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The Environmental Consequences of Foreign Finance Inflows and Economic Performance in Africa

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The purpose of this study was to examine the impact of foreign finance inflows and economic performance on environmental degradation in Africa. The study was motivated by the quest to reexamine the validity of the environmental Kuznets curve (EKC) theory in 15 selected African economies by practically decomposing the total environmental effects of foreign finance into three strands, namely scale, technique, and composition effects. The panel dataset contained the 15 largest economies selected from the five regions of the African continent from 1990 to 2020 and ensured the used of 31 observations for each country. To simultaneously guarantee heterogeneity among the long-run and short-run coefficients, the study employed pooled mean group (PMG) estimator of the dynamic heterogeneous panel auto-regressive distributed lag (panel ARDL) model as its analytical technique. The study revealed that economic performance was negatively and positively related to environmental degradation in the short-run and long-run, respectively. This confirms the existence of an inverted U-shaped relationship between economic performance and environmental degradation and also validates the existence of the environmental Kuznets curve (EKC) hypothesis. Moreover, foreign finance was inversely related to environmental degradation, which implies that poor environmental quality cannot be directly linked to foreign capital inflows among the investigated countries.

Keywords: Foreign finance, environmental degradation, economic performance, environmental Kuznets curve (EKC)

JEL: C10, F43, H10

The industrial sector of the African continent has been one of the most critical contributors to its economic performance i.e., 27.2 percent of Gross Domestic Product (GDP) in recent years (Ayentimi and Burgess, 2019). Growing industrial output requires increased attraction of cross-border resources, which are the most essential determinant of progress in the sector (Adeleye and Eboagu, 2019). As much as Africa desires to develop economically, the quest for economic development demands for high energy utilization, which calls for mobilization of foreign finances. However, the influx of foreign investors and investments has posed a huge concern about environmental pollution especially carbon emissions (Bekhet *et al*., 2017). Zaman and Moemen (2017) posited that economic development amid environmental degradation is something that should bring

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shame to everyone. Moreover, foreign finance stimulates economic activity by providing direct access to capital, generating positive externalities, transferring advanced technology and increasing productivity (Alshubiri and Elheddad, 2019; Nasir *et al.*, 2019). Foreign finance helps in nurturing local enterprise development, which further encourages employment opportunities for skilled and unskilled labor in the host country (Stojanovic, 2020). Foreign finance promotes economic growth but such growth is not free from environment cost (Shahbaz *et al.,* 2019). The fact is that developing economies undermine environmental quality via relaxed environmental regulation which is known as *pollution haven hypothesis* (Kisswani and Zaitouni, 2021). In such circumstances, multinationals are encouraged to make an investment in those countries which have relaxed environmental policies to enhance their production. This scenario provides opportunities to multinationals to gain full advantage of reduced cost of production which is known as *industrial flight hypothesis* (Christoforidis and Katrakilidis, 2021).

Relaxed environmental policies and reduced cost of production are sources of environmental degradation in the host country (Kisswani and Zaitouni, 2021; Christoforidis and Katrakilidis, 2021). Contrarily, foreign finance comes with advanced and energy efficient technology and works under better management practices that lead to improved environmental quality in the host country. This is termed as *pollution halo hypothesis*. Foreign finance affects economic growth, which affects energy consumption and hence carbon emissions in the host country (Shahbaz *et al.*, 2019). If multinationals or foreign investors employ advanced technologies for their production process, then foreign finance declines energy intensity and lowers CO_2 emissions otherwise foreign finance impedes environmental quality by increasing carbon emissions due to use of energy intensive technology. The relationship between foreign finance and carbon emissions via income or energy consumption has been discussed and empirically investigated in the literature, but results are inconclusive (Shahbaz *et al.*, 2019; Ren *et al.*, 2021).

The motivation for the study is based on the ambiguity in empirical evidence on foreign finance-environment linkages offers the rationale for re-investigating the relationship among foreign finance, environmental degradation and economic growth to establish a consistent and reliable empirical proposition in the context of the African continent. As such, this study fills the empirical and theoretical gaps in the literature by examining the association among foreign finance, environmental degradation and economic growth by testing the validity of the environmental Kuznets curve (EKC) hypothesis in the context of the African continent. The EKC hypothesis suggests that economic growth at an initial stage requires a high demand for raw materials and natural resources, which leads to more CO_2 emissions and harmful waste. Therefore, in the early phase of economic development, pollution and economic growth grow parallel. After a certain amount of time, modern techniques and technology are introduced in developed economies; industrial waste diminishes, mitigating environmental decay. Several studies have investigated the nexus between foreign direct investment (FDI) and economic growth (Rao *et al.*, 2020; Wu *et al.*, 2020; Raza *et al.*, 2021), FDI and environmental quality (Abdouli and Omri, 2021; Hao *et al.*, 2020), financial development, economic growth and environmental degradation (Saud *et al.*, 2019; Hunjra *et al.*, 2020; Baloch *et al.*, 2021). However, to the best of our knowledge, there is a paucity of studies that have scrutinized the effects of foreign finance (i.e., FDI and foreign assets) on environmental degradation in the context of the African continent.

