	-0.0161	0.0222	-0.7251	0.4850
$\Delta GFCF_{t-1}$	0.2584	0.0388	6.6553	0.0001
$\Delta GFCF_{t-2}$	0.0567	0.0292	1.9457	0.0803
ECT_{t-1}	-0.3045	0.0263	-11.598	0.0000
R-Squared	0.9601			
Adjusted R-Squared	0.9153			

Source: Authors' Computation using E-views
Dependent Variable: *RGDP*

Table 5. Estimated ARDL Short Run Coefficients Sample Period: 1981–2020

Appendix-IV

Independent Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
CORP	-0.1578**	0.0319	-4.9462	0.0006
CO_2	-0.5849**	0.1651	-3.5431	0.0053
OPEN	0.4672**	0.0878	5.3206	0.0003
ENG	2.1325*	0.9482	-2.2489	0.0483
GFCF	0.8608**	0.1249	-6.8927	0.0000
C	26.3984**	6.4762	4.0762	0.0022

Source: Authors' Computation using E-views
Dependent Variable: *RGDP*
Note: ** and * denote statistical significance at 1% and 5%, respectively

Table 6. Estimated ARDL Long-Run Coefficients (Sample Period: 1981–2020)

Appendix-V

Serial correlation test:		***p*-value**
f-statistic	0.5054	0.6213
LM Statistic	3.9267	0.1404
Heteroscedasticity test:		***p*-value**
f-statistic	1.2024	0.3964
LM Statistic	25.9925	0.3535
Normality Test:		***p*-value**
Jarque-Bera	0.8647	0.6490
Linearity Test		***p*-value**
t-statistic	1.0330	0.3286
f-statistic	1.0670	0.3286

Source: Authors' Computation using E-views

Table 7. Results of Post Estimation tests