Thus, this study's objective is to examine the impact of foreign finances and economic growth on environmental degradation in Africa. In attaining the fundamental objective, it is imperative to raise the following questions to guide this investigation: Does economic performance affect environmental quality in Africa? How has foreign finances impacted the environmental quality of African countries? The novelty of this study is based on the practical decomposition of the total environmental effect of foreign finance into three strands, namely scale, composition, and technique effects. Foreign finance affects the environment through income, which is referred to as income or scale effect. Foreign finance impacts the environment through the transformation of an economic structure i.e., the transition of the economy from agriculture to industry and then industry to services, which is known as composition effect. Foreign finance assists recipient economies in deploying technological tools which may affect the environmental quality which is termed as technique effect.

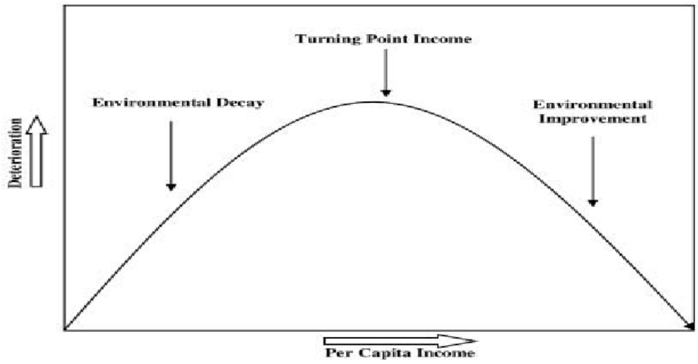
The rest of this study is structured as follows: Section two comprises the literature review; section three focuses on the methodology; section four presents the results, section five presents the discussion, section six concludes the paper by outlining the summary of findings, while section six and seven present study implications and limitations and future directions, respectively.

LITERATURE REVIEW

Theoretical Underpinnings

-The Environmental Kuznets Curve (EKC)

The linkage between environmental disruption and economic growth was first examined through the environmental Kuznets curve (EKC) hypothesis postulated by Grossman and Krueger (1995) following the earlier work of Simon Kuznets in the 1960s. This ground-breaking study explained that environmental degradation increases correspondently with economic growth. The study suggests that when there is a rise in the income level and when the income ascends to a particular level, at the defining moment, CO_2 emission declines. An inverted U-shaped relationship between environmental degradation and economic growth is made as shown in Figure 1. Ahmed and Azam (2016) posited that the current literature displays the connection between the environment, energy usage, and economic progression is extensively examined. The EKC hypothesis illustrates structural transformation in the environmental economy with economic growth (Hunjra *et al.*, 2020). Economic growth can be connected to persistent structural changes in the productive sectors of society and is based on the degree of change, which varies from one era to another, depending on the economy. The most common phase is the transition of growth from the agricultural to the industrial sector, which is closely followed by a systemic transition to the services sector of the economy (Rao *et al.*, 2020). Environmental degradation rises to a toxic level because of an obvious transformation in the economic structure following the changes in the production pattern from the rural to the urban communities and from the agricultural to the industrial sector based on intensive production and consumption. This transformation emerges after a period of decline, which is because of the emergence of modern technology that has beneficial effects on the financial and overall economic sector of the country (Dogan and Turkekul, 2016). Therefore, when the industrial activities of an economy rise, it becomes expedient to enlighten individuals about the consequences on the environment, which can promote higher investment in the environment, higher technological efficiency and better environmental quality (Baloch *et al.*, 2021).



Source: Yandle *et al.* (2004)

Figure 1. Environmental Kuznets Curve (EKC)

Economic Performance and Environmental Degradation Nexus

The issues relating to global warming and climate change have become a topical subject of debate in the economic and environmental literature as CO_2 emission has emerged as a critical concern to national economies and the international community (Saud *et al.*, 2019). This challenge has grown more significantly in recent years because of man-made activities relating to oil, gas and other associated products, which are critical sources of energy in the industrial, transportation, and services sectors linked to economic growth and development (Hunjra *et al.*, 2020). The EKC espoused by Grossman and Krueger (1995) illustrates the inequality of income relationship, which proposes that countries create economic inequality that rises to a certain level, and beyond that, the gap diminishes after reaching average income represented by an inverted U-shape. Since the groundbreaking investigation of Grossman and Krueger (1995), the EKC has generated scholarly attention and garnered several empirical applications. The EKC hypothesis opines that at the earlier stage high use of natural resources, and high demand for raw materials which bring about high CO_2 emissions and harmful substances spurs economic growth and development (Iheanachor *et al.*, 2023). As such, in the first stage of economic development, poor environmental quality, and economic growth have a direct relationship. After some period, advanced technological approaches are introduced to manage and reduce industrial waste and improve the quality of the environment.

In Azerbajan, Mikayilov *et al.* (2018) employed the fully modified ordinary least square (FMOLS) methods to examine the nexus between economic growth and CO_2 emission over the period 1992 to 2013 and reported that economic growth has a positive and statistically significant impact on CO_2 emission in the long-run, showing that the EKC theory does not hold for the country. Salahuddin *et al.* (2018) suggested that positive economic performance reduces environmental quality because rising production capacity and volume leads to rising level of environmental pollution. However, Hao and Liu (2015) contended that economic growth can improve environmental output through countries' continued clean production.

The EKC hypothesis plays a critical role in evaluating issues relating to environmental degradation, economic growth and foreign finance (Xie *et al.*, 2019). Munir and Ameer (2019) suggest that carbon dioxide (CO_2) is considered a fundamental source of environmental pollution and constitutes the largest degree of GHGs. Several extant studies opine that economic activities directly or indirectly affect the magnitude of CO_2 emission and confirm CO_2 emission effect on pollution from a global perspective (Ozcan *et al.*, 2018). The EKC hypothesis is designed as a U-shaped nexus between foreign financial indicators or economic growth and environmental pollution measured by CO_2 emissions. The theory explains the dynamic process of change involving the rising level of economic growth and its impact on CO_2 emissions (Saud *et al.*, 2019). The relationship begins with the connection between economic growth and increase in CO_2 emissions, and then, these emissions declines to the barest minimum when the economy attains the level of sustainable growth and development (Rao *et al.*, 2020).

Based on the empirical and theoretical examination of the relationship between economic performance and environmental degradation in the section above, hypothesis one is proposed below to test the existence of the EKC model in the African context.

H_{01}: Economic Performance does not have a significant effect on Environmental Degradation.

Foreign Direct Investment and Environmental Degradation Nexus

There are two strands of arguments pertaining to how FDI as a form of foreign finance affecting the environmental quality of the host economy. It is considered to have positive effects on the host country's economy on one side (Shahbaz *et al.,* 2018). However, some other studies contend that although FDI can boost the host nation's economic growth and, however, it may create externalities that are detrimental to the environment (Abdouli and Omri, 2021).

Foreign finance through various capital inflows is essential to assist developing economies in financing clean energy projects (Paramati *et al.,* 2017). This position is based on external factors such as transferring technology, economic knowledge, and capital flow that lead to the reduction of environmental degradation through effective control of CO_2 emissions. The studies focusing on Gulf Cooperating Council and five ASEAN countries revealed that economic growth and energy consumption are the two critical sources of pollution emission, whereas FDI flows have no role in pollution emission (Abdouli and Omri, 2021). Behera and Dash (2017) employed the dynamic ordinary least squares (DOLS) and the fully modified ordinary least squares (FMOLS) estimators to examine the relationship between FDI and environmental quality and revealed that FDI has a positive effect on environment quality. Also, Koçak and Şarkgüneşi (2018) used the structural break co-integration test and the OLS estimator to investigate the potential impact of FDI on carbon emissions in Turkey over the period from 1974 to 2013. The results showed that there is an existence of a long-term balanced relationship among FDI, GDP, energy use, and carbon emissions. The study also revealed that FDI has a potential impact on carbon emissions. They also found that the impact of FDI on carbon emissions is positive with a two-way relationship.

Sarkodie and Strezov (2019) examined the impact of foreign direct investment (FDI) inflows, economic growth and energy consumption on carbon emissions from 1982 to 2016 considering China, India, Iran, Indonesia and South Africa as the leading carbon emitters in the emerging economies. The study discovered that the impact of energy use on carbon dioxide emissions is significantly positive. Their final findings reported that FDI inflows can boost eco-technological transfer, upgrading in labor, and eco-friendly management in emerging economies.

Kivyiro and Arminen (2014) revealed that in Sub-Sahara Africa, FDI, economic development, CO_2 emissions, and energy consumption move in the same direction in the long-run. Omri *et al.* (2020) also find bi-directional causality between economic growth and FDI flows and CO_2 emissions and FDI, showing that FDI may exert adverse effect on the host economy. Fan and Hao (2020) analyzed foreign investment demand for energy and a clean environment and found a positive relationship between these factors, which promotes consumer energy and stimulates production in a country. In another study by Grabara *et al.* (2021), there was evidence that FDI increases CO_2 emissions.

In Kuwait, Salahuddin *et al.* (2018) analyzed the relationship between electricity use, financial development, economic growth, and FDI and CO_2 emissions over 1980 to 2013. The study used co-integration and ARDL estimators and VECM Granger causality and indicated that in both long-run and short-run, CO_2 emissions increases because of electricity use, economic growth and FDI.

Behera and Dash (2017) explored the interrelationship between urbanization, energy usage, foreign direct investment (FDI), and carbon emissions of 17 countries in the South and Southeast Asia (SSEA) region over the period of 1980-2012. The study used Pedroni co-integration and found that fossil fuel, energy consumption, and FDI significantly affect carbon emission in the SSEA province. Similarly, Sung *et al.* (2018) investigated how FDI affects the level of carbon emissions in China. The study used panel data for 2002-2015, considering 28 industrial sectors in China. Based on the findings, the study reported that FDI is a positive prognosticator of environmental quality in China. This proves that FDI reduces the intensities of carbon emissions. Huang *et al.* (2022) asserted that foreign capital inflows raise the level of CO_2 emissions (CE) which exhibits a straight link between FDI and CE. But economic development and regulatory quality avert this positive link into negative. Therefore, the effect of FDI inflows on the host country's environmental quality has always been one of the most controversial issues to date and there is little attention in the African context. The debate on the likely effect of FDI on environmental degradation is inconclusive. As such, this study proposes to test the null hypothesis based on the discussion above:

H_{02}: FDI does not have a significant effect on environmental degradation in Africa.

METHODOLOGY

Sample and Procedure

This empirical study examined the impact of foreign finance and economic performance on environmental degradation in some selected African countries based on the size of the economies. To attain this objective, the study deployed panel data techniques. The panel dataset contained the 15 countries drawn from the five sub-regions of the African continent. In central Africa, the Democratic Republic of Congo, Rwanda, and Cameroon were selected from the East African sub-region. Kenya, Ethiopia, and 6Uganda were chosen for the study while North Africa was represented by Egypt, Algeria, and Morocco. Similarly, South Africa, Angola and Zambia were chosen while the West Africa Sub-region was represented by Nigeria, Ivory Coast, and Ghana. The choice of these countries for this study was because they possess the largest economies in their respective sub-region from the perspective of their GDP and FDI size in the last two decades. The study investigated these economies for the period of 31 years between 1990 and 2020. Thus, the study employed panel data involving the 15 cross-sectional units (countries) for the period of 31 years. Following previous studies, the panel datasets include data on carbon emission a proxy for environmental quality (Behera and Dash, 2017), net FDI (Alshubiri and Elheddad, 2019; Blanco *et al.,* 2013; Lau *et al.*, 2014), net foreign assets (Shahbaz *et al.*, 2018), real GDP per capita, energy consumption and trade openness (Alshubiri and Elheddad, 2019). The measurement and definition of the variables are presented in Table 1. The panel datasets were obtained from the World Development Indicators (WDI).

Data Analysis Techniques

The panel data analysis stages include preliminary analysis, estimation and post estimation tests. The preliminary analysis involves descriptive analysis and pre-estimation tests (such panel unit root tests and panel co-integration test). The post-estimation tests include a cross-sectional dependence (CD) test and a normality test. The pre-estimation tests include a Panel unit root test and a panel co-integration test. The Panel unit root

Variables	Definition	Sources
CO_2	CO_2 Emission (metric tons per capita)	World Development Indicator (2020)
FDI	FDI, net inflows (constant US$)	World Development Indicator (2020)
NFA	Net foreign assets (constant US$)	World Development Indicator (2020)
RGDP	Real Gross Domestic Product per capita at 2010 constant basic prices	World Development Indicator (2020)
ENG	Energy consumption per capita measured in kg of oil equivalent per capita	World Development Indicator (2020)
TOP	Trade openness (the sum of export and import as a % of Gross Domestic Product GDP)	World Development Indicator (2020)

Source: Authors' presentation

Table 1. Description of Variables and Sources

test was conducted to determine the stationarity of the variables using (Levin *et al.*, 2002), ADF-Fisher Chi-square and Im, Pesaran and Shin. While panel co-integration test was conducted to examine the long-run relationship among the variables using Kao residual co-integration test. Based on the results of the pre-estimation tests, the study employed PMG (Pooled Mean Group) estimator of the dynamic heterogeneous panel (panel ARDL). The PMG estimator assumes homogeneity among the long-run coefficients while the short-run coefficients are assumed to be heterogeneous. Meanwhile, it is empirically essential to conduct a cross-sectional dependence test. It is likely that a considerable amount of cross-sectional dependence may be present in the disturbance terms. The foregoing may be attributed to the fact that the unobserved common shocks among the selected countries may be captured in the error term. Apparently, the unobserved common shocks may arise because of the probable interdependencies among the selected African countries because of global economic interactions (Opoku *et al.*, 2019).

Model Specification

The model is based on the Grossman and Krueger's (1995) environmental Kuznets curve (EKC) model adapted from recent studies (Doytch and Uctum, 2016; Alshubiri and Elheddad, 2019). Thus, the model is specified in the form of panel regression equation in which carbon emission is expressed as a function of net FDI, net foreign assets, real GDP per capita, energy consumption and trade openness. The panel equation is implicitly expressed as follows:

$$CO2_{it} \ = \ f(FDI_{it}, NFA_{it}, GDPC_{it}, ENG_{it}, TOP_{it}) \qquad (1)$$

Where: CO_2 = carbon emission, *FDI* = foreign direct investment, *NFA* = net foreign asset, *GDPC* = GDP per capita, *ENG* = energy usage, *TOP* = trade openness.

The panel ARDL $(p, q_2, q_2, q_3, q_4, q_5)$ model is specified as follows:

$$\Delta CO2_{it} = \gamma + \sum_{j=1}^{p} \alpha_j \, \Delta CO2_{i,t-j} + \sum_{j=0}^{q_1} \beta_{4j} \, \Delta FDI_{it-j} + \sum_{j=0}^{q_2} \beta_{4j} \, \Delta NFA_{it-j} + \sum_{j=0}^{q_3} \beta_{3j} \, \Delta GDPC_{it-j} + \sum_{j=0}^{q_4} \beta_{4j} \, \Delta ENG_{it-j} + \sum_{j=0}^{q_5} \beta_{4j} \, \Delta TOP_{it-j} + \lambda CO2_{it-1} + \delta_1 FDI_{it-1} + \delta_2 NFA_{it-1} + \delta_3 GDPC_{it-1} + \delta_4 ENG_{it-1} + \delta_5 TOP_{it-1} + \mu_i + \varepsilon_{it} \qquad (2)$$

Where *p*, q_1, q_2,q_3, q_4 and q_5 are the respective maximum lags of the dependent variable (CO_2) and the explanatory variables (*FDI*, *NFA*, *GDPC*, *ENG* and *TOP*) while α_j, β_{1j}, β_{3j},β_{1j},β_{4j} and β_{5j} are the coefficients associated with the dependent variable and the explanatory variables at the various lags. Furthermore, μ_i is the country-specific effect and ε_{it} is the error term

Following equation (2), the panel ARDL Error Correction Model (ECM) specification is given as follows:

$$\Delta CO2_{it} = \gamma + \sum_{j=1}^{p} \alpha_j \, \Delta CO2_{t-j} + \sum_{j=1}^{q_1} \beta_{1j} \, \Delta FDI_{it-j} + \sum_{j=1}^{q_2} \beta_{2j} \, \Delta NFA_{it-j} + \sum_{j=1}^{q_3} \beta_{3j} \, \Delta GDPC_{it-j} + \sum_{j=1}^{q_4} \beta_{4j} \, \Delta ENG_{it-j} + \sum_{j=1}^{q_5} \beta_{5j} \, \Delta TOP_{it-j} + \theta ECT_{it-j} + \mu_i + \epsilon_{it} \quad (3)$$

Equation (3) states the ECM form of the panel ARDL model, which closes the gap between the disequilibrium and equilibrium in the long-run and long-run, respectively. The coefficient (θ) of the error correction term (ECT) term called the speed of adjustment is expected to be negative to restore the model to equilibrium, *i.e.*$\theta < 0$.

Following equation (2), the long-run form model is expressed as follows:

$$CO2_{it} = \varphi_0 + \varphi_1 FDI_{it} + \varphi_2 NFA_{it} + \varphi_3 GDPC_{it} + \varphi_4 ENG_{it} + \varphi_5 TOP_{it} \quad (4)$$

Thus, the long-run coefficients in relation to equation (2) are defined as follows:

$$\varphi_1 = \frac{-\delta_1}{\lambda}, \varphi_2 = \frac{-\delta_2}{\lambda}, \varphi_3 = \frac{-\delta_3}{\lambda}, \varphi_4 = \frac{-\delta_4}{\lambda}, \varphi_5 = \frac{-\delta_5}{\lambda} \quad (5)$$

From equations (5), the parameters φ_1, φ_2, φ_3, φ_4 and φ_5 are the long-run impacts of *FDI*, *NFA*, *GDPC*, *ENG* and *TOP,* respectively, on CO_2.

RESULTS

Descriptive Statistics

This sub-section provides the summary statistics of the variables being examined, such as carbon emission (CO_2), net foreign direct investment (*FDI*), net foreign assets (*NFA*), real GDP per capita (*GDPC*), energy usage (*ENG*), and trade openness (*TOP*).

Table 2 (see Appendix-I) presents the summary statistics of the variables being examined. The series such as energy consumption (*ENG*) and trade openness (*TOP*) have their standard deviations below their averages. This suggests that the values of the variables appear to have a moderate amount of spread around their respective mean values. Thus, the aforesaid variables are likely to have strong predictive performance across the selected cross-sectional units (countries). However, emission (CO_2), net foreign direct investment (*FDI*), net foreign assets (*NFA*), and real GDP per capita (*GDPC*) series have standard deviations above their respective mean values, thus, showing that the panel series appear to have wider spread around its mean value. Thus, aforesaid variables are likely to have weak forecasting power across the cross-sectional units. Meanwhile, the Jarque-Bera statistics revealed that all the series were not normally distributed having significant test statistics. This preliminary finding necessitated the need for further statistical analysis to ascertain the stationarity of the series. Such tests included the Levin, Lin & Chu t test, the Im, Pesaran and Shin W-stat, and the ADF panel unit root test.

Panel Unit Root Tests

Table 3 (see Appendix-II) reports the result of the panel unit tests using *Levin, Lin and Chu t*, *Im, Pesaran, and Shin W-stat*, and ADF-Fisher Chi-square criteria. The aforementioned three test methods were considered in ascertaining the consistency in the stationarity status of the variables. As revealed in the Table 3, all the variables being investigated are integrated of order one, which implies they are *I(1)* processes. Thus, the panel root test results justify the use of the PMG estimator (pooled mean group) for the panel data estimation.

Panel Co-integration Test

The Table 4 (see Appendix-III) presents the results of co-integration test using Kao residual test method. As shown in the Table, the ADF statistic (-3.7184) is statistically significant, having its *p*-value of less than 5 percent (0.05). This implies the existence of co-integration or long-run relationship among the panel series being investigated such as CO_2, *FDI*, *NFA*, *GDPC*, *ENG,* and *TOP*. The significant result of the co-integration test also shows the non-existence of a spurious relationship between the dependent and explanatory variables.

Model Estimation

Using the pooled mean group (PMG) estimator, the estimation provides results for both short-run and long-run estimates. The variables such as were CO_2, *GDPC*, *ENG* and *TOP* expressed in natural log forms for the estimation, while *FDI* and *NFA* were used in their original forms since they include negative observations.

Short-Run Estimation Results

Table 5 (see Appendix-IV) reports the result of the PMG short-run form. The coefficient (-0.2221) of the error correction term (ECT_{t-1}) which is the speed of adjustment is negative and statistically significant (since the *p*-value is less than 1 percent). This suggests that the share of CO_2 emission adjusts to *FDI*, *NFA*, *GDPC*, *ENG* and *TOP* at the speed of about 22.21 percent from the short-run disequilibrium to the equilibrium in the long-run. Thus, about 22.21 percent of the disequilibrium in the previous periods has fallen back to equilibrium in the current period. Meanwhile, *FDI*, *ENG,* and *TOP* appear to have statistically significant impact on carbon emission (CO_2) while *NFA* and *GDPC* exert an insignificant impact on carbon emission in the short-run across the selected African countries.

Long-Run Estimation Results

Table 6 (see Appendix-V) presents the result of the long-run estimates of the panel ARDL using the PMG. Energy consumption (*ENG*) exerts a positive and significant effect on carbon omission (CO_2) in the long-run with a partial elasticity coefficient of 0.6443. Thus, a 1 percent rise (fall) in *ENG* will, on average, amount to about 0.644 percent rise (fall) in CO_2. However, net foreign asset (*NFA*) and GDP per capita (*GDPC*) appear to have respectively positive and negative but insignificant effects on CO_2 emission for the panel data dimensions. Nevertheless, a unit rise (fall) in *NFA*, will on average, result in a rise (fall) in CO_2 emission by about 0.000033 percent (that is, $-3.28 \times 10^{-6} \times 100$ in case of log-lin model) while a 1 percent rise (fall) in *GDPC*, will on average, amount to about 0.202 percent fall (rise) in CO_2. Therefore, CO_2 emission appears to be inelastic regarding *GDPC*, *ENG* and *TOP.* In essence, hypothesis 1 (H_{01}) is rejected and the research question one is answered.

On the other hand, the estimated long-run equation reveals that net foreign direct investment (*FDI*) and trade openness (*TOP*) exerts negative and statistically significant impact on carbon omission (CO_2) having partial regression coefficients of -1.46×10^{-5} and -0.2180. Numerically, a unit($1million) rise (fall) in *FDI*, will on average, result in a fall (rise) in CO_2 by about 0.00015 percent (that is, $-1.46 \times 10^{-5} \times 100$ in case of log-lin model) while a 1 percent rise (fall) in *TOP*, will on average, amount to about 0.218 percent fall (rise) in CO_2. This implies that hypothesis 2 (H_{02}) is rejected and the answer to research question two is provided. *FDI* and *TOP* seem to be catalysts for the mitigation of environmental degradation. On the contrary, energy consumption appears to be a worsening factor in environmental degradation.

Global Test of Significance

Overall test of significance was conducted to examine whether the explanatory variables (*FDI*, *NFA*, *GDPC*, *ENG* and *TOP*) were jointly significant in influencing the response variable (CO_2) using the Wald test.

$$\boldsymbol{H_0}: \varphi_1 = \varphi_2 = \varphi_3 = 0$$
$$\boldsymbol{H_1}: Not\ all\ \alpha's\ are\ simultaneously\ equal\ to\ zero$$

Table 7 (see Appendix-VI) presents the Wald test result. Both the *f*-statistic and the Chi-Square statistic suggest that the explanatory variables (*FDI*, *NFA*, *GDPC*, *ENG* and *TOP*) have joint significant influence on the response variable (CO_2) having their corresponding *p*-values less than 5 percent. Thus, the null hypothesis is rejected.

Post Estimation Tests

The post estimation tests include a cross-sectional dependence test and normality test. Table 8 (see Appendix-VII) presents the results of the serial cross-sectional dependence test and normality test. For the cross-sectional dependence test, the null of "no cross-sectional dependence" cannot be rejected since the *p*-values of the selected test statistics (such as Pearson LM Normal, Pearson CD Normal, and Friedman Chi-square) are insignificant. This suggests that the residuals are cross-sectionally independent, which implies that the estimated model does not suffer cross-sectional serial correlation. Similarly, the normality test result reveals that the residuals of the estimated panel model are normally distributed, having statistically insignificant Jarque-Bera statistic.

DISCUSSION

For estimating the effect of economic performance on environmental degradation, this study deployed the Pooled Mean Group (PMG) and the Panel Autoregressive Distributed Lag (Panel ARDL) estimators to examine the short-run and long-run effects. In the short-run, economic performance exerts a positive and significant impact on the environmental quality of the 15 African countries interrogated in this study. However, in the long-run, economic performance exerts a negative impact on their environment. The short-run and the long-run results, which revealed positive and negative relationship as depicted in Tables 4 and 5 confirm the existence of an inverted U-shaped relationship between economic growth and environmental degradation. This result validates the existence of the environmental Kuznets curve (EKC) hypothesis within the context of the 15 African countries considered for this study and rejects the study's hypothesis one which states that economic performance does not have a significant impact on environmental degradation. From Table 4 it can be seen that in the short-run, the level of environmental degradation increased remarkably when economic performance increased. However, the long-run result in Table 5 shows that the level of environmental degradation reduced as the economy continued to improve overtime. This is consistent with the postulation of Grossman and Krueger's (1995) EKC theory, which posits that environmental degradation increases with economic growth and environmental quality improves after a certain level of income. The result is also consistent with the empirical findings of Akbostanci *et al.* (2009), Salahuddin and Gow (2014), and Hao and Liu (2015).

For estimating the impact of FDI on the level of environmental degradation in countries selected for this study, the coefficient (-0.2221) of the error correction term (ECT_{t-1}) which is the speed of adjustment is negative and statistically significant (since the *p*-value is less than 1 %). This suggests that CO_2 emission adjusts to FDI at the speed of about 22.21 percent from the short-run disequilibrium to the equilibrium in the long-run. Thus, about 22.21 percent of the disequilibrium in the previous periods has fallen back to equilibrium in the current period. This implies that FDI has a negative and statistically significant impact on the level of environmental degradation (CO_2 emission) across the countries selected for this investigation. This result indicates the rejection of hypothesis two which states that FDI does not have a significant impact on environmental degradation. The result is consistent with the findings of (Abdouli and Omri, 2021; Paramati *et al.*, 2017; Sung *et al.*, 2018; Wu *et al.*, 2018).

Part of the contribution of this present study is to model the environmental consequences of foreign finance and economic growth using panel data of selected 15 countries from the five sub regional blocs of the African continent by applying Pooled Mean Group (PMG) and the Panel Autoregressive Distributed Lag (Panel ARDL) estimators. The study revealed that economic performance was negatively and positively related to environmental degradation in the short-run and long-run, respectively. This confirms the existence of an inverted U-shaped relationship between economic performance and environmental degradation and also validates the existence of the environmental Kuznets curve (EKC) hypothesis among the selected countries.

Moreover, foreign finance was inversely related to environmental degradation, which implies that poor environmental quality cannot be directly linked to foreign capital inflows among the investigated countries.

CONCLUSION

This study examined the impact of economic performance and foreign finance on environmental degradation in a view to ascertain the existence of the EKC as empirical evidence among 15 selected African countries. The panel dataset contained the 15 largest economies selected from the five regions of the African continent from 1990 to 2020 and ensured 31 observations for each country. To simultaneously guarantee heterogeneity among the long-run and short-run coefficients the study employed PMG (Pooled Mean Group) estimator of the dynamic heterogeneous panel (panel ARDL) as its analytical technique.

The empirical results revealed two interesting outcomes: first, the short-run demonstrates that economic performance exerts a positive and significant impact on environmental degradation, which implies that economic growth has an adverse impact on the environmental quality due to weak regulations. At that stage of economic growth, domestic and foreign firms engage in operations designed to save environmental cost, which confirms the existence of Pollution Haven hypothesis among the countries (Blanco *et al.*, 2013). However, in the long-run, economic performance exerts a negative impact on their environment, which indicates an improvement in the environmental quality. Therefore, both short-run and the long-run results as depicted in the Tables 4 and 5 confirm the existence of an inverted U-shaped relationship between economic performance and environmental degradation which also validates the existence of the environmental Kuznets curve (EKC) theory within the context of the 15 African countries considered for this study. The second result indicates that foreign finance is inversely related to environmental degradation. This indicates that the menace of environmental degradation cannot be directly linked with the inflow of foreign finance among the 15 African countries interrogated in this study. Although some previous studies affirmed that environmental degradation in Africa are not linked to foreign finance inflows (Ojewumi and Akinlo 2017) thereby confirming the existence of the Pollution Haven Hypothesis in the region. However, current study posits that environmental degradation in the continent is largely a function of other socio-economic factors rather than FDI inflows. The bulk of FDI to the continent are portfolio investments channeled into the financial sector rather than the industrial sector.

IMPLICATIONS

This current study provides important policy implications which suggest that the government of the various African countries selected for the investigation should continue to provide incentives to foreign investors to attract more FDI into the critical sector of their respective economies as the menace of environmental degradation is not directly linked to the inflows of foreign finance in this current study. Although FDI was not directly linked to environmental degradation in the selected countries, however, the socio-economic factors such as population growth, urbanization, industrialization, and intensification of agricultural activities which are responsible for environmental degradation must be addressed decisively. However, it was asserted that environmental degradation and economic performance unveiled an upturned U-shaped curve, identified as the environmental Kuznets curve (EKC) (Grossman and Krueger 1995; Mikayilov *et al.*, 2018).

The EKC model has its theoretical and practical implications as it posits that when a nation is experiencing economic growth, a rising trend in emissions is observed but as the journey of growth continues, pollution and emissions start decreasing, making the environment better off eventually (Mikayilov *et al.*, 2018; Iheanachor *et al.*, 2023). Therefore, the various national governments must embrace environmental friendly technology in the industrial sector of their respective countries.

LIMITATIONS AND FUTURE DIRECTIONS

This study has a few limitations. First, the various forms of foreign finance were not comprehensively examined, as the study simply focused on foreign direct investment as a form of foreign finance. Second, the study sample is limited to the African countries, which does not allow for generalization of the findings to rest of the world.

The limitations found in this study could serve as a direction for future research. Therefore, future research endeavor may consider the mediating role of institutions in determining the relationship between foreign finance (FDI inflows, Diaspora workers' remittances, foreign assets and foreign aids) and economic growth on environmental quality. This study also recommends that future research is required to consider political and social variables that can add value to foreign investment and economic performance and impact the environment situation.

In addition, future research in this space can be designed to consider varieties of variables to examine its association with CO_2 emissions and also different proxies for environmental degradation. Such studies can also assess the multiple structural breaks connected with the data set. Furthermore, a more sophisticated econometric technique can be applied by researchers to establish a more reliable understanding of the EKC hypothesis in different regions of the world. As such, the researchers are expected to concentrate on this methodological context such as quantile ARDL, to understand the form of EKC with different quantiles of income and decomposition analysis, to examine the linkages between the environment, economic performance, and foreign finance. Future research also possibly taking either regional level or sectoral level or longer periods depends on the availability of the data.

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Appendix-I

	Variables					
Statistics	**CO_2**	**FDI**	**NFA**	**GDPC**	**ENG**	**TOP**
Mean	1.1457	1194.273	1576.680	354663.3	772.930	54.5764
Median	0.376	493.000	161.2555	118888.1	509.961	50.4061
Maximum	8.569	11578.10	16006.21	2773611.	3129.067	152.547
Minimum	0.016	-7397.295	-530.3182	2358.725	250.245	19.684
Std. Dev.	1.8563	2110.266	3198.456	549902.3	661.8109	22.555
Skewness	2.5623	1.6503	2.5370	2.4028	2.1338	1.5751
Kurtosis	9.0086	9.2219	9.0015	9.0530	6.3539	6.3880
Jarque-Bera	1208.314	961.1070	1196.650	1157.335	570.8087	414.6707
***p*-value**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Obs.	465	465	465	465	465	465

Source: Authors' computation using E-Views

Table 2. Summary Statistics Panel Data Dimensions: 1990 – 2020

Appendix-II

Variable	Statistics					I(d)
		Level	*p*-values	Δ	*p*-values	
CO_2	Levin, Lin & Chu t	-1.9275	0.1768	-9.7805	0.0000	*I(1)*
	Im, Pesaran & Shin W-stat	1.1380	0.8724	-11.2749	0.0000	
	ADF	27.0049	0.8724	176.264	0.0000	
FDI	Levin, Lin & Chu t	-2.0334	0.0210	-5.1409	0.0000	*I(1)*
	Im, Pesaran & Shin W-stat	-0.8752	0.1907	181.009	0.0000	
	ADF	35.8485	0.2131	365.342	0.0000	
NFA	Levin, Lin & Chu t	7.1664	1.0000	-1.3648	0.0862	*I(1)*
	Im, Pesaran & Shin W-stat	10.2413	1.0000	-6.1714	0.0000	
	ADF	6.4186	1.0000	120.809	0.0000	
GDPC	Levin, Lin & Chu t	-1.3358	0.0908	-3.8891	0.0001	*I(1)*
	Im, Pesaran & Shin W-stat	15.0614	0.9919	-5.6171	0.0000	
	ADF	12.3196	0.9894	90.5919	0.0000	
ENG	Levin, Lin & Chu t	0.9076	0.8179	-7.7049	0.0000	*I(1)*
	Im, Pesaran & Shin W-stat	3.6495	0.9997	-9.9604	0.0000	
	ADF	11.6808	0.9989	154.065	0.0000	
TOP	Levin, Lin & Chu t	-1.5211	0.0982	-10.5274	0.0000	*I(1)*
	Im, Pesaran & Shin W-stat	-1.2920	0.2644	-12.5274	0.0000	
	ADF	41.9941	0.0717	198.517	0.0000	

Source: Authors' computation using E-Views

Table 3. Panel Unit Root Test Results Panel Data Dimensions: 1990 – 2020

Appendix-III

	t-Statistic	Prob.
ADF	-3.7184	0.0001
Residual variance	0.0106	
HAC variance	0.0105	

Source: Author' computation using E-Views

Table 4. Co-integration Test Result Panel Data Dimensions: 1990 – 2020

Appendix-IV

Variable	Coefficient	Std. Error	*t*-stat.	*p-value*
ECT_{t-1}	-0.2221	0.0539	-4.1214	0.0000
ΔFDI	-3.04E-05	1.40E-05	-2.1782	0.0301
ΔNFA	2.12E-05	0.00012	0.1677	0.8669
$\Delta GDPC$	0.3285	0.2701	1.2162	0.2247
ΔENG	2.6365	1.5824	1.6661	0.0966
ΔTOP	-0.0563	0.0328	-1.7149	0.0873
C	-0.7883	0.2021	-3.9004	0.0001
T	0.0034	0.0021	1.6654	0.0968

Source: Authors' computation using E-Views
Dependent Variable: CO_2

Table 5. Estimated Panel ARDL Short-Run Result Panel Data Dimensions: 1990 – 2020

Appendix-V

Variable	Coefficient	Std. Error	*t*-stat.	*p*-value
FDI	-1.46E-05	6.96E-06	-2.0992	0.0365
NFA	3.28E-06	3.09E-06	1.0628	0.2886
GDPC	-0.2024	0.1390	-1.4561	0.1463
ENG	0.6443	0.1180	5.4599	0.0000
TOP	-0.2180	0.0681	-3.2006	0.0015

Source: Authors' computation using E-Views
Dependent Variable: CO_2

Table 6. Estimated ARDL Long-Run Coefficients Panel Data Dimensions: 1990 – 2020

Appendix-VII

Test Statistic	Value	*p*-value
f-stat.	21.3218	0.0000
Chi-square	106.609	0.0000

Source: Authors' computation using E-Views

Table 7. Result of Wald Test

Appendix-VII

Cross-sectional Dependence Test:		*p*-value
Pearson LM Normal	1.5974	0.1102
Pearson CD Normal	-0.5529	0.5803
Friedman Chi-square	24.0209	0.7711
Normality Test:		***p*-value**
Jarque-Bera	1.1058	0.5027

Source: Authors' computation using E-Views

Table 8. Post Estimation Test Results